LAND POLICY REFORM AND LAND RENTAL MARKETS IN ETHIOPIA:
Equity, Productivity and Welfare Implications

LAND REFORMER OG JORDLEIE i ETIOPIA:
Implikasjoner for Likhet, Productivitet og Velferd

PHILOSOPHIAE DOCTOR (PHD) THESIS
DOCTOR OF PHILOSOPHY (PHD) THESIS

Hosaena H. Ghebru

DEPARTMENT OF ECONOMICS AND RESOURCE MANAGEMENT
NORWEGIAN UNIVERSITY OF LIFE SCIENCES

Ås 2010

Thesis number: 2010:24

ISSN No.: 1503-1667

ISBN No.: 978-82-575-0934-7

Acknowledgment

It is a pleasure to thank those individuals and institutions who made this dissertation possible.

I am highly grateful to Professor Stein T. Holden, my doctoral supervisor, not only for his constant guidance, encouragement and supervision during the field surveys and while writing this dissertation but also for the understandings and close collaborative works we have accomplished together for the last several years. It was you who encouraged and facilitated the successful application of the PhD study proposal back in 2004 while I was mourning my late father. I remain grateful for all the encouragements and professional guidance. Many thanks also go to Prof. Gerald Shively for his critical comments and constructive suggestions that made greater contribution to the scientific quality of the last paper of the thesis.

NORAD, Norwegian Research Council and the World Bank are gratefully acknowledged for their financial support to conduct the fieldworks in Ethiopia. I would also like to extend my gratitude to the Norwegian loan fund (lånekassen) and the Norwegian tax payers for funding my stay in Norway. I am also indebted to Mekelle University, my home institution, for granting my leave of absence and the administrative and logistic support I received during the field surveys. I am also grateful to all members of the 2002/03 and 2005/06 NORAD fellows' joint fieldwork conducted in Tigray, Ethiopia. It has been a pleasure and inspiring to work with individuals of diverse nationalities. I also thank all the administrations of 11 district, chairpersons of the 16 surveyed villages and all the sample respondents. Without their cooperation, it would not have been possible to collect the huge data set within short period of time.

Doing research at the Development Economics group of the IØR at the Norwegian University of Life Sciences has been a pleasure and Unforgettable experience. I would like to thank Arild Angelsen, Ragnar Øygard, and Mette Wik for creating such a nice and pleasant working environment. I am grateful to all my previous and current colleagues Gebrehaweria, Getaw, Sosina, Therese, Jetendra, Daniel, Rodney, Herbert, Tatewangire, Fitsum, Menale, to mention few. Thank you for all the intellectual discussions we had during the Friday lunch seminars and other social events. I thank Stig Danielsen and Reidun Ascheim for their unreserved logistic and administrative support at the department.

I reserve my most special gratitude to my dearest wife and friend Tsega Zenebe. You witnessed and shared all the frustrations and joys in the process of writing this dissertation. During the final year of writing-up this thesis, your words of encouragement, love and responsible act were very touching and inspiring – i cannot put a price on it! I am also indebted to our gorgeous daughter *Delina* for her unconditional love and refreshing smiles.

Special thanks goes to my late father *Memhir* Ghebru Hagos who has invested in me and has given me the chance to be where I am now but did not live long to witness the outcome. I dearly miss him and dedicate this dissertation to him. I'd also like to thank my mum, *Memhirt* Leteberhan Mulaw, for her unreserved love, endless moral support and prayers. Finally, the acknowledgements would not be complete without a heartfelt thanks to members of my family, family in-law and friends who stood by me and believed in me.

Hosaena H. Ghebru
April 2010
Ås, Norway

Table of Content

Introduction

LAND POLICY REFORM AND LAND RENTAL MARKETS IN ETHIOPIA: Equity, Productivity and Welfare Implications

1. INTRODUCTION

The land holding system in most developing countries is not purely an economic affair. It is very much intertwined with people's culture and identity. That is partly why land-related issues usually generate intense emotional reactions particularly in rural areas. Obviously, for rural residents of most developing countries, land is a primary means of production used to generate a livelihood for households. It is also an important asset that farmers use to further accumulate wealth when possible and, equally importantly, what they transfer in the form of wealth to future generations (Deininger and Binswanger 1999). Accordingly, the size of the land they own, the feeling of security that they have on their holdings, and the process through which land disputes are adjudicated all affect the households' income, their incentive to work and invest, their desire to use their land in a sustainable manner, and even their social and economic status in their respective communities. In predominantly agrarian societies, all these factors combine to affect agricultural output and productivity and, along with it, the socio-economic welfare of its citizens.

As agricultural productivity and growth in Africa has been low or even declining, in some countries there is a renewed interest in understanding factors that promote or inhibit agricultural investment, including land tenure security and land markets (Holden et al. 2008). Moreover, how to improve the poor's access to land is becoming a critical issue in the face of growing scarcity of land relative to the rural population, especially after the recent wave of large-scale global land grabs (Cotula et al. 2009; FAO 2009).

Like most agrarian communities, land is one of the most important assets and a major conventional input in Ethiopia. The farming sector hardly produces enough food for the peasant household, which is highly ascribed to the tardy progress in farming methods and extensive and severe problem of land degradation. This is particularly so in the highlands above 1500 meters above sea level, which account for about 40 percent of the total land area but are home for 90 percent of the total population and 70 percent of livestock in the country. The population continues to grow rapidly in these highlands and exert pressure on agricultural land availability, particularly arable land for cultivation and pasture. Despite years of foreign development assistance and food aid, the country still struggles to address the root cause of food insecurity and poverty.

Historical and empirical evidences suggest that the land tenure system in the country (lack of adequate access to land, tenure insecurity, diminution of farm holdings, etc) has been among the major reasons for food insecurity and rural poverty in the country (Hoben 2000; Holden and Yohannes 2002). This calls up on the need for having land policies and a system of land administration that supports secure property rights, broadens access to land and supports incentives for improved land use management. It is with the desire to reap such benefits that the current Government of Ethiopia, through the Ministry of Agriculture and Rural Development (MOARD), has embarked on a national land certification program in the country (Deininger et al. 2008; Holden et al. in press).

Prior to 1975, Ethiopia's land tenure system was diverse and complex with absentee landlordism in the south and a more communal *rist* system dominating the north. Tenure was highly

insecure, arbitrary evictions were common, and many lands underutilized. High inequality of land ownership reduced productivity and investment, leading to political grievances and eventually the downfall of the imperial regimen in 1975. The communist regime that took power transferred ownership of all rural land to the state property and user rights to land were distributed to households based on needs (household size). Further land redistributions to accommodate new households and adjust land sizes to changes in household sizes has lead to declines in tenure security and soil degradation (Rahmato 1984; Holden and Yohannes 2002).

The change in government in 1991 implied a shift towards a more market-friendly policy regime. Although land remained state property, short-term land renting and hiring of labour were allowed. The 1995 constitution (FDRE 1995) vests land ownership in the state and upholds the right of every Ethiopian who wants to engage in agriculture to receive inheritable use rights to a piece of land for free. The 1997 devolution of power and responsibility of land policy to regional governments (FDRE 1997) and the endorsement and implementation of a national land certification program were widely considered as a real sign of intent by the government and important step in efforts aimed at market development, sustainable natural resource management, enhancing agricultural productivity, and economic growth. Although such enactment has led to inter-regional diversities, three major issues are common across regions, namely (1) a halt in large-scale administrative land redistribution; (2) allowing the operation of land rental markets; and (3) mortgaging and sale of land are universally prohibited.

The halt in administrative land redistribution has left the market-based tenure arrangements (share/cash rentals) to be the main source of access to land providing farmers with accompanying opportunities, incentives and risks that will have an influence on their land use and management

decisions. How much these decisions influence the efficacy of the land tenancy market can be assessed in terms of the effects on: (i) access and distribution of land – equity implications; (ii) input use intensity – technical efficiency; (iii) land-related investment – technological change; and (iv) land-related disputes and conflicts. These intermediary outcomes of the land rental market ultimately influence the livelihood strategy and welfare of rural farm households.

Thematically, as visually represented in figure 2, the focus of this dissertation is articulated towards a critical assessment of the equity, productivity and welfare implication of the land tenancy market and examines to what extent the recent land policy reform (land registration and certification, in particular) in the country has affected agricultural productivity. In order to generate a solid understanding of these issues, the set of separate studies in this dissertation strive to answer the following main research questions:

1. What factors determine participation of households in the land rental market and how efficient is the market in terms of satisfying the growing demand for land? (PAPER 1)

2. How does the land rental market affect the welfare of poor and vulnerable groups? Are the poor rationed-out? To what extent does this market act as a buffer to prevent households liquidating assets? (PAPER 2)

3. What are the technical efficiency implications of participation in land rental markets?

   (PAPER 3)

4. What are the long-term investment and overall land productivity growth consequences of the land registration and certification program? (PAPER 4)

5. What is the magnitude of efficiency (input use intensity) and productivity (technology adoption) effects of the existing land policy (land certification) in the country? (PAPER 5)

2. Land Tenure System in Ethiopia

2.1. The Evolution of Land Tenure Policy in Ethiopia

Preceding the radical land reform of the 1975, which was the major turning point in shaping the evolving tenure systems today, Ethiopia had a diverse and complex land tenure system. The existence of so many land tenure systems, coupled with the lack of reliable data, has made it difficult to give a comprehensive assessment of landownership in Ethiopia. However, the tenure system can be understood in a rudimentary way if one examines it in the context of the basic distinction between land tenure patterns in the north and those in the south (Rahmato 1984; Adal 2002).

In the northern regions – including Tigray - the major form of ownership was a type of communal tenure system commonly known as *rist*. According to this system, all descendants (both male and female) of an individual founder were entitled to a share, and individuals had the right to use (a usufruct right) a plot of family land. Holding *rist* rights was conditional on paying taxes and meeting service obligations. *Rist* rights were inheritable and tradable in form of rent, but could not be sold or mortgaged, as the land belonged not to the individual but to the descent group. The residual interest over the *rist* land was not vested in individual rist holders but in communities[1].

[1] A more detailed description of the *rist* land tenure system can be found in Rahmato (1984) and Crummy (2000).

On the other hand, in the southern part of the country the private tenures commonly known as the *'gebar'-'gult'* (tenancy system) was in place. Unlike the *rist* tenure system, the *gult right* was linked to legal and political institutions of the crown than hereditary rights. The chief features of these tenures were high concentration of private ownership, widespread absentee landlordism, and high rate of tenancy. In the year 1974-75, for example, as many as fifty-one percent of all the holdings were partly or wholly operated by tenants (MOA, 1975). Access to land was largely contingent on landlord-tenant agreements. Rights of ownership included rights to lease, sale and mortgage. But tenants had only conditional use rights. Failure to meet these conditions could subject tenants to eviction without compensation.

Broadly speaking, the Ethiopian land tenure system during the imperial regime was dominated by drastic power imbalances between landlords and peasantry. During this period considerable insecurity of tenure prevailed in all the tenure systems but mainly in private tenures where most of the holdings were under tenancy. Insecurity of tenure among the tenants was related to unenforceable oral contractual arrangements, threat of eviction without compensation, lengthy and costly disputes and litigation, and absence of due process of law free from political influence.

Movements for political change with the motto of "land-to-the-tiller" led to a downfall of the imperial regime of HaileSelassie in 1974 to be replaced by a military regime know as the *derg*. The military government (1974 – 1991) announced an agrarian reform program known as "Proclamation to provide for the Public Ownership of Rural Lands" (*the derg* 1975). This proclamation declared all rural land to be the property of the state [Article 3] – without any compensation to previous rights holders – and prohibited all tenancy relations [Article 4.5]. The

Proclamation provided the legal basis for the distribution of usufruct rights to a large number of rural families who had been working under exploitative tenancy contracts for a small group of landlords.

The Proclamation made a number of provisions. Farmers were entitled to free land through their respective farmers' associations at their places of residence. Farmers hold only use rights that cannot be transferred in any form (sale, mortgage, or lease). Bequeathing of allocated usufruct rights was limited to primary family members like spouse and children upon death of the rights holder. The plot size per family was restricted to a maximum of 10 hectares, and no factor markets were allowed to operate legally including labor market (Rahmato 1984). Considering the difference in agrarian relations that had existed in the North and South prior to the reform, the changes were more radical for tenant cultivators (and landlords) in the South than for *rist* rights holders in the North. In the *rist* system, land distribution had already been relatively egalitarian.

As reviewed by Tesfaye (2003), the 1980s were marked by major drive towards agrarian collectivization (i.e., formation of cooperative societies, expansion of collective farms, villagization). But these advances started unwinding in late 1980s. Some elements of the reform reversed such as the dissolution of producer cooperatives and abandonment of grouping the rural population into new villages. The process hastened after the fall of the military government in 1991. The then government also expressed its intent to move towards market-based land policy in 1989, which included the rights to use hired labour and rent land (Holden et al. in press).

While committed itself to a free market philosophy, the land policy of the current regime that took power in 1991 reflects a continuation of the past (1974-1990). It has been largely guided by a self-proclaimed social protection against a great fear that opening land markets would pave the way for involuntary dispossession of land from poor and vulnerable peasants. The 1995 federal constitution (FDRE 1995) draws a broad framework for land policy in the country and reaffirms the constitutionality of public land ownership and the inalienability of landholdings. It guarantees free access to land with added right to bequeath their land and holders of land rights are constitutionally protected from eviction except where there is a need for total or partial redistribution of land to ensure "fair and proportionality". Under the current constitution, land is still not subject to sale but only to short term renting. Since land belongs to the state, only the movable and immovable properties developed on land are treated as private and hence transferable in any form. In line with the 1989 policy that was declared in the wake of the downfall of the previous regime, the legal restrictions on factor markets such as labor market have abated.

The country's national land policy has been further clarified by 1997 federal rural land administration proclamation (FDRE 1997). The proclamation elaborates the rights specified in the 1995 constitution (FDRE 1995) and delegates responsibility for land administration to regional governments by providing guidelines that the regional governments must follow in developing and enacting regional land laws. Accordingly, four regional governments have already enacted laws that determine land use and administration in their respective regions (i.e., proclamation 23/1997 of the Tigray region in 1997 (TNRS 1997); proclamation 46/2000 of the Amhara region in 2000 (ANRS 2000); proclamation 56/2002 of the Oromiya region in 2003

(ONRS 2003); and proclamation 52/2003 of the Southern Nations, Nationalities and Peoples region in 2003(SNNPRS 2003).

Notwithstanding the salient similarities among these emerging regional land policies that appear to reflect the bundle of rights specified in the 1995 constitution, there are differences in legal provisions and restrictions attached to the regional laws. The proclamation 23/1997 of the Tigray region (TNRS 1997), for instance, implies a residency requirement. The regional proclamation stated that if someone abandoned their land for a period of more than two years, regardless if they held a certificate, the administration would take the land and distribute it to someone else. The proclamations clearly indicate a willingness to reallocate land away from those who have alternative sources of income. The guiding philosophy appears to be one of assuring access to land for individuals who have no alternative means of livelihood. While this policy serves an equity objective, it may provide little incentive for individuals who generate income from non-agricultural sources to invest in agriculture. The rural land use law in the region also permits land rental for a maximum period of two years for plots under traditional farming and ten years for farming using non-traditional technologies.

Unlike many other developing countries, land inequality has not been a major problem in Ethiopia since the 1975 reform. Rather, the issue of land tenure insecurity has long been considered as an impediment to growth in the agricultural sector and stagnation of the overall economic development of the country (Hoben 2000; Holden and Yohannes 2002). Challenged by the difficult task of balancing the demand for continued redistribution of land to accommodate young landless families against the need to ensure tenure security of current landholders to encourage long-term investments in land, the current regime, through the Ministry

of Agriculture and Rural Development (MOARD), has embarked on a national land registration and certification. The aim is to provide only limited rights in the form of perpetual user rights, rights to bequeath, rights to obtain compensation for investment on the land in the case of loss of the land, and rights to lease out the land for a limited period. Partly due to the high and increasing land scarcity and a historical land policy that promoted tenure insecurity, the land certificates represented a substantial improvement in the country (Alemu 1999; Holden and Yohannes 2002).

In 1998–99, Tigray (the case study area) was the first region to implement a land certification process using simple traditional methods. More than 80% of the region's population had received land certificates when the process was interrupted by war with Eritrea. At the time, however, this process represented a unique large-scale low-cost approach that set a new standard for land reform. This is because it entailed much lower costs than the traditional piecemeal high-tech approach that dominates in most other countries (Deininger et al. 2008). The approach also gives the poor hope that they can benefit from the land certification process, whereas they have been mostly excluded in countries where high-cost high-tech methods have been implemented (Besley and Burgess 2000; Deininger 2003)[2].

Other regions in Ethiopia have already learnt from the Tigray experience and have started to implement similar land registration and certification programs (Deininger et al. 2008). The Amhara region initiated land registration and certification in 2003 with some donor support using and testing modern equipment, and the Oromia and Southern regions both commenced

[2] Therefore, this provides us with an excellent opportunity to study some of the possible benefits (productivity implications) of this low-cost approach to land certification. Paper 4 and 5 focus on the empirical investigation of the investment and productivity effects of the land certification program in the region.

land reform programs in 2004. As of 2008, the national land administration program has registered about 20 million plots of some 5.5 million households (Deininger et al, 2008; Holden et al in press)

2.2. Structure of the Tenancy Market in Ethiopia

During the 1975 land redistributive reform, the common practice was to allocate land considering the number of household members giving less emphasis to other factors such as quality of land, size of family workforce and ownership of farm assets (Rahmato 1984). Though this led to a relatively egalitarian distribution of land holdings across households, marked heterogeneity in non-land resource endowment (such as labor and oxen) causes inequalities in relative factor endowment ratios across households (Adal 2002). Such a situation coupled with imperfect (missing) farm input markets contributed to an active land rental markets in the country dominated by sharecropping arrangements (Teklu and Lemi 2004; Holden and Ghebru 2005; Bezabih and Holden 2006; Pender and Fafchamps 2006; Tadesse et al. 2009). An important policy concern is then whether land reform in the form of registration and certification has contributed to increased tenure security, especially for the poor and for women. Anecdotal evidence from Tigray (Pender et al., 2002, MUT, 2003) suggests that cultural taboos that prevent women from cultivating their own land may cause female-headed households to depend on assistance from men or on renting out or sharecropping their land. This may imply that the certificates have a higher value for women than for men.

Holden and Ghebru (2005) found the land rental market in Tigray to be characterised by substantial transaction costs and asymmetries because of rationing on the tenant side. As a result, many tenants and potential tenants failed to rent as much land as they wanted to. However, as a

large share of the contracts encompassed kin and kinship ties, this appeared to improve access to land in the market (Holden and Ghebru 2005). Another study in Ethiopia's Amhara region also found signs of high transaction costs in the land rental market (Deininger et al. 2009).

The fact that non-land factor markets are imperfect (missing) coupled with the egalitarian land distribution in the country create a Reverse-Share-Tenancy scenario according to which landlord households are contextually described as non-land-resource poor (not necessarily land abundant) households while tenants are best described as non-land-resource rich (not necessarily landless or nearly landless) households (Ghebru and Holden 2009).

3. Theoretical Perspective: *Property Rights, Market Imperfections, and Institutions*

The issue of land tenure has been a thorny issue in the literature for quite a while. In the 60s and 70s the main concern of the debate was on issues of equity and security as the debate mostly concerned bringing justice in land allocation in countries that emerged from colonialism. Since the collapse of the Soviet Union a different kind of debate has emerged about land tenure centered around efficiency issues and sustainability of resource use in the context of transitions from a socialist mode of production towards a more market oriented system (Cotula et al 2004). The purpose of this sub-section is not to look at these debates in any detail. Instead, an attempt is made to briefly summarize the theoretical perspectives of issues of tenure security, market imperfection, institutions, and the evolution of property rights.

Property rights and tenure security

Property rights theory does not emphasize who "owns" land, but rather analyzes the formal and informal provisions that determine who has a right to enjoy *benefit streams* that emerge from the

use of assets and who has no such rights (Libecap 1989; Eggertsson 1990; Bromley 1991). These rights need to be sanctioned by a collective in order to constitute effective claims. As defined by Libecap (1996) the term property rights refers to "all actors' rights, which are recognized and enforced by other members of society to use and control valuable resources". Feder and Feeny (1991) also define property rights as a bundle of characteristics, which comprise exclusivity, inheritability, transferability and enforcement mechanisms. Broadly, property rights to land can cover one or more of the following: 'access, appropriation of resources and products, provision of management, exclusion of others, and alienation by selling or leasing', with only ownership as 'the accumulation of all of these' (Janvry et al. 2001; Ostrom 2001).

On the other hand, the concept of tenure insecurity, which is associated with lack of well-defined property rights, can be understood as a random probability of loss of future income due to conflicting challenges (Deininger and Feder 1998). According to Barrows and Roth (1990) eliminating such a threat through well-defined complete individualistic property rights, codified and protected by the state, will clearly increase the benefit from productivity enhancing long term investments and thus the owner's willingness to undertake them.

Property rights thus describe the uses which are legitimately viewed as exclusive and define who the owners of these exclusive rights are. Bell (1990) characterizes property rights according to two major dimensions: transferability and security of rights. Using these dimensions two extreme right regimes can be identified, vis a vis, the perfect market model (individualized or private rights) and its opposite (communal rights). Although there is wide recognition about the desirability of tenure security for agrarian development, there is no clear and universally

applicable blueprint as to what appropriate property right regime ought to be as it depends on underlying conditions of socio-cultural and geographic factors.

Land tenure reform towards individual freehold system has long been seen as a prerequisite for development in Sub-Saharan Africa (Feder and Noronha 1987; Migot-Adholla et al. 1994). The arguments in favor of reforming the customary African land tenure were mainly based on the neoclassical economic theory of property rights ((Demsetz 1967; Barzel 1997) that predicts greater productivity as land tenure becomes more secure and individualized. Reflecting neoliberal thinking of private property rights, Besley (1995) identified three channels through which secure property rights can, in principle, affect positive economic outcomes, namely: (i) tenure security and higher land investment incentives (ii) smooth functioning of the land markets (tradability) that lubricate factor-ratio adjustment, and (iii) facilitating access to institutional credit by allowing land to be used as collateral. Theses hypothesized effects of tenure security heavily rely on the neoclassical framework that presupposes markets for all goods and services (including credit and insurance markets) exist and, therefore, market clearing prices determine demand and supply choices of households (Bardhan 1989; Hoff et al. 1993)

Market Imperfections, Institutions and the Evolution of Property Rights

However, in areas where risk, information asymmetry and moral hazard are pervasive and transaction costs (mainly information and enforcement costs) are prohibitively high, such hypothesized effects of individualized property rights may not hold empirically. As Stiglitz (1986) argues, this is so because the efficiency of market economy and the allocation of resources (property rights) rely up on the conditions of perfect information and the existence of

complete markets. When high transaction costs characterize the market, which cause absence or imperfections in the input and/or output markets, household production and consumption decisions become non-separable (Singh et al. 1986; Janvry et al. 1991; Sadoulet and Janvry 1995).

This implies, regardless of the security of tenure, such absence or imperfections in the market undermine farm households to undertake profitable investments ((Holden et al. 2001) and participate in any form of exchange process (Kranton 1996). Farm households internalize such imperfections by producing a limited range of goods and services for own consumptions especially when social protection for food security are absent, making household decision making process more responsive to their initial resource endowment rather than market signals (Sadoulet and Janvry 1995; Holden et al. 2001). For instance, the size and strength of the *investment demand effects* of tenure security depends on the attractiveness of the investment (Deininger et al. 2003) which ultimately depends on the development of rural input-output and other inter-temporal markets. In areas with no or few off-farm employment opportunities, or other safety nets, improved tenure or secure property rights may not be a guarantee to incentivize farmers to install improved farming technology (which normally comes with higher risks)[3].

Hence, with such imperfections in the markets and limited institutions to support the functioning of markets in developing countries, liberalization, in the form of individualization of property rights, have failed to achieve the promised benefits of reducing the investment disincentives associated with communal property rights system (Shiferaw et al. 2008). This scenario is even

[3] Paper 4 and Paper 5 of this dissertation work focuses on investigating the magnitude of the investment and productivity enhancing effects of the land certification program in the country.

compelling in rural areas of Sub-Saharan Africa where land is not only a productive asset but also performs important functions as social safety net and old age insurance ((Deininger and Feder 1998; Holden 2007). In such high risk environments, individualization of communal land rights that neglects the safety net function may reduce poor people's option for risk management and insurance and may leave everybody worse-off (Deininger and Feder 1998). This implies policy interventions in the form of granting only usufructuary rights (use rights) that limits any land alienation may come to the rescue in an effort to avoid myopic sale of land by individuals[4].

On this backdrop, recent literature on land property rights (Larson and Bromley 1990; Bromley 1991; Schlager and Ostrom 1992; Janvry et al. 2001) acknowledges that privatization and individualization is not *a priori* the most efficient means of achieving tenure security. This was the basis for the revision of the 1975 World Bank land policy, which called for the introduction of private land rights in Africa, acknowledging the fact that communal tenure system can increase tenure security and provide a basis for land transactions that are more cost-effective than freehold titles (Deininger and Binswanger 1999).

Although few African countries have gone through a revolutionary (land reform) and policy induced (land titling) tenure change[5], there are evidences that indicate tenure regimes (or,

[4] The current land policy in Ethiopia falls into this category while, at the same time, dealing with the issue of tenure security through formalization of these rights in the form of land registration and certification program which is being implemented since 1998.

[5] Land reform and land titling are often used interchangeably. But, as Burns (2007) explains, land titling is a process of adjudication which is employed to recognize an existing rights to land, where as, on the other hand, land Reform usually seeks to reassign rights to land, a process which has far greater potential for disputation, and usually attracts a significant degree of political attention and community sensitivity. Land registration and titling, by itself, can take various forms that ranges from a system of converting registered rights to freehold to a mere record (register) of existing rights to land (Cotula et al 2004). The Ethiopian land registration and certification program falls into the latter category as it issues land holders a written document specifying the use rights to the land.

property rights) evolve towards individualized land rights in response to increased demand for secured land rights over scarce land resources (Platteau 1996). According to the evolutionary theory of land rights, the demand for individualization of property rights in land can be conceived as an induced institutional response to higher shadow price of land to encourage long term land investment (Binswanger and McIntire 1987; Ruttan 1989; Deininger and Feder 1998). Boserup (1965) was the first to point out the fact that, historically, higher population density was the driving force behind an endogenous process of better definition and enforcement of property rights. Another important factor that led to the evolution of individual property rights to land is the reduction in income and consumption risk. As pointed out by Deininger and Feder (1998), there are three major avenues for this to come about, namely (1) the development of output, and inter-temporal (credit and insurance) markets; (2) the emergence of access to non-covariate streams of off-farm income; and (3) technical progress that allows diversification, reduction of the covariance of yields, and the probability of crop failure.

This is particularly the case in the Sub-Saharan Africa as the desirability of communal land rights (ownership) mainly rests on its role as an "insurance policy" to eliminate the threat of permanent assets loss or to reduce vulnerability to consumption shocks. Once alternative and less costly mechanisms to insure against such risks become available through well-developed output and inter-temporal markets, the demand for individualized rights may intensify. This implies that, given population density is low and land is relatively abundant, the usufructuary rights given under the communal property rights system do not impose large losses as long as markets for output, capital and insurance are poorly developed, which ultimately undermines people's ability and pay-off for making long term investments. Hence, with the prevalence of

high transaction costs and market imperfections, costs – in terms of investment disincentives and forgone land transfers – associated with communal land rights are low which undermines the legitimacy of private property rights.

4. Conceptual framework: Tenure Security and the Efficacy of Land Rental Markets

Building upon the historical, empirical and theoretical perspectives outlined above, key relationships among the factors governing the performance of land rental markets and the efficacy of land policy reform are summarized subsequently. After the land redistributive reforms dominated the land tenure debate during the last decade of the 20th century, there is now a renewed global interest in land policy and legal reforms (IFAD 2001; Bonfiglioli 2003; Deininger 2003). Partly due to a very high population pressure and high food and fuel prices, very integral to this growing research and policy agenda are issues of land tenure security and land markets (Holden et al. 2008).

There is now a growing consensus that, even in rural African contexts where individual titling of land may not be desirable or feasible, formalizing land rights through land registration and certification (by providing poor land owners or users with options to have their rights documented) can yield significant benefits (Deininger et al. 2008). For instance, a landholder who is insecure of long-term rights is less likely to commit resources into long-term investment as shown, for example, in Place and Hazell (1993) for Ghana, Kenya, and Rwanda; Gavian and Fafchamps (1996) for Niger; and Gebremedhin et al (2003), Shiferaw and Holden (1998) and Tekie (2001) for Ethiopia. The other key benefit associated with better enforcement of property rights is its role in lubricating tradability in land rights. Whilst the empirical evidence is

generally scarce, there are a few pointers that indicate female-headed households are less secured in effectively controlling their land rights than male-headed households limiting their market participations (Holden et al. in press) and productive efficiency (Bezabih and Holden 2006; Holden and Bezabih 2008).

For instance, Deininger et al (2006) argue that secure tenure rights would allow a relaxation of the impediments to factor mobility and hence enables the allocation of land from the less efficient to the most productive farmers. However, imperfect or missing capital and labor markets in rural areas may prevent operation of land sales markets from bringing about socially desirable outcomes (Deininger and Binswanger 1999; Zimmerman and Carter 1999; Sadoulet et al. 2001). Under such circumstances, not only does the lack of (financial) resources limit the poor's access to the market, but vulnerable farmers may also end up selling their land in an act of distress (*ex post risk response*) to get access to liquid assets. Recognition of these limitations of land sales markets justify policy interventions to try and impose restrictions to prevent land concentration as a result of distress sale by the poor (Deininger and Feder 1998; Deininger et al. 2003).

The efficacy of land rental markets

Rightly so, the land rental market has, thus, become an increasingly important land redistribution mechanism especially in the presence of missing or imperfect rural markets. This is so since, rental markets have lower transaction costs, are more versatile and can help households deal with shocks or stresses without loss of productive assets over the long-term (Deininger and Binswanger 1999; Sadoulet et al. 2001; Deininger et al. 2003). There is a large body of

literature that demonstrated adjustments in land rental contract (adoption of share-cropping contracts) as an induced institutional innovation to overcome the working capital shortage (Otsuka and Hayami 1988; Deininger et al. 2003; Otsuka 2007; Holden et al. 2008). Empirical studies on the allocative efficiency and equity effects of land rental markets show beneficial effects in terms of providing alternative access to land, enabling farmers to pool resources and equalizing factor proportions and distribution of land holdings (Teklu and Lemi 2004; Pender and Fafchamps 2006; Deininger et al. 2008; Ghebru and Holden 2008).

The efficiency and equity advantages of the land rental markets can be questioned when transaction costs in land rental markets are prohibitively high (Coase 1960). When land rental markets are imperfect, not only does factor adjustment through the tenancy market fail to compensate for the imperfections in other factor markets (Bliss and Stern 1982; Skoufias 1995), it may also create inequalities in access to land which may lead to widespread and deepened poverty incidence (Holden et al. 2008). On the other hand, high transaction costs associated with search for partners, negotiations, monitoring and enforcement of contracts may give rise to induced institutional innovations *(ex ante risk responses)* that reduces such costs considerably, such as interlinked markets (Stiglitz 1974) ; kinship contract arrangements (Sadoulet et al. 1997); and sharecropping contract arrangements (Otsuka et al. 1992). For instance, in an attempt to reduce the danger of asset abuse by the tenant, landlords could choose share tenancy contracts while *risk-averse* tenants may opt the same contract with the aim of defusing production risks (Otsuka and Hayami 1988; Otsuka 2007).

Possible disincentive effect due to sharing of output in share tenancy contract arrangements is another concern associated with a potential efficiency losses in land rental markets. The Marshallian theory asserts that sharecropping is inefficient because of its disincentive effect of output sharing on the tenant's supply of labor. This neoclassical analysis of share tenancy (Marshallian inefficiency) hinges on the assumptions of prohibitively high cost of supervision from the landlord side and unlimited access to land of tenants. Recent theoretical work on sharecropping has called on various microeconomic reasons to explain the prevalence and diffusion of share tenancy in much of the developing world, despite the well known disincentive effect created by sharing the output. Cheung (1969) was the first to formally outline how sharecropping might be as productive as other contractual forms, or even preferred to them. In his model, the landowners' ability to limit the supply of land and manipulate the rental share (higher bargaining power) results in costless monitoring and enforcement of effort.

Another theoretical explanation for sharecropping efficiency is when contracts are repeated over time so that the gains from long term cooperation are greater than the losses of short term cheating (Binswanger and Rosenzweig 1986; Hayami and Otsuka 1993; Hayami 1997; Otsuka 2007). In this case, faced with the threat of eviction, the tenant will raise effort level (Basu 1992). The literature has also explained how significant shirking of share tenants can be prevented when the tenant's self-interested behavior is identical to the landlord's optimum - using kinship ties to internalize moral hazard problems (Otsuka et al. 1992; Hayami and Otsuka 1993; Sadoulet et al. 1997). Hence, in spite of the conventional view on inefficiency of share tenancy arrangements (conventionally know as the Marshallian inefficiency), the existing literature describe sharecropping as the best solution in a second-best world characterized by

market failures (borrowing constraints and risks) and high transaction (contract enforcement) costs (Binswanger and Rosenzweig 1986; Otsuka 2007).

In general, as shown in figure 1, the efficacy of land rental markets from the perspective of efficiency and equity depends on bio-physical environments (agricultural potential, rainfall, etc) pressure factors underlying the scarcity value of land (population pressure, market access and market integrations) capacity of indigenous institutions to innovate or adopt to new demand conditions for land, and public policy and its legal frame work (such as land policy reforms). The influence of these factors, however, cannot be isolated from each other. For instance, capacity of indigenous institutions (farmers associations, land administration committees, etc) to find institutional solutions to a scarcity of land weakens where non-land factor markets are poorly developed, return to investment in land is low, population pressure is prohibitively high and public policy acts in a way that undermines the security of holdings.

Likewise, a policy reform in land comes along with changes in opportunity, incentive and risk that influences land use and management decisions of farm households. How much these decisions influence the efficacy of a particular tenure arrangement (for example, land rental market) can be assessed in terms of a set of outcomes shown in the flow diagram below: (1) Access and distribution of land (equity implications); (2) input use intensity (technical efficiency); (3) long term investment in land (technological change); and (4) disputes and conflicts arising from deficient tenure. These intermediary outcomes ultimately have an impact on the livelihood and welfare of the rural population.

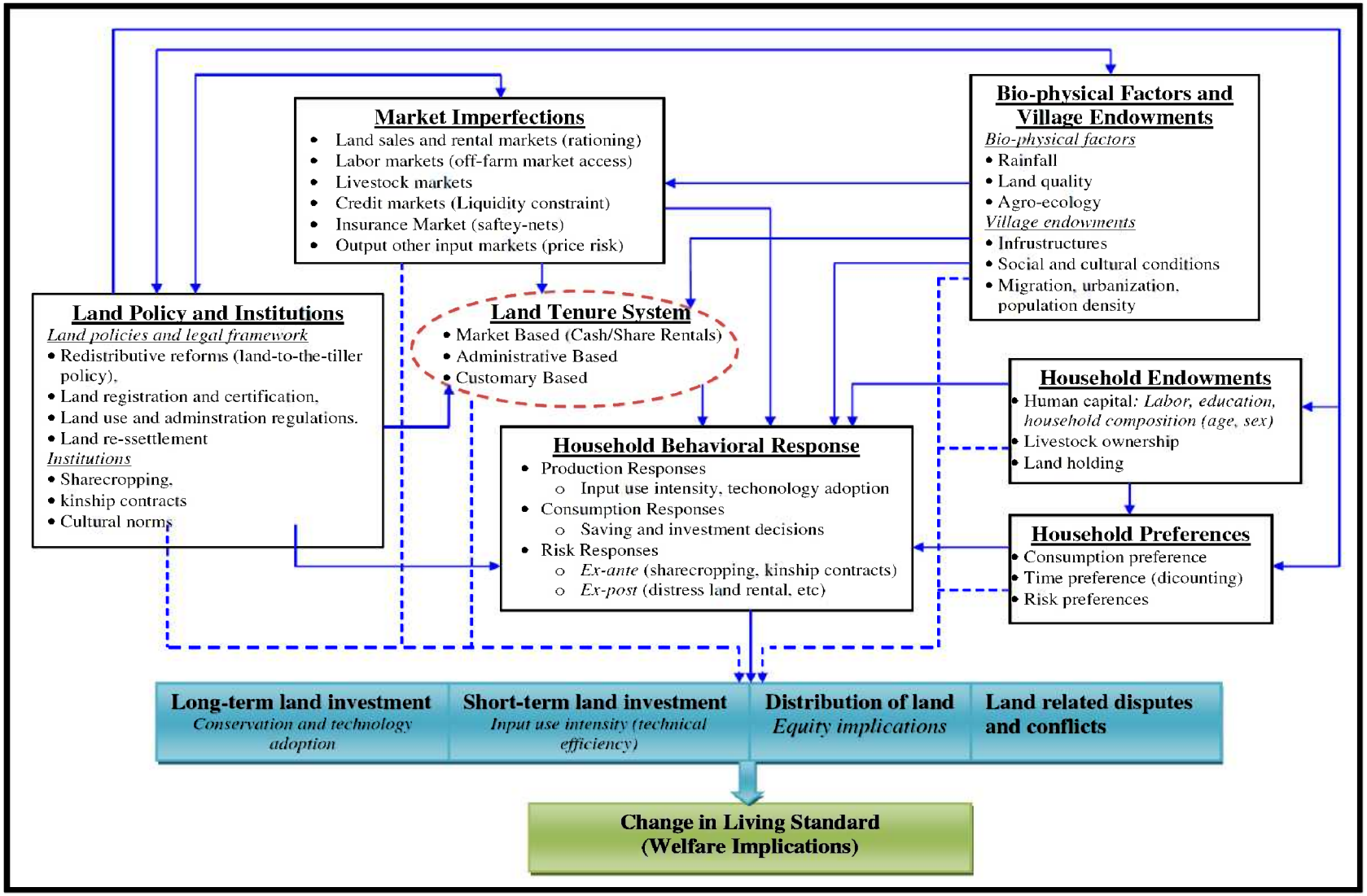


Figure 1: Conceptual Framework – the Efficacy of Land Policy Reforms and Land Rental Markets

5. Data and Methods

The main data source for this report is based on a longitudinal data covering a stratified random sample of 400 farm households from the Tigray region in northern Ethiopia. The surveys covered 16 sub-districts (*tabia's*) that are stratified sample of villages originally included in the 1998 IFPRI community and household survey to represent the major variation in agro-ecological factors, market access, population density, and access to irrigation. The four wave panel of household survey stretched for almost a decade, covering the survey years of 1997/98, 2000/01, 2002/03 and 2005/06. The author was involved in collecting the data for the last two rounds of the panel survey as well as the 2006/07 survey conducted on a separate district.

Based on the availability of each survey data and the focus of each dissertation paper, the magnitude and type of data utilization differs from one dissertation paper to the other (see Table 1). For instance, with the aim of assessing the productivity differentials of the kin-based share-tenancy arrangements, Paper 4 utilized a unique data that consists of information from tenancy market partners of sampled households. The 2005/06 dataset was, thus, used as a basis for the analysis of this study only for completeness of the partner data.

Table 1: Data Utilization Structure of Each Dissertation Work

Dissertation Papers	1997/98	2000/01	2002/03	2005/06		2006/2007
				Sample	Rental Partner	Separate district
PAPER 1			√			
PAPER 2	√	√	√	√		
PAPER 3				√	√	
PAPER 4	√	√	√	√		
PAPER 5						√

Paper 5, assessing the productivity impacts of land use certification, is based on a separate data. Possession of land use certificate is potentially endogenous if lack of possession is due to household specific factors (such as, households may not collect certificates because they may not have considered them to be important; or some households have lost their certificate and could not get a new one). Such reasons, unlike an administratively caused factors – such as incomplete registration and certification due to lack of sufficient certificates, manpower or other regulatory reasons - could cause correlations between possession of certificate and factors that affect productivity – a problem of endogeneity bias.

To tackle this problem, a district from the Tigray regional state of Ethiopia was identified as a district where a relatively larger portion of farm households were without land use certificates. After a through empirical investigation of the process of registration and certification in the district, farm households from the four sub-districts were , then, stratified based on whether they have land use certificate or not. A careful measure - to exclude households with household specific reasons for not possessing the land use certificate - has, therefore, been taken before a random selection of 320 farm households (80 farm household units from each of the four villages in the district). Table 1 below summarizes data utilization structure of each dissertation paper.

Comparability of the data set is assured because the data collection process relied on a standardized questionnaire. Multi-purpose questionnaires were used to gather a host of household demographic variables, information on household income, expenditure, access to public services, farmers' perception of land degradation and tenure security as well as plot level data on the plots' biophysical features, production history and input use. To further ensure the comparability of the dataset the surveys were carried out during similar seasons (May – July).

Depending on the focus, data utilization and methodological challenges of each article, the empirical analysis in this dissertation work employed non-parametric and parametric micro-data methods. The nonparametric methods include: propensity matching methods to improve comparability of parcels across different groups; non-parametric (Kaplan-Meier estimator) and semi-parametric (Cox's proportional hazard) survival models to evaluate the dynamics and duration dependence of poverty and make welfare comparisons by households' tenancy market status; and Data Envelopment Analysis (DEA) models to investigate and decompose productivity impacts of land certification programs.

Like any other micro-data studies, however, the studies included in this dissertation work were not free from the two major analytical challenges: namely, sample selection bias and endogeneity bias. Sample selection bias refers to problems where the dependent variable is observed only for a restricted, nonrandom sample. PAPER 1 of this dissertation falls victim of such bias. Dealing with the determinants of amount of land transacted, one observes an individual's amount of land transacted only if the individual has joined a tenancy market. For instance, if young and inexperienced individuals are more likely to join a tenancy market and therefore manage to lease-in small amount of land partly due to their inexperience ceteris paribus, then failure to control for this self-selection (correlation) will yield biased estimates. Heckman's selection correction model is used to tackle this problem – where in the first stage a probit model is used to predict the probability of tenancy status and in the second stage, the inverse Mills' ratio [IMR] is included as a regressor with bootstrapping techniques applied to correct standard errors.

On the other hand, endogeneity bias refers to the fact that an independent variable included in the model (in this case, kinship status/possession of certificate) is potentially a choice variable correlated with unobservables related to the error term of the outcome variable (in this case,

volume of land leased/farm level productivity). This dissertation faced such analytical challenges in several of the separate studies when an attempt was made to: investigate the role of kinship on farm productivity (PAPER 3); and evaluate the role of land certificate on productivity and long-term investment (PAPER 4). For instance, endogenous matching may cause kinship contracts to be endogenous in the intensity of leasing models. Households may use kinship contracts to reduce risk in contracting but they may also be more inclined to do so when the risk is high (possess large amount of land). Likewise, household specific factors that determine possession of land use certificate (not seeing it as important) may correlate with unobservable factors that determine their farm level productivity.

To tackle such analytical bottlenecks, the dissertation work benefited from a host of methodological alternative approaches. Other than the fixed and random effects regression models that took advantage of the panel data, the dissertation work made use of two-stage least square models, and least squares switching regression models. Alternatively, we also applied a control function (CF) approach by including the residuals (generalized residuals) to control for the endogeneity of certificate/kinship variable (Wooldridge 2005). In the later case, the generalized residual is a variable constructed from the inverse Mills' ratio [IMR] of the probit models for kin and non-kin sub-samples with bootstrapping techniques applied to correct standard errors.

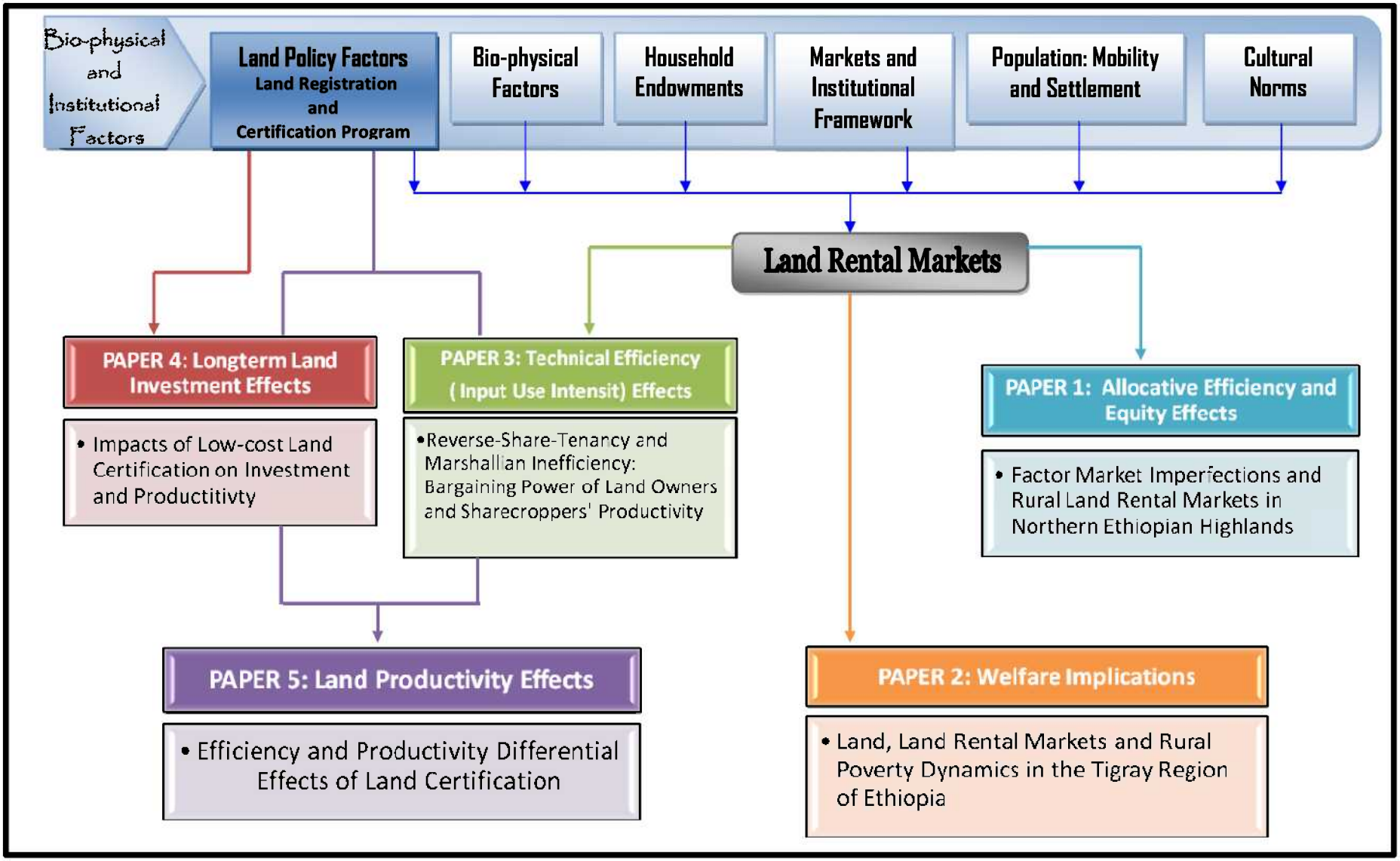


Figure 2: An Over of the Structure of Papers in the Dissertation

6. Summary of Research Findings

PAPER 1: FACTOR MARKET IMPERFECTIONS AND RURAL LAND RENTAL MARKET IN NORTHERN ETHIOPIAN HIGHLANDS

This paper investigates the role of factor market imperfections (transaction costs) in affecting the likelihood and intensity of participation on both sides (demand and supply sides) of the tenancy market. It explores the extent to which rationing problems may affect adjustment and allocative efficiency in the land rental market. Therefore, the main objectives were: (1) to investigate factors that affect farm households' likelihood of participation (land rental market entry); (2) to assess the efficiency of factor ratio adjustment through the land rental market (intensity of participation): and (3) to examine the extent of transaction costs, rationing, and asymmetry in the land rental market.

Due to the nonlinearity of the dependent variables, we applied and tested alternative econometric models. First we tested censored tobit versus double-hurdle models, and since the tobit models were rejected in favor of the double-hurdle models, we tested for selection bias on both sides of the market separately. On the tenant side, we found significant selection bias in all specifications. On the landlord side, we found no significant selection bias except in one of the specifications (not included here). Consequently, in order to control for selection bias related to unobservable characteristics, we used Heckman two-stage selection models.

The results confirm that households' participation in the tenancy market was mainly to tackle the persistence of relatively high imperfections in non-land factor markets as ownership of oxen has turned out to be a key determinant. The analyses demonstrate significant transaction costs in

the tenancy market limiting the access to and the degree of adjustment in the market. Although a high ratio of kinship contracts in the communities appeared to be associated with better functioning land rental markets, households that previously participated in the market appeared to face lower transaction costs in the market. Our findings indicate that the growing landlessness due to continued population growth, increasing land scarcity, and limited opportunity to further subdivide farms among children create an increasing pressure on the demand side of the land rental market causing tenants to be rationed out. A test on the symmetry of factors causing participation on both sides of the tenancy market confirms this asymmetry.

PAPER 2: LAND, LAND RENTAL MARKETS AND RURAL POVERTY DYNAMICS IN THE TIGRAY REGION OF ETHIOPIA

Based on findings of the Paper 1, it has been speculated that there may be limited prospects for poor landless households to utilize the tenancy ladder as a way out of poverty since households without oxen and other farm endowments were found more likely to be rationed out of the market for tenancies. On the other hand, households that are poor in non-land endowments but have land may benefit from the land rental market due to the possibilities of getting a relatively higher income by renting out their land than they would have obtained by farming the land themselves. Many female-headed households belong to this category, and, this implies that the land rental market may serve as an important source of livelihood and a safety net for these poor landlords. This paper, thus, aims to help better understand the correlations between the welfare dynamics of households and their tenancy market participation in the Ethiopian context.

For this purpose, a 4-wave longitudinal data (that stretched for almost a decade from 1997/98 – 2005/06) are translated into survival format using STATA statistical software with

a year as a time unit. The cost-of-basic-needs approach was applied to construct a regional poverty line. To maintain welfare comparisons across years and different locations, the consumption expenditure was adjusted for temporal and spatial price differences. Methodologically, a non-parametric Kaplan-Meier survival model has been applied to estimate the hazard ratios, defined as the probability that the poverty spell ends at time *t* conditional that the spell last till period *t-1*. A multivariate proportional hazard model has also been used to control for other economic factors that can influence the duration of the poverty spell.

Using an extreme poverty line (the regional food poverty line) as a benchmark, the overall results show that re-entry rates are higher than exit rates in the region pointing to the fact that majority of households in the region are not only in a state of extreme poverty but they are also highly vulnerable (a very high risk that non-poor households can fall back below the food poverty threshold). After dividing the sample in terms of farm households' status in the land rental market, the study has shown that tenant households are not only systematically more at risk of falling below the food poverty line, they are also more likely to remain poor for a much longer number of years as compared to landlord households. According to the non-parametric results, landlord households were found to have significantly lower hazard rates for entering into poverty as well as higher probabilities of leaving poverty.

Using a multivariate proportional hazard model, the results reveal that participation and the degree of participation in the supply side of the tenancy market was associated with higher chances of escaping poverty. On the other hand, the chances of escaping poverty were limited and insignificant for participation and the size of participation on the demand side of the tenancy

market. The empirical evidence also confirms that households headed by older and literate people have relatively larger exit rates from poverty as compared to households headed by younger and illiterate ones.

Though transacting farmers may engage themselves in win–win rental arrangements by the time they join the tenancy market, results indicate that gains are unequal as those tenants who enter the markets from low economic leverage (were poor) are liable to face lower margin of net gains, which may limit their ability to move out of poverty. A new policy restriction[6] on the functioning of land markets may aggravate such problems as tenure insecurity of (potential) landlords may end up marginalizing those poor (potential) tenants from accessing land. The remedies may not lie in suppressing the rental markets but understanding them more to address the constraints by taking policy measures such as formalization of the land rental markets and improving tenure security of households (land certification programs).

PAPER 3: REVERSE-SHARE-TENANCY AND MARSHALLIAN INEFFICIENCY: BARGAINING POWER OF LANDOWNERS AND THE SHARECROPPER'S PRODUCTIVITY

Even if there are evidences that suggest households may use kinship contracts to reduce the risk of moral hazard and adverse selection problems, the empirical evidence on the technical efficiency-enhancing role of kinship is mixed and inconclusive. This paper, thus, attempted to void this gap in the literature giving proper emphasis to the reasons behind households' choice of kin-tied contracts. The basic hypothesis is that, other than the motive of reducing the problems

[6] The fact that the regional government has very recently enacted a law that decrees leasing out more than half of own holding as illegal and subject to confiscation illustrates that such policy measures undermine the sense of tenure security of land holders.

associated with imperfections in the land tenancy market, poor farm households may opt for such contracts as a form of "insurance policy" against future consumption risks.

We follow up on this and aim to show that, other than the expected higher degree of social concern between kin tenants and their landlords, the strategic response (opportunistic behavior) of tenants - to varying economic and property right condition/status of the landlord - is equally important in affecting their performance on sharecropped plots. Failure to account for such heterogeneity of the characteristics of landlord households may conceal the opportunistic behavior of tenants. Making use of a unique tenant-landlord matched plot level data from the northern highlands of Ethiopia, our inclusion of such heterogeneous economic and property right conditions of landlords allows us to show that with variations in such characteristics of the landlord, otherwise identical share tenants (say, kin tenants) can have different productivity.

For this end, tenant household fixed-effect models with different specifications to assess the relevance of characteristics of landlords have been applied. As an alternative, we applied a control function (CF) approach to control for the possible endogeneity of the *kinship* variable. Taking advantage of the availability of information about the kinship, bargaining power and tenure (in)security of matched landlords, our findings indicate sharecroppers' yield are significantly lower on plots leased from landlords who are non-kin; female; with lower income generating opportunity; and tenure insecure than on plots leased from landlords with contrasting characteristics. A decomposed analysis (after considering interaction effects of kinship status of tenants with variables controlling for the bargaining power and tenure security status of landlords) also shows a strong (statistically significant) evidence of Marshallian inefficiency on kin-operated plots leased from landlords with weaker bargaining power and higher tenure

insecurity. This study, thus, shows that failure to control for such heterogeneity of landowners' characteristics may cause the lack of clarity in the existing empirical literature on the extent of moral hazard problem in sharecropping cultivation. The empirical evidence implies that strengthening the property rights of landholders may not only have a direct productivity-enhancing effect on owner-operated smallholder cultivation but also an indirect impact on the productivity of transacted plots.

PAPER 4: IMPACTS OF LOW-COST LAND CERTIFICATION ON INVESTMENT AND PRODUCTIVITY

This article assesses the investment and productivity impacts of the Ethiopian low-cost land certification using a unique and detailed data set with household and plot panel data from 1998, 2001, and 2006. The data provides a balanced household panel covering 16 representative communities in 11 districts in the Tigray region, where certification was implemented first in Ethiopia. With the last survey round, eight years after the reform, we were able to assess some of the longer-term impacts of certification. Alternative econometric methods were used to test and correct for endogeneity of certificates. The rich household-plot panel data allowed us to control for time-invariant unobservable village, household, and plot heterogeneity in the land productivity analysis by using household fixed effects.

Farm households' perceptions indicated that the low-cost land certification program that was implemented on a broad scale in the Tigray region in Ethiopia in the late 1990s contributed to increasing tenure security and reducing land disputes. The reform has been pro-poor, as we found that livestock-poor households were more likely to have received land certificates than livestock-rich households. Using a unique household farm-plot panel data set, we found that land certification has contributed to increased investment in trees, better management of soil

conservation structures, and enhancement of land productivity. The productivity increase due to land certification was estimated to be about45%. Strong public investments in soil conservation may explain why no effects of certification were found for such investments. It is noticeable that our hypothesis stating that restrictions on tree planting on arable land have prevented investment in trees, especially eucalyptus, had to be rejected. One may question the current restrictions on tree planting, especially on land marginally suited for crop production, as such land is well suited for profitable tree production. This could be a better way to enhance the food security of such households that could use the income from selling of trees to buy food. The main reason for such positive impacts of certification is that certification has reduced tenure insecurity that was high due to the past policy with state ownership of land, providing households restricted user rights to land only, and frequent land redistributions that undermined investment incentives (Alemu 1999; Deininger and Jin 2006).

The investment effects of certification can only partially explain the productivity effects of certification. Holden, Deininger, and Ghebru (2007) have shown that land certification has stimulated the land rental market in Tigray, and this may explain some of the remaining productivity impact because inefficient land managers are less likely to cultivate the land themselves after receiving certificates. It is also possible that land certification has stimulated use of inputs like manure, fertilizer, and improved seeds but that requires further investigation and is left for future research.

PAPER 5: EFFICIENCY AND PRODUCTIVITY DIFFERENTIAL EFFECTS OF LAND CERTIFICATION

This paper is a follow-up study to paper 4 and analyses the productivity impacts of the Ethiopian land certification program by identifying how the investment effects (technological gains) would

measure up against the benefits from improvements in input use intensity (technical efficiency). Taking advantage of a detailed plot-specific household survey from the northern highlands of Ethiopia, this paper introduces some innovative elements in analyzing the productivity effects of the land certification program in Ethiopia. Rather than simple comparisons of relative productivity differentials between certified farms and farms without certificate, this study decompose such group differences in productivity into: (1) differences in efficiency spread within each group (catching-up effect - factor intensity effect), and (2) differences in technology (distance between group frontiers – technology effect). We accomplish this task of analyzing group productivity difference by constructing a non-parametric DEA-based Malmquist productivity index.

Comparing the performance of group of farms with formalized land use right (certificate) against those without certificate, the objectives of the study are twofold. First, it examines whether or not there are any productivity enhancing benefits from land certification. This analysis servers as a vehicle for understanding the overall productivity differential effects of the land certification program. Second, an attempt has been made to isolate and examine the pathways through which land certification influences agricultural productivity. This analysis is the core of the paper and provides insights into how substantial the technological gains (investment effects) of land certification are against the benefits from improvement in technical efficiency (input use intensity). To the best of our knowledge, we are not aware of any other study on the productivity impacts of land reforms that analyse and decompose efficiency and productivity effects.

Based on the results from the DEA-based Malmquist productivity index, we found that farms without land-use certificate are, on aggregate, less productive than those with formalized use

rights. Using the decomposed analysis, we found no evidence to suggest that the productivity difference between the two groups of farms is due to differences in technical efficiency. Rather, the reason is down to 'technological advantages' or favorable investment effects (in the form of conservation structures, adoption of inorganic fertilizers, and modern seed varieties) that farm plots with land use certificate benefit when evaluated against those farms not included in the certificates. Results from the first order stochastic dominance analysis support the empirical findings, showing the dominance of overall productivity of farm plots with certificate over those plots without certificate.

Therefore, the recent wave of land certification projects in the country may not be an ill-advised direction or strategy since such policy measure was found to improve the competitiveness and productivity of farms with land use certificate when evaluated against farms not included in the certificate. However, the certification program by itself may not achieve the promised effects on agricultural development unless it is complemented by measures such as improving the financial and legal institutional frameworks. This is witnessed from our results that show the low level of within-group efficiency of farms in each group

7. Overall Conclusion and Policy Relevance

Based on the empirical studies of this dissertation, the main conclusions are:

- The land rental market was found to have an important role as a safety net for poor (potential) landlords while high frictions in the land rental market that cause rationing in the supply side of the market limits the benefits to poor (potential) tenants. Recent policy restrictions on how much land households are allowed to rent out (TNRS 2006;2008) threaten the tenure security of poor and vulnerable households, such as female-headed

and older households, that lack the necessary non-land resources to farm their land efficiently.

- The findings indicate that sharecropping does not necessarily lead to less efficient land use, as it is shown that inefficiency are caused more by policy distortions (tenure insecurity) and imperfections in other markets than by the operation of land rental markets per se. Therefore, strengthening of property rights may not only have a direct productivity-enhancing potential on owner-operated smallholder agriculture but can also have an indirect impact on the performance on transacted plots. Recent changes in the regional land proclamation (TNRS 2006) authorize confiscation of landholdings of households who had their primary source of livelihood outside the village for more than two years. While this policy serves an equity objective, it may provide little incentive for individuals who generate income from non-agricultural sources to invest in agriculture.
- We also found that land certification has contributed to increased investment in trees, better management of soil conservation structures, and enhancement of land productivity. It is possible that the benefits from the low-cost and participatory land certification could have been higher if the land certificates had provided stronger rights. The current restrictions on land rights in the form of soil conservation requirements, prohibitions of tree planting on arable land, digging of sand, and mining of rocks, and the short duration of land rental contracts may undermine such benefits. Strengthening the rights towards such resources may be an important instrument to promote agricultural and non-agricultural development.

References

Alemu, T. (1999). Land Tenure and Soil Conservation: Evidences from Ethiopia. Unpublished Phd-Dissertation, Göteborg University, Göteborg.

ANRS (2000). "Amhara National Regional State (Anrs) Rural Land Administration and Use Proclamation." **Proclamation No. 46/2000**.

Bardhan, P. (1989). Alternative Approaches to the Theory of Institutions in Economic Development. In: P. Bardhan. The Economic Theory of Agrarian Institutions. New York, Oxford University Press.

Barrows, R. and M. Roth (1990). "Land-Tenure and Investment in African Agriculture - Theory and Evidence." Journal of Modern African Studies **28**(2): 265-297.

Barzel, Y. (1997). Economic Analysis of Property Rights. Cambridge, UK, Cambridge University Press.

Basu, K. (1992). "Limitted Liability and the Existance of Share Tenancy." Journal of Development Economics **38**: 203-220.

Bell, C. (1990). "Reforming Property Rights in Land and Tenancy." The World Bank Research Observer **5**(2): 143 - 166.

Besley, T. (1995). "Property-Rights and Investment Incentives - Theory and Evidence from Ghana." Journal of Political Economy **103**(5): 903-937.

Besley, T. and R. Burgess (2000). "Land Reform, Poverty Reduction, and Growth: Evidence from India." Quarterly Journal of Economics **115**(2): 389-430.

Bezabih, M. and S. T. Holden (2006). Tenure Insecurity, Transaction Costs in the Land Lease Market and Their Implications for Gendered Productivity Differentials. The 26th International Conference of the International Association of Agricultural Economists, Brisbane, Australia. .

Binswanger, H. P. and J. McIntire (1987). "Behavioral and Material Determinants of Production Relations in Land-Abundant Tropical Agriculture." Economic Development and Cultural Change **36**(1).

Binswanger, H. P. and M. Rosenzweig (1986). "Behavioural and Material Determinants of Production Relations in Agriculture." Journal of Development Studies **22**: 503-539.

Bliss, C. J. and N. H. Stern (1982). Palanpur: The Economy of an Indian Village. Delhi and New York, Oxford University Press.

Bonfiglioli, A. (2003). Empowering the Poor: Local Governance for Poverty Reduction. New York, United Nations Capital Development Fund (UNCDF).

Bromley, D. W. (1991). Environment and Economy: Property Rights and Public Policy. Oxford & Cambridge, Blackwell.

Coase, R. H. (1960). "The Problem of Social Cost." The Journal of Law and Economics **III**: 1 - 44.

Cotula, L., S. Vermeulen, R. Leonard and J. Keeley (2009). Land Grab or Development Opportunity? Agricultural Investment and International Land Deals in Africa, . London/Rome, International Institute for Environment and Development (IIED), FAO and IFAD.

Deininger, K. (2003). Land Policies for Growth and Poverty Reduction, Oxford University Press US.

Deininger, K. (2003). Land Policies for Growth and Poverty Reduction. A publication of the World Bank and Oxford University Press, The World Bank.

Deininger, K., D. A. Ali and T. Alemu (2008). Land Rental Markets: Transaction Costs and Tenure Isecurity in Rural Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Deininger, K., D. A. Ali and T. Alemu (2008b). Impacts of Land Certification on Tenure Security, Investment, and Land Markets: Evidence from Ethiopia. Policy Research Working Paper No. 4764, Washington, D.C., The World Bank.

Deininger, K., D. A. Ali and T. Alemu (2009). Land Rental Markets: Transaction Costs and Tenure Isecurity in Rural Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Deininger, K., D. A. Ali, S. Holden and J. Zevenbergen (2008). "Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries." World Development **36**(10): 1786-1812.

Deininger, K. and H. Binswanger (1999). "The Evolution of the World Bank's Land Policy: Principles, Experience, and Future Challenges." World Bank Research Observer **14**(2): 247-276.

Deininger, K. and H. P. Binswanger (1999). "The Evolution of the World Bank's Land Policy: Principles, Experience and Future Challenges." The World Bank Research Observer **14**(2): 247-276.

Deininger, K. and G. Feder (1998). Land Institutions and Land Markets, The World Bank, Development Research Group, Rural Development.

Deininger, K., S. Jin, B. Adenw, S. Gebre-Selasie and M. Demeke (2003). Market and Non-Market Transfers of Land in Ethiopia: Implication for Efficiency, Equity, and Non-Farm Development, Policy Research Working Paper Series 2992, The World Bank.

Deininger, K. and S. Q. Jin (2006). "Tenure Security and Land-Related Investment: Evidence from Ethiopia." European Economic Review **50**(5): 1245-1277.

Demsetz, H. (1967). "Toward a Theory of Property Rights." Journal of American Economic Review **LVII**(2).

Eggertsson, T. (1990). Economic Behavior and Institutions. Cambridge, New York, Cambridge University.

FAO (2009). From Land Grab to Win-Win: Seizing the Opportunities of International Investment in Agriculture. Rome, FAO Economic and Social Perspectives - Policy Brief No. 4.

FDRE (1997). Rural Land Administration Proclamation of the Federal Government of Ethiopia. Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia. **Proclamation No. 89/1997**.

Feder, G. and D. Feeny (1991). "Land Tenure and Property Rights: Theory and Implications for Development Policy." The World Bank Economic Review **5**(1): 135-153.

Feder, G. and R. Noronha (1987). "Land Rights System and Agricultural Development in Sub-Saharan Africa." The World Bank Research Observer **2**(2): 143 - 169.

Gavian, S. and M. Fafchamps (1996). "Land Tenure and Allocative Efficiency in Niger." American Journal of Agricultural Economics **78**(May): 460-471.

Gebremedhin, B., J. L. Pender and S. Ehui (2003). Land Tenure and Land Management in the Highlands of Ethiopia. The Second EAF International Symposium on Contemporary Development Issues in Ethiopia, Addis Ababa, Ethiopia, Center for African Development Policy Research.

Ghebru, H. and S. T. Holden (2009). Reverse-Share-Tenancy and Marshallian Inefficiency: Eviction Power of Landowners and the Sharecropper's Productivity. In. Unpublished Manuscript, Norwegian University of Life Sciences, Department of Economics and Resource Management, Ås.

Ghebru, H. H. and S. T. Holden (2008). Factor Market Imperfections and Rural Land Rental Markets in Northern Ethiopian Highlands. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Hayami, Y. (1997). Development Economics: From the Poverty to the Wealth of Nations. Oxford, UK, Oxford University Press.

Hayami, Y. and K. Otsuka (1993). The Economics of Contract Choice: An Agrarian Perspective. Oxford, Clarendon press.

Hoben, A. (2000). Ethiopian Rural Land Tenure Policy Revisited. Paper Presented at the Symposium for Reviewing Ethiopia's Economic Performance 1991 - 1999. Organized by Inter-Africa Group. Addis Ababa. April 26 - 29.

Hoff, K., A. Braverman and J. E. Stiglitz (1993). Introduction. In: K. Hoff, A. Braverman and J. E. Stiglitz. The Economics of Rural Organizations. Oxford, Oxford University Press.

Holden, S., B. Shiferaw and J. Pender (2001). "Market Imperfections and Land Productivity in the Ethiopian Highlands." Journal of Agricultural Economics **52**(3): 53-70.

Holden, S. and H. Yohannes (2002). "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." Land Economics **78**(4).

Holden, S. T. (2007). Growing Importance of Land Tenancy and Its Implications for Efficiency and Equity in Africa. In: E. Bulte and R. Ruben. Development Economics between Markets and Institutions: Incentives for Growth, Food Security and Sustainable Use of the Environment. Wageningen, Wageningen Academic Publishers. **4**.

Holden, S. T. and M. Bezabih (2008). Gender and Land Productivity on Rented Land in Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T., K. Deininger and H. H. Ghebru (in press). "Tenure Insecurity, Gender, Low-Cost Land Certification and Land Rental Market Participation in Ethiopia." Journal of Development Studies.

Holden, S. T. and H. Ghebru (2005). Kinship, Transaction Costs and Land Rental Market Participation. In. Working Paper, Norwegian University of Life Sciences. Ås.

Holden, S. T., K. Otsuka and F. M. Place (2008). The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T., K. Otsuka and F. M. Place (2008). Land Markets and Development in Africa. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

IFAD (2001). The Challenge of Ending Rural Poverty - Rural Poverty Report 2001. Rome, International Fund for Agricultural Development (IFAD).

Janvry, A. d., M. Fafchamps and E. Sadoulet (1991). "Peasant Household Behavior with Missing Markets: Some Paradoxes Explained." The Economic Journal **101**: 1400-1417.

Janvry, A. d., G. Gordillo, J.-P. Platteau and E. Sadoulet (2001). Access to Land, Rural Poverty, and Public Action. In: A. d. Janvry, G. Gordillo, J.-P. Platteau and E. Sadoulet. Access to Land, Rural Poverty, and Public Action. Oxford, Oxford University Press**:** 1 - 26.

Kranton, R. E. (1996). "Reciprocal Exchange: A Self-Sustaining System." American Economic Review **86**(4): 830-851.

Larson, B. A. and D. W. Bromley (1990). "Property Rights, Externalities, and Resource Degradation." Journal of Development Economics **33**: 235-262.

Libecap, G. D. (1989). Contracting for Property Rights, Cambridge University Press.

Migot-Adholla, S. E., G. Benneh, F. Place and S. Atsu (1994). Land, Security of Tenure, and Productivity in Ghana. In: J. W. Bruce and S. E. Migot-Adholla. In Searching for Land Tenure Security in Africa. Dubuque, IA, Kendall/Hunt.

ONRS (2003). "Oromia National Regional State (Onrs) Rural Land Use and Administration Proclamation." Megelta Oromia **Proclamation No. 56/2003**.

Ostrom, E. (2001). The Puzzle of Counterproductive Property Rights: A Conceptual Analysis. In: A. d. Janvry, G. Gordillo, J.-P. Platteau and E. Sadoulet. Access to Land, Rural Poverty, and Public Action. Oxford, Oxford University Press: 129 - 150.

Otsuka, K. (2007). Efficiency and Equity Effects of Land Markets. In. Handbook of Agricultural Economics, Elsevier.

Otsuka, K., H. Chuma and Y. Hayami (1992). "Land and Labor Contracts in Agrarian Economics: Theories and Facts." Journal of Economic Literature **30(4)**(December): 1965-2018.

Otsuka, K., a. H. Chuma and Y. Hayami (1992). "Land and Labour Contracts in Agrarian Economies: Theories and Facts." Journal of Economic Literature **30**: 1965-2018.

Otsuka, K. and Y. Hayami (1988). "Theories of Share Tenancy: A Critical Survey." Economic Development and Cultural Change **37**(1): 32-68.

Pender, J. and M. Fafchamps (2006). "Land Lease Markets and Agricultural Efficiency in Ethiopia." Journal of African Economies **15(2)**: 251-284.

Place, F. and P. Hazell (1993). "Productivity Effects of Indigenous Land-Tenure Systems in Sub-Saharan Africa." American Journal of Agricultural Economics **75**(1): 10-19.

Platteau, J.-P. (1996). "The Evolutionary Theory of Land Rights as Applied to Subsaharan Africa: A Critical Assessment." Development and Change **27**(1): 29-86.

Rahmato, D. (1984). Agrarian Reform in Ethiopia. Uppsala, Scandinavian Institute of African Studies.

Ruttan, V. W. (1989). "Institutional Innovation and Agricultural Development." World Development **17**(9): 1375-1387.

Sadoulet, E., A. de Janvry and S. Fukui (1997). "The Meaning of Kinship in Sharecropping Contracts." American Journal of Agricultural Economics **79**(May): 394-407.

Sadoulet, E. and A. d. Janvry (1995). Quantitative Development Policy. Baltimore and London, Johns Hopkins University Press.

Sadoulet, E., R. Murgai and A. de Janvry (2001). Chapter 8: Access to Land Via Land Rental Markets. In: G. G. d. A. Alain de Janvry, Elisabeth Sadoulet, Jean-Phillipe Platteau. Access to Land, Rural Poverty, and Public Action, Oxford University Press: 196-219.

Schlager, E. and E. Ostrom (1992). "Property-Rights Regimes and Natural-Resources: A Conceptual Analysis." Land Economics **68**(3): 249-262.

Shiferaw, B. and S. T. Holden (1998). "Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands: A Case Study in Andit Tid, North Shewa." Agricultural Economics **18**: 233-247.

Shiferaw, B., G. Obare and G. Muricho (2008). "Rural Market Imperfections and the Role of Institutions in Collective Action to Improve Markets for the Poor." Natural Resource Forum **32**(1): 25 - 38.

Singh, I., L. Squire and J. Strauss, Eds. (1986). Agricultural Household Models: Extensions, Applications and Policy. Washington, D.C., The World Bank and The John Hopkins University Press.

Skoufias, E. (1995). "Household Resources, Transactions Costs, and Adjustment through Land Tenancy." Land Economics **71**(1): 42-56.

SNNPRS (2003). "Sourthern Nations, Nationalities and Peoples Regional State (Snnprs) Rural Land Administration Proclamation." **Proclamation No. 52/2003**.

Stiglitz, J. E. (1974). "Incentives and Risk Sharing in Sharecropping." Review of Economic Studies **41**(2): 219-255.

Stiglitz, J. E. (1986). "The New Development Economics." World Development **14**(2): 257-265.

Tadesse, M. A., S. T. Holden and R. Øygard (2009). Contract Chioce and Poverty in Southern Highlands of Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Teklu, T. and A. Lemi (2004). "Factors Affecting Entry and Intensity in Informal Rental Land Markets in Southern Ethiopian Highlands." Agricultural Economics **30**: 117-128.

TNRS (1997). Rural Land Use Proclamation of the Tigray National Regional State. Negarit Gazetta of the Council of Tigray National Regional State. Mekelle, Ethiopia. **Proclamation No. 23/1989 (EC)**.

Zimmerman, F. J. and M. R. Carter (1999). "A Dynamic Option Value for Institutional Change: Marketable Property Rights in the Sahel." American Journal of Agricultural Economics **81**(2): 467-478.

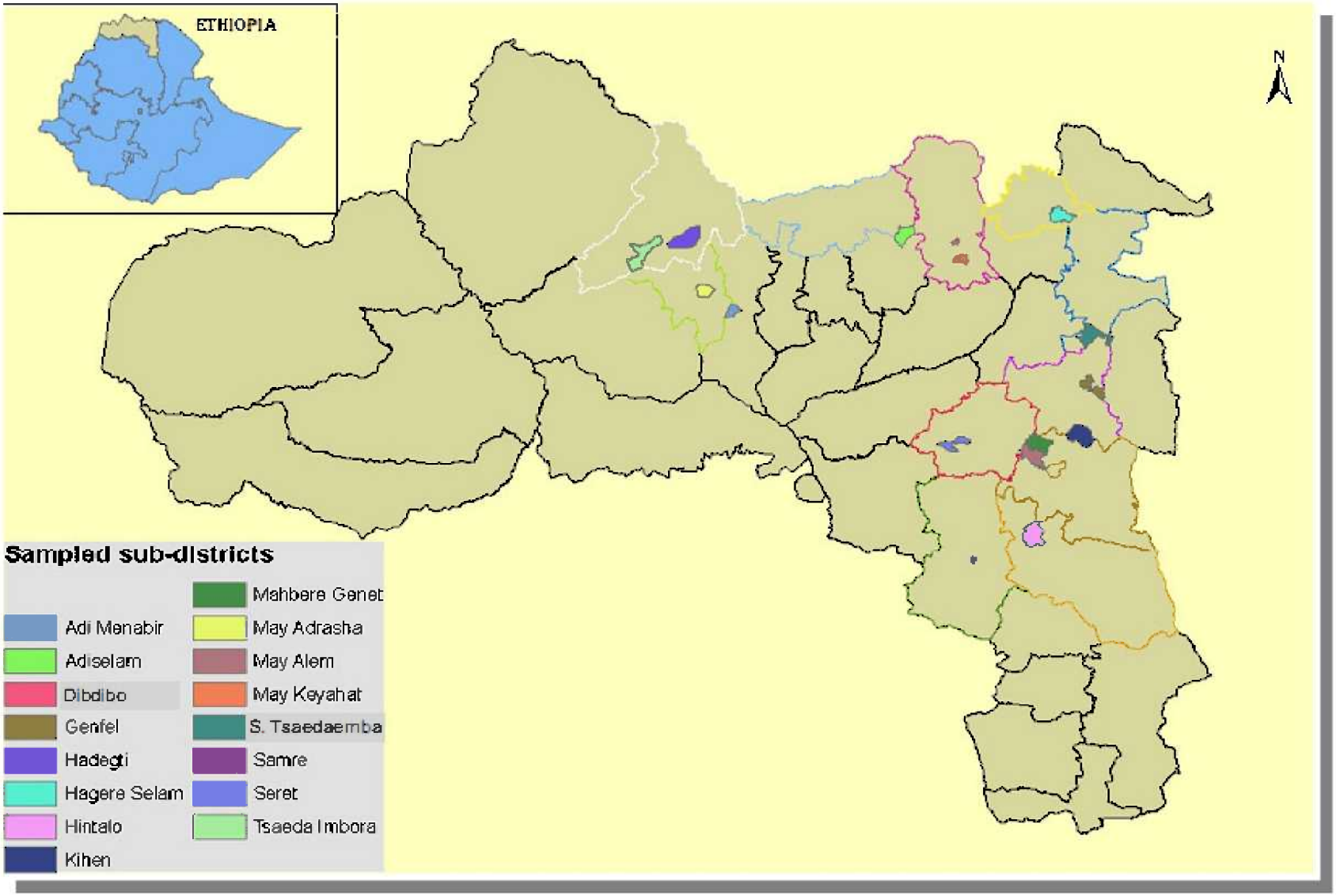


Figure 3: Map of the Tigray National Regional State and the sampled villages

Paper 1

CHAPTER 4

Factor Market Imperfections and Rural Land Rental Markets in Northern Ethiopian Highlands

Hosaena Ghebru and Stein Holden

When markets are perfect, renting and buying land are closely related. Tenants pay rent to landlords and buyers pay equivalent amounts to banks as interest to loans. In a world, however, with asymmetric information (costly or unavailable) and imperfections in capital and various agricultural input markets, there are good reasons for farm households to prefer transferring land through land lease markets rather than through the formal land sales markets (Sadoulet et al 1998; Chapters 1 and 2).

Besides the acute market imperfections for nonland factors of production due to high transaction costs, the Ethiopian constitution of 1995 gives the land rental markets an exceptional role. The constitution which bans any land sales make the land rental market the core venue of land transfer among farmers alongside the alternative land transfer mechanisms of inheritance, land takings for investment purposes, and redistribution of communal lands

Rural land tenancy markets have received ample attention, both theoretically and empirically but much of the attention has focused on the efficiency aspects of alternative land tenure contracts (Otsuka et al. 1992; Singh 1989; Otsuka and Hayami 1988; Pender and Fafchamps 2006; Stiglitz 1974; Sadoulet et al. 1998; Gavian and Ehui 1999 and Ahmed et al. 2002). The majority of studies, however, fail to address the primary reasons behind the firsthand decision of households' participation in the tenancy market in an imperfect world.

In such a world, due to adverse selection and moral hazard problems, the tenancy market may not clear with a market clearing price. This may be due to high transaction costs for the landlords and may cause households who want to lease in land to be rationed out (Bell and Sussangkarn 1988). Bliss

In S.T. Holden, K. Otsuka and F.M. Place, eds. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) Publisher. 2008.

and Stern (1982) suggested that sharecropping involves moral hazard problems and a strong likelihood of rationing. Sharecropping implies absence of a market clearing price in the land rental market and this leads to an asymmetry between the two sides of the market (landlords and tenants) and to rationing on the tenant side of the market. Empirical studies by Skoufias (1995), Tikabo and Holden (2004), and Tikabo et al. (2008), and other chapters in this book essentially assess whether factor market imperfections create a rationale for the land rental market, and whether transaction costs in the land rental market prevent participation and complete adjustment in this market. In our study we provide additional evidence on the extent of rationing of participants and nonparticipants in the market.

The empirical literature on the land-leasing behavior of households is dominated by studies conducted in South and Southeast Asia, leaving sub-Saharan Africa (SSA) to be still underexplored. With particular reference to Ethiopia, despite the highly debated issue of the land tenure system that has lasted for several decades, few studies have been conducted that address the allocative efficiency of land tenancy markets. Exceptions include Ahmed et al. (2002), Pender and Fafchamps (2006), Deininger (2003), and Teklu and Lemi (2004), but the findings from these earlier studies are inconclusive because of data limitations and methodological weaknesses. This chapter adds to these studies by assessing the role of factor market imperfections (transaction costs) in dictating the likelihood and intensity of participation on both sides (demand and supply sides) of the tenancy market. Specifically, the chapter empirically explores the extent to which rationing problems may affect adjustment and allocative efficiency in the land rental market.

The following three broad objectives will be discussed: (1) to investigate factors that affect farm households' likelihood of participation (market entry); (2) to assess the efficiency of factor ratio adjustment through the land rental market (intensity of participation): and (3) to examine the extent of transaction costs, rationing, and asymmetry in the land rental market. We address these issues by analyzing household survey data from a random sample of 400 households from 16 villages in the Tigray region in the northern highlands of Ethiopia collected in 2003.[1] Conceptually we build on the theoretical models in Chapter 2.

*Hypotheses**

Our basic hypothesis is that, in an attempt to adjust farm input combinations, the persistence of relatively high imperfections in nonland factor markets as compared to the informal land markets enhances farm households' participation and level of transaction in the land rental market. Therefore, the distribution of nontradable or semi-tradable inputs may play a dominant role in rural household decisions to participate in land lease markets as well

* See Appendix 1 for theoretical model

as their level of transaction. Our first hypothesis (H1) becomes: Landlords with low endowments of semi-tradable or nontradable inputs relative to their land holdings will look for potential tenants with high endowments of such farm inputs.

The semi-tradable/nontradability and skewed distribution of the nonland farm inputs among farm households cause farmland (physically immobile and fairly distributed factor) to be more mobile than nonland farm factors in an economic sense (contrary to their ease of physical mobility and highly skewed distribution) (hypothesis H2).

Significant transaction costs in the land rental market lead to incomplete adjustments of operational land related to owned land and other nonland semi-tradable and nontradable resources (hypothesis H3).

Kinship networks are important when property rights are weak and tenure insecurity is prevalent, as kinship relations provide mutual insurance and reduce market frictions (Sadoulet et al. 1998). Kinship ties among farm households, therefore, trigger more participation and enhance the degree of participation in the informal land lease market (hypothesis H4).

The asymmetry in the land lease market favors the landlord side of the market (hypothesis H5) such that tenants and potential tenants tend to be rationed and they thus achieve only partial adjustment toward their desired cultivated area.

The fragmented land holdings of farm households due to the rugged topography and land distribution policies of the past in Ethiopia, in combination with economies of scale on very small plot sizes in oxen-based cropping systems, cause nonconvex transaction costs in the land rental market. This leads to a preference for transacting whole plots rather than fine-tuning the areas rented in and out through the subdivision of plots for renting (hypothesis H6).

Estimation Methods

In order to test our hypotheses we used four dependent variables to identify the determinants of participation in the informal land rental market as well as farm households' intensity of land transactions. Two dummy dependent variables TENT and LLORD (identifiers for participants as tenants and landlords in the land rental market, respectively) and two variables, land leased in, LLI, and land leased out, LLO, have been used.

Our hypothesis was that oxen are important for tenants' access to the land rental market, whereas the area rented in is unaffected by the number of oxen owned by tenants. This implies that it is relevant to assess whether participation or access is determined by different variables than those determining the degree of participation. If trust and reputation are important

determinants of transaction costs in the market, earlier market participation may also be crucial for access but it may be less important for the degree of participation.

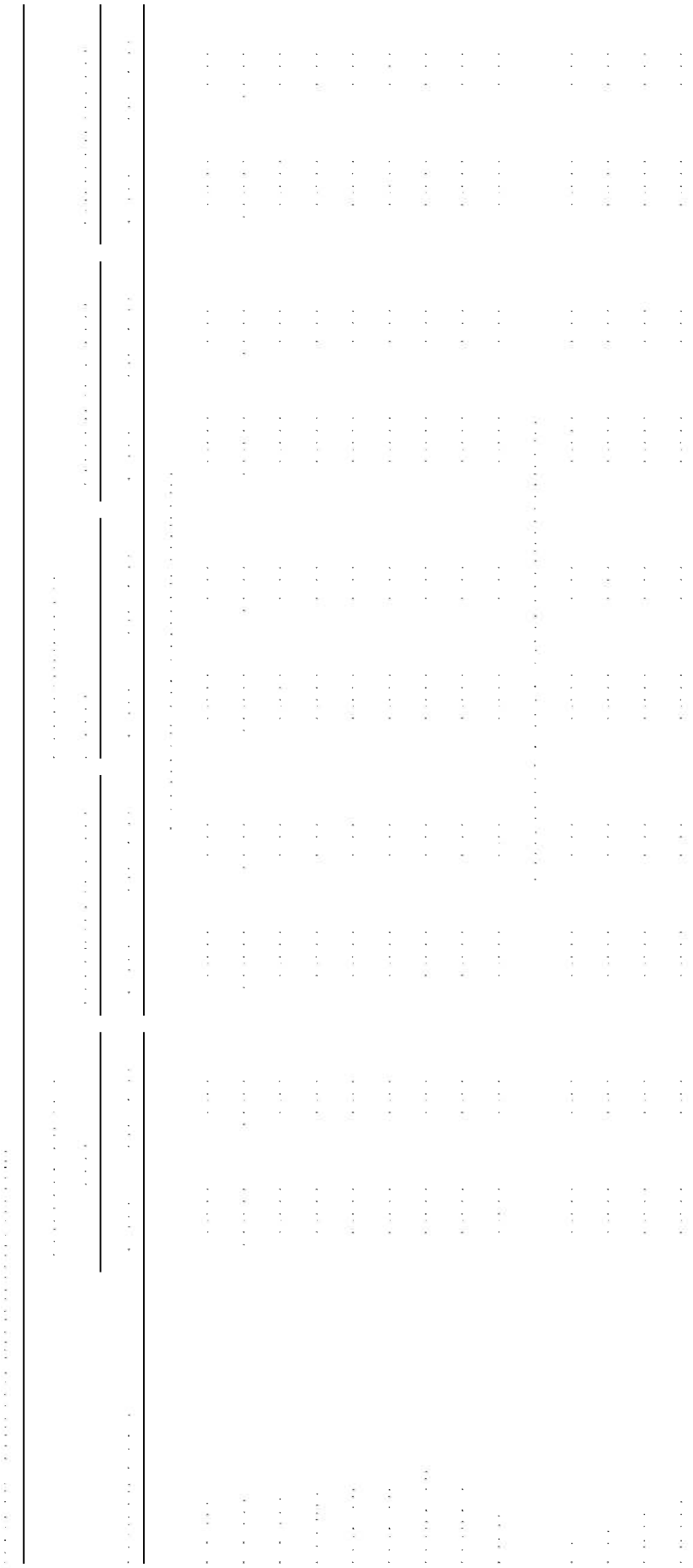
Consequently, we tested alternative econometric models to find out which specifications were most appropriate. First we tested censored tobit versus double-hurdle models, and since the tobit models were rejected in favor of the double-hurdle models, we tested for selection bias on both sides of the market separately. To test the robustness of results, alternative specifications were used, including models with and without a dummy variable for earlier market participation in the trade selection equation as well as in the second stage. Similarly, we ran the models with and without the oxen dummy variables in the second stage. Tables 4-5 and 4-6, seen later in this chapter, present the results without oxen dummy variables in the second stage. The estimated models with oxen dummy variables in the second stage are available upon request. Oxen are essential for land cultivation and are used in pairs. Oxen are therefore a lumpy essential input. Households without oxen may fail to cultivate their land because they cannot afford to buy oxen, and because the rental market for oxen plowing is missing, making it impossible to hire oxen. We also found a positive correlation between oxen and farm size. The lumpiness of oxen, then, makes it relevant to run alternative models with dummies for households with different numbers of oxen.

In all cases the censored tobit models were rejected in favor of double-hurdle models. On the tenant side, we found significant selection bias in all specifications. On the landlord side, we found no significant selection bias except in one of the specifications (not included here). Consequently, in order to control for selection bias related to unobservable characteristics, we used Heckman two-stage selection models.

Data and Descriptive Analyses

The data used in the analysis come from a stratified random sample of 16 villages (with a random sample of 25 farm households from each) covering the five administrative zones of the Tigray region of Ethiopia. The stratified sampling of villages was based on agricultural potential, population pressure, access to irrigation, and market access. The survey was conducted from May to July 2003 and data were collected for the 2002–2003 crop season.

Table 4-1 shows that the average farm size (*Lando*) is only 1.106 hectares and, on average, each household is endowed with 1.502 units of adult male labor (*Totmal*) and 1.701 tropical livestock units excluding oxen (*Tluox*) (see Table 4-2 for an explanation of variable names). The mean oxen endowment (*Ox*) of the surveyed households is as small as 0.89 (far less than the minimum requirement of a pair of oxen to fully engage in self-sufficient crop cultivation activity).



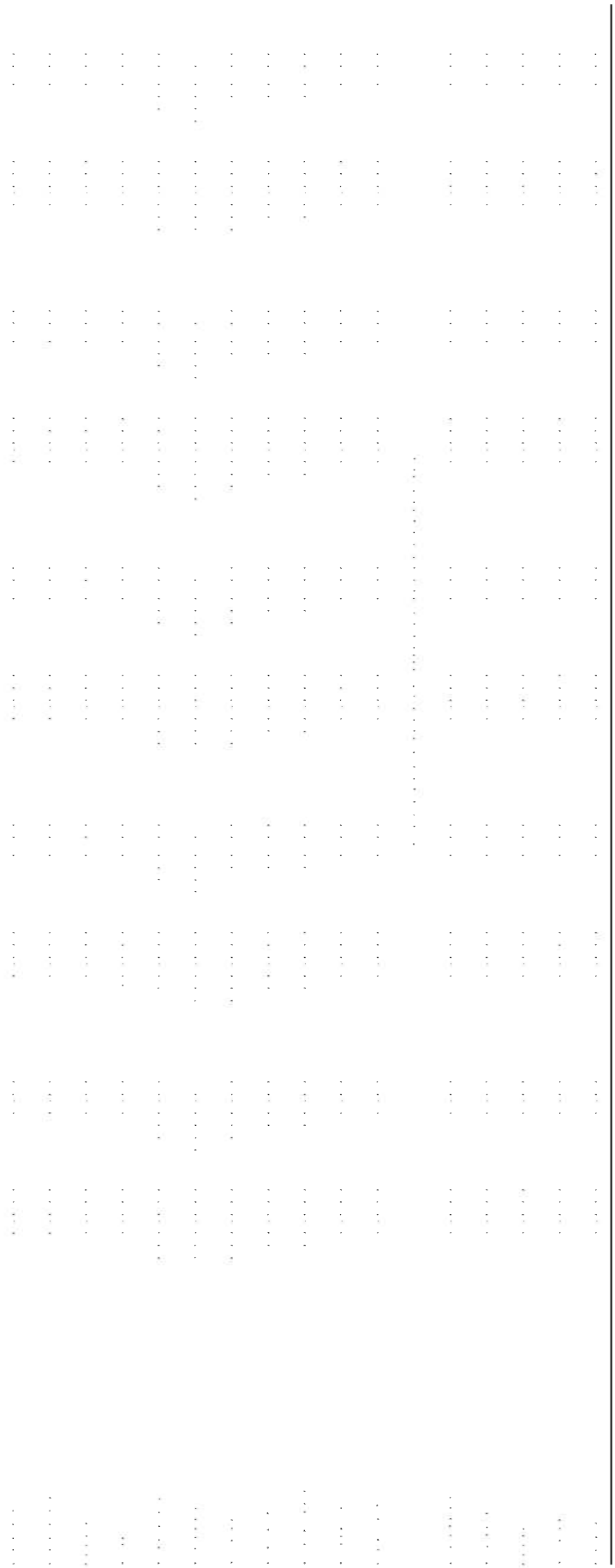


TABLE 4-2 Definition and description of variables used

Variable Name	*Variable Description*	*Variable Type*[1]
	Household level variables	
Hhhsex	Gender of the household head (1 = female, 0 = male)	d
Hhhage	Number of years age	c
Hhheduc	(1 = household head able to read and write, 0 = otherwise	d
Adulteq2	Adult equivalent family size	c
Kins3	Farm households who transact with kin-related partners only	d
Totmal	Number of adult males	c
Totmalp	Adult males per hectare of owned land	c
Totfemale	Number of adult females	c
Totfemp	Adult females per hectare of owned land	c
Kinrel	(1 = transact with kin-related partners only, 0 = otherwise	d
Ox1	Farm households with one ox	d
Ox2	Farm households with two oxen	d
Ox3	Farm households with three oxen	d
Ox4	Farm households with four oxen	d
Oxp	Oxen per hectare of owned land	c
Tluox	Tropical livestock unit other than oxen	c
Tluoxp	Tluox per hectare of owned land	c
Fs	Owned farm size	c
Fs-kins	Interaction variable of farm size with transactions among kin-related partners only	c
Irrlp1	Portion of irrigated land	c
Mktd	Household distance to major market (in minutes)	c
Road	Household distance to nearest road service (in minutes)	c
Ofdist	Distance to owned farm plots	c
Offma	Lagged off-farm employment activities	d
Lrmpb	Previous participation in the land rental market; 1 = yes, 0 = no	d
Lrmpbfs	Interaction variable of previous participation with farm size	c
	Village level variables	
Ecol	1 = if village is located above 2,000m above sea level, 0 = otherwise	d
Vgini	Gini coefficient showing land distribution within villages	c
Vilkin	Share of contracts that are among kin partners in the village	c
Irrg	Village access to irrigation projects	d
Mkt1	1 = if a village is located > 10km from major market, 0 = otherwise	d
Pop1	population density (1 if it is > 200 persons/km^2, 0 = otherwise)	d

d = discrete, c = continuous

As shown in Table 4-1, various farm household characteristics in our dataset provide some indications on the factors that affect the functioning of the land lease market, with the transacting households (tenants or landlords) having some distinct variations from the nontransacting households. We see that landlord households are more likely to be headed by females (55.1% against 27.8% for all households), but only 5.5% of the tenants were female-headed households. Landlord households also tended to have fewer oxen and other livestock than average, whereas tenants had more oxen and other livestock than average, pointing toward a situation with poor landlords and relatively wealthier tenants. Landlord households were also found to have less than average endowments of male labor, but tenants had an above-average amount of male labor and a below-average amount of female labor. The incidence of illiteracy was also higher among landlord households (77.5%) as compared to the 69% and 54% of the autarky and tenant household groups, respectively.

When it comes to land distribution, landlords did not have significantly more or less land than average, but tenants had a slightly above-average amount of land. It is therefore not typically the landless households that access land through the land rental market in Tigray. This may indicate that it is the inequitable distribution of nonland resources in form of oxen, other livestock, and male labor that is driving participation in the land lease market. A question then becomes: How will this situation, with relatively less wealthy and often female-headed landlord households and more wealthy and usually male-headed tenant households, affect their relative bargaining position and the extent of rationing in the tenancy market? Furthermore, we see that landlord households rented out, on average, about two-thirds of their land (*NLI* = net land leased in = –0.715 hectare), causing their average operational land holding (*Landop*) to be about 0.37 hectare while the average tenant increased his or her operational holding to 2.01 hectares.

The informal land tenancy market involved slightly more than half of the total respondents as landlords and tenants (24% and 29% of the total sample, respectively). Moreover, a large share of the respondents were reported as rationed households (about one-third of the total sample) that operated less than their optimal level (rationed tenants and potential tenants).

As shown in Table 4-3, nearly 53% of the sample respondents participated in the informal rural land tenancy market, which is active in all the sampled communities although with considerable degree of variations across villages, ranging from 16% (*Hagere-selam* village) to 83% (*Samre* village) among the sample respondents in each village. Using the data from the 2003 household survey, it is shown that most of the cultivated farm land area (81%) is under owner cultivation.

An overview of the extent of rationing on the two sides of the market is presented in Table 4-4. We see that rationing is much more prevalent on the tenant side, as 56% of the tenants against only 5% of the landlords considered themselves to be constrained in the market. In addition, as many as 33% of

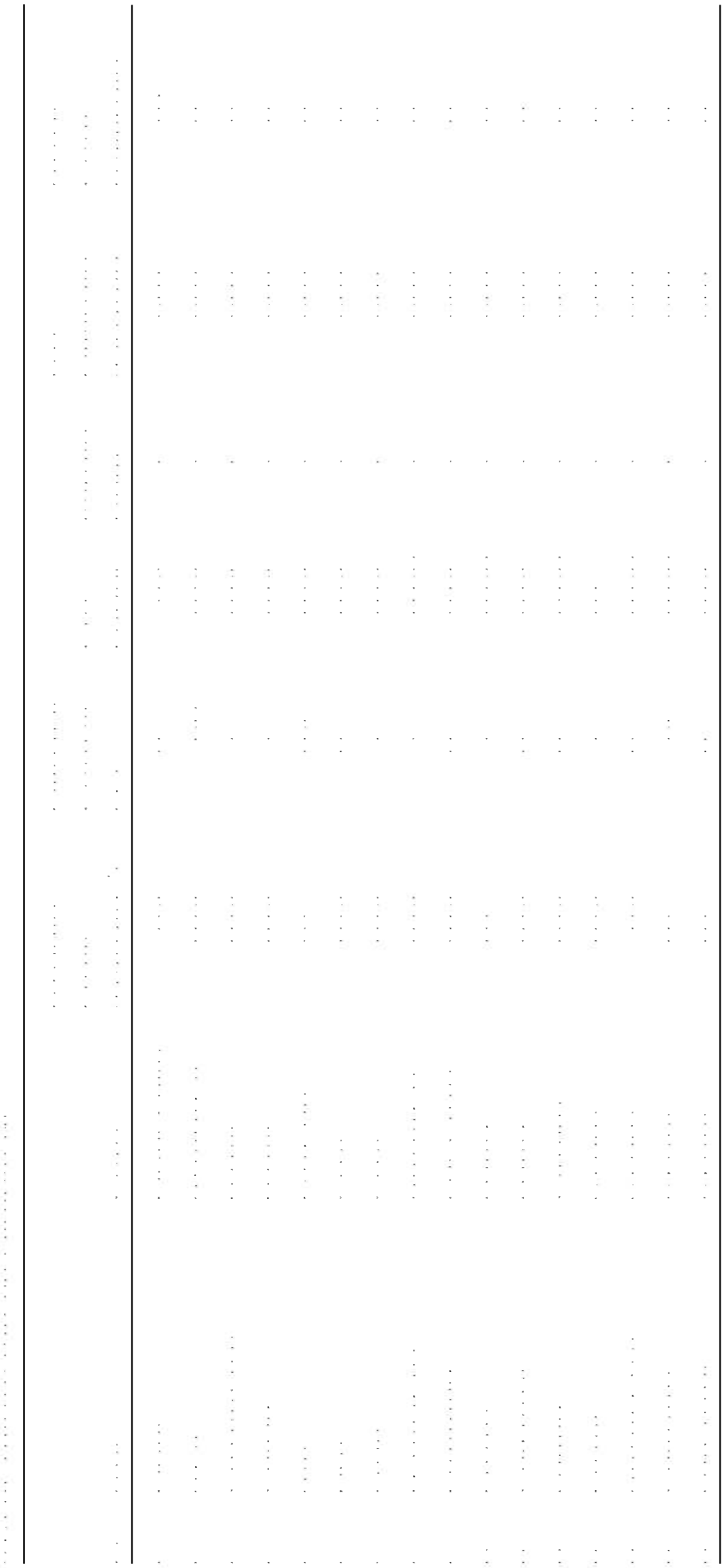


TABLE 4-4 Rationing on the two sides of the market

Supply Side of the Market		*Demand Side of the Market*	
Number of constrained landlords	4 (5%)	Number of constrained tenants[1]	61 (56%)
Amount of land leased-out	63.6 hectares	Amount of land leased-in	80.75 hectares
Desired land to lease out	65.1 hectares	Desired land to lease-in	126.5 hectares
Unfulfilled gap	1.5 hectares	Unfulfilled gap	45.75 hectares
% of the Actual—desired[2]	98%	% of the Actual—desired LLI	64%
Number of potential landlords	8 (5%)	Number of potential tenants	58 (33%)
Total sample respondents	89	Total sample respondents	109

[1]Farmers were explicitly asked, given their farming capacity, if they want to lease-in more amount of land.

[2]How much of their desired adjustment did farm households manage to satisfy through participation in the tenancy market.

the nonparticipating households wanted, but had failed, to enter the market as tenants, whereas this was the case for only 5% of the nonparticipants who wanted to participate in the market as landlords. The gap between the stated desired cultivated area and the actual rented area was also much larger on the tenant side than on the landlord side. This information appears to support our hypothesis HA5 about asymmetry and rationing in the tenancy market on the tenant side.

We also found that land transactions tended to be lumpy. Households preferred to rent out the entire plot. This indicates that the decision for each plot is whether to owner-cultivate or rent out each plot rather than deciding directly on area to rent out and then subdivide plots accordingly afterwards. There is typically a substantial distance from the homes of households and a number of their plots, although one plot tends to be located near or around the house. Typically, owners would first rent out the more distant plots, keeping the homestead plot as the last one to rent out. Since cultivation of a distant plot will require multiple visits and bringing along oxen and plows for repeated plowings and transportation of other inputs, and the output the related costs would be of a noncovex nature, the incentive would be not to further subdivide plots in line with our hypothesis HA6.

Results and Discussions

We will now turn to the econometric analysis that allows a more rigorous test of the allocative efficiency of the land rental market and the factors affecting it, while controlling for other variables as well as potential selection bias.

Likelihood of Participation

Supporting our basic hypothesis (HA1), the relative endowment of nonland farm inputs were found to significantly influence the household decisions to participate in the land lease market. As shown in Tables 4-5 and 4-6, the oxen dummies showing different numbers of oxen ownership (*ox1*, *ox2*, *ox3*, and *ox4*) were found to have strongly significant (at 5, 1, or 0.1% levels) effects on the participation in the market, whereas the effect of other livestock was less significant (significant at 5% level only at most). This may be because oxen are crucial for land cultivation, and landlords may not be willing to rent out their land to potential tenants who have no oxen. However, having one ox may be sufficient to go into collaboration with another farmer who also has one ox to form a pair of oxen needed for plowing. This may explain why the one ox dummy (*ox1*) had a significant positive effect on leasing in as well as a significant negative effect on leasing out decisions.

TABLE 4-5 Heckman two-step selection models for rented in plots: With bootstrapped standard errors

	ModH0	*ModH1*	*ModH2*
	b(se)	*b(se)*	*b(se)*
lli (**Land leased in equation**)			
fs	0.331(0.10)****	0.317(0.09)****	0.302(0.39)
road	0.001(0.00)	0.001(0.00)	0.001(0.00)
adulteq2	–0.127(0.10)	–0.103(0.09)	–0.103(0.09)
hhhsex	–0.179(0.33)	–0.122(0.34)	–0.123(0.32)
hhhage	–0.002(0.01)	–0.003(0.01)	–0.003(0.01)
hhheduc	–0.040(0.12)	–0.017(0.11)	–0.016(0.13)
totmale	0.076(0.11)	0.062(0.11)	0.062(0.11)
totfemale	0.273(0.16)*	0.241(0.16)	0.240(0.15)
tluox	0.030(0.03)	0.032(0.04)	0.032(0.03)
ofdist	0.002(0.00)	0.002(0.00)	0.002(0.00)
irrlp1	0.037(1.18)	0.091(1.12)	0.095(1.10)
offma	–0.001(0.12)	0.019(0.11)	0.020(0.11)
irrg	0.126(0.14)	0.138(0.14)	0.139(0.13)
mkt1	–0.202(0.12)*	–0.196(0.12)*	–0.197(0.12)
vgini	0.242(0.80)	0.513(0.78)	0.511(0.84)
pop1	0.070(0.13)	0.097(0.13)	0.097(0.13)
lrmpbfs			0.015(0.36)
Mills lambda	–0.319(0.13)**	–0.322(0.11)***	–0.319(0.15)**
Constant	0.677(0.46)	0.511(0.44)	0.509(0.47)
Trade selection equation			
fs	–0.049(0.16)	0.014(0.20)	0.014(0.19)
road	0.001(0.00)	0.001(0.00)	0.001(0.00)

TABLE 4-5 *(Cont.)*

	ModH0 *b(se)*	*ModH1* *b(se)*	*ModH2* *b(se)*
adulteq2	0.030(0.09)	0.040(0.09)	0.040(0.10)
hhhs	–0.929(0.33)***	–0.952(0.37)**	–0.952(0.38)**
hhha	–0.020(0.01)***	–0.014(0.01)	–0.014(0.01)*
hhhed	0.063(0.20)	0.117(0.24)	0.117(0.25)
totmalp	0.094(0.09)	0.121(0.10)	0.121(0.12)
totfemp	–0.002(0.08)	–0.014(0.10)	–0.014(0.09)
ox1	0.469(0.22)**	0.637(0.28)**	0.637(0.27)**
ox2	1.060(0.28)****	1.080(0.33)***	1.080(0.32)****
ox3	2.441(2.70)	2.702(2.73)	2.702(2.87)
ox4	7.851(0.62)****	7.298(0.52)****	7.298(0.56)****
tluoxp	0.091(0.05)*	0.068(0.07)	0.068(0.07)
ofdist	–0.002(0.00)	–0.004(0.01)	–0.004(0.01)
irrlp1	–1.502(2.31)	–0.873(3.20)	–0.873(2.60)
offma	–0.034(0.22)	0.012(0.27)	0.012(0.26)
irrg	–0.414(0.29)	–0.331(0.34)	–0.331(0.32)
mkt1	0.237(0.22)	0.035(0.24)	0.035(0.26)
vilkin	3.080(0.84)****	1.895(0.81)**	1.895(0.90)**
vgini	–1.921(1.53)	–1.715(1.73)	–1.715(1.79)
pop1	0.213(0.23)	0.078(0.26)	0.078(0.25)
lrmpb		1.634(0.35)****	1.634(0.35)****
Constant	–0.976(0.72)	–2.249(0.85)***	–2.249(0.81)***
Prob > chi2	0.000	0.000	0.005
Number of obs.	372	372	372

TABLE 4-6 Heckman two-step selection models for rented-out plots: With bootstrapped standard errors

	ModH0 *b(se)*	*ModH1* *b(se)*	*ModH2* *b(se)*
Llo (**Land leased out equation**)			
Fs	0.633(0.19)***	0.644(0.18)****	0.491(0.43)
Road	0.001(0.00)	0.000(0.00)	0.000(0.00)
Adulteq2	–0.020(0.07)	–0.023(0.07)	–0.023(0.07)
Hhhsex	0.262(0.20)	0.303(0.17)*	0.315(0.18)*
Hhhage	–0.001(0.00)	0.000(0.00)	0.001(0.00)
Hhheduc	0.043(0.12)	0.058(0.11)	0.063(0.11)
Totmale	0.137(0.11)	0.123(0.11)	0.122(0.11)
Totfemale	–0.039(0.09)	–0.028(0.08)	–0.026(0.09)
Tluox	–0.156(0.06)***	–0.180(0.05)****	–0.190(0.06)***

TABLE 4-6 *(Cont.)*

	ModH0 *b(se)*	*ModH1* *b(se)*	*ModH2* *b(se)*
Ofdist	0.001(0.00)	0.002(0.00)	0.002(0.00)
Irrlp1	–0.200(0.60)	–0.173(0.62)	–0.180(0.55)
Offma	0.086(0.15)	0.122(0.12)	0.138(0.13)
Irrg	0.197(0.14)	0.232(0.13)*	0.237(0.14)*
Mkt1	0.035(0.12)	0.051(0.11)	0.063(0.11)
Vgini	1.251(1.03)	1.350(0.89)	1.331(0.96)
Pop1	0.043(0.10)	0.069(0.09)	0.077(0.09)
Lrmpbfs			0.152(0.43)
Mills lambda	–0.116(0.21)	0.022(0.13)	0.075(0.22)
Constant	–0.406(0.76)	–0.692(0.59)	–0.773(0.67)
Trade selection equation			
Fs	–0.049(0.22)	–0.015(0.21)	–0.015(0.22)
Road	0.001(0.00)	–0.001(0.00)	–0.001(0.00)
Adulteq2	–0.048(0.10)	–0.031(0.09)	–0.031(0.10)
Hhhsex	0.284(0.31)	0.339(0.33)	0.339(0.37)
Hhhage	0.012(0.01)*	0.020(0.01)**	0.020(0.01)**
Hhheduc	0.009(0.27)	0.098(0.27)	0.098(0.27)
Totmalp	–0.232(0.13)*	–0.238(0.14)*	–0.238(0.15)
Totfemp	0.043(0.09)	0.054(0.10)	0.054(0.10)
Ox1	–0.800(0.23)****	–0.718(0.27)***	–0.718(0.29)**
Ox2	–1.240(0.99)	–1.268(0.99)	–1.268(0.75)*
Ox3	–5.965(0.33)****	–6.514(0.41)****	–6.514(0.39)****
Ox4	–5.708(0.47)****	–5.964(0.44)****	–5.964(0.51)****
Tluoxp	–0.125(0.09)	–0.190(0.10)*	–0.190(0.10)**
Ofdist	0.006(0.01)	0.006(0.00)	0.006(0.00)
Irrlp1	–0.154(1.96)	–0.322(2.08)	–0.322(2.00)
Offma	0.402(0.26)	0.426(0.26)	0.426(0.24)*
Irrg	0.315(0.32)	0.264(0.35)	0.264(0.37)
Mkt1	0.445(0.25)*	0.383(0.27)	0.383(0.28)
Vilkin	1.706(0.93)*	0.034(0.96)	0.034(0.95)
Vgini	–0.310(1.84)	–0.746(2.05)	–0.746(1.78)
Pop1	0.330(0.21)	0.151(0.28)	0.151(0.27)
Lrmpb		1.595(0.60)***	1.595(0.39)****
Constant	–1.983(0.74)***	–2.820(1.04)***	–2.820(0.84)****
Prob > chi2	0.000	0.000	0.000
Number of obs.	372	372	372

This result supports our basic hypothesis of the nontradability/semi-tradability of nonland farm inputs triggers farm household participation in the tenancy market. The result may indicate that there are higher transaction costs in the oxen rental market than in the land tenancy market. This finding is supported by the fact that 43% of the sample respondents were reported to have no oxen and yet only 11.5 % of them engaged in the oxen rental market. The significant (5 or 10% level) and negative coefficient of ownership of other livestock per unit of own land (*tluoxp*) in the supply side of the market indicates that households with more endowment of animals other than oxen are less likely to rent out their land. Households with relatively higher endowment of such animals may be forced to operate their own land to produce enough fodder to feed their animals, since, more often than not, fodder (crop residues) is taken by plot tillers (tenants) unless it is agreed to be shared with the landlord during the tenancy contract.

The coefficients showing household relative endowments of labor (*Totmalp* and *Totfemp*) were found to be statistically insignificant in the leasing in models, whereas male labor was significant (10% level only) and with a negative sign in two of the leasing-out models. This may imply that transaction costs are relatively lower in the labor market, but the fact that the sex of household head (*hhhs*) and age of head of household (*hhha*) variables were significant and with negative signs in the tenant models (Table 4-5) are also signs of imperfections and significant transaction costs in the labor market. This may be particularly important for female-headed households that lack male labor, since females are not allowed to plow with oxen. Perhaps this is because landlords have less trust in female-headed households as land managers. Potential female-headed tenant households may therefore have been totally rationed out of the market even if they had the necessary oxen endowment for farming. The insignificance of the labor variables may also partly be explained by the relative abundance of labor in most households.

The age of the household head (*Hhha*) variable could also have been interpreted as an indicator variable for farm experience. However, it was found to have a significant effect on both sides of the market such that the older the age of the household head, the higher the probability of renting out land, and the younger the household head, the higher is the likelihood of leasing in land. Older age, then, seems to capture less working capacity than more and better farm skills.

The regression results also show previous participation in the market for tenancies to have a significant positive effect on current probability of participation in both sides of the market. This attests our *a priori* expectation that households well acquainted with the existing tenancy market (having insiders' market information) are more likely to face a lower entry barrier in the tenancy market than others. Perhaps this is due to the high initial cost (fixed transaction cost) an agent may face when first attempting to enter the market. We refer the reader to Holden and Ghebru (2006) for a more comprehensive

theoretical treatment of the relationship between kinship, transaction costs, and market participation and to Holden et al. (2007a) for a more rigorous analysis of the change in market participation over time.

In line with our hypothesis HA4, kinship (social network) was found to have a positive impact in reducing the entry barriers for tenant households. We hypothesized that trust may be higher among kin and therefore factor adjustment through land market would be smoother in kin contracts. This could imply that the land rental market functions better in villages with a high share of kinship contracts. The highly significant and positive coefficient of the *vilkin* variable in Table 4-5 shows that the land rental market functions significantly better in villages with high share of kinship contracts by improving the access to the market for tenants. The *vilkin* variable was significant in only one of the models and at 10% only on the landlord side. This shows that kinship contracts may primarily help potential tenants to enter the market because rationing is more severe on this side of the market.

The regression results on the supply side (Table 4-6) provide some weak evidence that households that engaged more in off-farm income-generating schemes were more likely to rent out their land (significant at 10% level only in some model specifications). This may also indicate that there were imperfections in the labor market since extra ("high-pay") off-farm income was not used to hire ("low-pay") labor to substitute for lost household labor in farming. There are additional transaction costs related to hiring and monitoring hired labor, and such costs may be even higher for households engaged in off-farm work than for other households.

Intensity of Market Participation

Area leased out. We found (Table 4-6) that the tropical livestock units other than oxen (*tluoxp*) variable had a strongly significant negative effect on land area leased out by landlord households. Households with more livestock may need the land themselves for fodder production and may also be more wealthy and depend less on renting out land as a source of income and food.

The Heckman selection models in Table 4-6 also indicate that the amount of land leased out was positively correlated with farm size. This result is robust across the various model specifications except when the earlier market participation (*lrmpbfs*) variable is included in the lease-out equation. To examine whether landlord households adjust their factor endowment smoothly through the land rental market or not, we assess the size of the coefficient on the farm size variable and whether it is significantly different from 1.0 in the lease-out models, which is expected with a perfect land tenancy market with zero transaction costs, a linear response to nonland factors of production and constant returns to scale. In the first two models in Table 4-6, where the earlier market participation (*lrmpbfs*) variable was left out, the coefficient was significantly lower than 1 (0.63–0.64) and significantly different from 1,

but when we controlled for earlier market participation, the coefficient was reduced to 0.49 while the standard error became inflated, making the coefficient insignificantly different from 0 and 1. The earlier market participation variable was highly significant in the trade selection equation but was insignificant in the lease-out equation, probably due to its multicollinearity with farm size, making it appropriate to leave it out in the second stage. In the models that included oxen dummy variables in the second stage (not shown here), the earlier market participation variable was significant in the trade selection as well as in the lease-out equation, and its inclusion in the second stage also made the Mills lambda variable highly significant. Again, the farm size variable became insignificantly different from 0 and even changed signs to become negative. We therefore rely on the other model specifications in our analysis. With the inclusion of oxen dummy variables, the coefficients on farm size increased to 0.70 but still significantly less than 1 (at 10% level only). This may be interpreted as there being significant transaction costs that cause only partial adjustment on the landlord side. Such transaction costs may be related to searching for and finding trustworthy tenants.

Area leased in. The farm size variable was the only variable that was highly significant in the land-leased-out models in Table 4-5. Based on our theoretical model in Chapter 2, we expected that the area leased in would be lower the larger the own farm size is. Perhaps surprisingly, we found that the farm size variable was highly significant and with a positive sign in the first two model specifications. It remained positive, with about the same size in the third model specification where the earlier market participation variable was included in the lease-in equation but it became insignificantly different from zero. One explanation that we can suggest for this contradictory result is that some of the basic theoretical assumptions are violated (constant returns to scale). The other explanation is the rationing going on in the market such that primarily well-established households that have oxen and that also tend to have larger farm sizes are those that have access to the market as tenants. It is possible that there are economies of scale in production at such small farm sizes due to the lumpiness of oxen and the essential role oxen play in land cultivation. A certain farm size may be necessary to meet the feed requirement of the oxen, making it harder for relatively smaller farms to keep oxen and thus forcing them to rent out their land. Furthermore, female-headed households, who are female-headed because the women lost their husbands or got divorced, may have less land than male-headed households due to the rule of dividing the land such that the widow or divorced woman keeps only half of the land the couple had before. This may cause a correlation between farm size, sex of household head, and ownership of oxen.

We found that households with more female labor rented in significantly more land (significant at 10% level in only one of the model specifications). We also found in two of the models that tenants with better access to major

markets (*mkt1* = 1) were found to rent in significantly less land than those with poorer market access. This may be due to more lucrative employment opportunities in locations with better market access.

Market Symmetry and Rationing

A market symmetry test[2] has been made using the approach of Skoufias (1995), applying it on the censored tobit models. The results of the various Wald tests conducted to test market symmetry (the equality of coefficients on both sides of the market) are presented in Table 4-7 and show that the hypothesis of sym-

TABLE 4-7 Tests of market symmetry on intensity of participation in LRM (Wald test of equality of coefficients)

Hypotheses Tested	*Wald Statistic (R)*
Simultaneous equality of variables ($r = 19$)	132.36***
Individual variable tests (r = 1 for each)	
Fs	*16.21***
Road	*2.33*
Adulteq2	*3.85**
Kins3	*6.18***
Hhhsex	*1.53*
Hhhage	*5.25***
Hhheduc	*0.04*
Totmale	*4.89***
Totfemale	*0.82*
Ox	*0.3*
Tluox	*0.81*
Ofdist	*1.17*
Irrlp1	*0.63*
Offma	*0.56*
Lrmpb	*10.84****
Irrg	*2.81*
Mkt1	*7.91****
Vgini	*8.75****
Pop1	*1.99*

Note: r = number of restrictions

* significant at 10%; ** significant at 5%; and *** significant at 1%

metric resource adjustment in both sides (the demand and supply sides) of the tenancy market had to be rejected. This is also supported by the clear differences we found between the Heckman models on the two sides of the market as well as the descriptive analysis demonstrating rationing on the tenant side of the market. As shown in Table 4-7, the simultaneous test for the equality of all coefficients in the two sides of the market is rejected with a Wald statistic of 132.36, significant at 1% level. To identify the factors (variables) responsible for the asymmetric nature of the tenancy market, individual variable tests were made, comparing the two sides of the market. As the results reported in Table 4-7 show, variables like owned farm size (*fs*), village access to market (*Mkt1*), village distribution of land (*vgini*), previous participation in the tenancy market (*Lrmpbfd*), age of household head (*hhha*), and total male labor (*Totmal*) have been identified as variables with significant asymmetric roles in the market. These results suggest that the households' marginal responsiveness toward adjusting the desired cultivated area for these variables is not the same in each side of the market. Great caution, however, has to be exercised, since the results (tests) are entirely based on the censored tobit model that fails to capture the sample selection problem (selection bias) which was found significant especially on the tenant side of the market.

The preceding results, together with the findings in Tables 4-4, 4-5, and 4-6, give ample evidence that the tenancy market does not clear given a market clearing price. Rather, access and degree of access appear to depend on the resource endowments of households—especially oxen, earlier participation in the market, and the household's access to kin partners; and the level of trust and reputation that may depend on earlier market participation. Newcomers may face entry barriers, especially if they do not have oxen. Kinship relationships may help reduce these entry barriers. Finally, we should make the reservation that our analysis does not control for unobservable household and farm heterogeneity (Holden et al. 2007a). This is an area for future research using household panel data.

Conclusions

Our study in Tigray region in northern Ethiopia has demonstrated the importance of land rental markets for factor ratio adjustment in agriculture because of imperfections in nonland factor markets. The continued prohibition of land sales markets makes land rental transactions important for more long-term as well as short-term adjustments of factors of production across households. Ownership of oxen turned out to be a key determinant of land rental market participation as households without oxen typically failed to cultivate their land themselves and instead rented it out to households with oxen. The market for plowing services by oxen is severely constrained due to the lumpiness of oxen; the synchronized demand for oxen in rain-fed agriculture, which

is particularly important in semi-arid areas where rainfall is very limited and erratic; the crucial need of exact timing of farm operations relative to rainfall; and the moral hazard problem related to renting out oxen without the owner as a driver.

The household relative endowments of male and female labor were found to have weak effects on the likelihood of participation in both the demand and supply sides of the tenancy market. This may not be due to a well-functioning labor market, as off-farm labor opportunities are very scarce, but rather may be due to the relative abundance of household labor.

We found signs of significant transaction costs limiting the access to and the degree of adjustment in the land rental market. Although a high ratio of kinship contracts in the communities appeared to be associated with better functioning land rental markets, households that previously participated in the market appeared to face lower transaction costs in the market. Even though tenants were found to be wealthier than landlords, landlords controlled the market by selecting tenants such that many tenants and potential tenants perceived themselves to be rationed in the market, as a large share of them managed to rent in less land than they desired at the going contract conditions. The dominance of sharecropping may also help explain the lack of market clearing through a market clearing price.

The growing landlessness due to continued population growth, increasing land scarcity, and limited opportunity to further subdivide farms among children create an increasing demand for alternative employment opportunities and an increasing pressure on the land rental market. Our findings indicate, however, that there may be limited prospects for poor landless households to utilize the tenancy ladder as a way out of poverty since households without oxen and other farm endowments are likely to be rationed out of the market for tenancies. On the other hand, households that are poor in nonland endowments but that have land may benefit from the land rental market, for it enables them to get a higher income by renting out the land than they would have obtained by farming the land themselves. Many female-headed households belong to this category, and the land rental market has become an important source of livelihood and a safety net for these poor landlords. Thus, the salient conclusion of this chapter is that although the land rental market is imperfect, it works for the benefit of the poor and contributes to more efficient allocation of land among farm households.

Notes

1. Due to incompleteness of data and respondent dropouts, the entire analysis in this chapter considers 372 sample respondents only.
2. Testing for the equality on the two sides of the market with respect to the signs and size of parameters.

References

Ahmed, M. M., B. Gebremedhin, S. Benin and S. Ehui (2002). "Measurement and Sources of Technical Efficiency of Land Tenure Contracts in Ethiopia." Environment and Development Economics **7**: 507-527.

Alemu, T. (1999). Land Tenure and Soil Conservation: Evidences from Ethiopia. Unpublished Phd-Dissertation, Göteborg University, Göteborg.

.

Bell, C. and C. Sussangkarn (1988). "Rationing and Adjustment in the Market for Tenancies - the Behavior of Landowning Households in Thanjavur-District." American Journal of Agricultural Economics **70**(4): 779-789.

Bliss, C. J. and N. H. Stern (1982). Palanpur: The Economy of an Indian Village. Delhi and New York, Oxford University Press.

Deininger, K., S. Jin, B. Adenw, S. Gebre-Selasie and M. Demeke (2003). Market and Non-Market Transfers of Land in Ethiopia: Implication for Efficiency, Equity, and Non-Farm Development, Policy Research Working Paper Series 2992, The World Bank.

Ethiopia, F.-F. D. R. o. (1997). Rural Land Administration Proclamation of the Federal Government of Ethiopia. Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia. **Proclamation No. 89/1997**.

Gavian, S. and S. Ehui (1999). "Measuring the Production Efficiency of Alternative Land Tenure Contracts in a Mixed Crop-Livestock System in Ethiopia." Agricultural Economics **20**: 37-49.

Holden, S. and H. Yohannes (2002). "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." Land Economics **78**(4).

Otsuka, K., H. Chuma and Y. Hayami (1992). "Land and Labor Contracts in Agrarian Economics: Theories and Facts." Journal of Economic Literature **30(4)**(December): 1965-2018.

Otsuka, K. and Y. Hayami (1988). "Theories of Share Tenancy: A Critical Survey." Economic Development and Cultural Change **37**(1): 32-68.

Pender, J. and M. Fafchamps (2006). "Land Lease Markets and Agricultural Efficiency in Ethiopia." Journal of African Economies **15(2)**: 251-284.

Sadoulet, E., A. de Janvry and S. Fukui (1997). "The Meaning of Kinship in Sharecropping Contracts." American Journal of Agricultural Economics **79**(May): 394-407.

Sadoulet, E., S. Fukui and A. d. Janvry (1994). "Efficient Share Tenancy Contracts under Risk: The Case of Two Rice Growing Villages in Thailand." Journal of Development Economics **45**: 225-243.

Sadoulet, E., R. Murgai and A. de Janvry (1998). Access to Land Via Rental Markets. . Paper presented at the FAO/WIDER Seminar on Access to Land, Rural Poverty and Public Action, April 1998. Santiago, Chile.

Singh, N. (1989). Theories of Sharecropping. The Economic Theory of Agrarian Institutions. P. Bardhan. New York, Oxford University Press.

Skoufias, E. (1995). "Household Resources, Transactions Costs, and Adjustment through Land Tenancy." Land Economics **71**(1): 42-56.

State, T.-T. N. R. (1997). Rural Land Use Proclamation of the Tigray National Regional State. Negarit Gazetta of the Council of Tigray National Regional State. Mekelle, Ethiopia. **Proclamation No. 23/1989 (EC)**.

Stiglitz, J. E. (1974). "Incentives and Risk Sharing in Sharecropping." Review of Economic Studies **41**(2): 219-255.

Teklu, T. and A. Lemi (2004). "Factors Affecting Entry and Intensity in Informal Rental Land Markets in Southern Ethiopian Highlands." Agricultural Economics **30**: 117-128.

Tikabo, M. O. and S. T. Holden (2004). Land Tenancy and Efficiency of Land Use in the Highlands of Eritrea. Ås, Norway, Department of Economics and Resource Management, Norwegian University of Life Sciences.

Tikabo, M. O., S. T. Holden and O. Bergland (2008). "Factor Market Imperfections and the Land Rental Market in the Highlands of Eritrea: Theory and Evidence." Mimeo.

TNRS (1997). Rural Land Use Proclamation of the Tigray National Regional State. Negarit Gazetta of the Council of Tigray National Regional State. Mekelle, Ethiopia. **Proclamation No. 23/1989 (EC)**.

TNRS (2007). "Repealed Regulations for the Implementaion of Rural Land Administration and Use Proclamation." Negarit Gazetta of the Council of Tigray National Regional State **Proclamation No. 48/2007**.

Appendix 1: Theoretical Model

Landlord Model with Tenure Insecurity

The efficiency of the land rental market may be negatively affected if potential landlords fear losing the land if they rent it out. Policies like land-to-the-tiller programs that have been practiced in many countries may therefore have undermined the efficiency of the land rental market and therefore also the efficiency of land use. In Ethiopia land renting was prohibited, until recently when short-duration renting was permitted (FDRE 1997; TNRS 1997). Land redistribution policies may also have introduced tenure insecurity and many feared to rent out the land as this could be considered a sign that they were unable to manage the land (Holden and Yohannes 2002; Tekie 1999).

Based on this, we develop a simple household-cum-landlord model that may capture a variety of issues explaining the potential inefficiency of the land rental market. For simplicity we assume that the household maximises expected income (y) from production on own land, rental income from rented out land (R) and off-farm activity. The household has a fixed endowment of land ($\underline{A^l}$) and non-land resources ($\underline{N^l}$). The non-land resources may be used in farm production or to generate off-farm income (wN^w). We also assume that land is rented out through sharecropping arrangement where the tenant gets a share (α) of the output (q)[1]. Production risk may be one of the important reasons for sharecropping but we focus only on the risk related to tenure insecurity. Furthermore, we assume that land and non-land resources are complements in agricultural production. We use the following standard assumptions for the production functions:

$$q_A, q_R > 0, q_{AA}, q_{RR} < 0, q_{AN}, q_{RN}, q_{NA}, q_{NR} > 0$$

There is risk related to renting out land that we capture with a loss function. This is the expected future loss (λ) due to loss of the right to the rented out land. We use a single

[1] We have assumed that land renting is taking place only through sharecropping but the model could be equally valid in settings where fixed-rent contracts dominate. We have left the contract choice issue out of this model because sharecropping is the dominating contract type in the study area.

period model but include the present value of expected future loss of land due to land being rented out in this period. This is similar to including a user cost in the model, given by:

$$(1) \qquad \underset{R}{Max}\, y^l = pq\left(\underline{A}^l - R, \underline{N}^l - \underline{N}^w\right) + p(1-\alpha)q\left(R, \underline{N}^t\right) - \lambda\left(z^l, r^l, s^c, g, \psi\right)R + w\underline{N}^w$$

Income is maximized subject to the constraint that $R \geq 0$, implying that we should consider the corner solution related to participation or non-participation in the rental market as a landlord. It is possible that some of the variables are more important for the decision to rent out or not while other variables influence more the decision on how much to rent out. We assume that the net present value of the expected loss is a function of the landlord's characteristics (z^l), landlord's past experience of the contractual arrangement (r^l), the social capital in the community (s^c), the land distribution (g), and the policy (ψ).

More specifically, we assume that:

i. the risk of loss may be smaller if the landlord has a strong position in the community (z^l is high), then $\partial\lambda/\partial z^l < 0$,

ii. the longer experience in the land rental market by the landlord reduces tenure insecurity, i.e., $\partial\lambda/\partial r^l < 0$,

iii. a strong community (high social capital, s^c is high) provides its members secure rights to land and a safe livelihood, then $\partial\lambda/\partial s^c < 0$,

iv. an inequitable distribution of land, e.g. measured by the gini-coefficient, within the community may increase the probability of loss, implying $\partial\lambda/\partial g < 0$.

v. policies ultimately give the basis for tenure security or insecurity but the effects may be filtered through the local leadership, cultural norms, etc. Various policies may enhance or reduce tenure security, therefore $\partial\lambda/\partial\psi <> 0$.

The first order condition for the simple income maximisation problem becomes:

$$(2) \qquad \frac{\partial y}{\partial R} = p\left(1-\alpha(g)\right)q_R(R, \underline{N}^t) - pq_A\left(\underline{A}^l - R, \underline{N}^l - \underline{N}^w\right) - \lambda\left(z^l, r^l, s^c, g, \psi\right) \leq 0 \perp R \geq 0$$

Based on this equation, we can derive the following expected signs for the interior solution $\frac{\partial y}{\partial R} = 0$ and R>0 . The signs will also be the same for the decision to rent out land or not:

$\frac{\partial R}{\partial \underline{N}^l} < 0$, less land is rented out the more non-land resources the landlord has

$\frac{\partial R}{\partial \underline{A}^l} > 0$, more land is rented out the more land endowment the landlord has

$\frac{\partial R}{\partial \underline{N}^t} > 0$, more land is rented out the more non-land resources the tenant has

$\frac{\partial R}{\partial \underline{N}^w} > 0$, more land is rented out the more non-land resources are used off-farm

$\frac{\partial R}{\partial z^l} > 0$, more land is rented out the stronger position the landlord has in the community

$\frac{\partial R}{\partial r^l} > 0$, more land is rented out if landlords have earlier contract experience

$\frac{\partial R}{\partial s^c} > 0$, more land is rented out in communities with strong social capital (high trust communities)

$\frac{\partial R}{\partial g} <> 0$, less land is rented out the higher the gini-coefficient for land distribution is in the community when the tenure insecurity effect dominates, and more land is rented out when the income effect dominates

$\frac{\partial R}{\partial \psi} <> 0$, policies may reduce or enhance incentives to rent out land by landlords

These predictions are tested econometrically using the reduced form equation:

(3) $$R^l = R\left(\underline{A}^l, \underline{N}^l, \underline{N}^w, \underline{N}^t, z^l, r^l, s^c, g, \psi\right) + u^l$$

Tenant's Access to Land in the Rental Market

Based on our landlord model it is possible that potential tenants are rationed out of the land rental market. Access to the land rental market and the degree of participation may depend on a tenant's characteristics. We may assume that access to land is a function of the possession of non-land resources, social distance and reputation/farm skills, and trust as earlier introduced. Access may also be increased by good performance in previous contracts thus increasing the trust between him and the landlord and improving his reputation in the community as a good farmer.

Based on this we assume that (potential) tenants may be rationed in the land rental market. They may be fully or only partially rationed out of the market. That is; $0 \leq \overline{R}^t < R^t$, where R^t is the desired (unconstrained) rented in area (Bliss and Stern 1982). We assume that the desired rented-in area would maximize the expected utility of (potential) tenants. With zero transaction costs in the land rental market, constant returns to scale, and imperfections in markets for non-land factors of production, the desired area rented in would be inversely related to own land of tenants and decrease linearly with a coefficient of −1 in own land of tenants. Transaction costs would cause the coefficient to have an absolute value below 1 (Bliss and Stern 1982; Skoufias 1995). Very high transaction costs may cause potential tenants to be fully rationed out of the market for tenancies. The tenant's access to rented-in land at time $\tau = 0$ may therefore be formulated as follows:

$$(4) \qquad \overline{R}^t(\tau=0) = \sum_l \overline{R}^{lt}\left(c^{lt}(\tau=0)\right) = \sum_l \overline{R}^{lt}\left\{\overline{c}^{lt} + c^{lt}\left(\underline{N}^t, z^t, \int_{-\Upsilon}^{0} \gamma(\tau)\overline{R}^{lt}(\tau)d\tau + \sum_{\mathrm{P}} \int_{-\Gamma}^{0} \mu(\tau)\psi_{\mathrm{P}} d\tau\right)\right\}$$

Equation (4) says that the tenant's access to rented-in land is the sum of his access across a number of available landlords and depends on the transaction costs he faces in the land rental market at this point in time. These transaction costs depend on the non-land resource endowments of the tenant (at time $\tau = 0$), the tenant's reputation and other characteristics, e.g. social influence, and the trust that may depend on; the extent of earlier land rental transactions between the landlords and the tenant, and past policies. The impact of past policies may also be gradual and delayed and depend on the implementation process, local interpretation and acceptance by the community leadership.

Based on equation (4) we may draw the following hypotheses, whether (potential) tenants participate in the land rental market or not and how much land they have access to:

$\frac{\partial \overline{R}^t}{\partial \underline{A}^t} < 0$; that is, less land is likely to be rented the more land the tenant has;

$\frac{\partial \overline{R}^t}{\partial \underline{N}^t} > 0$; that is, access is likely to increase with tenant's non-land resource endowments;

$\frac{\partial \overline{R}^t}{\partial \underline{N}^{tw}} < 0$; access is likely to decrease with the tenant's off-farm use of non-land resources;

$\frac{\partial \overline{R}^t}{\partial z^t} > 0$; access is likely to increase with the reputation or influence of the tenant in the community;

$\frac{\partial \overline{R}^t}{\partial r^{lt}} > 0$; access is likely to be better for tenants who have had earlier contracts with the landlords;

$\frac{\partial \overline{R}^t}{\partial s^c} > 0$; access is likely to be better in high trust communities;

$\frac{\partial \overline{R}^t}{\partial g} > 0$; access is likely to increase with the gini-coefficient for land;

$\frac{\partial \overline{R}^t}{\partial \psi_P} <> 0$; policies may improve (provision of secure tenure rights) or constrain (land-to-the-tiller) the functioning of the land rental market.

Based on this structural model we derive and estimate a reduced form model, suppressing the inter-temporal dimension of the elements on the RHS, given by:

(5) $$\overline{R}^t(\tau = 0) = \overline{R}^t\left(\underline{A}^t, \underline{N}^t, \underline{N}^{tw}, z^t, k^{lt}, r^{lt}, s^c, g, \psi_P\right) + u^t \geq 0$$

Paper 2

LAND, LAND RENTAL MARKET AND RURAL POVERTY DYNAMICS IN THE NORTHERN HIGHLANDS OF ETHIOPIA

Hosaena H. Ghebru

Department of Economics and Resource Management (IØR),
Norwegian University of Life Sciences (UMB), P.O.Box 5003, N_1432, Ås, Norway, and
Department of Economics, Mekelle University, P.O.box 451, Mekelle, Ethiopia
Email: hosaenag@yahoo.com

Abstract

Using a four-wave panel data from the Tigray region of Ethiopia, the study investigated the persistence of rural poverty comparing rural households on both sides of the land rental market. Applying both non-parametric (Kaplan-Meier estimators) and multivariate (Cox's Proportional Hazard) survival models that control for duration dependence of poverty transition, our analyses reveal participation and degree of participation on the supply side of the tenancy market having a highly significant and positive effect on the chances of escaping poverty. On the other hand, the chances of escaping poverty are limited and insignificant for participation and size of participation on the demand side of the tenancy market. Households headed by older and literate people have relatively higher probabilities of exit from poverty as compared to households headed by younger and illiterate ones.

Keywords: *Poverty dynamics, duration of poverty spell, land rental markets, Ethiopia*

1. Introduction

Throughout Sub-Saharan Africa, access to rural land and its potential in reducing rural poverty has long been a subject of high policy agenda and research interest (Warriner 1969; Haggblade and Hazell 1988; Holden et al. 2008). The increasing number of Africans living in poverty has recently focused the attention of governments, international donors, and researchers toward "pro-poor" land policies (Cotula et al. 2004; Holden et al. 2008). The slow progress in redistributive and other land tenure reforms (land titling) has encouraged the exploration of land market transactions (Adams 2004) and caused major multilateral agencies like the World Bank to

rethink the role land markets can play in agricultural growth and poverty reduction (Deininger and Binswanger 1999).

The fact that rental markets have relatively lower transaction costs than land sales markets (Deininger and Binswanger 1999; Zimmerman and Carter 1999; Sadoulet et al. 2001) has given way to recognition of the critical role these markets can play as a means for providing the poor with access to land. Rightly so, during the past two decades, land policies and legal reforms to liberalize land rental markets have been top policy priority in many countries of sub-Saharan Africa (Holden et al 2008; Cotula et al 2004).

There is a large empirical literature on the welfare implications of land access and land distribution in Africa (Haggblade and Hazell 1988; Carter and May 1999; Jayne et al. 2003; Karugia et al. 2006; Rigg 2006; Jayne et al. 2008) but relatively few studies on the poverty-reducing impacts of land rental markets. In contrast with the earlier skeptical view on the performances of land rental markets, empirical studies from Rwanda (Blarel 2004; Andre and Platteau 1998), Ghana (Migot-Adholla et al 1994; Quisumbing et al 2003) and Malawi (Holden et al. 2006; Lunduka et al. 2008) show that land rental markets contribute to more equitable operational holding between the poor and the rich. On the other hand, studies from Ethiopia (Bezabih and Holden 2006; Holden and Ghebru 2006; Kassie and Holden 2006), Madagascar (Bellmare 2006), Tunisia (Laffont and Matoussi 1995) and Eritrea (Tikabo and Holden 2003) reveal transfers of land from relatively poorer landlords to wealthier tenants. What is empirically common with these studies is that they make deductions about the poverty-reducing effects of

land rental markets by analyzing the allocative efficiency and equity implications of such markets.

While it is true that allocative efficiency and equity implications of land rental markets can be implicative to suggest the poverty-reducing potential, this may not always be true as it is not always the landless (land-constrained) that are the poorest. The rural landless (mostly young and inexperienced in farming) may find alternative sources of income, either from agricultural labour or employment in the rural non-farm economy. Particularly, in countries with an egalitarian land ownership distribution, (for example, Ethiopia), the poorest members of society can be those with few capital or non-land productive assets and constrained access to micro-finance credit. On this backdrop, this paper aims to contribute at filling this research gap by conducting a direct welfare assessment of households considering their participation in the land rental market.

The availability of four-wave panel household level data collected (1998, 2000, 2003, 2006), made it possible to assess the welfare dynamics and characterize the poverty profiles of agents in both sides of the land rental market. We apply non-parametric Kaplan-Meier estimator (Kaplan and Meier 1958) and Multivariate Cox's proportional hazard model (Cox 1972) to assess the correlation of the rural land rental market participation with movements in and out of poverty. Based on the results from the non-parametric Kaplan-Meier estimators and the semi-parametric Cox's proportional hazard survival models, our analyses reveal participation and degree of participation on the supply side of the tenancy market having a highly significant and positive effect on the chances of escaping poverty. On the other hand, the chances of escaping poverty are limited and insignificant for participation and size of participation on the demand side of the

tenancy market. Households headed by older and literate people have relatively higher probabilities of exit from poverty as compared to households headed by younger and illiterate ones.

The rest of the paper is organized as follows. Section 2 reviews the literature on the land and rural household welfare comparing the Ethiopian context to the rest of the world. Descriptions of the data sources and techniques adopted while measuring welfare is discussed in section three followed by the econometric methods applied for the analysis (section 4). The last two sections are devoted for the discussion results and conclusion, respectively.

2. Land, Land Tenancy Market and Rural Welfare in Ethiopia

In Ethiopia, land is a crucial asset and an input in the agricultural sector that accounts for over 40 percent of GDP, 80 percent of the labor force and the mainstay for more than 85 percent of the total population (MoFED 2007; The World Bank 2005). Historical and empirical evidences suggest that lack of adequate access to land, tenure insecurity, diminution of farm holdings and landlessness have been among the major reasons for food insecurity and rural poverty in the country (Hoben 2000; Holden and Yohannes 2002). In response to these challenges, the current government of Ethiopia (which ousted the Military regime in 1991) has integrated the issues of access to land and tenure security to its national sustainable development and poverty reduction Program (FDRE-SDPRP 2002). Though land remains to be under public ownership, the devolution of land administration issues to regional governments and the endorsement and implementation of the participatory land certification program (FDRE 1997) were widely considered as a real sign of intent by the government in an attempt to enhance agricultural productivity and economic growth.

Prior to that, we had a country where the 1975 collectivization of farm land with the motto of land-to-the-tiller by the then socialist regime of '*Dergue*' led to an abolishment of any freehold system in the country (Proclamation no. 31/1975). In an attempt to maintain egalitarian land distribution, this confiscatory land reform included frequent practice of land allocation and redistribution as its main agenda (Rahmato 1984; Holden and Yohannes 2002). During this redistributive reform, the common practice was to allocate land considering the number of household members giving less emphasis to other factors such as size of family workforce and ownership of other farm assets (Rahmato 1984). Though this led to egalitarian distribution of land holding across households, marked heterogeneity in non-land resource endowment (such as labor and oxen) causes inequalities in relative factor endowment ratios across households. Any lack of one or more of the essential inputs for production by some households means there is a chance for underutilization of agricultural land despite the egalitarian distribution of land holding in the country. This makes the use of own (allocated) land holding for welfare comparisons not only less informative but also misleading. Since households were not free to transfer, exchange, or sell their allocated land, some households ended up with more land than they could utilize efficiently through owner cultivation, while others had less.

In an attempt to solve such productivity bottlenecks, the ban on the land rental market (fixed cash rental and sharecropping) was partly lifted in 1990 just before the downfall of the socialist regime. Even after the socialist regime was overthrown in 1991, land remains to be under state ownership and the legal ban on land sale remain intact as a form of social protection – to avoid

welfare risks that a free market in land entails[1]. In spite of this, high tenure insecurity, mainly due to the frequent state-sponsored land distribution and redistribution in the past, remains to be one of the major land-related problems in the country (Holden and Yohannes 2002; Holden et al. in press).

Following the 1997 devolution of power over land from federal to regional governments (FDRE 1997), the Tigray regional state became the first region to implement a land certification process using simple traditional methods in 1998–99. More than 80% of the region's population received land certificates. Far beyond the well-documented investment-enhancing effects of secure property rights (Feder et al. 1988; Besley and Coast 1995; Deininger and Feder 1998; Li et al. 1998; Smith 2004; Jacoby and Minten 2007; Do and Iyer 2008; Holden et al. 2009), there are early signs that formalization of land rights - in the form of providing households with inheritable user certificates – makes the market-based access to land both more common and increasing in the Ethiopian context (Deininger et al. 2008; Holden et al. in press). This is so since ownership uncertainties and cost of protecting property may be more severe when agents of the market lack formal land use rights.

From the supply side perspective, for instance, without clear and definite claims to the land, farmers (potential landlords) can be reluctant to transfer use-rights (rent/leas out land) to others for the mere fact of fearing to lose the land through administrative redistribution (Deininger et al. 2008; Ghebru and Holden 2008). In such circumstances, even if there is a possibility that the productivity of the land is far better under different operator (potential tenant) - with better skill

[1] The self proclaimed justification given by the current regime for state ownership of land is so as to protect the majority poor rural households from myopic land sales to solve their short term liquidity constraints.

and complementary farm inputs, it is possible that the land holder may decide to operate the land by him/herself. Land registration and certification could, therefore, reduce such uncertainties and increase land rental market efficiency (Holden et al. in press). This may ultimately increase farm level efficiency as factor-ratio adjustment can now be channeled through the more efficient land markets. The marginal benefit even becomes higher if the alternative for the farmer holding land but who is unable to cultivate him/herself was to leave their land unused for lack of complementary inputs such as family labor and oxen. In either of the cases, farmers who participate in the supply side of the tenancy market are more likely to improve their welfare status given the highly skewed non-land factor endowment and acute imperfections in such markets.

Such reluctance to lease-out land by landlords (due to insecurity of tenure) together with the national halt in the state-sponsored land redistribution[2] and legislative restrictions on land rental market activities[3] may have contributed to the acute problem of landlessness and land fragmentation in the country. This scenario has ultimately led to an increasing pressure on the demand side of the tenancy market. Unlike the potential benefits discussed above, the welfare benefits of access to land through the tenancy market may not be as straightforward and suggestive as it looks for the supply side of the market. We believe that such benefits largely depend on the leasees' asset portfolio composition (economic leverage) as well as the tenants' motivational issues (whether landlessness or land fragmentation (land consolidation) is the main factor behind the demand for more land). This emphasizes the need for considering the

[2] It is almost two decades since the 1990 land redistribution has been implemented in the study area and the region has repeatedly declared itself against future large-scale land redistribution (MUT 2003).

[3] The 2006 and 2008 regional land proclamations for Tigray allow farmers to lease out not more than half of their allotted land for a maximum of three years (TRNS 2006; 2007)

heterogeneity of agents in the demand side of the market while assessing the potential welfare implications.

Based on our field observations, two groups of tenants can be identified based on the factors driving the commoditization of land. The first group derives from the new wave of youngsters and immigrants – *the (near) landless poor.* The second group mainly consists of farmers with a likely motive of land consolidation. This latter group is mainly rich in complementary farm inputs (like labor and oxen) and consists of experienced farmers - *land-constrained non-poor.* Accordingly, we expect the tenancy market to have a potential of welfare enhancing impact for the latter group of tenants that are endowed with relative abundance of non-land complementary farm inputs. Such positive impacts, however, may not be obvious for the first group who join the land rental market from lower economic leverage as they are bound to face high transaction costs (constrained access), possibly access poor quality land and unfavorable terms of trade (poor bargaining power due to poor non-land resource base). This, altogether, may lower the margin of their net gain and their ability to cross the poverty threshold.

Motivation of the study

With aforementioned features of the land tenure system in the country, accompanied by acute factor market imperfections, the conventional approach of using own land holding for characterization of poverty and the welfare dynamics is not only less informative but also misleading. The fact that non-land factor markets are imperfect together with the legal ban on land sales creates a highly skewed land-to-nonland factor-ratio endowment - contrary to the egalitarian distribution of land holdings in the country (Ghebru and Holden 2008). This scenario

paves a potential for land markets to play a pivotal role with possible equity and efficiency effects that ultimately comes with a potential welfare gain. Hence, this study strives to assess the welfare enhancing potential of participation in the land rental market.

However, due to previously high tenure insecurity, acute land scarcity and high transaction costs of the land tenancy market participation in the country (Ghebru and Holden 2008; Holden et al. 2009), we firmly believe rationing in the land tenancy market and heterogeneity of households' livelihood strategy (asset portfolio composition) to have a varying effect on the relative degree of welfare gains among the market participants. Hence, failure to account for such heterogeneity across participant households in both sides of the tenancy market can conceal welfare value of access to land. This study accounts for such heterogeneity by analyzing the effect of access to land considering the tenancy market as a major venue. In doing so, special emphasis is given to the poor section of farm households in an attempt to evaluate how big the welfare gain (if any) is to pull poor tenant and landlord households all the way up through the prosperity ladder.

3. Data, Measurement of Poverty and Descriptive statistics

Data

Data used in this study comes from stratified random sample of 400 rural households covering 16 villages of the Tigray region in the northern Ethiopia[4]. The households have been surveyed four times in a period that stretches for almost a decade, covering the years 1997/98, 2000/01, 2002/03, and 2005/06. Out of the 400 sampled households, we used a balanced panel of 300 households due to respondent dropout mostly related to the Ethio-Eritrean border conflict that

[4] Each village was categorized based on the distance from the district market using 10km radius as a benchmark and population density on a benchmark of greater or less than 200 persons/km^2. See Ghebru and Holden (2008) for detailed description of sampled villages.

lasted from 1998 to 2000[5]. Following the devolution of power from federal to regional governments, the Tigray regional state became the first region to implement a land certification process using simple traditional methods in 1998–99. The fact that our first survey took place just before the implementation of the low-cost land certification program in the region provides a unique opportunity to assess the potential welfare impacts of the tenancy market using the 1997/98 survey as baseline information.

Welfare indicators and measuring poverty

To investigate the dynamics of poverty, two welfare indicators were used in this study: the annual household per capita consumption expenditure and the regional poverty line. On the basis of the cost-of-basic-needs (CBN) approach (Ravallion and Bidani 1994), poverty is defined here in terms of inadequacy of consumption of basic needs such as food. As the objective of a poverty line is to capture the basic needs necessary to meet minimum living standards, the method used in this study addresses this objective by defining a consumption bundle – incorporating food and non-food items – that is adequate to meet the minimum nutritional requirements, and estimates the cost of purchasing that consumption bundle[6]. This includes the value of consumption from own production and imputed expenditures.

In addition to its advantage of being a more stable approach than those of income-based methods (Lipton and Ravallion 1995), we adopted the cost-of-basic-needs (CBN) definition of poverty

[5] The mean comparison tests using the 1997/98 data for potential attrition bias shows there is no significant difference in between the included and drop household samples in terms of per adult equivalent consumption expenditure, being a tenant and being a landlord.

[6] The nutritional anchor 2200 kilo calorie (Kcal) per day was used to define the poverty line which is the minimum level of nutrition an adult person must consume to subsist in Ethiopia (UNDP, 2000).

because this is the variable we are able to track over all rounds of the panel. However, the methods used in this paper could be applied to any mutually exclusive indicator of poverty.

To control for spatial cost-of-living differentials and allow for monthly price variation over the survey years, the household per capita consumption expenditure is deflated regionally and across periods using the 2000 southern zone prices as a base year. Thus, the annual household per capita consumption expenditure was adjusted for temporal and spatial price differences expressed in real 2000 southern zone prices. The household consumption expenditure per capita was also adjusted for household compositions to control for variations in demographic compositions across households so that the poverty line is reported in adult equivalent terms[7]. The absolute poverty line generated and used in this study which is adequate enough to purchase the nutritional requirements of 2200 Kcal is 1,014.29 ETB per adult equivalent consumption per year[8]. Whenever a household's consumption expenditure crosses over this amount that household is considered to make a poverty transition. An increase in consumption that moves a household over the poverty line is defined as an exit or movement out of poverty, while a decrease in per capita consumption that moves a household's income below the poverty line is defined as an entry or movement into poverty.

Descriptive analysis

These 16 communities were a sub-sample of communities in an IFPRI community and household survey. This study is based on a balanced panel of 300 households out of which only

[7] The adult equivalent scales used in this study are based on Dercon (2006) and are reported in Table A7.

[8] Details of the computation of food and non-food poverty lines is given in Appendix 1. For comparison reasons, we also carry out our estimations based on the World Bank's international poverty lines of one dollar a day and two dollar a day income per capita. Consequently, the Absolute poverty line used in this study is equivalent to a 1.2 dollar a day at 2000 PPP adjusted.

31 percent were participant households in the land tenancy market (8 percent as tenants and 23 percent as landlord households). As shown in Table 2, the percentage of households renting out land increased from 23.6% in 1997 to 27.2% in 2000 and to 26.2 and 28.9% in 2003 and 2006, respectively. The percentage of households that rented in land (tenant households) record a dramatic increased from 7.9% in 1997 to 30.8% in 2000 and then down to 27.5 and 26.6% in 2003 and 2006, respectively. The reason for dramatic increase in the year 2000 may be that having a land use certificate improve the sense of tenure security of farm households and reduce their reluctance to lease out land though this is not witnessed in the descriptive evidence from the supply side of the market.

Regardless of the tenancy status of households, table 2 also shows the welfare improvement in the region seems to be very slow. Even if the head-count ratio seems to reduce slightly, ¾ of the tenants and more than half of landlord households are poor at the end of the survey period. Even if there is no significant difference in the head-count ratios of tenants and landlords at the beginning of the survey, the summary statistics also shows 72% of the tenant households in the year 2006 were poor while only 58% of the landlords were poor households. However, as shown in the last three columns of Table 2, an average tenant seems to enjoye a higher per capita consumption level in the year 1997. This pattern remained fairly stable over the years the data covered.

Table 3 characterizes the persistence of poverty (duration of spell of poverty) and whether key household characteristics and their tenancy market status varies across each spell of poverty. Participation and degree of participation in the tenancy market both as a tenant or a landlord is

shown to be negatively correlated with being poor as less than half of the always poor households (46%) were participants while majority of the one-time poor (75%) were participant households. Comparing the two sides of the tenancy market, predominantly tenant households are the ones more likely trapped in poverty as compared to their landlord counter parts. This evidence is more elaborated in figure one showing a persistent climb of the "poverty ladder" for landlord households while this is not the case for predominantly tenant households. As it is shown in the diagram, only 39% of the landlord households were below the lower poverty class (below the food poverty line) during the 2006 survey period while nearly one out of two tenants (53% of the tenants) are below this poverty class. While there is no significant systematic difference in poverty persistence with respect to the age and gender of the head of households, the chance of being in state of extreme poverty is lower for households richer in livestock endowment.

Table 4 presents tabulations of land holding and household expenditure variables arrayed by per adult equivalent expenditure (PCUE) deciles. Consistent with the land distribution policy in the country (see discussions in section 2), we find a fairly egalitarian distribution of land across deciles in each survey period. Considering the 2200 kilocalories per capita as our under-nutrition cut-off (see UNDP 2000), it is apparent that under-nutrition is not a threat only to those in the top decile in 1997 and to those in the top two deciles in the year 2000 and 2003. Overall, at least 70% of the population is below the poverty line in all survey periods that extended for nearly a decade (1997 – 2006). Such high level of poverty and under-nutrition is more pronounced when the food poverty line of 760 ETB is contrasted to the expenditure per adult equivalent of each decile group. As it is shown in Table 4, the bottom eight deciles (80% of the

sampled respondents) in 1997 are below this conservative poverty line while the extreme poverty situation remains to persist even in 2006 with the bottom half of the households to be under this extreme poverty (below the food poverty line). In general, the overall evidence shows the persistence of poverty in the region with majority of the poor households (nearly half) remained in state of poverty over the years the data covered (four-time poor).

4. Methodology

One of the main analytical bottlenecks for lack of empirical studies on the welfare impacts of the land tenancy market participation is lack of appropriate counter-factual – the welfare situation of participant households if it were rationed-out of the market. This makes welfare comparisons with households that voluntarily do not participate in the market wrong and a cause for selection bias (Holden 2007). Due to lack of appropriate instruments, the main empirical strategy in this study therefore focuses on investigating how participation in the land tenancy market is correlated with movements in and out of poverty. The potential welfare gain from participation may depend on the economic leverage of farm households by the time they join the tenancy market (see discussion in section 2). For this reason, we focus on analyzing poor households' chance of escaping poverty separately from non-poor households' chance of re-entry into poverty.

Farm households' chances of escaping poverty may as well depend on the duration of time the household stayed in state of poverty. This is because that poverty experience can have a causal impact on future poverty. This may be because of a poverty trap or due to depreciation of human and physical capital or loss of motivation and/or ability to work (Basu 1999; Carter and Barrett

2006). Such persistence (duration dependence) of poverty causes the application of standard logit/probit estimates in the analysis of chances of escaping poverty to be biased and inconsistent. This is so because we don't know whether a household observed as being poor in the first survey (1997/98) is: beginning a spell of poverty; or remaining (continue) in the state of poverty.

To control for such effects of persistence (duration dependence) of poverty and the problem of left-censoring, the chances of escaping poverty and re-entry into poverty have been modeled as the probability of exiting from or re-entering into a "spell" of poverty (non-poverty). In this case, we look at the conditional probability of a household moving out of poverty given that it has not yet exited and it is necessary that we observed the household falling in to poverty at an earlier period (Baulch et al. 1998). For this reason, using parametric and non-parametric spell approaches that control for duration dependence of poverty: namely, a non-parametric Kaplan-Meier survival function (Kaplan and Meier 1958); and a semi-parametric Cox's Proportional hazard model (Cox 1972), we wish to investigate the role participation in the land rental market might have (if any) in increasing or decreasing the probability of entry or exit from poverty.

Non-parametric spell approach: Kaplan-Meier Method

The standard approach to analyze poverty spells is to compute the probabilities of exiting and re-entering poverty given certain states and other characteristics of households, using either non-parametric or parametric methods (see examples by Bane and Ellwood (1986) and Stevens (1994; 1999). The probabilities can be considered as random variables with known distributions (see Antolin, Dang, & Oxley, (1999)). Survival analysis based on duration data of poverty spells attempts to provide estimates for such important questions as what is the fraction of the

population that remains poor after ''t'' periods (a measure of poverty persistence)? Of those that remain poor in each period, what percentage escapes poverty (exit or hazard rate)? How can multiple events or spells be taken into account, etc.?

Non-parametric methods are quite powerful in estimating the probabilities of exiting or re-entering poverty without assuming any functional form on the distribution of the spells (Kaplan and Meier 1958). We report two hazard rates, one for the probability of exiting poverty at successive durations of the poverty spell and another for the probability of re-entering poverty at successive durations of the non-poverty spell. Exit rates relate to a cohort of households that have just started a spell of poverty and thus are ''at risk'' of exit thereafter. That is to say, a poverty spell begins at period t for those households who were observed to be non-poor up until (t-1). In this regard, those that fail to escape poverty create a right-censored observation, as the spell would continue at the year of the last observation (in our case 2006). Similarly, re-entry rates refer to the cohort of households that have just started a non-poverty spell at period t, having been poor until (t-1) and are ''at risk'' of re-entering poverty (see Bane & Ellwood, 1986; and Stevens, 1999 for detailed discussion on exit and re-entry rates). Given theses definitions of exit and re-entry, the observations that are relevant for estimating the exit and re-entry rates in our case are spells that occur in wave 2 (survey year 2000 in our case) or later.

We used the non-parametric Kaplan–Meier method to estimate the probability of new poor surviving as poor or of newly non-poor surviving as non-poor. The survivor function F(t) is defined as the probability of survival past time t (or equivalently the probability of failing after

t). Suppose our observation is generated within a discrete-time interval $t_1, \ldots, t_k$; then the number of distinct failure times observed in the data (or the product limit estimate) is given by:

$$\hat{F}(t) = \prod_{i|t_i \le t} \left(\frac{n_i - f_i}{n_i} \right), \tag{1}$$

where n_i is the number of individuals at risk at time t_i, and f_i is the number of failures at t_i. The product $\hat{F}(t)$ is overall observed failure times less than or equal to one. The Kaplan-Meier estimator readily accommodates right-censored observations through n_i since households that failed to end a poverty or non-poverty spell in each period contribute to it. The standard error of Eqn. (1) can be approximated by:

$$SD(\hat{F}(t)) = \hat{F}(t)^2 \sum_{t_i, t} \frac{f_i}{n_i (n_i - d_i)}. \tag{2}$$

The hazard rate, h(t), for ending a poverty spell or a non-poverty spell at period t can be computed easily from Eqn. (1) as:

$$h(t) = \begin{Bmatrix} 1 - \hat{F}(t) & \text{if t=1} \\ \dfrac{\hat{F}(t) - \hat{F}(t-1)}{\hat{F}(t)} & \text{if t>1} \end{Bmatrix} \tag{3}$$

Eqn. (3) is the basis for computing exit and re-entry rates reported in this paper.

Parametric Spell Approach: Cox's Proportional Hazard Model

Though the non-parametric Kaplan–Meier survival function provides consistent estimates of hazard rates, as well as the degree of duration dependence, it does not distinguish between the many possible sources of poverty persistence – covariates that capture household heterogeneity

which affects probability of ending or entering a spell. The parametric method adopted in this study, Cox's proportional hazard model, allows for the estimation of covariates/factors that contribute to ending or entering a particular spell, including the effect of the duration of the spell itself.

The parametric method, therefore, models the distribution of spell durations via the probabilities of ending a spell. Suppose we are interested in modeling the duration of poverty for household *i* which entered at t_0, then we can define a dummy $\delta_i = 1$ to distinguish households which completed the spell (exited out of poverty)[9] from those who continued in the poverty spell, $\delta_i = 0$ at the end of the period (months, years or rounds in our case). The percentage that completed a spell is the event-rate (or ''hazard rate'') for that period and corresponds to a ''survivor-rate,'' which indicates the percentage continuing in poverty at that point. Formally, a discrete-time hazard rate h_{pi} can be defined as:

$$h_{pi}(T_{pi}, X_{pi}(t)) = pr\left[T_{pi} = t \mid T_{pi} \geq t; X_{pi}(t)\right], \qquad (4)$$

where h_{pi} denotes the discrete time hazard rate for person *i*; T_{pi} shows household *i*'s p^{th} poverty spell; X_{pi} refers to a vector of time-invariant and time-varying covariates for individual *i*.

[9] The model represents the econometrics for the analysis of the probability of escaping poverty for two reasons: one, to simplify notations; two, because our data is very much left censored to incorporate the analysis for re-entry to poverty. Only 26 of the 300 households in the panel were non-poor in the baseline survey. However, the methodology can be easily applied for the analysis of the probability of poverty re-entry with out any loss of generalization.

Defining the probability that a spell of poverty has not yet ended from $t = t_0$ until t *-1* after having survived the preceding j intervals as $(1-h_{pi}^{s})$, the probability of ending a spell of poverty in the p^{th} interval where $T_{pi} = t_p$ is given by the hazard function:

$$h_{pi} = Pr\left[T_{pi} = t\right] = h_{pi}\prod_{s=1}^{t_p-1} 1-h_{pi}^{s}, \tag{4}$$

where t_p represents the poverty spell.

Thus we are investigating the way in which heterogeneity between the different households affects the probability of entry or exit by scaling the underlying baseline hazard h_{pi}. A household enters a spell of non-poverty by moving above the consumption-based poverty line. The spell then continues until they drop below the poverty line. Some households do not exit poverty by the end of the sample period – in this case they are recorded as having a right censored spell which also contributes to the likelihood of ending the spell (hazard of poverty exit). However, like the non-parametric Kaplan-Meier estimator, the parametric hazard method includes the right-censored spells in the calculation of the likelihood function which is captured by the probability of ending the spell at $T_{pi} \geq t$ given by:

$$\Pr(T_{pi} \succ t) = \prod_{s=1}^{tp} (1 - h_{pi}^{s}). \tag{5}$$

One of the most widely applied parametric models to investigate spell of durations is Cox's proportional hazard model (Cox, 1972) where Eqn. (4) is rewritten as:

$$h_{pi}(T_{pi}, X_{pi}(t)) = \lambda_0(T_{pi})\exp\left[X_{pi}(T_{pi})'\beta\right], \tag{6}$$

where $\lambda_0(T_{pi})$ is the interval-specific baseline hazard (exit or escaping) rate, which is unknown, and X_{pi} refers to a vector of fixed and time-varying covariates for household *i* and β are the coefficients we want to estimate. A positive coefficient increases the chances of the event occurring - a negative one reduces it.

As it is the case that household characteristics (like social exclusion, motivation, inherent inability, and so on), which are not observable in our data, can affect the hazard functions, we control for unobservable household heterogeneity by adding a multiplicative random term "θ_i" in to equation 6, which is given by:

$$\begin{aligned} h_{pi}(T_{pi}, X_{pi}(t), \theta_i) &= \lambda_0(T_{pi})\exp\left[X_{pi}(T_{pi})'\beta\right]\theta_i \\ &= \lambda_0(T_{pi})\exp\left[X_{pi}(T_{pi})'\beta + \log(\theta)\right] \end{aligned} \tag{7}$$

In this latter case, allowance is made for heterogeneity of households reflected by differences in their observed characteristics (X_{pi}) and unobserved characteristics θ_i to have affected the household hazard function. The former explains the estimated distributions of spells in or out of poverty for a household and the latter is proved to change the baseline hazard rate of transition as a latent multiplicative effect called frailty parameter (Meitzen, 1986, Blau, 1998).

5. Results and Discussions

5.1. Poverty transition and Survival functions: Kaplan-Meier Estimator

Using the non-parametric Kaplan-Meier estimator, our estimates of hazard and survival function are displayed in Tables 5 to 9 which report estimates of the probability of poverty exits and re-

entry in to poverty, separately for each poverty line definitions.[10] Results in Table 5 show the survival function and the probabilities of poverty exit using the absolute poverty line as a base. As the main theme of this paper is to assess the potential impact the informal tenancy market might have on the welfare status and dynamics of households, survival functions and estimated hazard rates are reported in Table 6 for households based on their status in the tenancy market while Tables 7 and 8 report the hazard and survival functions comparing households based on the gender of the heads of households and the locations of households, respectively.

As illustrated in Table 5, the overall estimated hazard (exit) rates does not show the anticipated negative duration dependence. For a group of households that have just begun a spell of poverty spell, only 17% would have left poverty after the first year while the probability of escaping poverty after three spells remains to be around 18%. Such evidence of non-negative duration dependence is more elaborated when the food poverty line is considered to categorize households as poor and non-poor. As shown in Table 9, nearly 28% of households who spent their first food poverty spell manage to escape poverty; after three spells, the probability of exit slightly increases showing a 32% chance of escaping food poverty. As it is very likely for these extremely poor (food insecure) households to be targeted by public intervention programs, it is not surprising to observe an increase (decrease) of the estimated exit rates (survivor function[11]) as the duration of state of poverty increases.

[10]The exit rates refer to persons that experience a poverty spell and are at risk of exiting. The re-entry rates, on the other hand, refer to persons that have terminated a poverty spell and are at risk of falling back in. However, as the number of non-poor households at the beginning of the survey year (1998) were too few (26), analysis on vulnerability or chances of re-entry was not possible to conduct using the Absolute Poverty Line. For this reason, re-entry probabilities were only calculated based on an extreme poverty line – i.e., the regional food poverty line. Results of the exit and re-entry probabilities using the Food poverty line are summarized in Table 9 (see Appendices 2 to 6 for results using each respective household group).

[11] Comparing the survivor function from Table 5 with the results reported in Appendix 2.

Comparing the exit probabilities of tenant and landlord households using the absolute poverty line a benchmark, results in Table 6 reveals that there is a systematic difference in the ability to escape poverty in between the two groups showing poor landlords to have higher exit rates than poor tenant. The probability for a predominantly tenant household to escape absolute poverty after spending one spell in poverty was 16%, while for a predominantly landlord household it is almost a double, with estimated exit rates of 30%. Even if the hazard rates seem to reduce slightly as duration of poverty increases, there is no strong evidence to suggest negative duration dependence. This is illustrated in Table 6 as the probabilities of escaping poverty after staying poor for two spells are merely of 13% and 27%, respectively for tenants versus landlords. In line with the results from the descriptive summary, a very large proportion of households from each respective group remained poor after spending three spells in poverty. As shown in Table 6, the probability of remaining poor three rounds after the start of poverty spell was higher for tenant households (74%) than landlord households (55%).

The last two columns of Table 9 display the estimated re-entry probability (vulnerability) of those who have just terminated an abrupt poverty spell (food poverty). In this case the results confirm the existence of negative duration dependence of vulnerability for landlord households, i.e., the more a landlord remains out of food poverty, the less likely it is that s/he will fall below the food poverty line in the successive periods. However, the same cannot be said about tenant households. The results also show that even if there is no significant difference between tenant and landlord households' exit (re-entry) probabilities at the beginning of the spell of poverty (non-poverty), the difference is more visible the longer the duration of the spells are. As shown in Table 9, after three spells, not only do landlord households have a relatively higher chance of

escaping poverty as compared to poor tenants, but they are also a less vulnerable group to fall back in to extreme poverty once they are above the food poverty line.

Overall, results show that re-entry rates are higher than exit rates pointing to the fact that large number of households are not only in a state of extreme poverty (food poverty) but they are also highly vulnerable (a very high risk that non-poor households can fall back below the food poverty threshold), particularly the years just after an exit from poverty has occurred. For instance, after three spells of staying food secure, there is a chance that almost one tenant out of two (50% re-entry rate) to fall back in to a state of desperation in the subsequent period while the probability for landlords is very low with estimated re-entry rates of 10%.

After dividing the sample in terms of the gender of the household head, results reported in Table 7 show that the probability of ending a spell of poverty seems to be unaffected (15%) regardless of the duration of spell a male-headed household stays below the poverty line. In the case of female-headed households, however, probability of escaping poverty is not only slightly higher than male-headed households with estimated probabilities of 21% after spending two spells in poverty, but it does also rise to 31% the longer the duration of spell poverty is. On the other hand, using the food poverty line as a benchmark for defining poverty status, results from Table 9 show similar trends. The result show that the longer the duration of spell (of poverty/non-poverty), female-headed households as compared to male-headed households seem to have a relatively higher chance of escaping food poverty (41% and 29%, respectively) and are also less likely to be vulnerable fall back in to food poverty (13% and 43% respectively)[12].

[12] The Tigray region (study area) has launched a Productive Safety Net Program (PSNP) and the Food Security Package in November 2002. Effective targeting mechanisms of such programs could implicate this trend as

5.2. Correlates of the likelihood of Escaping Poverty: Parametric results

The results presented so far emphasize the dynamic nature of poverty within the panel which demands the importance of examining the correlates (factors) influencing entry and exits from poverty. As the sample base is limited to analyze the chances of re-entry into poverty after spell of non-poverty, we only focus on investigating the correlates that facilitate or hinder the chance of escaping poverty using the proportional hazard model. However, using an indicator variable (poor/non-poor) to identify transition out of poverty has its own limitations since transitions that occur within a small interval may simply reflect measurement errors or transitory income shocks that do not significantly affect household welfare (Barrett et al 2006). In order, to reduce the potential biases caused by this problem, we use an alternative (strong) indicator to define exits from poverty as occurring only if post transition household expenditure is greater than 125% of the absolute poverty line[13]. However, as estimated hazard rates are more likely to be sensitive to the used definition of poverty, we report and discuss results using both alternative indicators. As the main aim of this paper is to assess the role of tenancy market, Table 10 reports alternative proportional hazard estimates considering mere participation in the tenancy market (Models 2 and 4), and degree of participation (Models 1 and 3) for the unadjusted and adjusted poverty transitions, respectively.

---

female-headed households are prioritized to be targeted by these intervention strategies in the region.(Fredu, 2007; Mirutse, 2006).

[13] Even if it is not a guarantee to filter out "genuine" poverty transitions, we believe that excluding any transitions within 25% range of the absolute poverty line will help to reduce the risk of considering transitory shocks or measurement errors as genuine welfare improvements. We follow similar practices by Bane and Ellwood (1986), Duncan et al (1984), Jenkins (1999) and more recently Devicienti (2002) who control such biases by excluding certain ranges of welfare transitions around the poverty line.

Consistent with the results from the non-parametric analysis, participation and the degree of participation in the supply side of the tenancy market tend to be more associated with higher chances of escaping poverty. The results from table 10 show poor households that lease out their land, especially those who leases out higher proportion of their land, are more likely to escape poverty though mere participation in the land rental market doesn't influence poverty exit when the adjusted poverty line is considered as a benchmark to define transition or transformation. On the other hand, the chances of escaping poverty are limited and insignificant when participation as well as the size of participation in the demand side of the tenancy market are taken in to consideration. This result is consistent with the persistence of a relatively higher friction (variable transaction costs) in the study area that (poor) tenants face in the tenancy market (Holden and Ghebru 2005; Ghebru and Holden 2008).

The results also show the importance other factors like access to irrigation, number of adult male members, and more generally household composition on the chance of escaping poverty. With limited off-farm income generating opportunity in the region, the chance of escaping poverty seems to be more limited for a household endowed with a large adult male labor force. This result indicates the evidence of the negative demographic effect out weighing the positive income effects of labor force endowment. The negative coefficient of the dependence ratio variable explains that households with high dependency ratios seem to be trapped in poverty as they find it harder to escape poverty. The parametric evidence further indicates that farm households who have access to irrigation have better chance of escaping poverty. This result is consistent with the empirical evidence by Gebregziabher et al (2009) from similar study area in Ethiopia that shows the positive role access to irrigation plays in increasing farm household

income. Showing significant positive effects, the age and access to formal education of household heads are correlated with better chances to end a poverty spell.

6. Conclusion

Using a four-wave panel data from the Tigray region of Ethiopia, the study investigated the persistence of rural poverty comparing rural households on both sides of the land rental market. Using an extreme poverty line (the regional food poverty line), overall results show that re-entry rates are higher than exit rates in the region pointing to the fact that large number of households are not only in a state of extreme poverty but they are also highly vulnerable (a very high risk that non-poor households can fall back below the food poverty threshold). After dividing the sample in terms of farm households' status in the land rental market, the study has shown that tenants households are not only systematically more at risk of falling below the food poverty line, they are also more likely to remain poor for a much longer number of years as compared to landlord households. According to the non-parametric results, landlord households were found to have significantly lower hazard rates of entering in to poverty as well as higher probabilities of leaving poverty. The difference is even higher when an extreme poverty line (the food poverty line) is considered.

Results from multivariate proportional hazard model reveal that participation and the degree of participation in the supply side of the tenancy market tend to be more associated with higher chances of escaping poverty. On the other hand, the chances of escaping poverty are limited and insignificant when participation and the size of participation on the demand side of the tenancy market was taken into account. The empirical evidence also confirms that households headed by

older and literate people have relatively larger exit rates from poverty as compared to households headed by younger and illiterate ones.

Though transacting farmers may engage themselves in win–win rental arrangements by the time they join the tenancy market, results indicate that gains are unequal as those tenants who enter the markets from low economic leverage (were poor) are liable to face lower margin of net gains, which may limit their ability to move out of poverty. Policy restriction[14] on the functioning of land markets may aggravate such problems as tenure insecurity of (potential) landlords may end up marginalizing those poor (potential) tenants from accessing the land. The remedies may not lie in suppressing the rental markets but understanding them more to address the constraints by taking policy measures such as formalization of the land rental markets and improving tenure security of households (land certification programs). Due to limited off-farm employment opportunity and high scarcity of land in the region, it is possible that access to additional land through the tenancy market can protect vulnerable (but non-poor) tenants not to fall back into a state of poverty. This requires further investigation and is left for further research.

[14] The fact that the regional government has very recently enacted a law that decrees leasing out more than half of own holding as an act of illegal and subject to confiscation illustrates that such policy measures undermine the sense of tenure security of land holders.

Reference:

____ (2005). Well-Being and Poverty in Ethiopia: The Role of Agriculture and Agency. Washington, D.C., The World Bank, Poverty Reduction and Economic Management, Report no. 29468-ET.

Adams, M. (2004). Land Reform, Agriculture and Poverty Reduction. London, DFID Policy Division.

Andre, C. and J. P. Platteau (1998). "Land Relations under Unbearable Stress: Rwanda Caught in the Malthusian Trap." Journal of Economic Behavior & Organization **34**(1): 1-47.

Antolâin, P., T.-T. Dang and H. Oxley (1999). Poverty Dynamics in Four Oecd Countries. Paris, Organisation for Economic Co-operation and Development (OECD) working paper 212. Economics Dept.

Bane, M. J. and D. T. Ellwood (1986). "Slipping into and out of Poverty - the Dynamics of Spells." Journal of Human Resources **21**(1): 2-23.

Bank, W. (2005). Well-Being and Poverty in Ethiopia: The Role of Agriculture and Agency. Washington, D.C., The World Bank, Poverty Reduction and Economic Management, Report no. 29468-ET.

Barrett, C. B., M. R. Carter and P. D. Little (2006). "Understanding and Reducing Persistent Poverty in Africa: Introduction to a Special Issue." Journal of Development Studies **42**(2): 167-177.

Basu, K. (1999). "Child Labor: Cause, Consequence, and Cure, with Remarks on International Labor Standards." Journal of Economic Literature **37**(3): 1083-1119.

Besley, T. and E. Coast (1995). "Group Lending, Repayment Incentives and Social Collateral." Journal Development Economics **46**: 1-18.

Bezabih, M. and S. T. Holden (2006). Tenure Insecurity, Transaction Costs in the Land Lease Market and Their Implications for Gendered Productivity Differentials. The 26th International Conference of the International Association of Agricultural Economists, Brisbane, Australia. .

Blarel, B. (1994). Tenure Security and Agricultural Production under Land Scarcity: The Case of Rwanda. In: J. W. Bruce and S. E. Migot-Adholla. In Searching for Land Tenure Security in Africa. Dubuque, IA, Kendall/Hunt.

Carter, M. R. and C. B. Barrett (2006). "The Economics of Poverty Traps and Persistent Poverty: An Asset-Based Approach." Journal of Development Studies **42**(2): 178-199.

Carter, M. R. and J. May (1999). "Poverty, Livelihood and Class in Rural South Africa." World Development **27**(1): 1-20.

Cotula, L., C. Toulmin and C. Hesse (2004). Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues. London, International Institute for Environment and Development.

Cox, D. R. (1972). "Regression Models and Life Tables " Journal of the Royal Statistical Society Series B **34**(2): 187-220.

Deininger, K., D. A. Ali and T. Alemu (2008). "Assessing the Functioning of Land Rental Markets in Ethiopia." Economic Development and Cultural Change **57**(1): 67-100.

Deininger, K. and H. Binswanger (1999). "The Evolution of the World Bank's Land Policy: Principles, Experience, and Future Challenges." World Bank Research Observer **14**(2): 247-276.

Deininger, K. and H. Binswanger (1999). "The Evolution of World Bank's Land Policy: Principles, Experience, and Future Challenges." The World Bank Research Observer **14**(2): 247-276.

Deininger, K. and G. Feder (1998). Land Institutions and Land Markets, The World Bank, Development Research Group, Rural Development.

Dercon, S. (2006). "Economic Reform, Growth and the Poor: Evidence from Ethiopia." Journal of Development Economics **81**(1): 1-24.

Devicienti, F. (2002). "Poverty Persistence in Britain: A Multivariate Analysis Using the Bhps, 1991-1997." Journal of Economics-Zeitschrift Fur Nationalokonomie: 307-340.

Do, Q. T. and L. Iyer (2008). "Land Titling and Rural Transition in Vietnam." Economic Development and Cultural Change **56**(3): 531-579.

FDRE-MOFED (2002). Sustainable Development and Poverty Reduction Program (Sdprp)-Ethiopia, Federal Democratic Republic of Ethiopia - Ministry of Finance and Economic Development.

FDRE (1997). Rural Land Administration Proclamation of the Federal Government of Ethiopia. Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia. **Proclamation No. 89/1997**.

Feder, G., T. Onchan and Y. Chalamwong (1988). "Land Policies and Farm Performance in Thailand's Forest Reserve Areas." Economic Development and Culture Change **36**(3): 483-501.

Gebregziabher, G., R. E. Namara and S. Holden (2009). "Poverty Reduction with Irrigation Investment: An Empirical Case Study from Tigray, Ethiopia." Agricultural Water Management **96**(12): 1837-1843.

Ghebru, H. H. and S. T. Holden (2008). Factor Market Imperfections and Rural Land Rental Markets in Northern Ethiopian Highlands. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Haggblade, S. and P. B. Hazell (1988). Prospects for Equitable Growth in Rural Sub-Saharan Africa, Agriculture and Rural Development Department, The World Bank, working paper no. 0008.

Hoben, A. (2000). Ethiopian Rural Land Tenure Policy Revisited. Paper Presented at the Symposium for Reviewing Ethiopia's Economic Performance 1991 - 1999. Organized by Inter-Africa Group. Addis Ababa. April 26 - 29.

Holden, S. and H. Yohannes (2002). "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." Land Economics **78**(4).

Holden, S. T., K. Deininger and H. Ghebru (2009). "Impacts of Low-Cost Land Certification on Investment and Productivity." American Journal of Agricultural Economics **91**(2): 359-373.

Holden, S. T., K. Deininger and H. H. Ghebru (in press). "Tenure Insecurity, Gender, Low-Cost Land Certification and Land Rental Market Participation in Ethiopia." Journal of Development Studies.

Holden, S. T. and H. Ghebru (2005). Kinship, Transaction Costs and Land Rental Market Participation. In. Working Paper, Norwegian University of Life Sciences. Ås.

Holden, S. T., R. Kaarhus and R. Lunduka (2006). Land Policy Reform: The Role of Land Markets and Women's Land Rights in Malawi. In. Working Paper, Norwegian University of Life Sciences. Ås, Norway.

Holden, S. T., K. Otsuka and F. M. Place (2008). The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T., K. Otsuka and F. M. Place (2008). Land Markets and Development in Africa. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T. and H. Yohannes (2002). "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." Land Economics **78**(4): 573-590.

Jacoby, H. G. and B. Minten (2007). "Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar." World Bank Economic Review **21**(3): 461-485.

Jayne, T. S., T. Yamano, M. T. Weber, D. Tschirley, R. Benfica, A. Chapoto and B. Zulu (2003). "Smallholder Income and Land Distribution in Africa: Implications for Poverty Reduction Strategies." Food Policy **28**: 253-275.

Jayne, T. S., B. Zulu, G. Kajoba and M. T. Weber (2008). Access to Land and Poverty Reduction in Rural Zambia: Connecting the Policy Issues, Food Security Research Project, working paper no. 34.

Jenkins, S. P. (1999). Modelling Household Income Dynamics. Colchester, Working Paper 99-1, ISER - Institute for Social and Economic Research, University of Essex.

Kaplan, E. L. and P. Meier (1958). "Nonparametric-Estimation from Incomplete Observations." Journal of the American Statistical Association **53**(282): 457-481.

Karugia, J. T., W. Oluoch-Kosura, R. Nyikal, M. Odumbe and P. P. Marenya (2006). Access to Land, Income Diversification and Poverty Reduction in Rural Kenya. Paper presented at the 26th International Conference of the International Association of Agricultural Economists, Brisbane, Australia, International Association of Agricultural Economists.

Laffont , J. J. and M. S. Matoussi (1995). " Moral Hazard, Financial Constraints and Sharecropping in El Oulja." Review of Economic Studies **62**: 381-399.

Li, G., S. Rozelle and L. Brandt (1998). "Tenure, Land Rights, and Farmer Investment Incentives in China." Agricultural Economics **19 (1-2)**: 63-71.

Lipton, M. and M. Ravallion (1995). Poverty and Policy. In: J. Behrman and T. N. Srinivasan. Handbook of Development Economics, Elsevier Sciece B.V. **III:** Chapter 41.

Lunduka, R., S. T. Holden and R. Øygard (2008). Land Rental Market Participation and Tenure Security in Malawi. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Migot-Adholla, S. E., G. Benneh, F. Place and S. Atsu (1994). Land, Security of Tenure, and Productivity in Ghana. In: J. W. Bruce and S. E. Migot-Adholla. In Searching for Land Tenure Security in Africa. Dubuque, IA, Kendall/Hunt.

MoFED (2007). Ethiopia: Building on Progress - a Plan for Accelerated and Sustaininble Development to End Poverty. Addis Ababa, Ethiopia, Federal Democratic Republic of Ethiopia - Ministry of Finance and Economic Development (MoFED). **Annual Progress Report 2005/06**

Nega, F., E. Mathijs, J. Deckers, M. Haile, J. Nyssen and E. Tollens (2010). "Rural Poverty Dynamics and Impact of Intervention Programs Upon Chronic and Transitory Poverty in

Northern Ethiopia." African Development Review-Revue Africaine De Developpement **22**(1): 92-114.

Otsuka, K., A. R. Quisumbing, E. Payongayong and J. B. Aidoo (2003). "Land Tenure and the Management of Land and Trees: The Case of Customary Land Tenure Areas of Ghana." Environment and Development Economics **8**: 77-104.

Rahmato, D. (1984). Agrarian Reform in Ethiopia. Uppsala, Scandinavian Institute of African Studies.

Ravallion, M. and B. Bidani (1994). "How Robust Is a Poverty Profile." World Bank Economic Review **8**(1): 75-102.

Rigg, J. (2006). "Land, Farming, Livelihoods, and Poverty: Rethinking the Links in the Rural South." World Development **34**(1): 180-202.

Sadoulet, E., R. Murgai and A. de Janvry (2001). Chapter 8: Access to Land Via Land Rental Markets. In: G. G. d. A. Alain de Janvry, Elisabeth Sadoulet, Jean-Phillipe Platteau. Access to Land, Rural Poverty, and Public Action, Oxford University Press**:** 196-219.

Smith, R. E. (2004). "Land Tenure, Fixed Investment, and Farm Productivity: Evidence from Zambia's Southern Province." World Development **32**(10): 1641-1661.

Stevens, A. H. (1994). "The Dynamics of Poverty Spells - Updating Bane and Ellwood." American Economic Review **84**(2): 34-37.

Stevens, A. H. (1999). "Climbing out of Poverty, Falling Back in - Measuring the Persistence of Poverty over Multiple Spells." Journal of Human Resources **34**(3): 557-588.

Tikabo, M. O. and S. T. Holden (2003). Land Contract Choice: Poor Landlords and Rich Tenants - Evidence from the Highlands of Eritrea. Ås, Norway, Norwegian University of Life Sciences.

TNRS (2006). "Regulations and Procedures for the Implementaion of Rural Land Administration and Use Proclamation." Negarit Gazetta of the Council of Tigray National Regional State **Proclamation No. 97/2006**.

TNRS (2008). "Repealed Regulations for the Implementaion of Rural Land Administration and Use Proclamation." Negarit Gazetta of the Council of Tigray National Regional State **Proclamation No. 48/2007**.

Warriner, D. (1969). Land Reform in Principle and Practice. Oxford,, Clarendon P.

Zimmerman, F. J. and M. R. Carter (1999). "A Dynamic Option Value for Institutional Change: Marketable Property Rights in the Sahel." American Journal of Agricultural Economics **81**(2): 467-478.

Table 1: Variable Description

Variable	**Description**
Sex of household head	Gender of the household head (1=female, 0=male)
Age of household head	Age of the head of the household (number of years)
Education of household head	Educational status of the head of household (1=literate, 0=illiterate)
Female labor force	Number of female working-age family members in the household
Male labor force	Number of male working-age family members in the household
Number of senior members	Number of family members greater than 65 years of age
Dependency Ratio	Number of dependent family members divided by Adult labor force
Number of oxen	Number of oxen
Other livestock endowment	Possession of livestock other than oxen - in Tropical livestock unit
Farm size	Size of agricultural land owned by the household (in *tsimdi**)
Possess land use certificate	If the household posses a land use certificate (1=yes, 0=no)
Access to irrigation	If the household has an irrigated plot (1=yes, 0=no)
Location of residence	If the household resides in a semi-urban area (1=yes, 0=no)
Wage income	Amount of income from wage labor employment (Ethiopian Birr)
No operational holding	If the household has zero operational holding (1=yes, 0=no)
Ratio of land leased-in	Total area leased-in divided by total operational holding
Ratio of land leased-out	Total area leased-out divided by total own-holding
Tenant	If the household is a tenant household
Landlord	If the household is a landlord household
Irrigated size of plots	Total area of irrigated plots – in *tsimdi*
Village average expenditure	Village average household consumption expenditure per consumer unit
Household expenditure per consumer unit	Adult equivalent scale adjusted household expenditure

**Tsimdi* is a local area measurment equivalent to 0.25 hactare

Table 2: Households' welfare status and participation in the land tenancy Market

Survey year	Percentage of the total sample		Head-count Ratio			Mean Annual consumption expenditure of		
	Tenants	Landlords	Tenants	Landlords	Non-participants	Tenants	Landlords	Non-participants
1997	8	23	93	86	93	681.56	590.23	440.09
2000	30	25	81	72	88	796.95	743.77	533.58
2003	28	26	81	71	83	857.34	790.85	739.61
2006	26	28	72	58	70	996.83	853.73	870.11

Source: Survey data

Table 3: Summary key variables based on duration of a spell of poverty

	Poor Once		Poor Twice		Poor Thrice		Always Poor	
	Mean (std. err)		Mean (std. err)		Mean (std. err)		Mean (std. err)	
Age of household head	51.57	(3.41)	54.97	(1.16)	53.60	(0.88)	51.37	(0.55)
Sex of household head	0.25	(0.08)	0.31	(0.03)	0.27	(0.02)	0.17	(0.02)
Number of oxen	1.11	(0.29)	0.98	(0.08)	0.81	(0.05)	0.87	(0.03)
Other draft animals	2.34	(0.88)	1.49	(0.16)	1.28	(0.09)	1.31	(0.07)
Farm size (Tsimdi)*	4.30	(0.51)	4.65	(0.23)	4.05	(0.15)	3.91	(0.11)
Tenant household	0.36	(0.09)	0.27	(0.03)	0.20	(0.02)	0.27	(0.02)
Landlord household	0.39	(0.09)	0.42	(0.04)	0.28	(0.02)	0.19	(0.02)
Land leased-in	1.44	(0.48)	0.85	(0.14)	0.48	(0.07)	0.53	(0.05)
Land leased-out	1.13	(0.34)	0.99	(0.12)	0.83	(0.10)	0.45	(0.05)

Source: Survey data

*Tsimdi is a local area measurement which is equivalent to 0.25 hactare.

Table 4: Land Holding and Household Consumption Expenditure by Per Consumer Unit Expenditure (PCUE) Deciles

	1997		2000		2003		2006	
Deciles of PCUE	Own holding (ha/cu)	Expenditure per cu	Own holding (ha/cu)	Expenditure per cu	Own holding (ha/cu)	Expenditure per cu	Own holding (ha/cu)	Expenditure per cu
1	0.23	168.07	0.19	186.51	0.21	268.56	0.27	265.96
2	0.35	243.53	0.15	270.20	0.21	370.23	0.15	390.97
3	0.23	297.88	0.16	336.53	0.20	445.33	0.21	463.96
4	0.20	344.09	0.32	406.14	0.20	514.34	0.19	569.21
5	0.22	392.17	0.25	481.89	0.30	620.63	0.20	685.56
6	0.30	461.74	0.34	573.28	0.29	702.21	0.30	786.52
7	0.24	520.21	0.36	683.05	0.31	791.77	0.30	938.70
8	0.41	613.63	0.35	851.10	0.25	940.14	0.37	1160.29
9	0.48	789.80	0.38	1082.99	0.32	1173.65	0.37	1417.58
10	0.53	1633.24	0.40	1739.18	0.49	2021.01	0.46	2310.75

*PCUE: Per consumer unit household consumption expenditure

Table 5: Survivor Function and Exit Rates from Poverty for All Persons Beginning a Poverty Spell Using Kaplan-Meier-Estimates

Rounds (number of interviews) since start of poverty spell	Number of households at risk of exit at the start of period	Survivor's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	274	1	(.)	-	-
2	230	0.8394	(0.02)	0.1746	(0.03)
3	192	0.7007	(0.03)	0.1801	(0.03)

Table 6: Comparison of Survivor Function and Exit Rates from Poverty for Persons Beginning Poverty Spell Using Kaplan-Meier-Estimates - by Tenancy Market Status

	Tenants				Landlord			
Rounds since start of poverty spell	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	1	(.)			1	(.)		
2	0.8442	(0.04)	0.1690	(0.05)	0.7353	(0.05)	0.3051	(0.06)
3	0.7403	(0.05)	0.1311	(0.05)	0.5588	(0.06)	0.2727	(0.08)

Table 7: Comparison of Survivor Function and Exit Rates from Poverty for Persons Beginning Poverty Spell Using Kaplan-Meier-Estimates - by Gender of Household Head

	Male				Female			
Rounds since start of poverty spell	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	1	(.)			1	(.)		
2	0.8542	(0.03)	0.1573	(0.03)	0.8049	(0.04)	0.2162	(0.05)
3	0.7344	(0.03)	0.1508	(0.03)	0.5720	(0.05)	0.3164	(0.07)

Table 8: Comparison of Survivor Function and Exit Rates from Poverty for Persons Beginning Poverty Spell Using Kaplan-Meier-Estimates - by Settlement Type

	Semi-urban				Rural			
Rounds since start of poverty spell	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	1	(.)			1	(.)		
2	0.8529	(0.02)	0.1587	(0.03)	0.8	(0.05)	0.2222	(0.06)
3	0.7255	(0.03)	0.1615	(0.03)	0.6286	(0.06)	0.24	(0.07)

Table 9: Comparison of Exit and Re-entry rates of different household groups using Food Poverty line (Kaplan-Meier-Estimates)

	Exit rates		Re-entry rates	
Household Category	Rounds since start of Food Poverty spell		Rounds since start of Food non-poverty spell	
	2	3	2	3
All Respondents	0.2844	0.3242	0.6111	0.3256
	(0.04)	(0.04)	(0.12)	(0.12)
Tenant	0.4071	0.2500	0.5000	0.5714
	(0.08)	(0.08)	(0.20)	(0.27)
Landlord	0.4158	0.4242	0.4828	0.0952
	(0.90)	(0.11)	(0.18)	(0.10)
Male headship	0.2984	0.2906	0.5217	0.4286
	(0.04)	(0.05)	(0.15)	(0.17)
Female headship	0.2500	0.4086	0.7692	0.1333
	(0.06)	(0.09)	(0.22)	(0.13)
Semi-urban	0.2567	0.3083	0.7692	0.5263
	(0.04)	(0.05)	(0.18)	(0.23)
Rural	0.3704	0.3784	0.4242	0.1667
	(0.08)	(0.10)	(0.16)	(0.12)

Table 10: Proportional Hazard Model Estimates of Escaping Poverty

	Unadjusted Transition		Adjusted Trasition	
	Degree of partipation	Mere participation	Degree of partipation	Mere participation
Village average consumption expenditure	0.001	0.001	0.001	0.001
	0.00	0.00	0.00	0.00
Female labor force	-0.153	-0.162	-0.118	-0.127
	(0.14)	(0.14)	(0.15)	(0.15)
Male labor force	-0.374***	-0.392****	-0.340***	-0.360***
	(0.12)	(0.12)	(0.13)	(0.13)
Household members > 65 years old	0.072	0.06	0.143	0.148
	(0.24)	(0.24)	(0.25)	(0.26)
Dependency ratio	-0.983**	-1.030**	-0.841*	-0.852*
	(0.42)	(0.42)	(0.48)	(0.48)
Sex of the household head	0.105	0.125	0.119	0.144
	(0.25)	(0.25)	(0.27)	(0.27)
Age of the household head	0.014*	0.015**	0.011	0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Literate household head	0.391*	0.36	0.432*	0.373
	(0.23)	(0.23)	(0.26)	(0.25)
Access to irrigation	0.549**	0.534**	0.549**	0.566**
	(0.24)	(0.25)	(0.27)	(0.28)
Farm size	-0.01	-0.006	-0.015	-0.013
	(0.03)	(0.03)	(0.03)	(0.03)
Location of residence – semi-urban	0.177	0.154	0.128	0.114
	(0.23)	(0.23)	(0.25)	(0.26)
Number of draft animals	0.021	0.021	-0.006	-0.011
	(0.07)	(0.07)	(0.08)	(0.08)
Number of oxen	0.14	0.131	0.046	0.027
	(0.12)	(0.13)	(0.14)	(0.14)
Size of irrigate land holding	-0.094	-0.083	-0.129	-0.122
	(0.12)	(0.12)	(0.15)	(0.15)
Village population density	-0.017	-0.009	0.006	-0.008
	(0.20)	(0.20)	(0.23)	(0.23)
lli_ratio (size leased-in/total operational holding	-0.647		-0.351	
	(0.51)		(0.50)	
llo_ratio (size leased-out/total own holding	0.660**		0.641**	
	(0.28)		(0.32)	
If the household is tenant household		-0.25		-0.261
		(0.26)		(0.30)
If the household is landlord household		0.383*		0.211
		(0.23)		(0.25)
No. of Subjects	274	274	266	266
No. of Exits	124	124	101	101
Log likelihood	-647.22	-649.118	-515.733	-517.405
chi squared	53.795	50.322	39.572	36.523
Prob > chi squred	0.000	0.000	0.002	0.006
Number of Obs.	694	695	609	610

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%;
Standard errors, corrected for clustering at household level, are included in parentheses..

Table A1: Survivor Function and Exit Rates from Food Poverty for All Persons Ending a Poverty Spell Using Kaplan-Meier-Estimates

Rounds (number of interviews) since start of poverty spell	Number of households at risk of exit at the start of period	Survivor's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1		1	(.)	-	-
2		0.7510	(0.03)	0.2844	(0.04)
3		0.5415	(0.03)	0.3242	(0.04)

Table A2: Survivor Function and Re-Entry Rates into Food Poverty for All Persons Ending Poverty Spell Using Kaplan-Meier-Estimates

Rounds (number of interviews) since start of non-poverty spell	Number of households at risk of exit at the start of period	Survivor's Function (%)	(Std. Err)	Re-entry rates	(Std. Err)
1		1	(.)		
2		0.5319	(0.07)	0.6111	(0.12)
3		0.3830	(0.07)	0.3256	(0.12)

Table A3: Comparison of Survivor Function and Exit Rates from Food Poverty for Persons Ending Poverty Spell Using Kaplan-Meier-Estimates - by Tenancy Market Status

	Tenants				Landlord			
Rounds since start of poverty spell	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	1	(.)	-	-	1	(.)	-	-
2	0.6618	(0.06)	0.4071	(0.08)	0.6557	(0.60)	0.4158	(0.90)
3	0.5147	(0.06)	0.2500	(0.08)	0.4262	(0.60)	0.4242	(0.11)

Table A4: Comparison of Survivor Function and Re-Entry Rates into Food Poverty for All Persons Ending Poverty Spell Using Kaplan-Meier-Estimates- by Tenancy Market Status

	Tenants				Landlord			
Rounds since start of non-poverty spell	Surviror's Function (%)	(Std. Err)	Re-entry rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Re-entry rates	(Std. Err)
1	1	(.)	-	-	1	(.)	-	-
2	0.6000	(0.13)	0.5000	(0.20)	0.6111	(0.12)	0.4828	(0.18)
3	0.3333	(0.12)	0.5714	(0.27)	0.5556	(0.12)	0.0952	(0.10)

Table A5: Comparison of Survivor Function and Exit Rates from Food Poverty for Persons Ending Poverty Spell Using Kaplan-Meier-Estimates - by Gender of Household Head

	Male				Female			
Rounds since start of poverty spell	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Exit rates	(Std. Err)
1	1	(.)	-	-	1	(.)	-	-
2	0.7403	(0.03)	0.2984	(0.04)	0.7778	(0.05)	0.2500	(0.06)
3	0.5525	(0.04)	0.2906	(0.05)	0.5139	(0.06)	0.4086	(0.09)

Table A6: Comparison of Survivor Function and Re-Entry Rates into Food Poverty for All Persons Ending Poverty Spell Using Kaplan-Meier-Estimates- by Gender of Household Head

	Male				Female			
Rounds since start of non-poverty spell	Surviror's Function (%)	(Std. Err)	Re-entry rates	(Std. Err)	Surviror's Function (%)	(Std. Err)	Re-entry rates	(Std. Err)
1	1	(.)	-	-	1	(.)	-	-
2	0.5862	(0.09)	0.5217	(0.15)	0.4444	(0.12)	0.7692	(0.22)
3	0.3793	(0.09)	0.4286	(0.17)	0.3889	(0.11)	0.1333	(0.13)

Table A7: Equivalence scales for household consumption need adjustments

Years of age	Men	Women
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
14-16	1.06	0.86
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
60 plus	0.84	0.74

Source: Adopted from Dercon (2006).

Appendix 1: Computation of the food and non-food poverty lines

Poverty is defined here in terms of inadequacy of consumption of basic needs such as food. The objective of a poverty line is to capture the basic needs necessary to meet minimum living standards. The cost-of-basic-needs (CBN) method addresses this objective through defining a consumption bundle – incorporating food and non-food items – that is adequate to meet the nutritional requirements, and estimates the cost of purchasing that consumption bundle.

Throughout this paper, an income-based definition of poverty is used. This is not to deny the importance of consumption-based or multi-dimensional approaches to the measurement of poverty - indeed, there is now a large literature on the multi-faceted nature of poverty and the importance of integrating "qualitative" and "quantitative" approaches to poverty measurement. However, most poverty analysts would agree that the inability to acquire a certain minimum bundle of goods lies at the core of most concepts of poverty. Furthermore, income- or consumption-based definitions of poverty have the advantage of clearly dividing a population into mutually exclusive categories. Although consumption-based poverty measures are usually more stable than those of income (Lipton and Ravallion, 1995), we have adopted an income-based definition of poverty because this is the variable we are able to track over all five years of the panel.

However, the methods used in this paper could be applied to any mutually exclusive indicator of poverty. Whenever a household's income crosses over the poverty line that household makes a poverty transition. An increase in income that moves a household over the poverty line is defined as an exit or movement out of poverty, while a decrease in income that moves a household's income below the poverty line is defined as an entry or movement into poverty. One difficulty that arises with such a definition of poverty transitions is that if a household's income is close to the poverty line relatively small changes in income may be associated with exits out of and entries into poverty. To avoid this problem, we have adopted a definition of poverty transitions which requires a household to experience both a change in real income of 10 per cent or more and to have crossed the poverty line before it is said to enter or exit poverty.

The important question related to this method is that of how to estimate the non-food component of the poverty line, in a way such that it captures the basic non-food requirements. A standard approach, recommended by a number of researchers, has been to estimate the non-food component from the expenditure composition of households whose food expenditures are close to what is required to achieve the nutritional anchor. The standard approach for poverty line estimation using the CBN method is to first find a food consumption bundle of the population likely to be poor (called henceforth the "reference group"), and then estimate the cost of consuming this bundle using the prices faced by the reference group. The food expenditure thus derived constitutes what is referred to as the food poverty line. This method is described in detail below.

Defining Food Poverty Line

The method implemented to derive the food poverty line is as follows:

(i) the households in the bottom 50% ranked by real per-capita total consumption expenditure are chosen as the reference group;

(ii) all food items for which information on expenditure, quantity and estimated calorie value are available are selected;

(iii) the aggregates of food expenditures and calorie intakes in the reference group are calculated;

(iv) the cost per calorie is derived by dividing the former with the latter;

(v) **the food poverty line is defined at ETB 773 per adult equivalent per year** by multiplying the per calorie cost with the nutritional anchor per year (2200*365 Kcal)

Variable	Obs	Mean	Std. Dev.
cal_cost	174	.0009636	.0002914

The Food Poverty line, therefore, is calculated as:

FOOD POVERTY LINE (/Adult Eqv./year) = (COST PER CALORIE) * (Nutritional Anchor per Year)

= (0.0009636) * (2200*365)

= **ETB 773.77**

The food poverty line obtained above has to be translated into an absolute poverty line that also incorporates the expenditure required to attain basic non-food needs. How this is done is described below.

How to derive the non-food component of the poverty line?

Deriving the non-food component of the poverty line is less straightforward than deriving the food poverty line, since it is not clear what level of non-food expenditures should be defined as basic needs. Important literature in this area proposes a range of seemingly appropriate nonfood poverty lines by linking non-food expenditures to food expenditures.

The lower bound of the non-food poverty line is defined as the ***average per capita non-food expenditure of households whose per capita total expenditure is close to the food poverty line***. The logic behind this definition is as follows. Such households' non-food expenditure should be considered as absolutely necessary for sustaining the minimum living standards, simply because any amount of spending on non-food items for such households necessarily reduces their food expenditure below what is required to attain the minimum calorie requirement.

The upper bound is defined as the ***average per-capita non-food expenditure of households whose per-capita food expenditure is close to the food poverty line***. The rationale for such an "upper bound" is as follows. The average non-food expenditures among households whose food expenditure is around the food poverty line is applicable to households that no longer need to sacrifice food expenditures necessary to meet the minimum calorie requirement in order to consume nonfood items. As long as the non-food poverty line is chosen from the range between the above lower and upper bounds, such an approach is justifiable. The national poverty line is then calculated by adding up the food poverty line and the non-food poverty line.

To estimate the upper and lower bounds, we use a simple non-parametric approach. For estimating the upper bound, the reference group is selected as households whose real per capita food expenditures are within an interval of plus or minus 10 percent around the food poverty line

(i.e., between 696.39 and 851.15). The median per-capita nonfood expenditure of this reference group is taken as the upper bound.

Estimating the lower bound differs only in terms of the definition of the reference group. This group now consists of households whose real per-capita total expenditures are in the interval of plus or minus 10 percent around the food poverty line.

Accordingly, the results from the non-parameteric estimates (allowances) for the upper and lower boundaries for the non-food expenditure are:

1. Upper boundary: ETB 298.15
2. Lower boundary: ETB 182.89

The following table summarizes all the poverty lines at 2000 southern zone prices (the minimum requirement to satisfy 2200 Kcal/day/adult equivalent.

Poverty line	ETB/year
1. Food Poverty Line	773.77
2. Lower Poverty Line	956.66
3. Upper Poverty Line	1,071.92
4. Absolute Poverty Line (Av. Of 2 & 3)	**1,014.29**

Paper 3

REVERSE-SHARE-TENANCY AND MARSHALLIAN INEFFICIENCY: BARGAINING POWER OF LANDOWNERS AND THE SHARECROPPER'S PRODUCTIVITY

Hosaena H. Ghebru[1 2] and Stein T. Holden[1]

[1]Department of Economics and Resource Management (IØR)

Norwegian University of Life Sciences (UMB), P.O.Box 5003, N_1432, Aas, Norway

[2]Department of Economics, Mekelle University, P.O.box 451, Mekelle, Ethiopia

Email: hosaenag@yahoo.com

Abstract

Making use of a unique tenant-landlord matched data from the Tigray region of Ethiopia, we are able to show how strategic responses of tenants - to varying economic and property right status of the landlords - are important in explaining productivity differentials of sharecroppers. The results show that sharecroppers' yield are significantly lower on plots leased from landlords who are non-kin; female; with lower income generating opportunity; and tenure insecure households, than on plots leased from landlords with contrasting characteristics. While, on aggregate, the result shows no significant efficiency loss on kin-operated sharecropped plots, a more decomposed analysis indicates strong evidence of Marshallian inefficiency on kin-operated plots leased from landlords with weaker bargaining power and higher tenure insecurity. This study, thus, shows how failure to control for such heterogeneity of landowners' characteristics can explain the lack of clarity in the existing empirical literature on the extent of moral hazard problems in sharecropping contracts.

JEL classification: D1, O13, O18, Q12, Q15

Keywords: Marshallian inefficiency; kinship; matching; Reverse-Share-Tenancy; Ethiopia

1. Introduction

Amid claims about the potential disincentive effects and efficiency losses of sharecropping, its prevalence and diffusion in much of the developing world makes share tenancy arguably one of

the most controversial subjects in agricultural economics. In an attempt to better explain the contrasting evidences on the efficiency of sharecropping tenancy, Otsuka and Hayami (1988), Singh (1989), Hayami and Otsuka (1993) and Otsuka (2007) have reviewed a large body of literature and claiming that the evidence on the alleged systematic downward bias in input intensify and productivity are far from conclusive.

Only recently have case studies from Pakistan by Jacoby and Mansuri (2009); from Thailand by Sadoulet et al (1994; 1997); from India by Sharma and Dreze (1996); from Ethiopia by Gavian and Ehui (1999), Pender and Fafchamps (2006), and Kassie and Holden (2007); from Ghana by Otsuka and others (2003); and from Tunisia by Arcand and others (2007) started to establish alternative conditions under which particular circumstances share tenancy can be no less efficient than owner-operated or fixed rent contracts. For instance, Otsuka (2007) suggested that land-to-the-tiller policies in several Asian countries created tenure insecurity on the landlord side and this may explain the Marshallian efficiency in these countries. The two notable studies by Sadoulet and others (1997) and Kassie and Holden (2007; 2008) stand out for the similarities in their approach to consider the role indigenous institutions play to internalize the disincentive effects of share tenancy. Both studies tried to explain sharecropping efficiency differentials in terms of the role kinship ties between tenant and landlord play in mitigating the problem of moral hazard that looms over share tenancy arrangements.

While the empirical evidence by Sadoulet et al (1997) from the Philippines shows the positive role of kinship tenancy arrangements, results by Kassie and Holden (2007;2008), on the other hand, reveal the contrary – showing that nonkin operated farms are more productive than kin-operated farms. We believe such discrepancy can partly be voided by considering the motives

why farm households opt for kin-tied transactions and exchanges. Though it is a well documented fact that households tend to operate within their own social circle mainly to tackle problems associated with market imperfections (moral hazard, adverse selection) and high transaction costs (Arrow 1968; Sen 1975; Sadoulet et al. 1997; Fafchamps 2004), such arrangements may also be considered by poor households as a form of "insurance policy" against consumption risks during times of crop failure. In such a case, poor landowners are more likely to be economically dependent and highly reliant on kin-based tenancy arrangements (Macours 2004). There are claims that such economic dependence may degrade their bargaining power and undermine their ability and will to exercise eviction as a threat to induce the effort /performances of tenants (Holden and Bezabih 2008). We follow up on this and aim to show, other than the expected higher degree of social concern between kin tenants and their landlords, the strategic response (opportunistic behavior) of tenants to varying economic and tenure security condition/status of the landlord can have an effect on the performance of sharecropped plots[1].

As these, studies by Sadoulet et al (1997) and Kassie and Holden (2007; 2008), are made from the demand (tenant) side of the market, they only partly consider the heterogeneity of agents from the supply side of the market (landlords) in their efficiency analysis. Failure to account for such heterogeneity of the characteristics of landlord households may conceal the opportunistic behavior of tenants. Making use of unique matched tenant-landlord plot level data from the northern highlands of Ethiopia, our inclusion of such heterogeneous economic and property right conditions of landlords allows us to reconcile and bridge these contrasting findings. We used household fixed effects method to control for unobservable household heterogeneity while non-

[1] On the other hand, Holden and Bezabih (2008) approach this from the land lord side, comparing male and female landlord households while taking into account the tenant characteristics, including possible kinship relationships between landlords and tenants.

parametric matching method was applied to control for plot selection bias in rental and partner selection decisions. Our results confirm that, after controlling for plot selection bias, sharecroppers' yield on plots leased from landlords who are non-kin; female, with lower income generating capacity or those who are believed to be tenure insecure are significantly lower than plots leased from households with contrasting conditions. Failure to control for such heterogeneity of landowners' characteristics, thus, may cause the lack of clarity in the existing empirical literature on sharecropping productivity differentials. The empirical evidence implies that strengthening property rights of landholders may not only have a direct productivity-enhancing effect on owner-operated smallholder cultivation but also an indirect impact on the productivity of transacted plots.

This paper is organized as follows. Section 2 reviews the literature on the evolution of land tenure and the structure of the tenancy market in Ethiopia. The theoretical model adapted in this study together with testable hypotheses is discussed in section 3. Section 4 is devoted for econometric methods applied for the analysis while section 5 describes the data sources and variable definition. The last two sections are devoted for the discussion and summary of the findings.

2. The land tenure system and sharecropping in Ethiopia

Civil war and border conflicts have had severe negative impacts on development in Ethiopia since a military regime (Derg) took power from Haile Sellassie I in 1974 and made all land state property. The regime followed up with frequent land redistributions and land allocation based on family size was practiced to maintain an egalitarian land distribution (Rahmato 1984; Holden and Yohannes 2002). After a long civil war in northern Ethiopia, the military government was overthrown and a new government formed in 1991 where a new federal land proclamation was

introduced in 1995 and followed up by regional land proclamations at different points in time after that allowing for some variation in the land laws across regions as long as these did not violate the federal land law. Even though the 1975 land reform in Ethiopia contributed to an egalitarian land distribution, land rental markets are very active and are dominated by sharecropping arrangements (Teklu and Lemi 2004; Deininger et al. 2008; Ghebru and Holden 2008; Tadesse et al. 2008).

In an attempt to examine the possible effects of the land tenure system on the dynamics of the tenancy market and its efficiency, three key issues stand out as distinguishing features of the land tenure system in Ethiopia: 1) tenure insecurity; 2) land fragmentation and landlessness; and 3) rural factor market imperfections and the "Reverse-Share-Tenancy" scenario.

Tenure Insecurity (supply-side-effects)

One of the major land-related problems in Ethiopia, mainly due to the frequent land distribution and redistribution in the past, has been insecurity of tenure (Alemu 1999; Hoben 2000). This calls up on the need for having land policies and a system of land administration that supports secure property rights, broadens access to land and supports incentives for improved land use management. It is with the desire to reap such benefits that the current Government of Ethiopia, through the Ministry of Agriculture and Rural Development (MOARD), has embarked on a land certification program in the country (Deininger et al. 2008)[2]. In addition to the well-documented investment effects of secured property rights (Feder et al. 1988; Besley and Coast 1995; Deininger and Feder 1998; Li et al. 1998; Holden et al. 2009), there are early signs that suggest

[2] The Tigray region was the first to start a land certification process in 1998-99 and used simple traditional methods in the implementation. More than 80 of the population in the region had received land certificates when the process was interrupted by the war with Eritrea (Deininger et al 2008; Holden et al 2009)

formalization of land rights - in the form of providing households with inheritable user certificates – lubricate the functioning of land rental markets and factor ratio adjustment process (Holden et al. in press).

Important policy concerns however are whether the land reform in form of registration and certification has contributed to increased tenure security, especially for the poor, including women. From the supply side perspective, for instance, without clear and definite claims to the land, farmers (potential landlords) can be reluctant to rent/leas out to others for fear of losing the land through future administrative redistribution (Deininger et al. 2008; Ghebru and Holden 2008). In such circumstances, despite the possibility that the productivity of the land is better under different operator (potential tenant) - with better skill and complementary farm inputs, it is possible that the land holder may decide to operate the land by himself or lease it out to a less-effective kin tenant (Holden and Bezabih 2008).

Furthermore, the cultural rule against women cultivating their land cause single women to depend on assistance from men or renting out or sharecropping out their land to a kin. This cultural taboo causes female-headed households in Tigray often to be (kin) landlords and among the poorest of the poor (MUT 2003). Anecdotal evidences from Tigray (Pender et al. 2002; MUT 2003) show that women think differently about their land certificates than men as their tenure rights have been less secure than that of men. This may imply that the certificates have a higher value to women than they have to men. Having a certificate may thus come to the rescue in strengthening the bargaining power of female-headed (poor) households and this may have a productivity-enhancing effect. Empirical evidence of a previous study by Holden et al (in press) from the study area (using the same sample) shows that possession of land use certificate has increased participation in the tenancy market especially of female headed households.

Land Fragmentation and Landlessness / demand side effect

Following the legal reforms in the country, the halt in the administrative redistributions of land accompanied by rapid population growth in the country means farm households rely on intra-household land distribution (inheritance) so as to accommodate descendants. This pushes the problem of land fragmentation beyond the limit[3] creating a rapid increase in demand for land through the land rental market. Such direct (landlessness) and indirect (land fragmentation) effects of the population growth and the recent land policy reforms make the tenancy market the main venue for land-constrained farm households to get access to additional land and for landless households for mere access to land[4].

In support of this, a study by Ghebru and Holden (2008) and Holden et al (in press) found that land rental market in Tigray is characterized by substantial transaction costs and asymmetries due to rationing of tenants. According to this empirical evidence, many tenants and potential tenants failed to rent-in as much land as they wanted – potentially causing the new wave of youngsters in the region who are land poor or landless and inexperienced to be rationed out of the market. The fact that a large share of the contracts in the study area are among kin partners wherein kinship ties appeared to improve access to land in the market (Holden and Ghebru 2005; Ghebru 2009), is indicative enough to suggest the prevalence of frictions in the tenancy market

Non-Land Factor Market Imperfections and Reverse-Share-Tenancy

Despite the relatively egalitarian distribution of land holding across households in the country

[3] The landholding size for an average farm household in Ethiopia is only one hectare while the problem is more acute in the study area with an average landholding size of 0.5ha (Ghebru and Holden, 2009).

[4] Though we were not able to analyze the severity of landlessness in the region from our sampled data as it includes only those households with access to arable land, our matched partner data shows that 17% of the tenants were landless.

(Rahmato 1984; Adal 2002), heterogeneity in non-land resource endowment (such as labor and oxen) causes inequalities in relative factor ratios across households (Ghebru and Holden 2008). On the other hand, due to problems of moral hazard, liquidity constraints and seasonality of farm production, labor and oxen rental markets does not function smoothly (Bliss and Stern 1982; Holden et al. 2001; Holden et al. 2008). This may cause the factor-ratio adjustment process an uphill task to achieve through the non-land factor markets. Under such circumstances, despite the highly fragmented land holdings of households, there is a possibility that households may join the supply side of the tenancy market due to lack of one or more essential non-land factors of production.

Hence, the fact that non-land factor markets are imperfect coupled with the egalitarian land distribution in the country create a "Reverse-Share-Tenancy" scenario according to which landlords are contextually described as poor in non-land resources (not land rich households) while tenants can be best described as asset rich landowners rather than landless or near-landless poor households. Empirical evidence supports the persistence of such contracts in Ethiopia (Ghebru and Holden 2008; Ghebru 2009; Holden and Bezabih 2008); Eriteria (Tikabo and Holden 2003); and Madagaskar (Bellemare 2006; Bellemare 2008). Whether or not the "Reverse-Share-Tenancy" scenario in the country has an impact on the performance (technical efficiency) of the tenancy market is an empirical issue this study strives to address.

3. Theoretical Model

Starting from the reverse share tenancy and the inherent tenure insecurity in the Ethiopian tenure system, we draw on a two-period utility maximization model developed by Kassie and Holden (2007; 2008) to show how the power of eviction by the landlord upon unsatisfactory performance

increases the performances/incentives of an agent to work hard in the first period and thereby reduces the Marshallian disincentive effects on the output of sharecropped land.

We assume that the tenant is risk averse and maximizes expected utility, U, of income (Y) from farm production (Q) from PA allocated land (A^o) and leased land (A^r) with the probability (η) of carrying the rental contract through period two to produce Q^{r2}. We assume that the probability of contract renewal (η) in period two depends on the amount of output produced in period one (Q^{r1}) and kinship relations between landlord and tenant measured by (κ). In addition, we assume that economic and tenure security of the landlord (S) is a critical factor affecting the probability of contract renewal[5]. Hence, contract renewal is given by:

$$(1) \qquad \eta = \eta(Q^{r1}, \kappa, S), \text{ and } \partial\eta/\partial Q^{r1} > 0, \partial\eta/\partial\kappa > 0, \partial\eta/\partial S < 0, \partial^2\eta/\partial Q^{r1}\partial S > 0$$

Thus, we assume that good performance is more important to reduce the threat of eviction (probability of contract renewal) when tenants deal with landlords with higher tenure security and strong socioeconomic status which ultimately decreases the search costs and thereby the cost of eviction of the landlord. We assume it could be harder to impose eviction threats by landlords with weak bargaining power and insecure property rights conditions due to their poor bargaining power and economic dependences. When landlords enjoy tenure security and stronger economic condition together with rationing on the supply side of the market, the threat of eviction upon unsatisfactory performance is real and high, forcing tenants to cultivate the leased-in land with

[5] Bezahih and Holden (2009) shows that female landlords who are assumed to have a poor socioeconomic and property right status are less likely to exercise their power of eviction due to high search cost and insecurity of land ownership. In our study, gender and age of the household head, possession of land use certificate, proportion of land leased out and the ownership of livestock by the landlord households were used as indicators alternatively to capture the economic and tenure security parameter (S).

greater care and intensity. On the other hand, when landlords are economically dependent and tenure insecure, this may undermine their power of eviction in which case the Marshallian disincentive effects are visible (Kassie and Holden 2007; 2008).

Following Kassie and Holden (2007) a two-period utility maximization model for a sharecropping owner-cum-tenant is developed and given by:

$$\underset{A_{it},x_{it},z_{it}}{Max}\ \mathrm{EU(Y)} = EU_1\left\{\begin{array}{l}\left[p_{q1}\theta_1 Q^{o1}(A_{o1},x_{o1},z_{o1},z_{h1}) - p_{x1}x_{o1}\right] \\ +\left[p_{q1}\theta_1 Q^{r1}(A_{r1},x_{r1},z_{r1},z_{h1})\beta - p_{x1}x_{r1}\right]\end{array}\right\} \quad (2)$$
$$+\rho \mathrm{EU}_2\left\{\begin{array}{l}\left[\eta(Q^{r1}(.),\kappa,S).p_{q2}\theta_2 Q^{r2}(A_{r2},x_{r2},z_{r2},z_{h2})\beta - p_{x2}x_{r2}\right] \\ +\left[p_{q2}\theta_2 Q^{o2}(A_{o2},x_{o2},z_{o2},z_{h2}) - p_{x2}x_{o2}\right]\end{array}\right\}$$

Where β is the output share going to the tenant in a pure sharecropping arrangement, the subscripts *o*=PA allocated plots, *r*=leased plot, 1 and 2 indicate period one and two, respectively, ρ is the discount factor given by $\frac{1}{1+\delta}$ and δ is the discount rate, *x* is the conventional inputs (fertilizer, labor, oxen, seed), *z* observed and unobserved household and plot characteristics, p_x is price of inputs, p_q is the price of output, θ is weather-related risk factor, which, following (Stiglitz, 1974) is treated as a multiplicative factor distributed with $E\theta=1$ and positive finite variance. The first order conditions (FOCs) for maximization of this problem under pure sharecropping arrangement are:

$$\frac{EU_y \theta_i}{EU_y}\frac{\partial Q^{oi}}{\partial x_{oi}}.p_q = p_{xi} \quad (3)$$

and,

(4) $$\beta \frac{EU_{1y}\theta_1}{EU_{1y}} \frac{\partial Q^{r1}}{\partial x_{r1}} \cdot p_q + \rho \frac{EU_{2y}\theta_2}{EU_{1y}} \frac{\partial Q^{r1}}{\partial x_{r1}} \frac{\partial \eta}{\partial Q^{r1}} \cdot p_q Q^{r2} \beta = p_{x1}$$

The FOC in equation (1.3) is with respect to input use on tenant's own plots while the FOC equation (1.4) is with respect to input use on sharecropped plots which both satisfy the equality of expected marginal utility of farm input use to the respective input prices. The problem of the sharecropper is therefore to optimally distribute (utilize) the non-land resources between the owned plots and sharecropped plots until:

(1.5) $$\frac{EU_y\theta_i}{EU_y} \frac{\partial Q^{oi}}{\partial x_{oi}} \cdot p_q = \beta \frac{EU_{1y}\theta_1}{EU_{1y}} \frac{\partial Q^{r1}}{\partial x_{r1}} \cdot p_q + \rho \frac{EU_{2y}\theta_2}{EU_{1y}} \frac{\partial Q^{r1}}{\partial x_{r1}} \frac{\partial \eta}{\partial Q^{r1}} \cdot p_q Q^{r2} \beta = p_{x1}$$

which tells us that non-land resources are utilized by the sharecropper until the expected marginal returns from such resources are equal on the owned and sharecropped plots. The standard Marshallian inefficiency hypothesis prevails when the tenant does not care about his future utility from the sharecropped land, i.e., $\rho = 0$ which is given by:

(1.6) $$\frac{EU_y\theta_i}{EU_y} \frac{\partial Q^{oi}}{\partial x_{oi}} \cdot p_q = \beta \frac{EU_{1y}\theta_1}{EU_{1y}} \frac{\partial Q^{r1}}{\partial x_{r1}} \cdot p_q$$

However, due to the scarcity of arable land in the study area and the resultant rationing in the demand side of the market, we expect a positive discount factor ($\rho > 0$). In such a case, the second term of the right hand side of equation (1.5) shows the value of the potential loss of future utility from the sharecropped land due to eviction (contract non-renewal). Therefore, the more the tenant is concerned about the threat of eviction or contract insecurity (the larger ρ gets), the more input and effort he/she puts on the sharecropped land so as to qualify for contract renewal

which is shown by the term $\partial\eta/\partial Q^{r1}$ (implying the decrease in the probability of eviction by increasing effort/yield in period one). Using the implicit function theorem on equation (1.4), we are able to show that a sharecropper applies less input and effort if the land is leased from a landlord with poor economic and property right conditions (S=0).

Building upon the theoretical model and the structure of the tenancy market in the country (see section 2), we aim to show how the strategic response (opportunistic behavior) of tenants to varying economic and property right condition/status of the landlord can affect their performance on sharecropped plots. Based on this, we expect stronger bargaining power and tenure security of the landlord to increase the contract insecurity effect on sharecroppers and, thereby, induce their effort on sharecropped plots. To the best of our knowledge, this is the first study to account for the supply side (landlord side) information in the analysis of sharecroppers' level of effort and productivity. A recent exception is Jacoby and Mansuri (2009) that analyzed the effect of supervision on sharecroppers' productivity using data on monitoring frequency collected from share tenants in rural Pakistan. To summarize, taking the supply-side forces into consideration, with variations in bargaining power and tenure (in)security of landlords, otherwise identical share-tenants can have contrasting productivity level.

Scenario 1: Landlords with secure property rights and strong bargaining power

Kinship arrangements and treat of eviction, in this case, may alternatively be used as complementary mechanisms to enhance efficiency of transacted plots with dual effects. The moral obligation of kin sharecropper accompanied by a relatively strong power of eviction by the landlord may work together to induce effort of a tenant and reduce the Marshallian disincentive

effects. Thus the performance on kin transacted plot from landlords with stronger bargaining power and tenure security is higher than plots leased from kin landlords with poor economic and property right status. The empirical evidence from the Philippines by Sadoulet et al (1997) supports this scenario.

Scenario 2: *Landlords with insecure property rights and weak bargaining power*

As landlords, in this case, are more likely to be economically dependent (with high consumption risk) with high the risk of losing the land, kinship transactions may reduces the potentially positive 'contract insecurity effect' (no real threat of eviction) on sharecroppers' input use leading to low productivity. Therefore, rationing on the supply-side of the tenancy market (Ghebru and Holden 2008) and imperfect/missing off-farm labor market in the area may force the negative contract security effect (no real threat of eviction) to outweigh the positive kinship effects on kin transacted plots. Hence, in line with the results from the case-study by Kassie and Holden (2007), productivity on sharecropped land may be higher for non-kin sharecropped parcels than for kin sharecropped plots.

3.1. Hypotheses

H1. *Marshallian inefficiency hypothesis.* Sharing of the output reduces incentives to apply inputs on sharecropped plots and this causes output on sharecropped land to be lower than on tenants' own plots.

H2. *Kinship eliminates/reduces Marshallian inefficiency.* Kinship ties increase the incentive of tenants to use more inputs on kin sharecropped plots. Testable implication: Output on kin sharecropped plots is not lower than on share tenants' own plots, while it is lower for non-kin

sharecropped plots.

H3. *Weak bargaining power and tenure insecurity of landlords eliminates/reduces threat of eviction*. Economic dependence (weak bargaining power)[6] and insecure property rights[7] of landowners reduce contract insecurity of tenants as it undermines landowners' freedom to evict tenants when performance is poor. Testable hypothesis:

H3_1. Output on sharecropped plots from male landowners is not lower than on share tenants' own plots, while it is so for sharecropped plots leased from female landowners.

H3_2. Output on sharecropped plots from landowners with off-farm labor income sources is not lower than on share tenants' own plots, while it is so for sharecropped plots leased from landowners with no access to other income sources.

H3_3. Yield is higher (the degree of Marshallian inefficiency is lower) on sharecropped plots leased from landlords with secure property rights than on plots leased from tenure insecure landowners.

4. Estimation Strategy

Based on the theoretical discussion in section 3 of this paper, the reduced form regression model for producer *i* on parcel *p* is

$$y_{ip} = \beta x_{ip} + \delta T_{ip} + \mu_i + \varepsilon_{ip} \qquad (1.7)$$

[6] In this study, bargaining power of land owners is accounted by considering either the gender of heads of households or whether or not the farm household has access to alternative income sources (income generated from off-farm labor activities). For legitimacy of the former approach, see studies by Holden and Bezabih (2008) and Holden et al (in press).

[7] Landlords' tenure (in)security owners is accounted by considering whether the landlord possesses land use certificate or whether or not the landlord is an absentee/near-absentee landlord (leasing-out more than half of own holding). The 2006 regional land proclamation that labeled leasing-out more than half of own holding as an act of illegal and thus, subject to confiscation vindicates our later approach to capture the issue of tenure (in)security.

where y_{ip} yield value per hectare is realized by tenant i on parcel p, x_{ip} includes observable plot characteristics, and T_{ip} is a vector of dummy variables representing kinship relationship between partners (kin and non-kin leased plots using tenant's own plots as counterfactual) that estimate the average yield differential between owner-cultivated and kin or non-kin transacted plots, respectively. The error component μ_i, captures the unobserved household heterogeneity that captures unobserved household characteristics such as farming ability, tenant's social connections, and others that are not observable but affect input use and productivity, while ε_{ip} is a random variable that captures plot-specific unobservable that are not captured in the model such as soil quality variations, plot susceptibility to erosion, and weed infestations.

Had tenant's effort been fully observable where $E(\mu_i) = 0$, estimating the above regression model with OLS would have been free of any bias and inconsistency. However, the very fact that tenant's effort is not fully observable by the landlord $E(\mu_i) \neq 0$ makes households to internalize such unobservable characteristics in their contract and/or partner choice decisions (self-selection of contract and/or partner types). In such a case, OLS estimates of $\delta's$ are biased and inconsistent which may lead to an overstatement of the disincentive effects of sharecropping (Jacoby and Mansuri 2009).

Amid the mass of empirical contributions, two articles, by Bell (1977) and Shaban (1987) addressed the fundamental problem of assessing the productivity differential that may exist between plots under sharecropping and plots under owner-operation by considering only those households that farm more than one plot – effectively, are those households that are simultaneously owner-operators and sharecroppers. The use of household-specific fixed effects

then allows one to compare the productivity of the two classes of plots while at least maintaining constant the identity of the household engaging in the farming activity. We adopt this strategy to correct selection bias as majority of tenants included in the study (91) are owner-cum-sharecropper households - owner-cultivators that also cultivate at least one sharecropped plot.

Note, finally, that our household fixed effects estimator may not be robust to correlation between T_{ip} and ε_{ip}, when there is adverse selection in the leasing market. Under adverse selection, sharecropped land tends to be of lower quality than owner-cultivated land (or, more importantly, non-kin sharecropped land may tend to be lower quality than kin sharecropped land). Thus, ignoring this form of selection bias when it is present would lead us to understate the productivity of share-tenancy vis á vis owner-cultivation (or more importantly understate the productivity of non-kin share-tenancy vis á vis kin share-tenancy. Two alternative approaches were used to deal with such plot selection bias caused by adverse selection: 1) A two-step non-parametric matching; and 2) A two-step control function (CF) approach.

We begin by applying a two-step non-parametric propensity score matching method on observable plot characteristics to identify: 1) those leased-in plots that are relatively comparable to owner-operated plots (see Appendix 11); and 2) using the sample of leased-in plots that satisfied the balancing and common support requirement, we implement the non-parametric matching method to further identify plots leased-in from kin that are fairly comparable to plots leased-in from non-kin landlords using observable plot characteristics (see Appendix 12).The matched data of plots that were used in the productivity analysis included the owner-operated and leased-in plots planted with cereal crops that satisfied the balancing and common support

requirement but excluding plots planted with perennial plants and plots leased-out by tenants. This caused the number of plot observations to be reduced from 1148 to 997 plots. This kind of data preprocessing reduces model dependence in the subsequent parametric analysis of the outcome equation (Ho et al. 2007).

As an alternative a Control Function (CF) approach (Wooldridge 2007) was also implemented to account for the possible endogeneity of plot-specific leasing-in decision of tenants using the already matched plots that satisfies the balancing and common support requirement. For an endogenous binary response variable T_{ip}^{*}, the Control Function (CF) approach based on equation (6) involves estimating

(1.8) $$E(y_{ip} \mid x_{ip}, T_{ip}) = x_{ip}\beta_1 + \gamma T_{ip} + E(\varepsilon_{ip} \mid x_{ip}, T_{ip}).$$

While making decisions regarding participation in the informal land lease market, we assume there is unobserved factor (utility index) T_{ip}^{*} that explain why farm households lease in. We postulate this variable T_{ip}^{*} (latent variable) is a function of vector of exogenous variables with the relationship specified as:

(1.9) $$T_{ip}^{*} = \beta_2 x_{ip} + u_{ip},$$

Where the observed binary response is given by:

$T_{ip} = 1$ if $T_{ip}^{*} = \beta_2 x_{ip} + u_{ip} > 0$, and
$T_{ip} = 1$ if $T_{ip}^{*} = \beta_2 x_{ip} + u_{ip} \leq 0$

Therefore, if $(\varepsilon_{ip}, u_{ip})$ is independent of x_{ip}, $E(\varepsilon_{ip} \mid u_{ip}) = \alpha_{ip} u_{ip}$, and $u_{ip} \quad Normal(0,1)$, then

(1.10) $$E(\varepsilon_{ip} \mid x_{ip}, T_{ip}) = \alpha_{ip}\left[T_{ip}\lambda(\beta_2 x_{ip}) - (1-T_{ip})\lambda(-\beta_2 x_{ip})\right],$$

where $\lambda(.) = \phi(.)/\Phi(.)$ is the inverse Mills ratios (IMR) of plot p cultivated by tenant i (see Wooldridge, 2008). This leads to a simple Heckman two-step estimate (for endogeneity) where we obtain the probit estimate $\hat{\beta}_2$ and generate the "*generalized residual*" as:

$generalized\ residual \equiv T_{ip}\lambda(\hat{\beta}\, x_{ip}) - (1-T_{ip})\lambda(-\hat{\beta}\, x_{ip})$, and use it as an additional regressor in the "Shaban-type" regression (equation 1.8) together with the endogenous binary choice variable T_{ip}. Due to lack of suitable instruments that are required to be exogenous and uncorrelated with the error term in the outcome equation, we rely on non-linearities as an identification strategy.

5. Data and Descriptive statistics

Data

Data used for analysis of this study are derived from 400 randomly selected farm households from a stratified sample of 16 '*tabias*' (communities) in the Tigray region of Ethiopia. These communities were stratified to represent the major variation in agro-ecological factors, market access, population density, and access to irrigation. Out of the 400 sampled households, only 385 (among whom 103 landlord and 105 tenant) households were used in the analysis. Furthermore, as the main issue of interest in this study is to assess the productivity differentials of the kin-based share-tenancy, tenant farm households are the relevant sample for the productivity analysis. For this end, household and plot information was also collected from 128 tenant partners matched with the 103 landlords.

Thus, 1148 plots operated by the 105 sampled and 128 partner tenants during the 2005/06 production year were considered for analysis though this study uniquely utilized the supply side (landlord side) information as a possible factor affecting sharecroppers' level of effort and productivity. However, since we applied a non-parametric matching method to identify comparable plots, the number of plots used for analysis reduced from 1148 to 997 plots. After excluding plots planted with perennial plants and plots leased-out by tenants[8], only 325 rented in plots[9] were found to be comparable with 611 owner-operated plots of 225 owner-cum-sharecroppers.

Descriptive Statistics

To be able to show how (kin/non-kin) sharecroppers' effort (productivity) is strategically responsive to variations in the bargaining power or economic independence and property right conditions (tenure security) of the landowner, we introduce four key indicators that we believe may capture the issues of economic and property rights status of landowners. Economic dependence and technical inability of landlord households may undermine their bargaining power and thereby their eviction power (Bezabih and Holden 2008). We use the gender of the household head and off-farm labor income-generating opportunity of landlords as alternative indicator variables to capture the economic status and bargaining power of landlords.

On the other hand, we use an indicator variable showing whether or not the sharecropped plot is included in the land use certificate of the landlord as a control variable to capture the potential role tenure security of the landholder might play in affecting the effort of kin and/or non-kin

[8]We found 18 of the sampled tenant households engage themselves not only in lease-in land but also leasing-out part of their own holding (24 plots). Similar practices are common in the study area as farms try to adjust distance to plots by transacting plots that are adjust to their residential area or their plots.

[9] The number of transacted plots further diminishes due to incompleteness of matched data from landlord partners.

sharecroppers. Previous study from the study area (using the same sample) supports this argument (Holden et al. in press) indicating that possession of land use certificate boosts the perception of tenure security status and confidence of landowners against losing the land. However, we feel this variable may not be effective enough to capture the tenure (in)security issues of landowners since majority of the rural households in the region possess land use certificates to their plots[10]. For this reason, we construct and use an indicator variable based on the fact "whether households lease-out at least half of their own holdings or not" as an alternative to capture the property right conditions of landlords. In addition to very high scarcity of land in the region, the 2006 regional land proclamation (TNRS 2006) that decrees leasing-out more than 50% of own-holding as an act of illegal and are subject to confiscation vindicates our approach. We believe that those absentee or near-absentee landlords belong to risk-group landlords that feel the pressure of tenure insecurity for-fear of future confiscations.

Table 2 compares a summary statistics of these (four) indicator variables together with other plot-specific characteristics based on their tenure and kinship status. The paired mean comparison tests (see the bottom section Table 2) show a significant and systematic difference in these key landlord characteristics. Significantly larger proportion kin-transacted plots are plots originated from female land owners than it is for non-kin transacted plots. Stated otherwise, the likelihood for a kin-tenant having a female landlord is significantly higher (57%) than it is for non-kin tenant (48%). Supporting our earlier argument on the role of economic independence of the landowner, off-farm income generating opportunity is significantly lower (13%) for landowners who leased-out plots to kin partners than those who transact plots with nonkin partners (27%).

[10] More than 80% of the rural farm households in the region and 86% of our sampled farm households possess land use certificates to their landholdings.

The summary result further indicates tenure insecure landowners (absentee landlords with no operational holding or those who lease out more than half of their land holding) are more likely to lease-out their plots to kin partners than to non-kin partners. Showing a potential rationing-out of young farmers, kin-sharecropped plots are mostly leased-in by younger tenants while the most established (more experienced) farmers get access to land through the less likely route of non-kin contracts. This leaves those younger tenants with relatively poorer endowment of such farm inputs to bask on access through kin-tied arrangements.

The first two columns of Table 3 report the main features distinguishing landlords from tenants. Strengthening our claim for "Reverse-Share-Tenancy" scenario in the region (see discussion in section 2 of this paper), Table 3 indicates that landlords are relatively poor in non-land farm inputs and other assets. While there is no significant difference in the size of owned landholding, landlord households, on average possess significantly lower amount of complementary farm inputs such as male and female adult labor force, oxen and other draft animals as compared to tenant households. On the outset, sharecroppers in the region are wealthier landowners rather than poor landless peasants while landlords correspond to households that are predominantly female; old and households poorer in non-land resource endowments. Showing the gender-bias in agricultural production, partly due to the cultural taboo against women in cultivation activities, more than 50% of the landlord households are female-headed while only 7% of the tenant households are headed by females.

In the last two columns of Table 3, we divide landlord and tenant households into two categories based on their kinship status. The results show landlord households with lower self-employment income (alternative income sources) are more reliant on kin-tied contract arrangements than those

with better off-farm income generating opportunity. This supports our argument that economic status (economic independence) of land owners has an effect on choice of contracts/partners. On the tenant side of the market, kin tenants are different from non-kin tenants in terms of their wealth status, oxen, and other livestock ownership - the later possessing more oxen and other draft animals and also posses more land holding. This is in line with the findings of previous studies from the study area showing the supply-constrained nature of the tenancy market in the region where access to land is highly rationed (Ghebru and Holden 2008) and kin-based (Holden and Ghebru 2005).

6. Results and Discussions

We begin our analysis by comparing the estimates of average yield differentials between sharecropped and owner-cultivates plots of owner-cum-sharecroppers. A summary of the estimated results is presented in Table 4 below[11]. In contrast with the Marshallian inefficiency hypothesis, on average, we found no strong evidence to suggest productivity on sharecropped plots is lower than on owner operated plots of sharecroppers once we control for plot quality, crop selection and unobserved household heterogeneity. Similar results, however, could not be reached once we control for variations in characteristics of partners from the supply side of the market. Taking advantage of unique information on the kinship, bargaining power and tenure security status of matched-landlords, Models 2 – 6 reported in Table 4 estimate and compare how responsive sharecroppers' performance is to such variations in the characteristics of landowners.

[11] Since model misspecifications and potential weaknesses of instruments used in the first stage estimation may cause inconsistency in estimates of the CF approach and make them too imprecise to be informative (Wooldridge 2007), we are thus less reliant on using the estimates of this approach (though results are reported) as a basis for analysis in the forthcoming discussions. This is more revealed as the *generalized residual* generated from the first stage selection equation (renting-in decision) is statistically not significant when included in all the alternative model specifications. Rather, we rely for analysis in this study on results from the household fixed effects model applied on matched plots that satisfied the common support and balancing properties.

Table 4: Linear household fixed effects estimates of determinants of yield value per hectare – the role of bargaining power and tenure security of land owners

Explanatory variables[#]	Model 1	Model 2[i]	Model 3[ii]	Model 4[iii]	Model 5[iv]	Model 6[v]
Leased-in plot (dummy)	-0.092					
	(0.066)					
Kin landlord		-0.031				
		(0.081)				
Non-kin landlord		-0.184**				
		(0.084)				
Female landlord			-0.255***			
			(0.103)			
Male landlord			-0.021			
			(0.134)			
Landlord with access to off-farm income[+]				-0.044		
				(0.111)		
Landlord with no access to off-farm income				-0.310**		
				(0.127)		
Landlord with certificate					-0.234***	
					(0.090)	
Landlord with no certificate					-0.057	
					(0.191)	
Absentee landlord						-0.229**
						(0.106)
Cultivator landlord						-0.035
						(0.153)
Joint F test for plot quality variables[++]	6.23****	6.19****	5.08 ****	5.10 ****	5.18 ****	4.86 ****
Joint F test for cultivated crop-type variables[+++]	8.44****	8.36****	6.91 ****	6.64 ****	7.22 ****	7.14 ****
Constant	6.92****	6.94****	6.88 ****	6.83 ****	6.91****	6.90****
	(0.197)	(0.229)	(0.230)	(0.231)	(0.229)	(0.231)
R_squared	0.01	0.01	0.135	0.133	0.132	0.138
Number of obs.	997	997	831	811	815	816
Model Test	F(12,760)= 7.6****	F(13,759)= 7.2****	F(13,593)= 5.83****	F(13,574)= 5.20 ****	F(13,578)= 5.65****	F(13,579)= 5.60 ****

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1

[#] In each alternative model specification, the counterfactual is owner-operated plots.

[i] A model specification by decomposing leased-in plots based on kinship status of the landlord. See Appendix 2 for detaieled resuts.

[ii] A model specification by decomposing leased-in plots based on gender status of the landlord. See Appendix 3 for deail results.

[iii] A model specification by decomposing leased-in plots based on access to off-farm income sources of landlords. See Appendix 4 for detailed results.

[iv] A model specification by decomposing leased-in plots based on the possesion of certificate by the landlord. See Appendix 5 for detailed results.

[v] A model specification by decomposing leased-in plots based on whether the landlord is an absentee or cultivator landlord. See Appendix 6 for dtailed results.

[++] Plot quality indicator variables include: flat plot slope, foothill plot slope, shallow soil depth, medium soil depth, log (plot distance from residence), homestead plot, and conserved plot

[+++] Crop dummy variables include: pulses and oil crops plot, teff plot, barley plot, wheat plot

Results reported under Model 2 show the positive role of kinship ties play in influencing sharecroppers' productivity. The results show, on average, non-kin sharecropped plots are significantly less productive than owner-cultivated crops though the same cannot be stated about kin-sharecropped plots. This finding is in line with our hypothesis (H2) and supports the claim by Sadoulet et al. (1997) that there is a relatively higher moral hazard problem among non-kin contracts as compared to kin-tied tenancy arrangements.

In line with our hypothesis of the gender bias in sharecroppers' effort/productivity, results from Model 3 of Table 4 further indicate that there is a strong evidence of Marshallian inefficiency when tenancy arrangements are made with female landlords. Such efficiency loss is more pronounced when female-transacted plots are operated by kin tenants[12] (see resulted reported under Model 1 of Table 5). While the results confirm there is no significant productivity loss on plots leased in from non-kin female landlord, a more decomposed results from Model 1 of Table 5 depicts there is rather a strong (statistically significant) evidence of Marshallian inefficiency on plots leased-in from kin and female land owners. This result confirms the claims that the economic dependence and tenure insecurity of female headed households (Holden et al. in press) tend to adversely affect sharecroppers' effort due to their limited power of eviction to induce effort (Bezabih and Holden 2009). This finding is in line with the threat of eviction hypothesis which is also similar with the findings of the study by Kassie and Holden (2007) from another region in Ethiopia.

The stochastic dominance analyses (Figure 1 – 3) support such parametric findings that show the distribution of yield on non-kin operated plots not only dominated by owner-operated plots of

[12] This result is in line with the findings of Holden and Bezabih (2008) from the Amhara region of Ethiopia.

tenants but also by the distribution of yields on plots operated by kin tenants. Comparing the gender productivity differential, the non-parametric significance test for differences in distribution of yield values per hectare (Table 6) also shows that the distribution of yield on plots

Table 5: Linear household fixed effects estimates of determinants of yield value per hectare – interaction effects

Explanatory variables	Model 1[i]	Model 2[ii]	Model 3[iii]	Model 4[iv]
Kin female landlord	-0.301 (0.121)**			
Nonkin female landlord	-0.244 (0.171)			
Kin male landlord	0.046 (0.192)			
Nonkin male landlord	-0.136 (0.161)			
Kin landlord with off-farm income		0.092 (0.155)		
Nonkin landlord with off-farm income		-0.165 (0.144)		
Kin landlord with no off-farm income		-0.298 (0.170)*		
Nonkin landlord with no off-farm income		-0.378 (0.194)**		
Kin landlord with certificate			-0.159 (0.121)	
Nonkin landlord with certificate			-0.373 (0.122)***	
Kin landlord without certificate			0.150 (0.306)	
Nonkin landlord without certificate			-0.014 (0.243)	
Kin absentee landlord				-0.278 (0.149)**
Nonkin absentee landlord				-0.143 (0.153)
Kin cultivator landlord				0.096 (0.188)
Nonkin cultivator landlord				-0.034 (0.235)
Joint F test for plot quality variables[++]	5.63****	5.10****	5.23****	5.26****
Joint F test for crop-type variables[+++]	6.98****	6.64****	7.36****	7.49****
Constant	6.88**** (0.23)	6.64**** (0.23)	6.90 **** (0.23)	6.89 **** (0.23)
R_squared	0.138	0.135	0.137	0.133
Number of obs.	828	811	815	816
Model Test	F(15,588)= 5.18****	F(15,572)= 4.50***	F(15,576)= 5.17****	F(15,577)= 4.91****

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1

® In each alternative model specification, the counterfactual is owner-operated plots.

[i] A model specification with interaction variables of kinship and gender status of land owners. See Appendix 7 for detaieled resuts.

[ii] A model specification with interaction variables of kinship and off-farm income access of land owners. See Appendix 8 for detaieled resuts.

[iii] A model specification with interaction variables of kinship and certificate possession of land owners. See Appendix 9 for detaieled resuts.

[iv] A model specification with interaction variables of kinship and whether the landlord is an absentee landlord or not. See Appendix 10 for detaieled resuts.

leased from female landlords is unambiguously dominated not only by owner-operated farms of tenants but also by the distribution of yield per hectare of plots transacted from male landlords.

We also found similar results when other income generating opportunity of the landlord was used to capture the economic (in)dependence of landowners. The results confirm that yields on plots leased from households with limited or no other income generating opportunity are significantly lower than yields on owner-operated plots of sharecroppers. As landowners with no (limited) other income generating opportunity are more likely to be economically dependent (Macours 2004), we expect such dependence to have undermined their bargaining power and efforts of tenants. As shown on Model 2 of Table 5, such strategic response to the lack of alternative income sources of landlords was found to be consistent regardless of the kinship status of tenants.

We also assessed the impacts of tenure insecurity of landowners on sharecroppers' effort using whether or not the landlord is an absentee landlord as an indicator variable to capture tenure (in)security. Results from Table 4 show, on average, yields on plots leased from absentee/near-absentee landlords are significantly lower than on owner-operated plots of sharecroppers. Since such groups of landlords are highly susceptible to confiscation of plots by the government, high reliance on kin-based tenancy arrangements of these landlords can undermine their power of eviction and partly explain such efficiency losses. However, as absentee landlords are more likely to live outside the village or are landlords who lack the technical (farming) ability, the lack (high cost) of supervision on tenants effort cannot be ruled-out as a factor for the lower productivity of such plots. Results from Table 5 are indicative to suggest such efficiency loss is more explained by the lack of incentive by tenants (due to contract security or lack of eviction threat from the landlord) than lack of supervision by landlords. As shown in the last column of

Table 5, the efficiency loss on plots of absentee landlords is more significant when the plot is operated by kin tenant while there is no strong evidence to suggest this when it is operated by non-kin tenants.

Surprisingly, and in contrast to our anticipation, Table 4 shows yields on plots sharecropped from landlords with certificates were found to be significantly lower than on owner-operated plots. The result shows, the efficiency loss is more pronounced when such plots are operated by nonkin tenants as shown in Table 5. On the outset, despite results from Table 4 indicates there is no significant efficiency loss on plots transacted among kin partners, the more decomposed analyses summarized in Table 5 show there is a strong (statistically significant) evidence of Marshallian inefficiency on kin-tenant operated plots leased from landlords who are female; absentee landlords; and landlords who have no access to off-farm income sources[13].

7. Conclusion and policy Implications

Taking advantage of unique information on the kinship, bargaining power and tenure (in)security of matched-landlords, our findings show how strategic sharecroppers are in internalizing such variations in the characteristics of landlords. The results show sharecroppers' yield are significantly lower on plots leased from landlords who are non-kin; female; with lower off-farm income generating capacity; and those who are believed to be tenure insecure than on plots leased from landlords with contrasting characteristics. Therefore, strengthening of property rights and empowerment of the rural poor may not only have a direct productivity-enhancing potential on owner-operated smallholder agriculture but can also have an indirect impact on the performance on transacted plots.

[13] This result is in contast with the findings of Kassie and Holden (2007;2008) and Holden and Bezabih (2008) from the Amhara region of Ethiopia.

A decomposed analysis (after considering interaction effects of kinship status of tenants with variables controlling for the bargaining power and tenure security status of landlords) also shows a strong (statistically significant) evidence of Marshallian inefficiency on kin-operated plots leased from landlords who are female and those who have no off-farm income generating capacity. The empirical evidence implies that strengthening the property rights of landholders may not only have a direct productivity-enhancing effect on owner-operated smallholder cultivation but also an indirect impact on the productivity of transacted plots. On the other hand, recent changes in the regional land proclamation (TNRS 2006) authorize confiscation of landholdings of households who had their primary source of livelihood outside the village for more than two years. While this policy serves an equity objective, it may undermine the bargaining power of (potential) landlords and efficiency of transacted plots.

References

Adal, Y. (2002). Review of Landholding Systems and Policies in Ethiopia under the Different Regimes. EEA/Economic Policy Research Institute, Working paper No 5/2002.

Alemu, T. (1999). Land Tenure and Soil Conservation: Evidences from Ethiopia. Unpublished Phd-Dissertation, Göteborg University, Göteborg.

Arcand, J. L., C. R. Ai and F. Ethier (2007). "Moral Hazard and Marshallian Inefficiency: Evidence from Tunisia." Journal of Development Economics **83**(2): 411-445.

Arrow, K. J. (1968). "The Economics of Moral Hazard: Further Comment." American Economic Review **58**(3).

Bell, C. (1977). "Alternative Theories of Sharecropping - Some Tests Using Evidence from Northeast India." Journal of Development Studies **13**(4): 317-346.

Bellemare, M. (2006). Testing between Competing Theories of Reverse Share Tenancy. Duke.

Bellemare, M. F. (2008). "Insecure Land Rights and Reverse Share Tenancy in Madagascar." Working paper **Durham , NC : Duke University**.

Besley, T. and E. Coast (1995). "Group Lending, Repayment Incentives and Social Collateral." Journal Development Economics **46**: 1-18.

Bliss, C. J. and N. H. Stern (1982). Palanpur: The Economy of an Indian Village. Delhi and New York, Oxford University Press.

Deininger, K., D. A. Ali and T. Alemu (2008). Land Rental Markets: Transaction Costs and Tenure Isecurity in Rural Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Deininger, K., D. A. Ali, S. Holden and J. Zevenbergen (2008). "Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries." World Development **36**(10): 1786-1812.

Deininger, K. and G. Feder (1998). Land Institutions and Land Markets, The World Bank, Development Research Group, Rural Development.

Fafchamps, M. (2004). Market Institutions in Sub-Saharan Africa. Cambridge, Massachusettes & London, The MIT Press.

Feder, G., T. Onchan and Y. Chalamwong (1988). "Land Policies and Farm Performance in Thailand's Forest Reserve Areas." Economic Development and Culture Change **36**(3): 483-501.

Gavian, S. and S. Ehui (1999). "Measuring the Production Efficiency of Alternative Land Tenure Contracts in a Mixed Crop-Livestock System in Ethiopia." Agricultural Economics **20**: 37-49.

Ghebru, H. (2009). Land, Land Rental Markets and Rural Poverty Dynamics in the Tigray Region of Ethiopia. Paper presented at the Annual Conference of the Norwegian Association for Development Research (NFU) 23-24 November, Kristiansand , Norway. .

Ghebru, H. H. and S. T. Holden (2008). Factor Market Imperfections and Rural Land Rental Markets in Northern Ethiopian Highlands. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Hayami, Y. and K. Otsuka (1993). The Economics of Contract Choice: An Agrarian Perspective. Oxford, Clarendon press.

Ho, D. E., K. Imai, G. King and E. A. Stuart (2007). "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." Political Analysis **15**(3): 199-236.

Hoben, A. (2000). Ethiopian Rural Land Tenure Policy Revisited. Paper Presented at the Symposium for Reviewing Ethiopia's Economic Performance 1991 - 1999. Organized by Inter-Africa Group. Addis Ababa. April 26 - 29.

Holden, S., B. Shiferaw and J. Pender (2001). "Market Imperfections and Land Productivity in the Ethiopian Highlands." Journal of Agricultural Economics **52**(3): 53-70.

Holden, S. T. and M. Bezabih (2008). Gender and Land Productivity on Rented Land in Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T., K. Deininger and H. Ghebru (2009). "Impacts of Low-Cost Land Certification on Investment and Productivity." American Journal of Agricultural Economics **91**(2): 359-373.

Holden, S. T., K. Deininger and H. H. Ghebru (in press). "Tenure Insecurity, Gender, Low-Cost Land Certification and Land Rental Market Participation in Ethiopia." Journal of Development Studies.

Holden, S. T. and H. Ghebru (2005). Kinship, Transaction Costs and Land Rental Market Participation. In. Working Paper, Norwegian University of Life Sciences. Ås.

Holden, S. T., K. Otsuka and F. M. Place (2008). Land Markets and Development in Africa. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Holden, S. T. and H. Yohannes (2002). "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." Land Economics **78**(4): 573-590.

Jacoby, H. G. and G. Mansuri (2009). "Incentives, Supervision, and Sharecropper Productivity." Journal of Development Economics **88**(2): 232-241.

Kassie, M. and S. Holden (2007). "Sharecropping Efficiency in Ethiopia: Threats of Eviction and Kinship." Agricultural Economics **37**(2-3): 179-188.

Kassie, M. and S. T. Holden (2008). Kinship, Tenure Insecurity, Input Use and Land Productivity: The Case of Sharecropping in Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Li, G., S. Rozelle and L. Brandt (1998). "Tenure, Land Rights, and Farmer Investment Incentives in China." Agricultural Economics **19 (1-2)**: 63-71.

Macours, K. (2004). "Ethnic Divisions, Contract Choice, and Search Costs in the Guatemalan Land Rental Market." Working paper **Johns Hopkins University**

MUT (2003). "Securing Land Rights in Africa: Can Land Registration Serve the Poor? Interim Report of Mekelle University Team, Mekelle University, Mekelle, Tigray, Ethiopia."

Otsuka, K. (2007). Efficiency and Equity Effects of Land Markets. In. Handbook of Agricultural Economics, Elsevier.

Otsuka, K. and Y. Hayami (1988). "Theories of Share Tenancy: A Critical Survey." Economic Development and Cultural Change **37**(1): 32-68.

Pender, J. and M. Fafchamps (2006). "Land Lease Markets and Agricultural Efficiency in Ethiopia." Journal of African Economies **15(2)**: 251-284.

Pender, J. L., B. Gebremedhin and M. Haile (2002). Economic Returns and Impacts of Policies and Programs Affecting Land Management in Tigray. Policies for sustainable land management in the highlands of Tigray, Northern Ethiopia, Axum Hotel, Mekelle, Ethiopia, EPTD NO.

Rahmato, D. (1984). Agrarian Reform in Ethiopia. Uppsala, Scandinavian Institute of African Studies.

Sadoulet, E., A. de Janvry and S. Fukui (1997). "The Meaning of Kinship in Sharecropping Contracts." American Journal of Agricultural Economics **79**(May): 394-407.

Sadoulet, E., S. Fukui and A. d. Janvry (1994). "Efficient Share Tenancy Contracts under Risk: The Case of Two Rice Growing Villages in Thailand." Journal of Development Economics **45**: 225-243.

Sen, A. K. (1975). Employment, Technology and Development. Oxford, Clarendon Press.

Shaban, R. A. (1987). "Testing between Competing Models of Sharecropping." Journal of Political Economy **95**(5): 893-920.

Sharma, N. and J. Dreze (1996). "Sharecropping in a North Indian Village." Journal of Development Studies **33**(1): 1 - 39.

Singh, N. (1989). Theories of Sharecropping. In: P. Bardhan. The Economic Theory of Agrarian Institutions. New York, Oxford University Press.

Tadesse, M. A., S. T. Holden and R. Øygard (2008). Contract Chioce and Poverty in Southern Highlands of Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Teklu, T. and A. Lemi (2004). "Factors Affecting Entry and Intensity in Informal Rental Land Markets in Southern Ethiopian Highlands." Agricultural Economics **30**: 117-128.

Table 1: Variable Description

Variable	**Description**
Sex of household head	Gender of the household head (1=female, 0=male)
Age of household head	Age of the head of the household (number of years)
Education of household head	Educational status of the head of household (1=literate, 0=illiterate)
Female labor force	Number of female working-age family members in the household
Male labor force	Number of male working-age family members in the household
Size of household	Number of family members
Number of oxen	Number of oxen
Other livestock endowment	Possession of livestock other than oxen - in Tropical livestock unit
Own a house with an iron roof	If the household possesses a house with an iron roof (1=yes, 0=no)
Farm size	Size of agricultural land owned by the household (in *tsimdi**)
Possess land use certificate	If the household posses a land use certificate (1=yes, 0=no)
Experienced land related dispute	If the household has experienced land related dispute in the last 15 years
Household index of fragmentation	Ratio of own holding to number of owned plots
Ratio of plots with certificate	ratio of the number of plots with certificate to the number of owned plots
No owned land holding	If the household has zero owned (PA allocated) land
Income from self-employment	Amount of income from self employment (Ethiopian Birr)
Income from non-labor activity	Amount of income from rental of oxen, labor, and/or houses (Ethiopian Birr)
Wage income	Amount of income from wage labor employment (Ethiopian Birr)
No operational holding	If the household has zero operational holding (1=yes, 0=no)
Absentee/near-absentee landlord	If the landlord has leased out at least half of own holding (1=yes, 0=no)
Shallow soil	Shallow soil (1=yes, 0=no)
Medium deep soil	Medium deep soil (1=yes, 0=no)
Deep soil	Deep soil (1=yes, 0=no)
Soil type - clay	Soil type – clay (1=yes, 0=no)
Soil type - black	Soil type – black (1=yes, 0=no)
Soil type - sand	Soil type – sand (1=yes, 0=no)
Soil type - red	Soil type – red (1=yes, 0=no)
homestead	If the plot is a homestead plot (1=yes, 0=no)
Land investment	If there is any soil and water conservation investment on a plot (1=yes, 0=no)
Irrigated plot	If the plot is irrigated (1=yes, 0=no)
Distance to plot	Distance of a plot from homestead (minutes walk)
Output/ha	The log of value of output per hectare
Crop planted with pulses or oil seeds	If crop cultivated on the plot is pulses or oil seeds (1=yes, 0=no)
Crop planted with *teff*	If crop cultivated on the plot is *teff* (1=yes, 0=no)
Crop planted with wheat	If crop cultivated on the plot is wheat (1=yes, 0=no)
Crop planted with barley	If crop cultivated on the plot is barley (1=yes, 0=no)

Table 2: Summary statistics of plots operated by owner-cum-sharecropper

Variable	Owner-operated plots (611)		Kin share-cropped plots(230)		Non-kin Share-cropped plots (156)	
Plot Characteristics	Mean	(St. Err)	Mean	(St. Err)	Mean	(St. Err)
Shallow soil	0.328	(0.470)	0.305	(0.461)	0.328	(0.471)
Medium deep soil	0.275	(0.447)	0.324	(0.469)	0.303	(0.461)
Deep soil	0.384	(0.487)	0.355	(0.480)	0.369	(0.484)
Soil type - clay	0.267	(0.443)	0.222	(0.416)	0.232	(0.423)
Soil type - black	0.270	(0.444)	0.296	(0.457)	0.242	(0.430)
Soil type - sand	0.251	(0.434)	0.237	(0.426)	0.294	(0.457)
Soil type - red	0.207	(0.405)	0.241	(0.429)	0.227	(0.420)
Irrigation	0.045	(0.207)	0.035	(0.183)	0.035	(0.185)
Farm size	1.248	(1.205)	1.261	(1.031)	1.626	(1.177)****
Distance to plot	30.34	(37.89)	35.88	(42.93)	35.94	(42.65)
Output/ha	620.6	(669.2)	518.6	(407.7)	411.9	(482.9)**
Crop Composition And Farm Inputs						
Crop grow – pulses and seeds	0.103	(0.304)	0.092	(0.290)	0.090	(0.287)
Crop grow – *teff*	0.336	(0.473)	0.374	(0.485)	0.360	(0.481)
Crop grow – wheat	0.180	(0.385)	0.172	(0.378)	0.124	(0.330)
Crop grow – barley	0.235	(0.424)	0.172	(0.378)	0.169	(0.375)
Amount of chemical fertilizer	9.23	(16.81)	9.99	(16.22)	11.93	(18.37)
Seed/ha	65.89	(76.22)	58.87	(69.95)	47.84	(85.46)
Plowing man days	5.08	(13.57)	3.15	(4.49)	4.41	(10.34)*
Weeding man days	13.75	(22.54)	10.56	(17.11)	7.82	(8.28)**
Harvesting man days	6.578	(9.044)	5.242	(4.920)	5.087	(5.612)
Threshing man days	4.155	(7.252)	3.618	(4.442)	2.544	(3.588)***
Oxen days	12.55	(24.51)	9.06	(7.70)	9.73	(19.49)
Tenant Characteristics– by plot category						
Sex of household head	0.080	(0.272)	0.108	(0.311)	0.060	(0.238)*
Age of household head	52.46	(11.83)	46.24	(12.54)	50.11	(12.99)****
Household size	6.594	(2.038)	6.192	(2.046)	6.413	(1.880)
Number of oxen	1.673	(1.176)	1.744	(1.205)	2.038	(1.442)**
Number of other livestock^{+}	3.004	(2.450)	2.925	(2.528)	3.474	(3.136)**
Education of household head	0.544	(0.498)	0.596	(0.492)	0.707	(0.457)**
Female labor force	1.553	(0.829)	1.428	(0.784)	1.353	(0.686)
Male labor force	1.841	(1.062)	1.676	(0.991)	1.810	(1.009)
Landlord Characteristics – by plot category						
Sex of household head	-	-	0.570	(0.496)	0.480	(0.501)*
Age of household head	-	-	54.50	(19.07)	55.75	(14.44)
Number of other livestock	-	-	0.235	(0.426)	0.385	(0.489)**
Number of oxen	-	-	0.167	(0.374)	0.154	(0.363)
No operational holding	-	-	0.602	(0.491)	0.478	(0.502)*
Possess land certificate	-	-	0.852	(0.357)	0.856	(0.350)
Absentee/near-absentee landlord	-	-	0.797	(0.404)	0.678	(0.470)**
Off-farm labor income opportunity^{++}	-	-	0.138	(0.347)	0.273	(0.448)**
Self-employment income^{++}	-	-	28.1	(111.6)	111.9	(442.4)**

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; $^{+}$ TLU equivalent; $^{++}$ off farm income sources excluding gifts, aid, remittance and other non-labor incomes.

Table 3: Descriptive statistics – Household level characteristics

Variables	Landlord (214)	Tenant (225)	Landlord		Tenant	
			All kin (97)	All Non-kin (78)	All kin (103)	All Non-kin (68)
Age of household head	54.68	49.25****	55.90	55.63	48.43	51.42
	(16.69)	(12.84)	(18.31)	(15.75)	(12.62)	(13.31)
Sex of household head	0.53	0.07****	0.54	0.49	0.07	0.03
	(0.50)	(0.25)	(0.50)	(0.50)	(0.25)	(0.17)
Education of household head	0.54	0.63*	0.52	0.54	0.54	0.72**
	(0.50)	(0.48)	(0.50)	(0.50)	(0.50)	(0.45)
Female labor force	1.07	1.45****	0.88	1.23***	1.51	1.42
	(0.81)	(0.79)	(0.81)	(0.84)	(0.85)	(0.73)
Male labor force	0.90	1.75***	0.82	0.99	1.73	1.76
	(1.07)	(0.97)	(1.06)	(1.12)	(0.98)	(0.96)
Household size	4.00	6.34****	3.49	4.41**	6.29	6.35
	(2.40)	(2.06)	(2.33)	(2.54)	(2.18)	(1.89)
Number of oxen	0.46	1.71****	0.40	0.53	1.51	1.94***
	(0.87)	(1.15)	(0.73)	(1.01)	(0.92)	(1.27)
Other livestock endowment	1.03	2.90****	0.91	0.90	2.48	3.19**
	(1.97)	(2.49)	(1.42)	(1.34)	(1.94)	(2.36)
Own a house with iron roof	0.58	0.88*	0.45	0.75	0.74	1.40*
	(1.09)	(1.99)	(0.79)	(1.44)	(1.83)	(2.69)
Farm size	4.06	3.94	3.35	4.41***	3.15	4.29***
	(2.87)	(2.93)	(2.57)	(2.59)	(2.40)	(2.81)
Posses a certificate	0.86	0.76***	0.86	0.87	0.75	0.81
	(0.35)	(0.43)	(0.35)	(0.34)	(0.44)	(0.40)
Experienced land conflicts	0.06	0.06	0.05	0.06	0.07	0.03
	(0.23)	(0.24)	(0.22)	(0.25)	(0.26)	(0.17)
Fragmentation index	1.35	1.43	1.25	1.38	1.15	1.58**
	(1.02)	(1.30)	(1.09)	(0.75)	(1.09)	(1.38)
Ratio of plots with certificate	0.82	0.80	0.83	0.83	0.80	0.82
	(0.35)	(0.38)	(0.35)	(0.35)	(0.38)	(0.37)
No owned land holding	0.00	0.09	0.00	0.00	0.10	0.06
	0.00	(0.29)	0.00	0.00	(0.31)	(0.23)
Self-employment income	98.58	196.94*	17.73	130.81**	133.08	177.33
	(486)	(927)	(89)	(519)	(728)	(628)
Non-labor income	339.10	125.31*	396.90	307.28	128.70	117.72
	(834)	(581)	(1062)	(664)	(773)	(336)
Wage income	214.58	261.41	143.62	250.96	221.93	260.28
	(1174)	(895)	(1005)	(1272)	(776)	(886)
No operational holding	0.46		0.52	0.40		
	(0.50)		(0.50)	(0.49)		
Ratio of land leased-out	0.69		0.69	0.67		
	(0.46)		(0.46)	(0.47)		

Note: Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%

Table 6: Test results of first-order stochastic dominance of productivity (Two-sample Kolmogorov-Smirnov test)

Basis of category	Tenure status of the plot	Log of value of Output/ha			P-values for two-sample Kolmogorov-Smirnov test†		
		N*	Mean	(Sd)	Group A Vs Group B	Group A Vs Group C	Group B Vs Group C
		(1)	(2)	(3)	(4)	(5)	(6)
Land Transaction	Sharecroppers' own plot (Group A)	611	7.429	(1.00)	0.001		
	Leased-in plot (Group B)	386	7.211	(1.04)			
Kinship	Sharecroppers' own plot (Group A)	611	7.429	(1.00)			
	Plot leased-in from kin (Group B)	230	7.348	(0.92)	0.398	0.000	0.021
	Plot leased-in from nonkin (Group C)	156	7.010	(1.18)			
Gender	Sharecroppers' own plot (Group A)	611	7.429	(1.00)			
	Plot leased-in from male (Group B)	199	7.278	(0.97)	0.078	0.002	0.021
	Plot leased-in from female (Group C)	174	7.145	(0.99)			
Off-farm income opportunity	Sharecroppers' own plot (Group A)	611	7.429	(1.00)			
	Leased-in from landlord with off-farm income (Group B)	105	7.237	(0.99)	0.010	0.063	0.222
	Leased-in from landlord without off-farm income (Group C)	96	7.103	(1.17)			
Possession of Certificate	Sharecroppers' own plot (Group A)	611	7.429	(1.00)			
	Plot leased-in from landlord with certificate (Group B)	43	7.420	(0.84)	0.014	0.067	0.318
	Plot leased-in from landlord without certificate (Group C)	162	7.134	(1.13)			
Absentee Landlord	Sharecroppers' own plot (Group A)	611	7.429	(1.00)			
	Leased-in from Absentee/near-absentee landlord (Group B)	167	7.214	(1.07)	0.712	0.0060	0.289
	Plot leased-in from Cultivator landlord (Group C)	37	7.114	(1.13)			

Note: †Test of H_0: distributions are equal against; H_a: distribution of first group stochastically dominates distribution of second group.

* The difference in number of observations is due to loss of data for lack of complete information from the match partner (landlord)

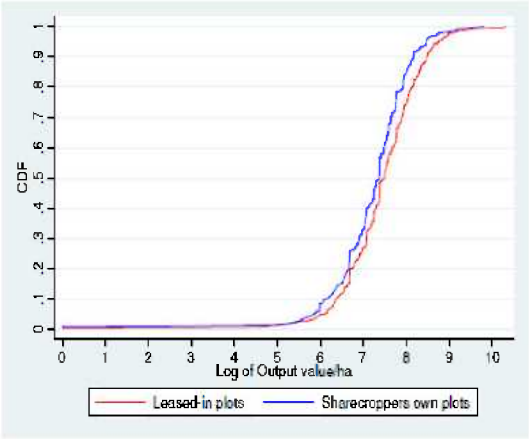


Fig. 1: First-order stochastic dominance of productivity – impact of share tenancy

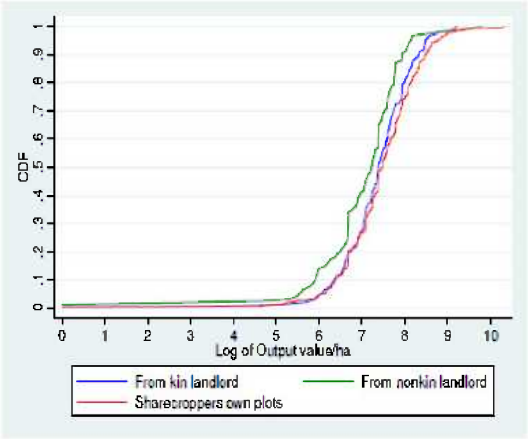


Fig. 2: First-order stochastic dominance of productivity – impact of kinship ties with landlord

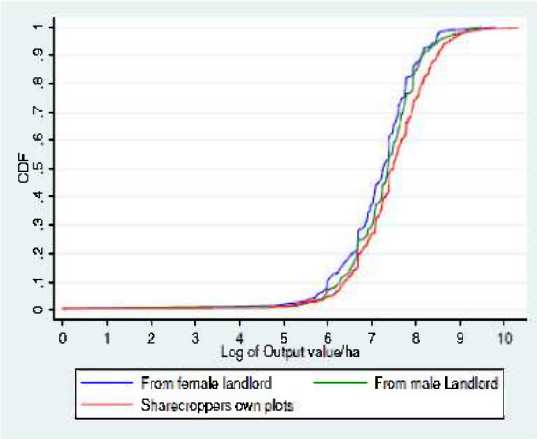


Fig. 3: First-order stochastic dominance of productivity – impact of gender of the landlord

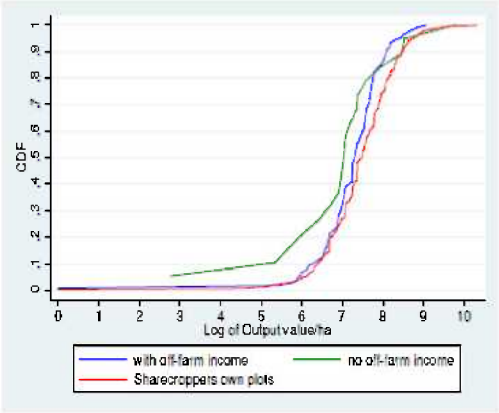


Fig. 4: First-order stochastic dominance of productivity –impact of off-farm income access of the landlord

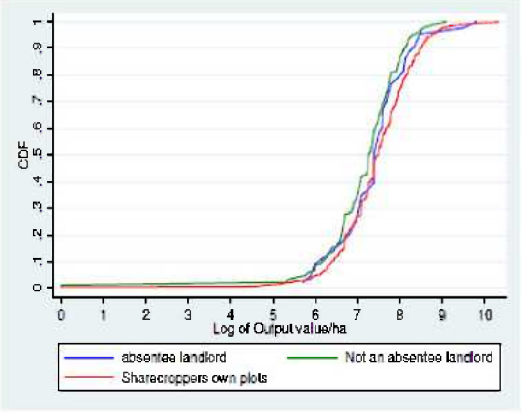


Fig. 5: First-order stochastic dominance of productivity – impact of whether the landlord is an absentee or not.

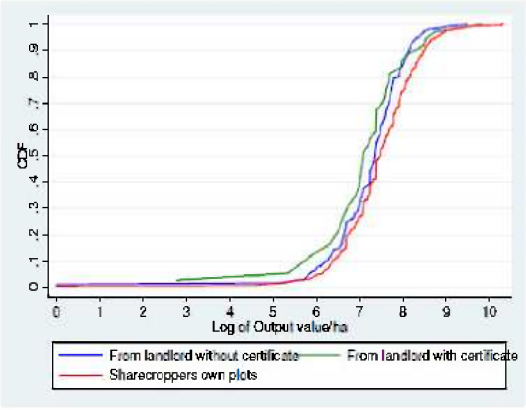


Fig. 6: First-order stochastic dominance of productivity – impact of possession of land use certificate by the landlord

Appendix 1: Linear household fixed Effects estimates of determinants of yield value per hectare

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Leased-in plot (dummy)	-0.152**	-0.121*	-0.092	-0.188
	(0.07)	(0.06)	(0.07)	(0.14)
Plot slope – flat		0.418****	0.395****	0.428****
		(0.10)	(0.10)	(0.10)
Plot slope – foot hill		0.383****	0.344****	0.390****
		(0.11)	(0.10)	(0.10)
Shallow soil		0.006	-0.013	0.008
		(0.09)	(0.09)	(0.09)
Medium deep soil		-0.063	-0.064	-0.035
		(0.09)	(0.09)	(0.09)
Conservation (dummy)		0.154*	0.103	0.090
		(0.08)	(0.08)	(0.08)
Log of distance to plot		-0.066*	-0.056*	-0.062*
		(0.03)	(0.03)	(0.03)
Homestead plot (dummy)		0.010	0.120	0.107
		(0.13)	(0.13)	(0.13)
Crop grown - *teff*			0.414****	0.375****
			(0.08)	(0.08)
Crop grown- pulses or oilseed			0.174	0.142
			(0.17)	(0.17)
Crop grown - wheat			0.562****	0.561****
			(0.11)	(0.12)
Crop grown - barley			0.339***	0.324***
			(0.12)	(0.12)
Generalized residual				0.073
				(0.10)
Constant	7.404****	7.248****	6.927****	6.961****
	(0.04)	(0.17)	(0.20)	(0.20)
R^2	0.006	0.063	0.106	0.116
Number of Obs.	997	997	997	964
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 2: Linear household fixed Effects estimates of determinants of yield value per hectare - the role of kinship

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Kin landlord	-0.083	-0.056	-0.031	-0.116
	(0.08)	(0.08)	(0.08)	(0.15)
Non-kin landlord	-0.256**	-0.220**	-0.184*	-0.257*
	(0.10)	(0.10)	(0.10)	(0.15)
Plot slope - flat		0.416****	0.393****	0.426****
		(0.10)	(0.10)	(0.10)
Plot slope - foot hill		0.375****	0.337****	0.382****
		(0.11)	(0.10)	(0.10)
Shallow soil		0.006	-0.014	0.006
		(0.09)	(0.09)	(0.09)
Medium deep soil		-0.064	-0.065	-0.037
		(0.09)	(0.09)	(0.09)
Conservation (dummy)		0.153*	0.102	0.088
		(0.08)	(0.08)	(0.08)
Log of distance to plot		-0.069**	-0.059*	-0.065*
		(0.03)	(0.03)	(0.03)
Homestead plot (dummy)		-0.002	0.108	0.095
		(0.13)	(0.13)	(0.13)
Crop grown - teff			0.412****	0.375****
			(0.08)	(0.08)
Crop grown - pulses or oilseed			0.176	0.145
			(0.17)	(0.17)
Crop grown - wheat			0.560****	0.561****
			(0.11)	(0.12)
Crop grown - barley			0.339***	0.327***
			(0.12)	(0.12)
Generalized residual				0.060
				(0.10)
Constant	7.404****	7.264****	6.942****	6.971****
	(0.04)	(0.17)	(0.20)	(0.21)
R^2	0.009	0.066	0.108	0.118
Number of Obs.	997	997	997	964
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 3: Linear household fixed Effects estimates of determinants of yield value per hectare - the role of gender of the landlord

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Female landlord	-0.326***	-0.306***	-0.255**	-0.181
	(0.11)	(0.10)	(0.10)	(0.18)
Male landlord	-0.080	-0.039	-0.021	0.016
	(0.14)	(0.14)	(0.13)	(0.20)
Plot slope - flat		0.487****	0.435****	0.468****
		(0.12)	(0.11)	(0.11)
Plot slope - foot hill		0.391***	0.336***	0.399****
		(0.12)	(0.11)	(0.11)
Shallow soil		0.024	0.016	0.029
		(0.11)	(0.11)	(0.10)
Medium deep soil		-0.016	-0.012	0.001
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.232**	0.176**	0.143*
		(0.09)	(0.09)	(0.09)
Log of distance to plot		-0.074*	-0.061	-0.063
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.025	0.091	0.074
		(0.15)	(0.15)	(0.16)
Crop grown - teff			0.399****	0.344****
			(0.09)	(0.09)
Crop grown - pulses or oilseed				0.026 -0.000
			(0.18)	(0.18)
Crop grown - wheat			0.594****	0.572****
			(0.13)	(0.13)
Crop grown - barley			0.355***	0.344***
			(0.12)	(0.13)
Generalized residual				-0.071
				(0.13)
Constant	7.409****	7.189****	6.878****	6.900****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.012	0.089	0.137	0.145
Number of Obs.	831	831	831	810
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 4: Linear household fixed Effects estimates of determinants of yield value per hectare - the role of access to off-farm job of the landlord

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Landlord with off-farm income source	-0.093 (0.12)	-0.052 (0.11)	-0.044 (0.11)	0.024 (0.20)
Landlord with no off-farm Income source	-0.414*** (0.13)	-0.380*** (0.13)	-0.310** (0.13)	-0.244 (0.19)
Plot slope - flat		0.480**** (0.12)	0.429**** (0.12)	0.464**** (0.12)
Plot slope - foot hill		0.371*** (0.13)	0.318*** (0.12)	0.382**** (0.11)
Shallow soil		0.045 (0.11)	0.034 (0.11)	0.048 (0.11)
Medium deep soil		-0.009 (0.11)	-0.006 (0.10)	0.010 (0.10)
Conservation (dummy)		0.213** (0.09)	0.159* (0.09)	0.127 (0.09)
Log of distance to plot		-0.063 (0.04)	-0.053 (0.04)	-0.054 (0.04)
Homestead plot (dummy)		0.011 (0.15)	0.113 (0.15)	0.098 (0.15)
Crop grown - teff			0.383**** (0.09)	0.326**** (0.09)
Crop grown - pulses or oilseed			(0.18)	0.041 0.012 (0.19)
Crop grown - wheat			0.597**** (0.13)	0.570**** (0.13)
Crop grown - barley			0.358*** (0.12)	0.345*** (0.13)
Generalized residual				-0.081 (0.14)
Constant	7.423**** (0.04)	7.172**** (0.21)	6.870**** (0.23)	6.888**** (0.24)
R^2	0.017	0.088	0.135	0.143
Number of Obs.	811	811	811	790
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 5: Linear household fixed Effects estimates of determinants of yield value per hectare - the role of possession of certificate by the landlord

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Landlord with certificate	-0.284***	-0.269***	-0.234***	-0.188
	(0.09)	(0.09)	(0.09)	(0.18)
Landlord without certificate	-0.067	0.036	0.057	0.113
	(0.21)	(0.20)	(0.19)	(0.24)
Plot slope - flat		0.459****	0.409****	0.453****
		(0.12)	(0.12)	(0.12)
Plot slope - foot hill		0.358***	0.302***	0.371****
		(0.13)	(0.12)	(0.11)
Shallow soil		0.039	0.032	0.043
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.029	-0.023	-0.008
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.212**	0.156*	0.124
		(0.10)	(0.09)	(0.09)
Log of distance to plot		-0.072*	-0.059	-0.060
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.029	0.089	0.078
		(0.15)	(0.15)	(0.15)
Crop grown - teff			0.411****	0.355****
			(0.10)	(0.09)
Crop grown - pulses or oilseed				0.055 0.027
			(0.18)	(0.19)
Crop grown - wheat			0.623****	0.595****
			(0.13)	(0.13)
Crop grown - barley			0.377***	0.363***
			(0.13)	(0.13)
Generalized residual				-0.066
				(0.14)
Constant	7.430****	7.231****	6.901****	6.913****
	(0.04)	(0.20)	(0.23)	(0.24)
R^2	0.013	0.081	0.133	0.142
Number of Obs.	815	815	815	792
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 6: Linear household fixed Effects estimates of determinants of yield value per hectare - the role of a landlord being absentee or cultivator landlord

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Absentee landlord	-0.312***	-0.275***	-0.230**	-0.141
	(0.11)	(0.11)	(0.11)	(0.19)
Cultivating landlord	0.012	0.050	0.035	0.151
	(0.14)	(0.16)	(0.15)	(0.21)
Plot slope - flat		0.443****	0.395****	0.439****
		(0.12)	(0.12)	(0.12)
Plot slope - foot hill		0.349***	0.294**	0.362***
		(0.12)	(0.12)	(0.11)
Shallow soil		0.051	0.042	0.049
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.010	-0.008	0.000
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.216**	0.157*	0.122
		(0.10)	(0.09)	(0.09)
Log of distance to plot		-0.071*	-0.058	-0.057
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.016	0.102	0.093
		(0.15)	(0.15)	(0.16)
Crop grown - teff			0.414****	0.361****
			(0.09)	(0.09)
Crop grown - pulses or oilseed				0.047 0.018
			(0.18)	(0.19)
Crop grown - wheat			0.618****	0.595****
			(0.13)	(0.13)
Crop grown - barley			0.369***	0.361***
			(0.13)	(0.13)
Generalized residual				-0.107
				(0.14)
Constant	7.431****	7.222****	6.896****	6.899****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.015	0.081	0.132	0.142
Number of Obs.	816	816	816	793
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 7: Linear household fixed Effects estimates of determinants of yield value per hectare - kinship and gender interaction effect

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Kin female landlord	-0.413****	-0.377***	-0.301**	-0.228
	(0.12)	(0.12)	(0.12)	(0.21)
Non-kin female landlord	-0.280	-0.270	-0.244	-0.167
	(0.18)	(0.17)	(0.17)	(0.23)
Kin male landlord	-0.055	0.006	0.046	0.081
	(0.21)	(0.20)	(0.19)	(0.29)
Non-kin male landlord	-0.125	-0.120	-0.136	-0.091
	(0.17)	(0.16)	(0.16)	(0.19)
Plot slope - flat		0.451****	0.406****	0.439****
		(0.12)	(0.12)	(0.11)
Plot slope - foot hill		0.365***	0.311***	0.374****
		(0.12)	(0.11)	(0.11)
Shallow soil		0.061	0.046	0.058
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.018	-0.014	-0.001
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.239**	0.183**	0.150*
		(0.09)	(0.09)	(0.09)
Log of distance to plot		-0.071*	-0.060	-0.063
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.042	0.072	0.053
		(0.15)	(0.16)	(0.16)
Crop grown - teff			0.393****	0.338****
			(0.09)	(0.09)
Crop grown - pulses or oilseed			0.024	-0.003
			(0.18)	(0.18)
Crop grown - wheat			0.605****	0.584****
			(0.13)	(0.13)
Crop grown - barley			0.347***	0.335***
			(0.12)	(0.13)
Generalized residual				-0.070
				(0.14)
Constant	7.408****	7.189****	6.884****	6.907****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.015	0.089	0.138	0.145
Number of Obs.	828	828	828	807
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 8: Linear household fixed Effects estimates of determinants of yield value per hectare - kinship and off-farm income access interaction effect

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Kin landlord with	0.032	0.094	0.092	0.196
off-farm income	(0.17)	(0.16)	(0.15)	(0.26)
Non-kin landlord with	-0.209	-0.179	-0.165	-0.051
off-farm income	(0.14)	(0.14)	(0.14)	(0.20)
Kin landlord without	-0.435**	-0.387*	-0.372*	-0.271
off-farm income	(0.22)	(0.20)	(0.19)	(0.22)
Non-kin landlord with-	-0.437**	-0.411**	-0.298*	-0.193
out off-farm income	(0.17)	(0.17)	(0.17)	(0.25)
Plot slope - flat		0.477****	0.426****	0.461****
		(0.12)	(0.12)	(0.12)
Plot slope - foot hill		0.373***	0.319***	0.382****
		(0.13)	(0.12)	(0.11)
Shallow soil		0.048	0.037	0.050
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.007	-0.006	0.008
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.213**	0.159*	0.125
		(0.10)	(0.09)	(0.09)
Log of distance to plot		-0.062	-0.053	-0.052
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		0.028	0.126	0.110
		(0.15)	(0.15)	(0.16)
Crop grown - teff			0.386****	0.330****
			(0.10)	(0.09)
Crop grown - pulses or oilseed				0.045 0.017
			(0.18)	(0.19)
Crop grown - wheat			0.593****	0.568****
			(0.13)	(0.13)
Crop grown - barley			0.358***	0.347***
			(0.12)	(0.13)
Generalized residual				-0.117
				(0.14)
Constant	7.421****	7.164****	6.866****	6.873****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.020	0.091	0.137	0.146
Number of Obs.	811	811	811	790
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 9: Linear household fixed Effects estimates of determinants of yield value per hectare - kinship and certificate interaction effect

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Kin landlord with certificate	-0.233*	-0.209*	-0.159	-0.099
	(0.12)	(0.12)	(0.12)	(0.22)
Non-kin landlord with certificate	-0.380***	-0.383****	-0.373***	-0.289
	(0.13)	(0.12)	(0.12)	(0.18)
Kin landlord with-out certificate	0.014	0.103	0.150	0.230
	(0.35)	(0.33)	(0.31)	(0.36)
non-kin landlord with-out certificate	-0.130	-0.014	-0.014	0.053
	(0.27)	(0.26)	(0.24)	(0.26)
Plot slope - flat		0.456****	0.404****	0.449****
		(0.12)	(0.12)	(0.12)
Plot slope - foot hill		0.356***	0.299**	0.368***
		(0.13)	(0.12)	(0.11)
Shallow soil		0.042	0.036	0.046
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.032	-0.027	-0.013
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.211**	0.155*	0.122
		(0.10)	(0.09)	(0.09)
Log of distance to plot		-0.074*	-0.061	-0.060
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.030	0.090	0.079
		(0.15)	(0.15)	(0.16)
Crop grown - teff			0.419****	0.362****
			(0.10)	(0.09)
Crop grown - pulses or oilseed				0.062 0.034
			(0.18)	(0.19)
Crop grown - wheat			0.629****	0.602****
			(0.13)	(0.13)
Crop grown - barley			0.378***	0.366***
			(0.13)	(0.13)
Generalized residual				-0.085
				(0.14)
Constant	7.429****	7.237****	6.903****	6.909****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.014	0.082	0.135	0.144
Number of Obs.	815	815	815	792
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 10: Linear household fixed Effects estimates of determinants of yield value per hectare - kinship and absentee landlord interaction effect

Explanatory Variables	Model_1	Model_2	Model_3	Model_4
Kin absentee landlord	-0.371**	-0.334**	-0.278*	-0.126
	(0.16)	(0.15)	(0.15)	(0.24)
Non-kin absentee landlord	-0.208	-0.174	-0.143	-0.145
	(0.16)	(0.15)	(0.15)	(0.18)
Kin cultivator landlord	0.017	0.049	0.096	0.244
	(0.17)	(0.20)	(0.19)	(0.26)
Non-kin cultivator landlord	0.012	0.054	-0.032	0.077
	(0.23)	(0.25)	(0.24)	(0.26)
Plot slope - flat		0.447****	0.398****	0.437****
		(0.12)	(0.12)	(0.12)
Plot slope - foot hill		0.352***	0.298***	0.362***
		(0.12)	(0.12)	(0.11)
Shallow soil		0.049	0.041	0.049
		(0.11)	(0.11)	(0.11)
Medium deep soil		-0.006	-0.004	-0.001
		(0.11)	(0.10)	(0.10)
Conservation (dummy)		0.217**	0.158*	0.122
		(0.10)	(0.09)	(0.09)
Log of distance to plot		-0.070*	-0.057	-0.056
		(0.04)	(0.04)	(0.04)
Homestead plot (dummy)		-0.019	0.098	0.093
		(0.15)	(0.15)	(0.16)
Crop grown - teff			0.413****	0.365****
			(0.09)	(0.09)
Crop grown - pulses or oilseed				0.046 0.020
			(0.18)	(0.19)
Crop grown - wheat			0.621****	0.600****
			(0.13)	(0.13)
Crop grown - barley			0.371***	0.364***
			(0.13)	(0.13)
Generalized residual				-0.114
				(0.14)
Constant	7.432****	7.216****	6.890****	6.894****
	(0.04)	(0.21)	(0.23)	(0.24)
R^2	0.016	0.082	0.133	0.142
Number of Obs.	816	816	816	793
Model test	0.000	0.000	0.000	0.000

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; Standard errors, corrected for clustering at household level, are included in parentheses..

Appendix 11: Stata program output for propensity score matching of owner operated and rented in plots of tenants

```
**************************************************
Algorithm to estimate the propensity score
**************************************************


The treatment is rentin

 if plot is |
rentedin in |
     2005=1 |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        622       61.10       61.10
          1 |        396       38.90      100.00
------------+-----------------------------------
      Total |      1,018      100.00


Estimation of the propensity score


Iteration 0:   log likelihood = -672.21971
Iteration 1:   log likelihood = -640.11786
Iteration 2:   log likelihood = -639.41721
Iteration 3:   log likelihood = -639.41552


Probit regression                                 Number of obs   =       1008
                                                  LR chi2(14)     =      65.61
                                                  Prob > chi2     =     0.0000
Log likelihood = -639.41552                       Pseudo R2       =     0.0488

------------------------------------------------------------------------------
      rentin |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        area |   .0786852   .0371088     2.12   0.034     .0059533    .1514171
home_adjuc~t |  -1.009582   .1592706    -6.34   0.000    -1.321747   -.6974177
         sd1 |   .3067603   .3440189     0.89   0.373    -.3675043     .981025
         sd2 |   .4468227   .3461107     1.29   0.197    -.2315418    1.125187
         sd3 |   .3315761   .3439614     0.96   0.335    -.3425759    1.005728
        slp1 |  -.2672591   .6227967    -0.43   0.668    -1.487918       .9534
        slp2 |  -.3829141   .6394135    -0.60   0.549    -1.636142    .8703132
        slp3 |  -.6749675   .6342534    -1.06   0.287    -1.918081    .5681464
        slp4 |  -.4207787   .6524653    -0.64   0.519    -1.699587    .8580298
         st1 |   -.250217   .4169117    -0.60   0.548    -1.067349    .5669149
         st2 |  -.2977536   .4205407    -0.71   0.479    -1.121998    .5264911
         st3 |  -.2082059   .4153078    -0.50   0.616    -1.022194    .6057823
         st4 |  -.0607486   .4151995    -0.15   0.884    -.8745247    .7530274
    distance |  -.0000927   .0011231    -0.08   0.934    -.0022939    .0021086
       _cons |  -.1196296   .5455241    -0.22   0.826    -1.188837     .949578
------------------------------------------------------------------------------


Note: the common support option has been selected
The region of common support is [.08555986, .65252565]
```

Description of the estimated propensity score
in region of common support

Estimated propensity score

	Percentiles	Smallest		
1%	.0965417	.0855599		
5%	.1156188	.0868567		
10%	.1770541	.0881746	Obs	1000
25%	.3662786	.0896247	Sum of Wgt.	1000
50%	.4118347		Mean	.3907127
		Largest	Std. Dev.	.1112674
75%	.4573342	.6243215		
90%	.5025208	.6268375	Variance	.0123804
95%	.5299288	.6331549	Skewness	-1.192016
99%	.5924497	.6525256	Kurtosis	4.152642

****
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****

The final number of blocks is 4

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each block

****
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
****

The balancing property is satisfied

This table shows the inferior bound, the number of treated
and the number of controls for each block

Inferior of block of pscore	if plot is rentedin in 2005=1		
	0	1	Total
.0855599	90	14	104
.2	210	113	323
.4	305	259	564
.6	6	3	9
Total	611	389	1000

Note: the common support option has been selected

****
End of the algorithm to estimate the pscore
****

APPENDIX 12: Stata Program Output for Propensity Score Matching of kin and non-kin rented in plots of Tenants

```
**************************************************
Algorithm to estimate the propensity score
**************************************************


The treatment is kin
        kin |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        173       41.09       41.09
          1 |        248       58.91      100.00
------------+-----------------------------------
      Total |        421      100.00


Estimation of the propensity score


Iteration 0:   log likelihood = -263.11836
Iteration 1:   log likelihood = -251.19069
Iteration 2:   log likelihood = -251.11696
Iteration 3:   log likelihood =  -251.1169

Probit regression                                 Number of obs   =        421
                                                  LR chi2(14)     =      24.00
                                                  Prob > chi2     =     0.0458
Log likelihood =  -251.1169                       Pseudo R2       =     0.0456

------------------------------------------------------------------------------
         kin |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Area |  -.2376719   .0682308    -3.48   0.000    -.3714018   -.1039419
home_stead   |   .6417935   .3799198     1.69   0.091    -.1028356    1.386423
         sd1 |  -.9471977   .6769245    -1.40   0.162    -2.273945    .3795499
         sd2 |  -.9908282   .6836871    -1.45   0.147     -2.33083    .3491739
         sd3 |  -1.013354   .6789247    -1.49   0.136    -2.344022    .3173141
        slp1 |   .0628091   .8273726     0.08   0.939    -1.558811    1.684429
        slp2 |   .3043208   .8625278     0.35   0.724    -1.386203    1.994844
        slp3 |  -.1037614   .8617671    -0.12   0.904    -1.792794    1.585271
        slp4 |   .2704457   .8872341     0.30   0.761    -1.468501    2.009392
         st1 |   .1583347   .7186996     0.22   0.826    -1.250291     1.56696
         st2 |   .2056601   .7286463     0.28   0.778     -1.22246    1.633781
         st3 |  -.0686015   .7240848    -0.09   0.925    -1.487782    1.350579
         st4 |   .1244772   .7169533     0.17   0.862    -1.280725     1.52968
    distance |   .0017655   .0017019     1.04   0.300    -.0015702    .0051013
       _cons |    1.27589   1.067652     1.20   0.232    -.8166687    3.368449
------------------------------------------------------------------------------


Note: the common support option has been selected
The region of common support is [.2397262, .90253403]


Description of the estimated propensity score
in region of common support
```

Estimated propensity score

Percentiles		Smallest		
1%	.3001078	.2397262		
5%	.3925498	.2572932		
10%	.4500827	.2858137	Obs	386
25%	.5302689	.3001078	Sum of Wgt.	386
50%	.6045403		Mean	.5947225
		Largest	Std. Dev.	.1125335
75%	.6659257	.8922467		
90%	.7139993	.9007514	Variance	.0126638
95%	.7780255	.9014371	Skewness	-.1756715
99%	.8922467	.902534	Kurtosis	3.566765

****
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****

The final number of blocks is 10

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each block

****
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
****

The balancing property is satisfied

This table shows the inferior bound, the number of treated
and the number of controls for each block

Inferior of block of pscore	kin 0	kin 1	Total
.2	0	3	3
.3	11	6	17
.4	31	21	52
.5	55	55	110
.6	46	106	152
.7	11	25	36
.8	1	12	13
.9	1	2	3
Total	156	230	386

Note: the common support option has been selected

****
End of the algorithm to estimate the pscore
****

Paper 4

Impacts of Low-Cost Land Certification on Investment and Productivity

Stein T. Holden, Klaus Deininger, and Hosaena Ghebru

New land reforms are again high on the policy agenda and low-cost, propoor reforms are being tested in poor countries. This article assesses the investment and productivity impacts of the recent low-cost land certification implemented in the Tigray region of Ethiopia, using a unique household and farm-plot-level panel data set, with data from before and up to eight years after the reform. Alternative econometric methods were used to test and control for endogeneity of certification and for unobserved household heterogeneity. Significant positive impacts were found, including effects on the maintenance of soil conservation structures, investment in trees, and land productivity.

Key words: household panel data, land productivity, low-cost land certification, soil conservation, tree planting, unobserved heterogeneity.

A new wave of land reforms has hit Africa, typically aiming to provide more private and secure property rights to land. Formalization of land rights are being promoted by the Commission for Legal Empowerment of the Poor, The World Bank, UN organizations, and many donor countries. Yet, it is questionable whether these reforms will succeed in promoting poverty reduction and economic growth, given past experiences and the difficulties of designing and implementing propoor land reforms. Past land titling programs have tended to benefit the wealthy and powerful at the expense of the poor and marginalized, owing to poor implementation, the high cost of obtaining titles in complex and often corrupt and inefficient bureaucracies, and limited or no formal recognition of customary land rights (Besley and Burgess 2000; Cotula, Toulmin, and Hesse 2004; Deininger 2003).

According to theory, tenure security is expected to enhance investment and vice versa (Besley 1995; Sjaastad and Bromley 1997). Therefore, if land certification can enhance tenure security it may enhance investment. In turn, tenure security may reduce conflicts over land, which may enhance the positive effects of tenure security on land productivity (Deininger and Castagnini 2006). In addition, property rights may contribute to better access to credit if land can be used as collateral and can contribute to land market development such that land will be reallocated to more efficient producers, which may stimulate investment on the land.

There are very few studies of the impacts of the new propoor and low-cost land reforms that have been implemented in some countries in recent years. One exception is Deininger et al. (2008) who assessed the early impacts of low-cost land registration and certification using a large cross-section data set from Ethiopia, a pilot country when it comes to such reforms. The cost of registration and certification was estimated to be about 1USD per farm plot or 3.5USD per household (Deininger et al. 2008) as compared to about 150 USD per household with the conventional titling upon demand that has been used in Madagascar (Jacoby and Minten 2007). The low-cost approach is affordable on a broad scale because of the use of simple technology, staff with limited training, and high local participation.[1] Yet, one may question whether this low-cost approach also

Stein T. Holden is professor of development and resource economics at the Norwegian University of Life Sciences, Klaus Deinger is lead economist and land tenure advisor at the World Bank, and Hosaena Ghebru is Ph.D. student in economics at the Norwegian University of Life Sciences and staff at Mekelle University, Tigray, Ethiopia.

The authors are grateful for the helpful comments from Fredrik Willumsen, two anonymous reviewers, and the editors Christopher B. Barrett and Jeffrey H. Dorfman on earlier versions of this manuscript. Funding was provided by the Research Council of Norway, the Norwegian Agency for Development Cooperation (NORAD), and the Norwegian Trust Fund. The authors acknowledge the efforts by students from Norwegian University of Life Sciences and Mekelle University involved in the data collection. Any remaining errors are the authors'.

[1] Modern technologies, such as total stations, GPSs, computers, advanced software, etc., were not used. Plots were demarcated using local materials and measured with ropes in the presence of all neighbors as witnesses. Information was recorded on a single page for each household with a number of plots. The data were entered in registry books kept at community and district levels.

Amer. J. Agr. Econ. 91(2) (May 2009): 359–373

DOI: 10.1111/j.1467-8276.2008.01241.x

means low-quality and minimal impacts. The Ethiopian experience has demonstrated that it is a scalable approach as more than 20 million plots and 6 million households have received certificates within a period of seven years (Deininger et al. 2008).

This article assesses the investment and productivity impacts of the Ethiopian low-cost land certification using a unique and detailed data set with household and plot panel data from 1998, 2001, and 2006. The data provide a balanced household panel covering sixteen representative communities in eleven districts in the Tigray region, where certification was implemented first in Ethiopia. With the last survey round, eight years after the reform, we were able to assess some of the longer-term impacts of certification. Alternative methods were used to test and correct for endogeneity of certificates. The rich household–plot panel data allowed us to control for time-invariant unobservable village, household, and plot heterogeneity in the land productivity analysis by using household fixed effects. The findings of significant and positive investment and productivity effects of certification have important land policy implications, as this is the first comprehensive impact assessment of the investment impacts of the low-cost, participatory, broad-based, high-speed land certification approach, which Ethiopia was one of the first countries to implement. The main reason for such positive impacts of certification is that certification has reduced tenure insecurity that was high due to the past policy with state ownership of land, providing households restricted user rights to land only, and frequent land redistributions that undermined investment incentives (Alemu 1999; Deininger and Jin 2006).

The article proceeds as follows. The first section provides an overview of the relevant literature and presents the hypotheses to be tested. The next section gives an overview of the land tenure history of Ethiopia, with an emphasis on the recent tenure reforms. A brief presentation of the data and descriptive statistics follows, before the estimated models are outlined. A comprehensive analysis of investment and productivity impacts is then presented, followed by the conclusion.

Literature Review and Hypotheses

The links between tenure security, credit markets, and investments are well established in neoclassical economic theory (Besley 1995; Haavelmo 1960; Jorgenson 1967). Investments may be enhanced through improving tenure security, facilitation of the use of land as collateral, and gains-from-trade effects (Besley 1995; Feder 1988). Reverse causality between investment and tenure security makes it important to take into account the fact that land rights and tenure security are endogenous (Brasselle, Gaspart, and Platteau 2002; Place and Otsuka 2001; Sjaastad and Bromley 1997). Tenure-insecure people possibly enhance their tenure security through investment, and this may be particularly important for visible investments, such as investment in trees (Deininger and Jin 2006).

Although significant investment impacts from land titles have been reported in Latin America (Alston, Libecap, and Schneider 1995; Deininger and Chamorro 2004; Lanjouw and Levy 2002; Lopez 1997) and Asia (Do and Iyer 2002; Feder 1988), studies of such interventions in Africa have found insignificant or no investment effects (Atwood 1990; Carter and Wiebe 1990; Migot-Adholla 1993; Migot-Adholla, Place, and Oluoch-Kosura 1994; Place and Migot-Adholla 1998). No empirical evidence was found of land titling enhancing credit markets, land markets, and investment in Kenya (Migot-Adholla, Place, and Oluoch-Kosura 1994; Pinckney and Kimuyu 1994; Place and Migot-Adholla 1998).

Holden and Yohannes (2002) found no evidence of tenure insecurity having a negative effect on investment in trees in southern Ethiopia, whereas poverty had a significant negative impact on such investments. Therefore, tenure security may be neither a necessary nor a sufficient condition for investment. Poor rural households face capital market constraints, as revealed by studies of their discount rates and returns to capital (Holden, Shiferaw, and Wik 1998).

On the other hand, Deininger and Jin (2006) found that transfer rights to land as well as tenure security were investment enhancing, based on a 2001 survey of the four major regions in Ethiopia. In addition, recent evidence from a broad cross-sectional survey in Ethiopia indicated that the recent land certification may have enhanced investment (Deininger et al. 2008). Both these studies use household-level cross-section data. The latter study did not analyze the effects on different types of investments.

Based on this brief review of the theory and relevant literature, the objective of this article

is to assess the investment and productivity impacts of the low-cost land certification program that was implemented in the Tigray region of Ethiopia, which was the first region in Africa to undergo a large distribution of nonfreehold land certificates. Specifically, the impacts on investment in and maintenance of soil conservation structures, tree planting, and land productivity are estimated. The following hypotheses are tested:

H1: Having a certificate for a farm plot enhances investments on the plot in terms of the building of new conservation structures, the improvement/maintenance of existing conservation structures, and the planting of trees.

H2: Restrictions on tree planting in the land proclamations (especially on eucalyptus) have prevented investment in trees. Therefore, land certification has not stimulated this type of investment and there will be no difference between plots with and without a certificate.

H3: Land certification has enhanced land productivity.

The Land Tenure System and Recent Land Reform in Ethiopia

Civil war and border conflicts have had severe negative impacts on development in Ethiopia, and land has played a central role in these conflicts. Emperor Haile Selassie lost power to the military Derg regime in 1974, which subsequently made all land state property. User rights to land were allocated to communities and to households within communities based on family size, leading to a very egalitarian land distribution. The reform was followed up with reasonably frequent land redistributions to maintain the egalitarian land distribution throughout the 1980s (Holden and Yohannes 2002; Rahmato 1984). After a long civil war in northern Ethiopia, the military government was overthrown and a new government was formed in 1991. Eritrea achieved independence and a more market-friendly policy was introduced in Ethiopia. As land legislation was based partly at the federal and partly at the regional level, this created variations both in the legislation and in how it was implemented across regions, which has provided interesting opportunities for research.

The Tigray region commenced the land registration and certification process in 1998–9 and was the first region to do so. It utilized simple traditional methods in implementation, including students with short-duration training, and strong local participation. The Amhara region started a land registration and certification process in 2003 with some donor support and used and tested more modern equipment, while the Oromia region and Southern Nations Nationalities and Peoples (SNNP) region started in 2004, and the process was still ongoing in these regions in 2007.

The Ethiopian land certificates provide only limited rights in the form of perpetual user rights, rights to bequeath, rights to obtain compensation for investment on the land in the case of loss of the land, and rights to lease out the land for a limited period. Nevertheless, in a country with high and increasing land scarcity and a historical land policy that promoted tenure insecurity, the land certificates represented a substantial improvement (Alemu 1999; Holden and Yohannes 2002). Land sales and mortgaging of land remain illegal and restrict capital markets development.

The new land laws and regulations impose obligations on certificate holders and penalties for violations. The basis for the land certificate to provide tenure security is that the land is properly conserved according to the earlier and most recent land proclamations and regulations (TLR 2007; TRLAUP 2006). There are restrictions on planting trees on arable land for food security reasons, making the effects of certification on tree planting uncertain. Another complicating aspect of analyzing the investment effects of certification relates to the widespread public interventions in soil and water conservation in Tigray. Special care has to be taken to distinguish between private and public investments at the farm-plot level. Public investments in conservation may crowd in or crowd out private investments in conservation (Hagos and Holden 2006; Holden, Barrett, and Hagos 2006). We have controlled for public investments in conservation at the farm-plot level when assessing the private investment impacts of certification. Public investments in conservation were introduced through a watershed approach, treating whole watersheds using a top-to-bottom approach by mobilizing people through compulsory participation, collective action, and provision of food-for-work incentives. Therefore, the presence of such public investments on plots is exogenous to households but may depend on the location and characteristics of plots.

The private investment effects of the low-cost certification approach used in Tigray may be low not only because of the low-cost approach itself, which may have affected the

quality of the implementation, but also because of the restrictions on the land rights provided by the certificates and public investments. Furthermore, the effects are likely to depend on the initial conditions before the reform, the trust of the rural people in the state and its local responsible organs and representatives, the local legal knowledge, and interpretations of the law. Severe poverty affects households' levels of education, access to information, ability to understand the law, and participation in implementation. In addition, severe resource constraints may affect the local institutions' capacity to implement the land reform and the quality of the process.

The Tigray Region in Northern Ethiopia

Tigray is located in northern Ethiopia and has a semiarid climate. Pastoralism dominates in the arid lowlands, while most of the population lives in the highlands 1,500 meters above sea level, where rain-fed agriculture (integrated crop and livestock production) provides the main source of livelihood. Droughts are frequent, whereas irrigation is developed only in a few locations, making food insecurity a major issue and policy challenge.

The region was affected severely by the civil war during the Derg regime (1974–91) when a large share of the region's population was engaged in the struggle against the government. The new government that was victorious in 1991 originated from the Tigray region, which has contributed to the recent developments in the region. Most rural households in Tigray are net buyers of food owing to the small farm sizes, adverse agroecological conditions, poor market access, and limited technology. The population density in the highlands varies from 40 to 750 persons/km^2 (Hagos and Holden 2003; Hagos, Pender, and Gebreselassie 2002). Public programs have been established to conserve the natural resources, provide safety nets, and enhance food security through food-for-work programs, which have targeted soil and water conservation and irrigation development. Stone terraces and soil bunds are the dominant types of conservation structures on arable land and have been established through public as well as private efforts. Stone terraces are more important on steeper slopes and can last for a long time, although some maintenance is required every year to keep them in good shape. Soil bunds are less durable but can last for several years depending on their size, the slope, and vegetation cover.

Data and Descriptive Statistics

We used a unique balanced household and plot-level panel data set covering the five main zones of the Tigray region in northern Ethiopia. Sixteen communities were strategically sampled from eleven districts to represent the major variation in agroecological factors, market access, population density, and access to irrigation. Within each community, there was a random sample of twenty-five households. The first survey round took place in 1998, just before the land registration and certification program was introduced, and was followed up with survey rounds in 2001 and 2006. We were able to distinguish public and private investments in soil conservation at the plot level but we were not able to match plots over time.

Descriptive Analysis

The baseline survey in 1998 revealed that 51% of the sample households feared losing their land owing to future land redistributions, indicating a high level of tenure insecurity based on the land policy where land redistributions within communities have been an important element. It was typically households with more than average land in the communities that feared such land redistributions because they were likely to be among the losers. The other half of the population was rather expecting to gain land in the next redistribution and, therefore, many of them hoped for a new redistribution (Hagos and Holden 2003).

The survey in 2006 included questions to households about their perceptions of the effects of the land certification. Based on these questions, 84% of the households stated that they perceived the risk of being evicted from their land to have been reduced due to the land certification and 78% of the households stated that certification has increased the probability that they will get compensation in the case of land takings. This provides a basis for the hypothesis that land certification has strengthened tenure security and may explain, at least partially, why land certification has eventually contributed to increased investment and land productivity. Two-thirds of the households also perceived that border disputes had been reduced after certification.

Land quality and basic household characteristics may not be the same for plots with and without a certificate. A two-step approach was used to deal with this problem: (*a*) using nonparametric matching on observable plot

characteristics to identify a sample that satisfies common support, and (*b*) using parametric regressions on the sample of plots that satisfied the common support requirement (Ho et al. 2007). The matched data of plots that were used in the productivity analysis included the plots planted with cereal crops with and without a certificate that satisfied the common support requirement but excluding rented-in plots. This caused the number of plot observations to be reduced from 2,718 to 2,380. The propensity score was constructed based on observable plot characteristics without including the endogenous investment variables through which the land certification may have affected productivity. This kind of data preprocessing reduces model dependence in the following parametric analysis (Ho et al. 2007).

An overview of the variables used in the regression analyses is provided in table 1, while table 2 compares the means of plots with and without a certificate in 2001 and 2006 for key investment and land productivity variables. Only plots that satisfied the common support requirement were included.

Table 2 indicates that stone terraces are more likely to be found on plots with a certificate (54%) than on plots without a certificate (48%), whereas the opposite appears to be the case for soil bunds (25% vs. 15%). There was no significant difference in the mean maintenance status of plots[2] with and without a certificate. The numbers of eucalyptus trees, indigenous trees, young trees, and tree seedlings were significantly higher on plots with a certificate than on plots without. This may indicate that households are less inclined to harvest and more inclined to plant trees on plots with a certificate. The mean value of output per hectare was significantly higher on plots with a certificate than on plots without a certificate. The yield distribution for plots with and without a certificate is presented in figure 1. A two-sample Kolmogorov–Smirnov test for equality of distribution functions was highly significant ($p = 0.004$), indicating that the distributions were different.

Specific Estimators and Econometric Model Specifications

Correlation between the certificate variable and the error term of the outcome equation may be the result of potential endogeneity of land certificates. An empirical investigation of the process of registration and certification revealed the following reasons why some households did not have land certificates: (*a*) administrative failures caused incomplete registration and certification in some communities, (*b*) some households may have been left out of the registration because they were absent at the time, (*c*) some households did not receive the certificates because the administration ran out of certificates and failed to obtain additional ones, (*d*) some households did not collect their certificates because they may not have considered them to be important at that time, and (*e*) some households have lost their certificates after they received them or, if there was a change in the head of the household, the new head of the household failed to take over the old certificate or obtain a new one. The administrative failures appear to have affected households and communities quite randomly and are not likely to create any endogeneity bias. However, reasons (*b*), (*d*), and (*e*) above may potentially create bias.

Three alternative models for determining which households had a certificate were formulated as follows:

$$(1)\quad C_{hpt} = \alpha_{10} + \alpha_{11} Q_{hpt} + \alpha_{12} D_v + \alpha_{16} \tau_{hpt} + u_{1hpt}$$

$$(2)\quad C_{hpt} = \alpha_{20} + \alpha_{21} Q_{hpt} + \alpha_{22} D_v + \alpha_{23} Z_{ht} + \alpha_{26} \tau_{hpt} + u_{2hpt}$$

$$(3)\quad C_{hpt} = \alpha_{30} + \alpha_{31} Q_{hpt} + \alpha_{35} D_h + \alpha_{36} \tau_{hpt} + u_{3hpt}$$

where

$C_{hpt} = \{0, 1\}$ is equal to 1 if the household has the plot on its land certificate, 0 otherwise
Q_{hpt} is a vector of plot specific biophysical characteristics
D_v is a vector of community dummies
τ_{hpt} is years since certification
Z_{ht} is a vector of observable household characteristics
D_h is a time-invariant vector of household dummies, and
$u_{1hpt}, u_{2hpt}, u_{3hpt}$ are the error components for the three alternative models.

[2] The variable has a range from −1 to 1 and the positive mean values indicate that the maintenance status of such structures has improved over time.

Table 1. Variable Descriptions for Plot Panel Data (1998, 2001, and 2006)

Variable	Description	Obs	Mean	Std. Dev.
Certificate	Dummy for certificate	2,380	0.64	
Certpr1	IV estimator for certificate	2,380	0.69	0.42
Cererror1	Error for IV estimator	2,380	−0.05	0.29
Certpr2	Household observed characteristics estimator for certificate	2,362	0.72	0.42
Cererror2	Error for observed household characteristics estimator for certificate	2,362	−0.07	0.31
Certpr3	Household fixed-effects estimator for certificate	2,380	0.61	0.45
Cererror3	Error for household fixed-effects estimator for certificate	2,380	0.04	0.14
Maintenance of SWC	Maintenance or improvement of soil conservation structure, 1 = improved, 0 = no change, and −1 = worsened	1,414	0.38	0.67
Eucalyptus trees	Number of eucalyptus trees	1,123	6.10	39.49
Tree seedlings	Number of tree seedlings, 0–2 years old	1,100	8.29	34.81
Log of yield value	Log of total output value per tsimdi*	2,380	7.02	0.95
Homestead plot	Dummy for homestead plot	2,380	0.31	
Plot size	Plot size in tsimdi	2,380	1.18	1.07
Public investment	Dummy for public investment in soil conservation on the plot	2,380	0.37	
Shallow soil	Soil depth: Shallow	2,380	0.40	
Medium deep soil	Soil depth: Medium	2,380	0.36	
Deep soil	Soil depth: Deep	2,380	0.24	
Flat slope	Slope: Flat, valley bottom	2,380	0.69	
Low hill	Slope: Low hill	2,380	0.23	
Mid hill	Slope: Mid hill	2,380	0.06	
Steep hill	Slope: Steep hill	2,380	0.02	
Soil type Cambisol	Soil type: Baekel = Cambisol	2,380	0.28	
Soil type Vertisol	Soil type: Walka = Vertisol	2,380	0.27	
Soil type Regosol	Soil type: Hutsa = Regosol	2,380	0.24	
Soil type Luvisol	Soil type: Mekayih = Luvisol	2,380	0.21	
Distance to plot	Distance to plot from home, minutes walk	2,380	24.18	29.47
Sex of household head	Sex of household head, 1 = female, 0 = male	2,360	0.15	
Age of household head	Age of household head	2,360	52.86	15.01
Education of household head	Education of household head (years)	2,360	0.42	0.74
Female labor force	Log of adult female labor force per tsimdi	2,360	0.89	0.50
Male labor force	Log of adult male labor force per tsimdi	2,360	0.85	0.60
Oxen per farm size	Log of oxen number per tsimdi	2,360	0.56	0.56
Other livestock per tsimdi	Log of tropical livestock units per tsimdi	2,360	1.01	0.75
Farm size	Size of own farm holding, tsimdi	2,379	4.68	4.09
Year	Year, Gregorian calendar	2,380	2,002.03	3.18

Note: * 1 tsimdi is the area a pair of oxen can plough in a day and is approximately 0.25 hectare.
SWC, soil and water conservation structures.

Table 2. Descriptive Statistics for Key Investment and Productivity Variables

	Certificate			No Certificate			
Variable	Mean	St. Error	N	Mean	St.Error	N	*t*-Test
Stone terrace	0.54	0.01	1,531	0.48	0.03	253	>*
Soil bund	0.15	0.01	1,531	0.25	0.03	253	<***
Maintenance of SWC	0.38	0.02	1,223	0.36	0.05	191	n.s.
Eucalyptus trees	5.05	1.26	924	1.37	0.71	168	>***
Tree seedlings	9.08	1.18	933	3.86	2.01	167	>**
Log of yield value	7.13	0.02	1,531	7.01	0.05	253	>**

Note: The table compares plots with and without certificate in 2001 and 2006. > means that plots with certificate have significantly higher value. Single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at 10%, 5%, and 1%, respectively.
SWC, soil and water conservation structures.

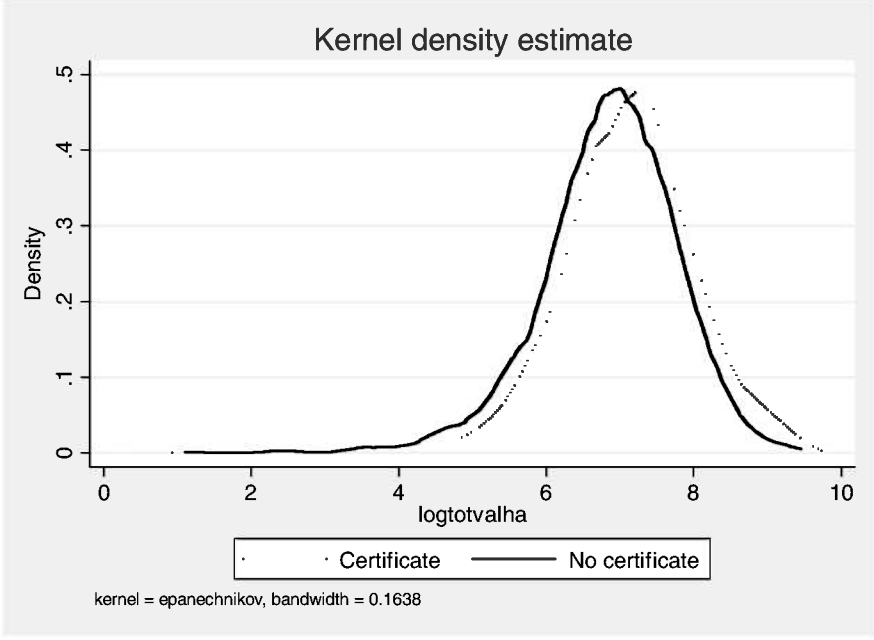


Figure 1. Kernel density graph of log of plot-level land productivity per hectare for plots with and without land certificate (matched sample)

In the first model (1), village fixed effects were tested as instruments to predict administrative failures. The "years since certification" variable was used as an instrument for loss of certificates or for changes in household heads with new heads failing to obtain a certificate. The detailed model results are presented in Appendix table A.1. Table A.2 shows that only 7.1% of the households without a certificate was predicted correctly. The weak predictive power may indicate that these instruments are poor or that the process was largely random. A further test of the latter was attempted by including observable household characteristics in specification (2). If such characteristics significantly affect certification, then there are reasons to worry about endogeneity bias. As seen in Appendix table A.1, two of these variables, livestock holding and farm size, were significant. Households with fewer animals and a larger farm size were more likely to have a certificate. Livestock may be a sign of wealth and influence, which may be positively correlated with tenure security, whereas under the old policy regime, households with larger land holdings were likely to be more tenure insecure and more prone to losing land in the next redistribution. However, model (2) was even weaker when it came to predicting households without a certificate, predicting only 1.2% of these households correctly (table A.2). To further test whether

unobserved household heterogeneity may explain certification, model (3), a linear probability model with household fixed effects, was tested. The results are shown in table A.1 and its predictive power in table A.2 and indicate that the model's predictive power for households without a certificate was 88.1%. This was substantially better than the two other models. However, it leaves an unexplained error that is uncorrelated with unobserved household heterogeneity. The *Certpr*3 variable also captures random administrative errors that caused some households to be excluded from certification. Therefore, using *Cererror*3 as a test of certification impacts is a very conservative test.

We used predictions from all three certification models and the actual certificate variable for more robust testing of the impacts of certification on investment and land productivity. The innovative aspect of this procedure is that the error terms of the second and third certification models may be seen, respectively, as weak and strong estimators of randomly allocated certificates. The sensitivity analysis included use of actual certificates, the weak and strong estimates of random certification (*Cererror*2 and *Cererror*3), and the IV approach with the weak instruments.

Following is a description of the different econometric models used for the impact assessment.

Investment Models

Models for farm-plot-level investments in stone terraces, soil bunds, maintenance, and improvement of soil conservation structures, and trees have the following general reduced-form formulation for capturing the certification impacts

$$(4)\quad I^P_{hpt} = \alpha_0 + \alpha_1 Q_{hpt} + \alpha_2 \hat{C}_{hpt} + \alpha_3 I^F_{hpt} + \alpha_4 Z_{ht} + \alpha_5 Z_v + \alpha_6 (C_{hpt} - \hat{C}_{hpt}) + \alpha_7 T_t + \zeta_h + e_{hpt}$$

where

I^P_{hpt} is private investment on plot p of household h in period t
Q_{hpt} is a vector of plot level time-varying biophysical characteristics
C_{hpt} is the actual certificate variable
$\hat{C}_{hpt}$ is the predicted certificate using alternative approaches
$(C_{hpt} - \hat{C}_{hpt})$ is the certificate error variable with alternative approaches
I^F_{hpt} is a public investment dummy on plot p of household h in period t
Z_{ht} is a vector of household characteristics
T_t is a time trend variable
ζ_h is an alternative error component
e_{hpt} is the transitory error component.

The dependent investment variables required the use of alternative models, as follows: (*a*) stone terraces and soil bunds: household random-effects probit and fixed-effects logit panel data models,[3] (*b*) maintenance/improvement of soil conservation structures: household random-effects proportional odds ordered logit panel data models, and (*c*) tree stock and tree planting models: random-effects tobit panel data models.[4] Fixed-effects models with limited dependent variables suffer from the incidental parameter problem, which leads to biased estimators (Greene 2004; Wooldridge 2005). Unlike investments in new conservation structures, maintenance and improvement of conservation structures is the sole responsibility of individual households and may therefore be a better indicator of individual incentives.

The four alternative specifications for the certification variables were used to check robustness. Bootstrapping was used to obtain robust and corrected standard errors for the predicted variables. As the survey design involved random sampling of households within villages, we resampled households in the bootstrapping process. Household random effects were used because plots within households are not independent.

The public investment variable should both control for its direct impact at plot level and its indirect crowding-in or crowding-out effects on private investment. We ran models with and without this variable to test the sensitivity of the findings.

[3] Using household fixed-effects models meant the loss of a substantial number of observations.

[4] Household fixed-effects models were infeasible because of too few observations with a positive number of trees.

Productivity Impact Models

The impacts on land productivity of land certification were estimated using parametric regression models with household fixed effects (GLS) as follows:

$$y_{hpt} = \beta_0 + \beta_1 Q_{hpt} + \beta_2 I^F_{hpt} + \beta_3 \hat{C}_{hpt} + \beta_4 D_t + \beta_5 (C_{hpt} - \hat{C}_{hpt}) + \vartheta_h + e_{hpt}$$

where ϑ_h is the unobservable time-invariant household, plot, and village characteristics that can be controlled for using household fixed effects. The dependent variable (y_{hpt}) was specified as the log of the total value of output per hectare. The log-transformed data had a more favorable (less skewed) distribution. The other variables on the right-hand side are as specified in the earlier models, including the alternative certification specifications.

Model Selection

The sensitivity analysis required a large number of models to be run, and it is only possible to present a small part of the results in this article. We have made a selection of models for presentation based on the following logic. We have not presented models where the results are highly unstable across the model, making it difficult to reach conclusions. This was the case with the soil conservation investment models. Where we had to rely on random-effects models, as for the tree investment models, we present results with the actual certificate and with *Certpr*3 and *Cererror*3. In the latter case, we assume that the *Certpr*3 controls for unobserved heterogeneity and that *Cererror*3 serves as a test of the effect of random certification. We included only one model with the *Certpr*3 and *Cererror*3 variables for the random-effects proportional odds ordered logit models for maintenance or improvement of soil conservation structures, including the public investment in conservation variable, as the results were not sensitive to this variable. Finally, we present a summary of the sensitivity analysis for the fixed-effects land productivity models, which includes only the coefficients and significance levels for the alternative certificate variables. The sensitivity analysis illustrates the stability of the alternative specifications and also serves as a basis for a discussion of the alternative approaches.

Results and Discussion

The analyses of the impacts on investment are presented first, followed by the analyses of the impacts on land productivity.

Effects on Soil Conservation Investment

A thorough testing was carried out for a large number of model specifications with alternative certificate variables, including random-effects and fixed-effects models, with and without time-varying household variables, and with and without the public investment variable (*Public investment*) for investments in stone terraces and soil bunds. For the soil bund models, the certificate variables were never significant. In the stone terrace regressions, the IV approach (*Certpr*1) yielded significant and positive results in five of the eight models, the actual certificate variable was significant in two out of eight models, and *Cererror*3 was significant in only one out of eight models. Although all coefficients were positive, this is only weak evidence of a positive response to certification. The weak response may be the result of the strong role of public investments and local collective action in soil conservation. The *Public investment* variable was highly significant and positive in all model specifications, indicating that much of this investment was driven by public efforts.

Effects on Maintenance or Improvement of Conservation Structures

We hypothesized that land certification has enhanced the efforts to improve or maintain existing soil conservation structures. We used proportional odds (ordered logit) models to test this hypothesis with the maintenance/improvement of conservation structures variable as the dependent variable. We present the results (table 3) from the household random intercept models including the public investment dummy variable because private incentives for maintenance of soil conservation structures may be affected by whether the structures were established through public or private efforts.[5] Household fixed-effects models were infeasible and, therefore, we specified the models with *Certpr*3 as a means to control for unobservable household characteristics and assessed the impact

[5] Removal of the public investment variable did not lead to any significant changes in the results.

Table 3. Impact of Certification on Maintenance and Improvement of Soil Conservation Structures

Variable	OLOG1
Certpr3	0.94 (0.317)
Cererror3	2.152* (0.973)
Year	1.131*** (0.04)
Public investment	1.12 (0.161)
Homestead plot	1.585*** (0.254)
Plot size	1.174** (0.093)
Shallow soil	0.496*** (0.086)
Medium deep soil	0.722* (0.124)
Flat slope	1.07 (0.397))
Low hill	0.774 (0.297)
Mid hill	1.173 (0.545)
Soiltype Cambisol	1.095 (0.202)
Soiltype Vertisol	0.704* (0.134)
Soiltype Regosol	0.835 (0.166)
Distance to plot	0.989*** (0.003)
Sex of household head	0.93 (0.258)
Age of household head	1.00 (0.007)
Education of household head	0.99 (0.114)
Female labor force	1.01 (0.115)
Male labor force	1.10 (0.104)
Oxen per farm size	0.94 (0.131)
Other livestock per tsimdi	0.896* (0.052)
Farm size	1.01 (0.035)
Cut point 1	1.9e + 105*** (1.30E + 107)
Cut point 2	3.7e + 106*** (2.60E + 108)
Household panel variance	4.402*** (0.54)
Number of observations	1,410
Log likelihood	−1,199.935
χ^2	74.97749
p-value	3.76E-07

Note: Proportional odds (ordered logit) models with household random-effects and predicted certificate variable using certpr2 and cererror2. Single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at 10%, 5%, and 1%, respectively. Bootstrapped standard errors, corrected for clustering at household level, included in parentheses.

of random certification from the *Cererror3* variable.

Table 3 shows that the effects of certification (*Cererror3*) were positive and significant at the 10% level, in line with our hypothesis H1. The public investment in conservation (*Public investment*) variable had no significant effect on the incentives for maintenance of conservation structures. In addition, we found that maintenance was better on homestead and larger plots and poorer on shallower and more distant plots.

Effects on Investment in Trees

The restrictions on tree planting, especially eucalyptus trees, on arable land caused us to launch an alternative hypothesis (H2) for the effects of certification on tree planting. However, eucalyptus may be the most profitable crop to grow for rural households in Ethiopia (Holden et al. 2003; Jagger and Pender 2000) and local norms and attitudes toward tree planting may differ from the rules stated by the law. The results from two household random-effects panel tobit investment models, including models with eucalyptus and tree seedlings (<two years old) are presented in table 4, using actual certificate. At the bottom of the table,

Table 4. Impact of Certification on Plot-Level Investments in Trees

Variables	Eucalyptus	Tree Seedlings
Certificate	58.740**	57.308**
	(26.57)	(22.47)
Year	26.387***	0.464
	(4.23)	(4.18)
Public investment	−27.898*	−34.055***
	(15.29)	(13.03)
Homestead plot	66.740***	102.008***
	(16.85)	(14.85)
Sex of household head	49.745*	−4.841
	(27.71)	(27.53)
Age of household head	0.392	0.648
	(0.58)	(0.50)
Education of household head	21.449**	8.24
	(9.13)	(7.72)
Female labor force, log	−11.345	−2.244
	(18.43)	(15.99)
Male labor force, log	28.721*	27.188*
	(15.34)	(14.16)
Oxen per farm size, log	−22.407	−22.116
	(20.35)	(18.06)
Other livestock per tsimdi	10.107	23.465
	(18.15)	(16.30)
Farm size	3.52	3.956
	(3.00)	(2.68)
Plot size	−7.187	−5.402
	(7.89)	(6.44)
Shallow soil	−34.870*	−23.311
	(19.91)	(17.15)
Medium deep soil	15.03	5.569
	(17.93)	(15.92)
Flat slope	−52.465	2.323
	(51.83)	(50.13)
Low hill	−46.601	34.838
	(52.53)	(50.09)
Mid hill	−88.471	−2.499
	(66.85)	(64.01)

(Continued)

Table 4. Continued

Variables	Eucalyptus	Tree Seedlings
Soil type Cambisol	−0.67	12.328
	(18.69)	(16.02)
Soil type Vertisol	2.831	14.355
	(21.58)	(18.42)
Soil type Regosol	15.581	25.365
	(20.00)	(16.97)
Distance to plot	−4.107***	−2.670***
	(0.94)	(0.58)
Constant	−5.30e + 04***	−1,215.956
	(8,461.02)	(8,364.61)
Household panel variance	49.454***	41.229***
	(13.32)	(12.88)
Residual variance	99.262***	106.317***
	(8.57)	(7.83)
Number of observations	1,073	1,079
Log likelihood	−772.910	−1, 091.378
χ^2	120.996	113.731
p-value	0.000	0.000
Rho (Panel variance fraction)	0.199	0.131
Model results with certpr3 and cererror3		
Certpr3	53.032	57.769*
	(38.919)	(31.300)
Cererror3	98.451*	53.525*
	(57.289)	(32.174)

Note: Household random-effects tobit models. Single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at 10, 5%, and 1%, respectively. Bootstrapped standard errors in parentheses, based on 500 replications, resampling households.

we show the results for the *Certpr*3 and *Cererror*3 variables when they replaced the actual certificate to control for unobserved household heterogeneity.

Table 4 shows that the actual certificate variable was significant at the 5% level and had a positive sign in both models. Models with *Certpr*3 and *Cererror*3 had a positive and significant effect (at the 10% level) for *Cererror*3 in both models, while *Certpr*3 was significant and positive in the seedling model. We can therefore reject hypothesis H2. Land certification has stimulated tree planting, including planting of eucalyptus, even with the restrictions on tree planting on arable land.

There was a negative and significant correlation between public investments in conservation structures on plots and stocks of eucalyptus and tree seedlings. This may be related to the restrictions on tree planting. Homestead plots had significantly more trees, whereas the number of trees was significantly lower on distant plots, as indicated by the strongly significant and negative effect of distance to plots. This may also be the result of lower tenure security on distant plots.

Productivity Impacts of Certification

The robustness of the productivity impacts was scrutinized with a series of parametric regressions with alternative specifications. The results are summarized in table 5 for models with alternative certificate specifications, for models with and without plots prior to certification (1998 year plots), with and without time-variant household variables, and with and without the public investment in conservation variable. As can be seen, there were significant and positive effects of certification in twenty-one out of thirty-two models, and coefficients were also positive in the other models. The IV estimator (*Certpr*1) gave very unstable results, whereas our alternative conservative estimator, *Cererror*3, appeared to be much more stable across different model specifications and gave a significant and positive effect of certification in all specifications. The productivity increase is about 45% based on this estimator. The actual certificate variable and the *Cererror*2 estimator were unstable across specifications but followed each other closely. When we compare these models with the *Cererror*3 specifications, it appears that they are sensitive to unobserved household heterogeneity that affected the allocation of certificates. We consider that these results provide new insights and give credit to our conservative approach in situations where there is a shortage of good instruments.

Finally, we included the conservation investment variables in the productivity models but did not have good instruments for predicting these. Such structures are more likely to be found on steeper slopes and these are associated with lower yields. We found no significant productivity effects from these conservation investment variables, but this could be due to their correlation with plot characteristics. When nearest neighbor and kernel matching methods were used to measure the impacts of investments in stone terraces on land productivity, we found a significant (at the 5% level) and positive effect of such investments on land productivity. Thus, the investment impacts may partially explain the productivity impacts.

Table 5. Sensitivity Analysis for Land Productivity Effects of Land Certification with Household Fixed-Effects Models

Sample	Time-Variant Household Charact.	Public Investment Included	Certificate Variable			
			Actual Certificate	Certpr1	Cererror2	Cererror3
BA + WW	Yes	Yes	0.086	0.339	0.084	0.375**
WW	Yes	Yes	0.370**	1.165***	0.372**	0.370**
BA + WW	Yes	No	0.087	0.334	0.086	0.377**
WW	Yes	No	0.366**	1.163***	0.368**	0.366**
BA + WW	No	Yes	0.106	0.456*	0.092	0.398***
WW	No	Yes	0.374**	1.357***	0.388**	0.384**
BA + WW	No	No	0.107	0.459	0.093	0.399**
WW	No	No	0.371**	1.357***	0.385**	0.371**

Note: BA + WW includes before (1998) and after (2001 and 2006) data, WW includes only data from 2001 and 2006 (with and without only). Single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at 10%, 5%, and 1%, respectively, based on bootstrapped standard errors with 500 replications, resampling households.

Conclusion

Farm households' perceptions indicated that the low-cost land certification program that was implemented on a broad scale in the Tigray region in Ethiopia in the late 1990s contributed to increasing tenure security and reducing land disputes. Using a unique household farm-plot panel data set covering the year before implementation of certification and up to eight years after certification, we found that land certification has contributed to increased investment in trees, better management of soil conservation structures, and enhancement of land productivity. The productivity increase due to land certification was estimated to be about 45% based on the conservative *cererror3* estimator. Strong public investments in soil conservation may explain why no effects of certification were found for such investments. It is noticeable that our hypothesis stating that restrictions on tree planting on arable land have prevented investment in trees, especially eucalyptus, had to be rejected. One may question the current restrictions on tree planting, especially on land marginally suited for crop production, as such land is well suited for profitable tree production. This could be a better way to enhance the food security of such households that could use the income from selling of trees to buy food.

The findings lend support to this low-cost and highly participatory, coordinated approach to certification. It appears not to be antipoor like the conventional high-tech demand-based approaches that have dominated the policy efforts and that have tended to exclude the poor because of their high costs.

The investment effects of certification can only partially explain the productivity effects of certification. Holden, Deininger, and Ghebru (2007) have shown that land certification has stimulated the land rental market in Tigray, and this may explain some of the remaining productivity impact because inefficient land managers are less likely to cultivate the land themselves after receiving certificates. It is also possible that land certification has stimulated use of inputs like manure, fertilizer, and improved seeds but that requires further investigation and is left for future research.

[Received September 2007; accepted September 2008.]

References

Alemu, T. 1999. *Land Tenure and Soil Conservation: Evidence from Ethiopia.* Unpublished Ph.D. dissertation, Göteborg University, Göteborg.

Alston, L.J., G.D. Libecap, and R. Schneider. 1995. "Property Rights and the Preconditions for Markets: The Case of the Amazon Frontier." *Journal of Institutional and Theoretical Economics* 151(1):89–107.

Atwood, D.A. 1990. "Land Registration in Africa: The Impact on Agricultural Production." *World Development* 18(5):659–71.

Besley, T. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy* 103(5):903–37.

Besley, T., and R. Burgess. 2000. "Land Reform, Poverty Reduction, and Growth: Evidence from India." *Quarterly Journal of Economics* 115(2):389–430.

Brasselle, A.S., F. Gaspart, and J.P. Platteau. 2002. "Land Tenure Security and Investment Incentives: Puzzling Evidence from Burkina Faso." *Journal of Agricultural Economics* 67(2):373–418.

Carter, M.R., and K. Wiebe. 1990. "Access to Capital and Its Impact on Agrarian Structure and Productivity in Kenya." *Journal of Agricultural Economics* 72:1146–50.

Cotula, L., C. Toulmin, and C. Hesse. 2004. *Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues*. London: International Institute for Environment and Development.

Deininger, K. 2003. *Land Policies for Growth and Poverty Reduction*. Washington, DC: The World Bank.

Deininger, K., D.A. Ali, S.T. Holden, and J. Zevenbergen. 2008. "Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries." *World Development* 36(10):1786–1812.

Deininger, K., and J.S. Chamorro. 2004. "Investment and Income Effects of Land Regularization: The Case of Nicaragua." *Agricultural Economics* 30(2):101–16.

Deininger, K., and R. Castagnini. 2006. "Incidence and Impact of Land Conflict in Uganda." *Journal of Economic Behavior and Organization* 60(3):321–45.

Deininger, K., and S. Jin. 2006. "Tenure Security and Land-Related Investment: Evidence from Ethiopia." *European Economic Review* 50:1245–77.

Do, Q.T., and L. Iyer. 2002. *Land Rights and Economic Development: Evidence from Vietnam*. Cambridge, MA: Department of Economics, MIT.

Feder, G. 1988. *Land Policies and Farm Productivity in Thailand*. Baltimore, MD: Johns Hopkins University Press.

Greene, W. 2004. "Fixed Effects and Bias Due to the Incidental Parameters Problem in the Tobit Model." *Econometric Reviews* 23(2):125–47.

Haavelmo, T. 1960. *A Study in the Theory of Investment*. Chicago: University of Chicago Press.

Hagos, F., and S.T. Holden. 2003. "Incentives for Conservation in Tigray, Ethiopia: Findings from a Household Survey." Unpublished. Department of Economics and Social Sciences, Agricultural University of Norway.

——. 2006. "Tenure Security, Resource Poverty, Public Programs, and Household Plot-Level Conservation Investments in the Highlands of Northern Ethiopia." *Agricultural Economics* 34:183–96.

Hagos, F., J. Pender, and N. Gebreselassie. 2002. "Land Degradation and Strategies for Sustainable Land Management in the Ethiopian Highlands: Tigray Region." International Livestock Research Institute.

Ho, D.E., K. Imai, G. King, and E.A. Stuart. 2007. "Matching as Nonparametric Preprocessing for Reduced Model Dependence in Parametric Causal Inference." *Political Analysis* 15:199–236.

Holden, S.T., C.B. Barrett, and F. Hagos. 2006. "Food-for-Work for Poverty Reduction and the Promotion of Sustainable Land Use: Can It Work?" *Environment and Development Economics* 11:15–38.

Holden, S.T., S. Benin, B. Shiferaw, and J. Pender. 2003. "Tree Planting for Poverty Reduction in Less-Favoured Areas of the Ethiopian Highlands." *Small-Scale Forest Economics, Management and Policy* 2(1):63–80.

Holden, S.T., K. Deininger, and H. Ghebru. 2007. "Land Certification and Land Market Participation in Tigray: A Household Panel Model with Unobservable Heterogeneity and State Dependence." Paper presented at Nordic Development Economics Conference, Copenhagen, 18-19 June.

Holden, S.T., B. Shiferaw, and M. Wik. 1998. "Poverty, Market Imperfections, and Time Preferences: Of Relevance for Environmental Policy?" *Environment and Development Economics* 3:105–30.

Holden, S.T., and H. Yohannes. 2002. "Land Redistribution, Tenure Insecurity, and Intensity of Production: A Study of Farm Households in Southern Ethiopia." *Land Economics* 78(4):573–90.

Jacoby, H., and B. Minten. 2007. "Is Land Titling in Sub-Saharan Africa Cost Effective? Evidence from Madagascar." *World Bank Economic Review* 21(3):461–85.

Jagger, P., and J. Pender. 2000. "The Role of Trees for Sustainable Management of Less-Favored Lands: The Case of Eucalyptus in Ethiopia." EPTD Discussion Paper No.65, IFPRI, Washington, DC.

Jorgenson, D.W. 1967. "The Theory of Investment Behavior." In R. Ferber, ed. *Determinants of Investment Behavior*. New York: Columbia University Press, pp. 129–55.

Lanjouw, J.O., and P.I. Levy. 2002. "Untitled: A Study of Formal and Informal Property Rights in Urban Ecuador." *Economic Journal* 112:986–1019.

Lopez, R. 1997. "Land Titles and Farm Productivity in Honduras." Washington, DC: The World Bank.

Migot-Adholla, S.E. 1993. *Indigenous Land Rights Systems in Sub-Saharan Africa: A Constraint on Productivity*. New York: Oxford University Press for The World Bank.

Migot-Adholla, S.E., F. Place, and W. Oluoch-Kosura. 1994. "Security of Tenure and Land Productivity in Kenya." In J.W. Bruce and S.E. Migot-Adholla, eds. *Searching for Land Tenure Security in Africa*. Iowa: Kendall/Hunt Publication.

Pinckney, T.C., and P.K. Kimuyu. 1994. "Land Tenure Reform in East Africa: Good, Bad or Unimportant." *Journal of African Economies* 3:1–28.

Place, F., and S.E. Migot-Adholla. 1998. "The Economic Effects of Land Registration on Smallholder Farms in Kenya: Evidence from Nyeri and Kakamega Districts." *Land Economics* 74(3):360–73.

Place, F., and K. Otsuka. 2001. "Tenure, Agricultural Investment, and Productivity in the Customary Tenure Sector of Malawi." *Economic Development and Cultural Change* 50:77–99.

Rahmato, D. 1984. *Agrarian Reform in Ethiopia*. Uppsala: Scandinavian Institute of African Studies.

Sjaastad, E., and D.W. Bromley. 1997. "Indigenous Land Rights in Sub-Saharan Africa: Appropriation, Security, and Investment Demand." *World Development* 25(4):549–62.

TLR. 2007. *A Regulation to Determine the Administration and Using of Rural Land*. Tigray Regional State, Ethiopia.

TRLAUP. 2006. *Rural Land Administration and Utilization Proclamation No.97/2006*. Tigray Regional State, Ethiopia.

Wooldridge, J.M. 2005. "Simple Solutions to the Initial Conditions Problem in Dynamic, Nonlinear Panel Data Models with Unobserved Heterogeneity." *Journal of Applied Econometrics* 20:39–54.

Appendix: Instrumentation Models for Land Certificate

Lack of certificates may be due to random administrative errors but may also be endogenous and correlated with observable and unobservable household and plot characteristics. In order to test for the importance of this and to test the robustness of the key results, two instrumentation approaches were chosen for the potentially endogenous certificate dummy variable:

1) Standard IV approach: Village dummy and years since certification variables are used as instruments. It is assumed that these variables capture random administrative errors causing some households not to have certificates (Model COP1 below). Certpr1 is the predicted certificate variable based on these instruments. As can be seen, these instruments may be weak in prediction.
2) Weak instrumentation approach: Estimate determinants of having land certificate using observable household and plot characteristics. The residual, Cererror2 = Certificate – Certpr2, from this model (COP2) is used as a (weak) predictor of households having randomly been allocated certificates.
3) Strong instrumentation approach: Estimate determinants of having land certificate with a linear probability model using household fixed effects and observable plot characteristics to predict certificate. The residual, Cererror3 = Certificate – Certpr3, from this model (COP3) is seen as a strong predictor of households having randomly been allocated certificates. This approach controls for time-invariant observable and unobservable household and plot characteristics.

The results from these three models are presented in table A.1.

Tables A.1 and A.2 show that the Certpr1 predicted variable created with the standard IV approach based on the exogenous village dummies and years since certification variables, and the Certpr2 predicted variable using observable household and plot characteristics, have means and standard deviations with much poorer fit than the model using household fixed effects and observable plot characteristics. If the cut-off point for correct prediction is set at 0.5, Certpr1 predicts only 7.1% of the plots without certificates correctly and Certpr2 only 1.2%, while the household fixed-effects model predicts 88.1% of these plots correctly, see table A.2 below. There appears therefore to be substantial randomness in relation to plots not having certificates and the exogenous instruments used to identify households without certificates do very poorly. The same is the case for observable household and plot characteristics (Certpr2). Only the linear probability model with household fixed effects and plot characteristics has a reasonable ability to predict households without certificates with 88.1% correct predictions. Based on these findings, we think it is reasonable to assume that lack of certificate is either random and use of actual certificate may be the best estimation strategy, or it is determined by unobservable household characteristics. If the first is true, this opens for use of nonparametric matching estimators as one of the approaches that is worth testing. If the second is true, Certpr3 may be used to control for unobserved household heterogeneity and use of Cererror3 may be the best strategy to assess the impact of random certification.

Table A.1. Determinants of Households Having Land Certificate

Variables	COP1	COP2	COP3
Years since certification	−0.100***		−0.011***
	(0.02)		(0.00)
Homestead plot	1.078***	1.058***	0.088***
	(0.18)	(0.18)	(0.02)
Plot size	−0.002	−0.039	0
	(0.06)	(0.06)	(0.01)
Shallow soil	−0.034	−0.043	−0.003
	(0.14)	(0.15)	(0.02)
Medium deep soil	−0.082	−0.119	−0.015
	(0.15)	(0.16)	(0.02)
Flat slope	0.101	0.05	0.007
	(0.28)	(0.29)	(0.04)
Low hill	−0.078	−0.071	−0.016
	(0.30)	(0.31)	(0.04)
Mid hill	0.014	−0.109	−0.019
	(0.34)	(0.35)	(0.05)
Soiltype Cambisol	0.182	0.217	0.021
	(0.17)	(0.17)	(0.02)
Soiltype Vertisol	0.021	0.031	0.005
	(0.16)	(0.16)	(0.02)
Soiltype Regosol	−0.204	−0.257	−0.028
	(0.17)	(0.17)	(0.02)
Distance to plot	−0.001	−0.002	0
	(0.00)	(0.00)	0.00
Public investment		−0.022	
		(0.14)	
Sex of household head		−0.135	
		(0.26)	
Age of household head		−0.002	
		(0.01)	
Education of household head		0.106	
		(0.12)	
Female labor force, log		0.136	
		(0.11)	
Male labor force, log		−0.053	
		(0.09)	
Oxen per farm size, log		−0.097	
		(0.12)	
Other livestock per farm size		−0.147***	
		(0.05)	
Farm size		0.071**	
		(0.03)	
Village fixed effects	Yes	No	No
Household fixed effects	No	No	Yes
Constant	2.320**	2.003***	1.040***
	(1.07)	(0.65)	(0.16)
Household panel variance	1.575***	1.723***	
	(0.20)	(0.20)	
Number of observations	1,985	1,967	1,985
Log likelihood	−625.2304	−633.5256	
χ^2	9.09E + 01	7.61E + 01	3,201.326
p-value	7.69E-09	3.61E-08	0
Rho (Panel variance fraction)	0.8285212	0.8484596	0

Note: Single asterisk (*), double asterisks (**), and triple asterisks (***) denote significance at 10%, 5%, and 1%, respectively.

Table A.2. Basic Statistics for Alternative Predictors for Certificate

Variable	Obs.	Mean	Std. Dev.	Correct Predictions: Have Certificate	Correct Predictions: Do Not Have Certificate
Certificate	2,024	0.790	0.407		
Certpr1	1,985	0.920	0.134	97.1	7.1
Certpr2	1,967	0.950	0.079	99.7	1.2
Certpr3	1,985	0.789	0.331	98.8	88.1

Paper 5

EFFICIENCY AND PRODUCTIVITY DIFFERENTIAL EFFECTS OF LAND CERTIFICATION

Hosaena H. Ghebru

Department of Economics and Resource Management (IØR),

Norwegian University of Life Sciences (UMB), P.O.Box 5003, N_1432, Ås, Norway, and

Department of Economics, Mekelle University, P.O.box 451, Mekelle, Ethiopia

Email: hosaenag@yahoo.com

Abstract

While theory predicts that better property rights to land can increase land productivity through tenure security effects (investment effects) and efficient input use due to enhanced tradability of land (factor intensity effect), empirical studies on the size and magnitude of these effects are very scarce. This paper analyses the productivity impacts of the Ethiopian land certification program by identifying how the investment effects (technological gains) would measure up against the benefits from any improvements in input use intensity (technical efficiency). For this purpose, we adopted a DEA-based Malmquist-type productivity index to decompose productivity differences into: (1) within-group farm efficiency differences - technical efficiency effect; and (2) differences in group production frontier, reflecting the longterm investment (technological) effects. The result shows that farms without land-use certificate are, on aggregate, less productive than those with formalized use rights. We found no evidence to suggest such productivity difference is due to inferior technical efficiency. Rather, the reason is down to 'technological advantages' or favorable investment effect farm plots with land use certificate enjoy when evaluated against those farms not included in the certificates. The low level of within-group efficiency of farms in each group also reinforces the argument that certification programs need to be accompanied by complementary measures such as an improved financial and legal institutional framework in order to achieve the promised effects.

Key words: Land certification, Data envelopment analysis, Malmquist Index, Productivity, Ethiopia.

1. Introduction

Poor agricultural productivity and food insecurity are persistent features of many less developed countries. Governments and international agencies have therefore rightly considered agricultural intensification the primary means for inducing technological change in developing countries that have high population pressure and low agricultural productivity. Integral to this growing global interest in public policy research and development agenda is the issues of land tenure security (Holden et al. 2008). Because of the conventional view that traditional or "customary" land rights impedes agricultural development (Johnson 1972; Gavian and Fafchamps 1996), many developing countries and major multilateral organizations have considered formalization of land rights (in the form of registration and certification of land) as top priority in their economic development agenda (Atwood 1990; IFAD 2001; Bonfiglioli 2003; Deininger 2003; Holden et al. in press).

In theory, there are three routes through which secure property rights may influence agricultural productivity. The first channel through which formalized property rights enhance productivity is by encouraging *long term land investment* and *adoption of new technologies* (Barrows and Roth 1990; Besley 1995; Sjaastad and Bromley 1997; Deininger and Jin 2006). According to this hypothesis, afraid of not recouping the investment made, the user hesitates to spend resources on land-improving technologies (conservation, manure, fertilizer, etc). As a result, the demand for investment declines and productivity suffers. Secondly, secure property right is also thought to influence agricultural productivity because it encourages efficient resource use *(factor intensity).* This is so since the establishment of clear ownership of land lowers the cost and risk of transferring land, which improves factor intensity such that land will be reallocated to more efficient producers. It has also been claimed that secure property rights can stimulate efficient resource use as it may reduce land related disputes

(Deininger and Castagnini 2006; Holden et al. 2008) and may contribute to better access to credit if land can be used as collateral.

While a growing body of literature explores the impact of tenure reforms on investment, access to credit and tradability of land in Africa (Feder et al. 1988; Pinckney and Kimuyu 1994; Besley and Coast 1995; Deininger and Feder 1998; Li et al. 1998; Place and Migot-Adholla 1998; Smith 2004; Jacoby and Minten 2007; Do and Iyer 2008; Holden et al. 2009; Holden et al. in press), studies on empirical assessment of the direct effects of such intervention on land productivity are very scarce. One exception is Holden et al (2009) who assessed the overall land productivity impacts of low-cost land registration and certification program in Ethiopia. This study did not distinguish between the routes through which secure property rights (land certification) can influence an agricultural productivity: the *technological effect* and *factor intensity effect*.

Taking advantage of a detailed plot-specific household survey from the northern highlands of Ethiopia, this paper introduces some innovative elements in analyzing the productivity effects of the land certification program in Ethiopia[1]. Rather than simple comparisons of relative productivity differentials between certified farms and farms without certificate, this study decompose such group differences in productivity into: (1) differences in within-group efficiency spread or individual performances within each group (catching-up effect - factor intensity effect), and (2) differences in technology (distance between group frontiers – technology effect). We accomplish this task of analyzing group productivity difference by constructing a non-parametric DEA-based Malmquist productivity index.

[1] The recent land certification in Ethiopia is arguably the largest land administration program carried out over the last decade in Africa, and possibly the world (Deininger et al. 2008b). The certification program in the country departs from traditional titling interventions in developing countries as it issues non-alienable use right certificates rather than full titles. See previous study by Holden et al. (2009) for detailed discussion of the land certification program in the Tigray region of Ethiopia (the study area) which was the first region to start the certification program in 1998.

Therefore, comparing the performance of group of farms with formalized land use right (certificate) against those without certificate, the objectives of the study are twofold. First, we wish to examine whether or not there are any productivity enhancing benefits from land certification. This analysis servers as a vehicle for understanding the overall productivity differential effects of the land certification program. Second, we aim to isolate and examine the pathways through which land certification influences agricultural productivity. This analysis is the core of the paper and provides insights into how the investment effects (technological gains) of land certification would measure up against the benefits from any improvements in input use intensity (technical efficiency). To the best of our knowledge, we are not aware of any other study on the productivity impacts of land reforms that analyze and decompose efficiency and productivity effects.

Based on the results from the DEA-based Malmquist productivity index, we found that farms without land-use certificate are, on aggregate, less productive than those with formalized use rights. Using the decomposed analysis, we found no evidence to suggest such productivity difference between the two groups of farms is due to differences in technical efficiency. Rather, the reason is down to 'technological advantages' or favorable investment effect that farm plots with land use certificate benefit when evaluated against those farms not included in the certificates. The low level of within-group efficiency of farms in each group also reinforces the argument that certification programs need to be accompanied by complementary measures such as an improved financial and legal institutional framework in order to achieve the promised effects.

This paper is organized as follows. Section 2 reviews the conceptual framework for the economic benefits of land reforms. The analytical approach adapted in this study to measure productivity and

productivity differences is discussed in section three. Section 4 describes the data sources and summary statistics while the last two sections are devoted for the discussion of results and concluding remarks.

2. Literature Review: Property Rights and Agricultural Productivity

Property rights theory does not emphasize who "owns" land, but rather analyzes the formal and informal provisions that determine who has a right to enjoy *benefit streams* that emerge from the use of assets and who has no such rights (Libecap 1989; Eggertsson 1990; Bromley 1991). These rights need to be sanctioned by a collective in order to constitute effective claims. Property rights with respect to land can cover one or more of the following: 'access, appropriation of resources and products, provision of management, exclusion of others, and alienation by selling or leasing', with only ownership as 'the accumulation of all of these' (Janvry et al. 2001; Ostrom 2001). In various combinations or 'bundles', these rights are of significance for agricultural development as they encourage different positive behaviors towards land (investment) and other people (dispute resolution). The recent literature on property rights over land and other natural resources commonly uses a broad classification: namely, open access (no rights defined), public (held by the state); common (held by a community or group of users); and private (held by individuals or "legal individuals" such as companies) property regimes.

Reflecting neoliberal thinking on private property rights and development, Besley (1995) identifies three channels through which farmers' acquisition of clearly defined property rights to land can, in principle, induce agricultural productivity, namely: (i) Technological Change: Long-term investment in land (ii) smooth functioning of the land (rental) markets that lubricate factor-ratio adjustment, and (iii) facilitating access to (informal) credit or informal collateral arrangement.

Tenure security: Investment Effect

Farm households' investment in practices that enhance the long-term viability of agricultural production hinges significantly on the expectations regarding the length of time over which the investor (farmers) might enjoy the benefits which mostly are long-term. These expectations depend on the sense of tenure insecurity (whether through ownership of disputes, eviction or expropriation by the government). With titling (ownership officially documented and verified via land certificates), the land holder's sense of tenure security will be enhanced and, therefore, boost incentives to invest in such practices that enhance long-term sustainability of agricultural production (such as land improvements, conservation practices and adoption of new technology) which ultimately may increase farm productivity (Gavian and Fafchamps 1996; Hayes et al. 1997; Gebremedhin and Swinton 2003; Deininger and Jin 2006; Deininger et al. 2008; Holden et al. 2009).

Tenure security: Market Efficiency Effect

In addition to its investment enhancing effects, formalization of land rights is also thought to influence agricultural productivity through the transaction (tradability) effect by facilitating the smooth functioning of land transactions (land rental markets in the Ethiopian context). This is so as imperfections in such markets (transaction costs and ownership uncertainties) may be more severe when agents of the market lack formal land use rights. From the supply side perspective, for instance, without clear and definite claims to the land, farmers (potential landlords) can be reluctant to transfer ownership (rent/leas out land) to others for the mere fact of fearing to lose the land through administrative redistribution (Deininger et al. 2008; Ghebru and Holden 2008). In such circumstances, it is possible that the land holder may operate the land by him/herself instead of transferring it even if the productivity of the land is far better under different operator (potential tenant) with better skill and complementary farm inputs. Better property rights to land could, therefore, come to the rescue to

reduce the cost and risk of land transactions which may ultimately improve factor mobility resource allocation, and, thus, farm productivity.

Access to credit: Interlinked Collateral (indirect tenure insecurity)

Finally, advocates of land titling (neoliberals) prioritized well-defined rights to land ownership because of the claim that land title can stimulate investment by means of collateral (credit supply) effect. According to this hypothesis, by turning land into a transferable commodity, farmers can use it as collateral to access the credit needed for productivity-enhancing investments. We may ignore this channel in the Ethiopian context as collateral use and sales of land is legally prohibited where farmers are only granted with usufructuary land rights[2]. Despite this fact that land is not mortgageable and can not formally be used as collateral, there are informal practices in the study area that make use of agricultural land as informal mortgages[3]. Under such arrangements which involve the informal land tenancy market, full use of an agricultural land for the credit period is transferred from the borrower (landlord) in exchange for an interest-free cash loan. Assuming that land registration and certification reduce boundary and ownership disputes, the use of parcels without certificates as informal mortgages can be minimal. In such a case, for farmers who have no registered and documented land rights, getting access to informal credit may not only be an expensive second-best alternative but can also be missing entirely due to the lack of guarantee informal money lenders look for. Formalizing land rights (land registration and certification)[4], may reduce such constraints (liquidity constraints) and enable farmers to improve variable input use which may increase farm level efficiency.

[2] See previous studies by Holden et al (2009), Ghebru and Holden (2009) for detailed discussion of the evolution of the land tenure system in Ethiopia and the recent land certification program in the Tigray region.

[3] At the time of the fieldwork, we noted few cases where landlords rented their field to tenants whom they had borrowed money from.

[4] Ethiopian farmers are, by law, are not land owners but are holders of land use rights. Thus, the recent land policy reform in the form of formalizing land rights does not provide full titling to the holder but only register and provide land use certificates.. In this paper, we use the two terms of land titling and certification interchangeably.

On this backdrop, the formalization of land rights and the resultant tenure security can be hypothesized to have an overall land productivity effect through two major channels, namely:

1. the "technological effects" because of land related investment and technology adoption that has a lasting effect - causing a shift in a production frontier, and
2. the "factor intensity effect" because of:
    a. A relative ease in farm factor-ratio adjustment (enabling farms to operate at an optimal scale) facilitated through a reduction in ownership uncertainty and smooth land transactions, and/or
    b. An improvement in variable input use intensity by reducing the transaction cost of accessing the informal credit market and, thereby, reducing the liquidity constraint.

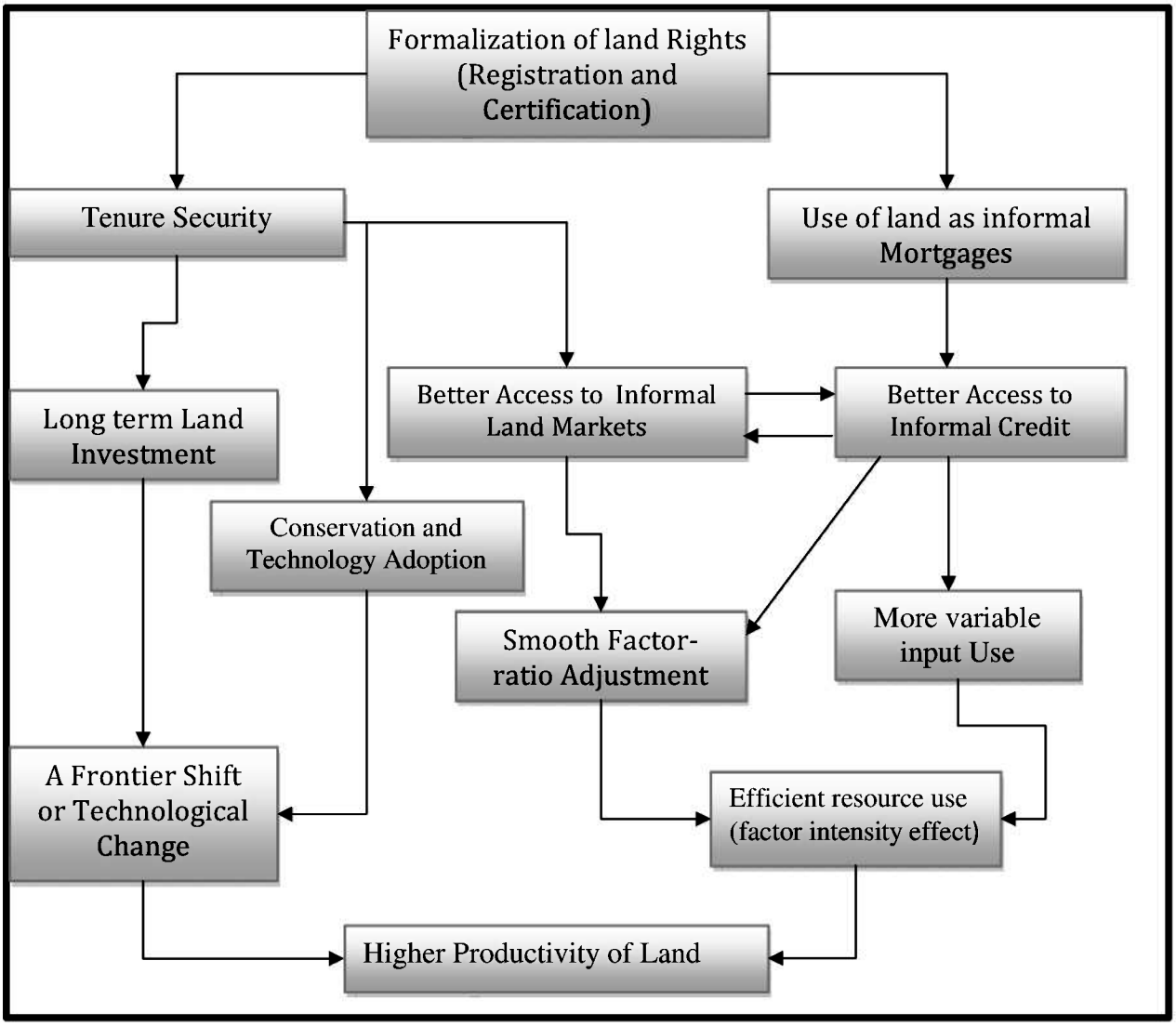


Fig. 1: The Impact of Land Certification on Productivity

While a growing body of literature explores the impact of tenure reforms on investment, access to credit and tradability of land in Africa (Feder et al. 1988; Besley and Coast 1995; Deininger and Feder 1998; Li et al. 1998; Smith 2004; Jacoby and Minten 2007; Do and Iyer 2008; Holden et al. 2009), studies on empirical assessment of the direct effects of such intervention on land productivity are very scarce. One exception is Holden et al (2009) who assessed the overall land productivity impacts of low-cost land registration and certification program in Ethiopia. This study did not distinguish between

the routes through which secure property rights (land certification) can influence an agricultural productivity: the *technological effect* and *factor intensity effect*.

Based on this brief review of theory and relevant literature, the objectives of the study are twofold. First, we wish to examine whether or not there are any productivity enhancing benefits from land certification. This analysis servers as a vehicle for understanding the overall productivity differential effects of the land certification program. Second, we aim to isolate and examine the pathways through which land certification influences agricultural productivity. This analysis is the core of the core of the paper and provides insights into how the 'technological gains' (investment effects) of land certification would measure up against the benefits from improvement in technical efficiency (factor intensity). To the best of our knowledge, we are not aware of any other study on the productivity impacts of land reforms that has attempted to show these decomposed effects.

3. Method of Analysis

There are two main competing methods for estimating the relative efficiency of farms: parametric (stochastic frontier analysis –SFA) and non-parametric (Data Envelopment Analysis – DEA)[5]. The parametric approach assumes a functional relationship between output and inputs and uses statistical techniques to estimate the parameters of the function. While this approach provides a convenient framework for conducting hypothesis testing, the results can be sensitive to the behavioral assumption and the functional forms chosen. The non-parametric approach (DEA), in contrast, has the advantage of imposing no a priori parametric restrictions on the underlying technology. It constructs a linear piecewise function from empirical observations on inputs and outputs without assuming any functional relationship between them.

[5] See Coelli (1995) for comprehensive reviews of the two approaches.

However, DEA is also not without criticism as it is a deterministic approach which gives no account of stochastic elements. A disadvantage which is common in this method is thus its sensitivity to outliers and data measurement errors. As this approach assumes any deviation from a frontier as a possible inefficiency, the efficiency score estimates can biased (downward) if the production process is largely characterized by stochastic elements. Since this paper is only interested in analyzing the overall productivity difference between two groups of farms but not in explaining the efficiency score estimates per se, we used the non-parametric DEA technique developed by Charnes *et al.* (1978) as we expect the efficiency ranking of farms would be similar under both alternative approaches[6].

Exogenous factors like government policy interventions or implementation of new development programs may provide rural farm household units with the various types and degrees of opportunities and challenges which ultimately affect their productivity. Productivity is defined here as the ability of a farm to either produce the maximum possible output from a given bundle of inputs and a given technology, or to produce the given level of output from the minimum amount of inputs for a given technology. This change in productivity due to policy interventions can be of a short-term nature (affecting factor intensity) or can be of a change with long-term horizon (technological adoption). Thus, productivity differences or changes can be attributed or decomposed into two components: pure technical efficiency and differences in technology.

Most empirical studies, thus far, analyses farm productivity differentials entirely based on a method by pooling decision making units to form a common benchmark frontier according to which performances are evaluated. Such aggregate measure of performance (efficiency) gives no notice of the

[6] Comprehensive studies conducted on the sensitivity of efficiency measures to the choice of DEA and parametric approaches reveal that, despite efficiency score estimates from each approach differ quantitatively, the ordinal efficiency ranking of farms obtained from the two approaches appear to be quite similar (Sharma *et al* 1999; Wadud and White 2000).

aforementioned sources of productivity differences (changes). In an attempt to void this gap and characterize potential productivity differentials in terms of pure technical efficiency difference and technological differences, the present study uses a two-step non-parametric approach. In the first step, Data Envelopment Analysis (DEA) is used to estimate efficiencies as an explicit function of discretionary (observed) input-output variables[7]. To evaluate productivity differences of farms that belong to two distinct groups (policy intervention in the form of land certification), in the second step, we adopt a DEA-based Malmquist productivity index where group-specific frontiers are defined to compare relative performances. The estimation methods used in this study are explained below.

Data Envelopment Analysis (DEA)

DEA is a linear programming technique for constructing a non-parametric piecewise linear envelope to a set of observed output and input data (Charnes et al. 1978; Fare et al. 1994). Assuming $X^i = (X_1^i, X_2^i, ..., X_M^i) \in \Re_M^+$ denotes the input vector to produce Y^i where i corresponds to a group a farm plot belongs to[8], the feasible production frontier that describes the technology of the farming units can be defined in terms of correspondence between the output vector Y^i and the input requirement set $L^i(Y^i)$ where:

(1) $L^i(Y^i) = \{X^i : (X^i, Y^i) \in T^i(X^i)\}$

[7] Resent application of DEA method on the estimation and explanation of agricultural efficiency in developing countries include Shafik and Rehman (2000) on Pakistan cotton farms, Dhungana et al. (2004) on Nepal rice farms, and Chavas et al. (2005) on Gambia farms.

[8] As the emphasis of the study is to explain the potential productivity differentials with respect to the land use certificate, from this on ward, we adopt two groups: *Group 1*: farms with no land use certificate, and *Group 2*: those which are with formalized use rights (certificates).

The production possibility set (input requirement set) $L^i(Y^i)$ provides all the feasible input vectors that can produce the output vector Y^i where $T^i(X^i)$ is the technology set of a group or government program *i* showing X^i can produce Y^i.

Assuming constant returns to scale, Farrell (1957) proposed a radial measure of technical efficiency in which the efficiency is measured by radial reduction of the levels of inputs relative to the frontier technology holding output level constant[9]. Stated otherwise, Farrell's input-oriented measure of technical efficiency estimates the minimum possible expansion of X^i which is given by:

$$(2) \qquad F^i(X^i, Y^i) = \min\{\varepsilon : \varepsilon X^i \in L^i(Y^i)\}$$

As formalized by Fare and Lovell (1978), Farrell's input-saving efficiency measures are the same as the inverse of Shephard's input distance function which provides the theoretical basis for the 'adopted' Malmquist productivity index.[10] Therefore, within the context of input distance function, equation 2 can be rewritten as[11]:

$$(3) \qquad D^i(X^j, Y^j) = \max_{\mu_{ij}}\{\mu_{ij} : (X^j / \mu_{ij}) \in L^i(Y^i)\} \qquad i, j = 1, 2$$

where $D^i(x^j, y^j)$ represents the input distance function for a farm in program or group *j* with respect to the frontier technology of group *i*, the scalar μ_{ij} is the maximum reduction (contraction) of the input

[9] The input-oriented model implicitly assumes cost-minimizing behavior and the output-oriented DEA, on the other hand assumes revenue maximizing behavior of farmers. In our case, it is thus reasonable to assume that farmers have a budget constraint and thus minimize costs.

[10] $F^i(X^j, Y^j) = \text{Min } \varepsilon = [D^i(Y^j, Y^j)]^{-1} \qquad i, j = 1, 2$

[11] The expression $D^i(X^j, Y^j)$ is the maximum value by which the input vector can be divided and still produce a given level of output vector y.

vector of a farm plot belonging group or program j (X^j) , the resulting deflated input vector (X^j / μ_{ij}) and the output vector (Y^i) are on the frontier of the farming system under group or program i.

The Malmquist Index

The Malmquist index was introduced by Caves et al. (1982) and developed further by Fare et al. (1994). The index is normally applied to the measurement of productivity change over time, and can be multiplicatively decomposed into an efficiency change index and a technical change index. Similarly, the 'adopted' Malmquist index (performance index for program evaluation) applied in this paper can be multiplicatively decomposed into an index reflecting the efficiency spread among farms operating within each group (internal efficiency effect), and an index reflecting the productivity gap between the best-practice frontiers of two different programs or groups (technology effect). A resent application of DEA-based Malmquist index on cross-sectional micro-data is a study by Jaenicke (2000) who analyzed the productivity differential effects of crop rotation farming system.

Taking the best practice farms under group 'i' as reference or base technology with C_n number of farms in group one (*without certificate* group) and C_w number of farms in group two (*with certificate* group), the input oriented Malmquist productivity index developed by fare et al. (1994) can be defined as:

$$(4) \qquad M_i\left(Y_j^1, Y_j^2, X_j^1, X_j^2\right) = \frac{\left(\prod_{j=1}^{C_n} D^i\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}}{\left(\prod_{j=1}^{C_w} D^i\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}} = \frac{1/\varepsilon_{i1}}{1/\varepsilon_{i2}} = \frac{\varepsilon_{i2}}{\varepsilon_{i1}}, \qquad \text{where } i = 1,2$$

The above ratio evaluates the distance of the farms in each group to a single reference technology *i*. The numerator evaluates the average (geometric mean) distance of farms in 'group one' from frontier *i* while the denominator evaluates the average distance of those farms in 'group two' with respect to frontier *i*[12]. Since there is no practical reason to prefer either frontier as a reference technology, the forthcoming analysis is made based on the geometric mean of the two indices generated using each group's frontier as reference. As a result, Equation (4) can be rewritten as:

$$(5) \qquad M_{12}\left(Y_j^1, Y_j^2, X_j^1, X_j^2\right) = \left[\frac{\left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}}{\left(\prod_{j=1}^{C_w} D^1\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}} \cdot \frac{\left(\prod_{j=1}^{C_n} D^2\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}}{\left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}} \right]^{\frac{1}{2}} = \left[\frac{\varepsilon_{12}}{\varepsilon_{11}} \frac{\varepsilon_{22}}{\varepsilon_{21}} \right]^{1/2}$$

Thus, the two ratios inside the square brackets evaluate the distance of each farms to a single reference frontier. The first ratio evaluates the average distance of farms in group one divided by the average distance of farms in group two using a technology defined by the best practice farms from group one. The second ratio is similar quotient taking group two's frontier as reference. Also, when comparing the two groups To avoid the limitations associated with defining an "ideal or representative" farms to represent each group, the aggregation of the distances or efficiency scores is conducted using the geometric mean which utilizes information from all farm plots.

A Malmquist index (M_{12}) greater than one indicates a higher productivity of farms cultivated under the second property right group (plots with land use certificate) than plots land certificate. This is so since the maximum reduction of an input vector of a farm that belongs to group-one necessary to reach the frontier (technology) under group *i* is always higher than that of a corresponding farm belonging to the

[12] Let Group one be group of farms without certificate and Group two be farms with land certificate

2nd group. The vise versa also holds true if M_{12} is less than one implying farms under the first group or program are superior than those which belong to the second group.

With particular relevance to the theme of this study, the use of the Malmquist productivity index provides an opportunity to further decompose the overall productivity differences between groups (M_{12}) into the following two sub-components:

$$(6)\qquad M_{12}\left(Y_j^1, Y_j^2, X_j^1, X_j^2\right) = \frac{\left[\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right]^{\frac{1}{C_n}}}{\left[\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right]^{\frac{1}{C_w}}} \cdot \left[\frac{\left(\prod_{j=1}^{C_n} D^2\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}}{\left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}} \cdot \frac{\left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}}{\left(\prod_{j=1}^{C_w} D^1\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}}\right]^{\frac{1}{2}}$$

$$= \underbrace{\frac{\varepsilon_{22}}{\varepsilon_{11}}}_{\text{Catching-up Effect}} * \underbrace{\left[\frac{\varepsilon_{11}}{\varepsilon_{21}} \cdot \frac{\varepsilon_{12}}{\varepsilon_{22}}\right]^{\frac{1}{2}}}_{\text{Frontier-shifter (Technology Gap)}}$$

The catching-up effect ***(M_{12}^e)***

The first sub-component of the Malmquist productivity index compares the difference in internal technical efficiency or within-group efficiency spreads. Its value is given by the ratio of the geometric means of the distance of farms in each group to their group specific frontier or technology, given by:

$$(7)\qquad M_{12}^e = \frac{\left[\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right]^{\frac{1}{C_n}}}{\left[\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right]^{\frac{1}{C_w}}} = \frac{\varepsilon_{22}}{\varepsilon_{11}}$$

A value of M_{12}^e greater than one indicates that the efficiency spread is bigger (that is there is lower efficiency levels) among farms in group-one than it is in group-two. This, in a sense, means, on

aggregate terms, farms in group-two seem to catch-up well with the performance of their own best practice farms as compared to those farms in group-one.

Productivity gap between best practice frontiers (frontier-shifter effect - M_{12}^{f})

The second sub-component of the Malmquist index which measures the distance between the best-practice frontiers of groups one and two is given by:

$$(8) \qquad M_{12}^{f} = \left[\frac{\left(\prod_{j=1}^{C_n} D^2\left(Y_j^1, X_j^1\right) \right)^{\frac{1}{C_n}}}{\left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right) \right)^{\frac{1}{C_n}}} \cdot \frac{\left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right) \right)^{\frac{1}{C_w}}}{\left(\prod_{j=1}^{C_w} D^1\left(Y_j^2, X_j^2\right) \right)^{\frac{1}{C_w}}} \right]^{\frac{1}{2}} = \left[\frac{\varepsilon_{11}}{\varepsilon_{21}} \frac{\varepsilon_{12}}{\varepsilon_{22}} \right]^{1/2}$$

Similarly, a value of M_{12}^{f} greater than one indicates greater productivity (dominance) of the frontier of group-two compared to group-one. In a case of no internal technical efficiency difference between the two groups (i.e., if the first sub-component of the index - M_{12}^{e} - is equal to one), any productivity difference represented by the Malmquist index (M_{12}) can only be explained by technological gap between the two groups - the distance between the two respective frontiers (i.e., . M_{12}^{f}).

Under this approach, Malmquist productivity index comparisons are predicated on the assumption that the production process on farm plots with land use certificate uses an entirely different technology than those plots without land certificate. Based on this, we can distinguish and compare four different performance measures of farms : Namely, Group A - performance evaluation of farms *without certificate* using a technology (frontier) defined by farms *without certificate*; Group B performance evaluation of farms *with certificate* using a technology defined by farms *without certificate*; Group C performance evaluation of farms *with certificate* using a technology defined by farms *with certificate*;

and Group D performance evaluation of farms *without certificate* using a technology defined by farms *without certificate.*

As a result, each index given by Equations (5) – (8) is a function of four separate input distance function: two standard (within group) distance function values and two inter-group distance function values. We follow Fare et al. (1994) technique to estimate the relative measures of efficiency (efficiency scores) by solving separate linear programming problem for each farm under the four categories. Considering a group frontier/technology *i* as reference or benchmark frontier, a linear programming problem for a farm belonging to group *j* can be stated as:

(9) $$[D^i(x^j, y^j)]^{-1} = \min \varepsilon_{ij}$$

s.t

(a) $y_j z_{ij} - y_j \geq 0$, (b) $x_j \varepsilon_{ij} - x_i \geq 0$, (c) $z_{ij} \geq 0$, and (d) $\sum_j z_{ij} = 1$

Where y_j is a vector of output in the benchmark sample, x_j is the *m x n* matrix of inputs the j^{th} farm in the benchmark sample, and ε_{ij} the *n x 1* vector of intensity weights indicating the input levels that the farm should aim at to achieve efficiency (Fare et al., 1994). Note that when the performance j^{th} farm is compared to a frontier generated from a sample excluding farm *j*, assuming constant returns to scale is sufficient to ensure the existence of a solution to the LP problem reducing the importance of constraint (d). The introduction of this additional restriction on the sum of weights, thus, allows us to generalize the problem to the case of variable returns to scale (VRS).

Stochastic Dominance Analysis

The main analytical problem which is common in this kind of non-parametric (DEA) productivity analysis is the difficulties with testing the statistical significance of such indexes which only results

from the ratio of the (arithmetic/geometric) means of group efficiencies (see discussions above). In order to obtain some insights, however, relating to the statistical significance of the DEA-based Malmquist indexes, we invoke the concept of first order stochastic dominance which allows us to compare and rank the distribution of measures of farm performance. Let X and Y denote the cumulative distributions functions of productivity for two groups of farms (say, the control group of *without land certificate* and the treatment group of *with certificate*, respectively). The first order stochastic dominance of productivity of farms *with certificate*, $Y(\varepsilon)$, relative to the productivity of farms *without certificate,* $X(\varepsilon)$, is given by:

$X(\varepsilon)-Y(\varepsilon)\leq 0\ \forall\ \varepsilon\in\Re,$ with strict equlity for some ε.

For empirical strategy of testing whether group productivities are statistically different, we follow banker (1996) and adopt a non-parametric two-sided Kolmogorov-Smirnov (KS) test[13]. Based on the empirical distributions of $X(\varepsilon)$ and $Y(\varepsilon)$,, the hypothesis that X is to the left of Y can be tested by the two-sided KS statistic tests with the null and alternative hypothesis expressed as:

$H_0: X(\varepsilon)-Y(\varepsilon)=0\ \forall\ \varepsilon\in\Re,\quad \text{Vs}\quad H_1: X(\varepsilon)-Y(\varepsilon)\neq 0\ for\ \text{some}\ \varepsilon\in\Re.$

Hence in order to conclude that A is stochastically dominated by B, we need to reject the null hypothesis. The Kolmogorov-Smirnov (KS) test uses the maximum vertical difference (deviation) between the two curves of the two groups as the statistic D given by:

$$D=\sqrt{\frac{mn}{N}}\max_{1\leq i\leq N}\{X_m(\varepsilon_i)-Y_n(\varepsilon_i)\}$$

where m and n are the sample sizes from the empirical observations of farms *without certificate* (X) and farms *with certificate*(Y), respectively and N=m+n. Note that unlike the t-statistic, the value of the D statistic (and hence the P value) is not affected by scale changes like using log. The KS-test is thus a

[13] For details on the K-S test, see Conover (1999).

robust test that only cares about the relative distribution of efficiency measure of sampled farms. The KS significance test results are presented in Table 10.

4. Data and Descriptive Summary

Data

The present study used a survey data specifically designed to investigate the productivity impacts of land use certificate. Before a sampling technique was applied, a thorough empirical investigation of the process of land registration and certification in the study area was conducted to identify whether administrative failure or household specific reason is the reason why for households did not have land certificates[14]. This caution was exercised because if the second factor prevails and households fail to collect land certificates for household-specific reasons, this may cause correlations between the certificate variable and the outcome variable – on-farm productivity (yield per hectare).

Taking this into account, a multi-stage stratified random sampling technique was used to identify representative farms. First, four villages were selected from a district in the Tigray region of Ethiopia due to the high percentage of households that had not received certificates due to administrative failure[15]. Second, extreme care was exercised to stratify households by identifying those who did not have certificates due to administrative failures and those who have received certificates in the same neighbourhoods[16]. Finally, a random sample of 320 farm household units (80 from each of the four villages) was taken among which 24 sampled households were dropped due to problems in the data

[14] See Holden et al (in press) for detailed characterization of factors affecting the certification process in the study area and the potential concern for endogeneity bias.

[15] Tigray region was the first region in Ethiopia to start the low-cost land certification and more than 80% of the farm households in the region has land use certificates for the parcels they operate (Holden et al 2009).

[16] Insufficient certificates and lack of personnel for incomplete registration and certification were found to be the two major administrative failures.

collection process[17]. From the total of 296 sampled households who operate 1356 plots, 161 (54.4%) were households who receive land use certificates while the remaining 135 (45.6%) were households without certificates.

As land quality may not necessarily be the same for plots with and without certificate, we a applied a two-step approach to deal with this problem: 1) using non-parametric propensity score matching on observable plot characteristics to identify comparable plots that satisfies common support and balancing properties (See Appendix 1); and 2) using the input-oriented DEA approach on the sample of plots that satisfied the common support and balancing requirement (Ho et al. 2007). The matched data of plots that were used in the productivity analysis included the plots planted with cereal crops with and without certificates that satisfied the common support requirement but excluding irrigated and rented in plots. This caused the number of plot observations to be reduced from 1356 to 1042 among which 566 plots were with certificate and the remaining 476 plot were without certificate. This kind of data pre-processing reduces model dependence in the subsequent analysis of the outcome equation. (Ho et al. 2007).

Descriptive Analysis

Table 2 summarizes some key characteristics of farm households based on their possession of land use certificate. Signifying the caution exercised while sampling the respondents, results from Table 2 shows that farmers with and without certificate have comparable demographic and endowment variables such as the sex and age of household heads, the average size of households, number of male and female labor forces and key livestock endowment variables like cow and oxen. Despite these

[17] To not compromise the quality of the data and avoid fatigue of respondents is, the survey questionnaire was administered in three separate sections: the household demography, the perception and plot level sections interviewed by separate enumerators at distinct times. Failure to collect complete data from each respondent caused dropout of sampled respondents.

similarities, there are marked differences in terms long-term land related investments and adoption of new technology (modern input applications) when farm households with land use certificate are compared to those without. The proportion of farm households who exert their labor on own-plot conservation s is slightly but significantly higher at 94.3% compared to 83.9% for those who do not have land certificates. Similarly, the percentage of those households who considered improving (maintaining) an already existent conservation structure is also significantly higher for those with certificate, 40.7%, compared to only 28.6% by households without land certificate.

A summary of plot level variables used both in the stochastic frontier and DEA-based Malmquist index analyses is provided in Table 3. As shown in the upper part of the table, there is no significant difference between plots with certificate and those without certificate in terms of output level and input use intensity. On average, output value per *tsimdi*[18] is slightly higher on farm plots with land use certificate than those without certificate though the difference is not significant at a conventional level.

A summary of plot-specific long-term land investments and new technology adoption (modern farm input application) presented at the bottom part of Table 3 reveals a significant difference between the two groups of plots[19]. Reinforcing the claim that land certification does improve tenure security and encourage long-term land related investments (see discussions in section 2), the result shows a significantly larger proportion of farms with land certificate has been conserved (56%) as compared to plots without land use certificate (51%). The chance of improvement (maintenance) of an already existing conservation structure is also higher is also significantly higher on plots with certificate (21%) than those without (15%). Showing the difference in new technology adoption (modern input use application), the summary result also depicts a higher likelihood of application of chemical as well as

[18] *Tsimdi* is a local area measurement unit which is equivalent to a quarter of a hectare.
[19] All the variables summarized are in their dummy (dichotomy) form to show a shift or a jump in the frontier which may not be the case had their level form have been considered.

organic fertilizer (53% and 29%, respectively) on plots with land certificate than on plots without certificate (only 46% and 23%, respectively). These summary results are consistent with results of a study by Holden et al. (2009) which was conducted in similar study area.

On the outset, the empirical evidence from the mean comparison tests of the two groups of farms show that there is a marked difference in terms of long-term land related investment and new technology adoption. We use this evidence as an empirical basis for further test of the productivity impact of land certification considering separate benchmarks (group-specific production frontiers) for each group of farm plots. This strong assumption is more reinforced by a positive and statistically significant certificate variable (when this variable was included as a right hand side variable together with the customary farm inputs) from parametric results of alternative stochastic frontier analyses in the forthcoming section.

5. Results and Discussion

Structural Efficiency Comparisons: Parametric Approach

To reinforce the results from the summary statistics and assess if at all land certification has a potential productivity enhancing effect, a parametric stochastic frontier analysis (SFA) has been conducted by including an indicator variable *certificate* as a right hand side alongside the customary farm inputs (like, labor, oxen, fertilizer, etc). Since this variable is constructed as a dummy variable (plots with land certificate=1, and 0, otherwise), any positive and significant coefficient for this variable posits a frontier-shifter effect of land certification – a preliminary empirical condition to proceed with the decomposed analysis of DEA-based Malmquist index approach.

Using the specifications of the Cobb-Douglas production function where results are interpreted as input specific output elasticities, a positive and statistically significant *certificate* variable reported in Table 4 indicates, on average, the best practice-farms with land use certificate performs better than the best-practice farms without certificate. The evidence indicates the superiority of frontier defined by plots with land certificate than the frontier defined by those without land certificate. This result supports our basic assumption of the analysis that production under farm plots with certificate uses different technology than production under farm plots without certificate. Results from separate stochastic frontier analysis reported in Table 5 also shows key comparable results from both groups of farm plots. In both groups (plots with and without certificate) output is most responsive to area under cultivation, labor and the value of seed. Despite the SFA results from the pooled data in Table 4, the very high estimates of technical inefficiency in both groups (very low technical efficiency score of 47% and 41% for plots with and without land use certificate, respectively) may indicate little difference in between the two groups in terms of within group efficiency spread.

As the major aim of the study is to explain the source/cause of productivity differentials effects of land certification by comparing performance of farm plots with and without certificate, further effort has been exerted to investigate whether any productivity differential is: 1) down to a mere difference in pure technical efficiency or within-group efficiency spread (the ability to catch-up with the best practice farms of each respective groups); or 2) due to technology gap (dominance of a frontier of one group over the other). Even if the parametric (SFA) results and evidences from the mean comparison tests discussed above are indicative to suggest the dominance of the second factor as a possible explanation for the productivity differential between the two groups, this can be tested more rigorously by applying a DEA-based Malmquist index approach.

Explaining Productivity Differences: *DEA-based Malmquist Index Approach*

As shown in section 3, the choice of base technology (reference technology) while computing the Malmquist index affects the outcome of the index and, thereby, the interpretation. Therefore, we analyze the group productivity differences using the averages of results when each group is used as a reference technology. For mere comparison, results of the adopted Malmquist index are reported in arithmetic and geometric averages. Table 6 reports the overall group productivity differences - the composite Malmquist productivity index as shown in equation (6) while tables 7 and 9 show results of the decomposed sub-components of the productivity index: the effect of the within-group efficiency spread (equation (7)); and the technology gap or frontier dominance effect (equation (8)), respectively.

Overall productivity difference

As discussed in section 3, values of the Malmquist index smaller than unity corresponding to group *i* means that, on average, group *i* is more productive (performs better) than the other group. From table 6, the value of the index equal to 1.2367 corresponding to the 'without certificate' group shows that, on average, farm plots without land use certificate are less productive than plots with formalized land use rights. For instance the value of the index 1.2367, means that, on average, plots without certificate requires 124% of inputs required by plots with land use certificate so as to be equally productive (be on the same frontier). This result is more elaborated by the index shown on the second row of table 6. In this case, the value of the index equal to 0.8086 means that, on average, the group of farm plots with land use certificate are more productive than their counterparts without land certificate as the former group requires only 80.7% of the inputs required by those without land certificate and still be equally productive (be on the same frontier).

As mentioned before, the major analytical bottleneck which is common in this kind of non-parametric analysis (DEA) is the difficulties with testing statistical significance of such indices. In order to obtain some insights with respect to the statistical significance of the results the productivity difference, we invoke the concept of first order stochastic dominance which allows us to compare and rank the distribution of measures of farm performance. Accordingly, the statistical significance test results from the two-sided Kolmogorov-Smirnov (K-S) test shows the overall productivity difference to be statistically significant. As reported in columns 1 and 2 of table 10, K-S significance tests shows that the null hypothesis of *identical distribution of overall productivity between the two groups* is rejected at 5%. This result is diagrammatically more elaborated from the first order stochastic dominance analysis in figure 1 where the performance (efficiency scores) of farm plots with land use certificates unambiguously dominated the performance of those plots without certificate. The result is robust no matter which group was considered to define the benchmark frontier.

The empirical contribution of this approach for comparative evaluation of group performances is more prodigious when the decomposed results of the DEA-based Malmquist index are analyzed. Using the two sub-components of the index, we are able to explain what portion of the overall group productivity difference is attributed to differences in pure technical efficiency (within-group efficiency spread) and what portion is explained by a difference in group frontier (technology gap). Table 7 reports the components of the index relating to the comparison within-group efficiency gap or relative internal efficiency (M_{12}^{e})

A slightly greater than one value for the catching up effect (1,0451) shows that farm households belonging to the group without land certificate has, on average, a relatively lower internal efficiency (higher efficiency spread) than those with land certificate when both farms are evaluated against their

respective production frontier. Stated otherwise, this result indicates that farms with land use certificate have a slight edge over plots without certificate in terms of catching-up with their respective best practice farms.

However, the statistical significance test results from the two-sided Kolmogorov-Smirnov (K-S) test shows the difference to be statistically insignificant. As reported in column 3 of table 10, K-S test for similarity between the distributions of the two groups shows, the null hypothesis that *distribution of pure technical efficiency between the two groups is identical* can not be rejected. The first order stochastic dominance analysis (figure 2) and the Lorenz curve (figure 3) also show that there is not much difference between the two groups based on the 'within group efficiency spread' parameter. This results more elaborated when the index is computed using the arithmetic average which reported a value of the decomposed index approximately equal to unity (1.0059 and 0.9941 as reported in table 6). This result supports the earlier results from the mean comparison tests that revealed no significant difference in input use intensity between the groups of farm plots.

The result from the second sub-component of the Malmquist index that compares the relative positions (and distance) of the production frontiers of respective groups (technology gap) is shown in table 9. Similar to the interpretations given to the overall Malmquist index in table 6, a value smaller than one means the group considered as a reference or base to define the technology enjoys a superior technology or frontier while the opposite scenario holds for the inferiority. Considering the group of farm plots with land use certificate as reference (second row of table 9), the value of the decomposed component equal to 0.8134 is nothing but an input saving parameter by which inputs applied in plots without certificate can be multiplied with and still produce the same level of output. This is synonymous as saying, on average, plots with land use certificate enjoys a technological advantage

(operates on a higher frontier) as compared to plots without land certificate. This shows that, with proper interventions (in this particular case, land certification), there is an input saving potential for those plots without land use certificate as compared to those with formalized land use rights.

The first order stochastic dominance analysis shown in figure 4 supports this evidence as it shows the superiority of the frontier defined by best practice farms with certificate over the frontier of those without certificate. For instance, with particular relevance to farm plots without certificate, their relative performance under the *without certificate* technology dominates their efficiency when evaluated against the technology defined by the *with certificate* farms (shown in figure 4A). On the other hand, when one refers to plots with certificate, their relative efficiency is far superior when their performance is evaluated against the best practice farms defined by those farms *without certificate* than when they are evaluated against the technology defined by their own group (shown in figure 4B). Both of these non-parametric evidences shows the superiority of the *with certificate* frontier over the frontier of those *without certificate.* Results from the two-sided Kolmogorov-Smirnov (K-S) test reported in table 10 reaffirm this result. Both null hypotheses: 1) identical distribution of relative performance of farms without certificate regardless of the reference benchmark technology[20] (column 4 of table 10); and 2) identical distribution of relative efficiency of farms with certificate regardless of the reference benchmark technology (column 5 of table 10), are rejected with 5% level of significance in favor of the dominance of the with certificate frontier over the frontier defined by farm plots without certificate.

6. Conclusions

Albeit the fact that issues of land rights and tenure security are high on the global policy agenda, comprehensive studies on how such new land reforms affect agricultural productivity are scarce.

[20] Referring to Equation(8), this null hypothesis tests if E_{11}-E_{21}=0 or, more specifically if E_{11}/E_{21}=1. If we can not reject the null hypothesis, it shows the two frontiers intersect and no dominance of the one frontier over the other. The alternative hypothesis is the dominance of the distribution of the first efficiency measure over the second.

Taking advantage of a detailed plot-specific household survey from the northern highlands of Ethiopia, this study analyzes the productivity impacts of the Ethiopian land certification program by identifying how the investment effects (technological gains) would measure up against the benefits from any improvements in input use intensity (technical efficiency).

Based on the results from the DEA-based Malmquist productivity index, we found that farms without land-use certificate are, on aggregate, less productive than those with formalized use rights. Using the decomposed analysis, we found no evidence to suggest such productivity difference between the two groups of farms is due to differences in technical efficiency. Rather, the reason is down to 'technological advantages' or favorable investment effect that farm plots with land use certificate benefit when evaluated against those farms not included in the certificates. Results from the first order stochastic dominance analysis support the empirical findings, showing the dominance of overall productivity of farm plots with certificate over those plots without certificate.

Therefore, the recent wave of land certification projects in the country may not be an ill-advised direction since such policy measure was found to improve the competitiveness and productivity of farms with land use certificate when evaluated against farms not included in the certificate. However, the certification program by itself may not achieve the promised effects on agricultural development unless it is complemented by measures such as improving the financial and legal institutional frameworks. This is witnessed from our results that show the low level of within-group efficiency of farms in each group.

Reference:

Atwood, D. A. (1990). "Land Registration in Africa: The Impact on Agricultural Production." World Development **18**(5): 659-671.

Banker, R. D. (1996). "Hypothesis Tests Using Data Envelopment Analysis." Journal of productivity analysis **7**(2-3): 139-159.

Barrows, R. and M. Roth (1990). "Land-Tenure and Investment in African Agriculture - Theory and Evidence." Journal of Modern African Studies **28**(2): 265-297.

Besley, T. (1995). "Property-Rights and Investment Incentives - Theory and Evidence from Ghana." Journal of Political Economy **103**(5): 903-937.

Besley, T. and E. Coast (1995). "Group Lending, Repayment Incentives and Social Collateral." Journal Development Economics **46**: 1-18.

Bonfiglioli, A. (2003). Empowering the Poor: Local Governance for Poverty Reduction. New York, United Nations Capital Development Fund (UNCDF).

Bromley, D. W. (1991). Environment and Economy: Property Rights and Public Policy. Oxford & Cambridge, Blackwell.

Caves, D. W., L. R. Christensen and W. E. Diewert (1982). "The Economic-Theory of Index Numbers and the Measurement of Input, Output, and Productivity." Econometrica **50**(6): 1393-1414.

Charnes, A., W. W. Cooper and E. Rhodes (1978). "Measuring Efficiency of Decision-Making Units." European Journal of Operational Research **2**(6): 429-444.

Chavas, J. P., R. Petrie and M. Roth (2005). "Farm Household Production Efficiency: Evidence from the Gambia." American Journal of Agricultural Economics **87**(1): 160-179.

Coelli, T. J. (1995). "Recent Developments in Frontier Modelling and Efficiency Measurement." Australian Journal of Agricultural Economics **39**(3): 219-245.

Conover, W. J. (1999). Practical Nonparametric Statistics. Chichester, John Wiley & Sons.

Deininger, K. (2003). Land Policies for Growth and Poverty Reduction. A publication of the World Bank and Oxford University Press, The World Bank.

Deininger, K., D. A. Ali and T. Alemu (2008). Land Rental Markets: Transaction Costs and Tenure Isecurity in Rural Ethiopia. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Deininger, K., D. A. Ali and T. Alemu (2008b). Impacts of Land Certification on Tenure Security, Investment, and Land Markets: Evidence from Ethiopia. Policy Research Working Paper No. 4764, Washington, D.C., The World Bank.

Deininger, K., D. A. Ali, S. Holden and J. Zevenbergen (2008). "Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries." World Development **36**(10): 1786-1812.

Deininger, K. and R. Castagnini (2006). "Incidence and Impact of Land Conflict in Uganda." Journal of Economic Behavior & Organization **60**(3): 321-345.

Deininger, K. and G. Feder (1998). Land Institutions and Land Markets, The World Bank, Development Research Group, Rural Development.

Deininger, K. and S. Q. Jin (2006). "Tenure Security and Land-Related Investment: Evidence from Ethiopia." European Economic Review **50**(5): 1245-1277.

Dhungana, B. R., P. L. Nuthall and G. V. Nartea (2004). "Measuring the Economic Inefficiency of Nepalese Rice Farms Using Data Envelopment Analysis." Australian Journal of Agricultural and Resource Economics **48**(2): 347-369.

Do, Q. T. and L. Iyer (2008). "Land Titling and Rural Transition in Vietnam." Economic Development and Cultural Change **56**(3): 531-579.

Eggertsson, T. (1990). Economic Behavior and Institutions. Cambridge, New York, Cambridge University.

Fare, R., S. Grasskopf and C. A. K. Lovell, Eds. (1994). Productivity Frontiers. Cambridge, Cambridge University Press.

Fare, R. and C. A. K. Lovell (1978). "Measuring the Technical Efficiency of Production." Journal of Economic Theory **19**(1): 150 - 162.

Farrell, M. J. (1957). "The Measurement of Productive Efficiency." Journal of the Royal Statistical Society Series a-General **120**(3): 253-290.

Feder, G., T. Onchan and Y. Chalamwong (1988). "Land Policies and Farm Performance in Thailand's Forest Reserve Areas." Economic Development and Culture Change **36**(3): 483-501.

Gavian, S. and M. Fafchamps (1996). "Land Tenure and Allocative Efficiency in Niger." American Journal of Agricultural Economics **78**(May): 460-471.

Gebremedhin, B. and S. M. Swinton (2003). "Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Programs." Agricultural Economics **29**(69-84).

Ghebru, H. and S. T. Holden (2009). Reverse-Share-Tenancy and Marshallian Inefficiency: Eviction Power of Landowners and the Sharecropper's Productivity. In. Unpublished Manuscript, Norwegian University of Life Sciences, Department of Economics and Resource Management, Ås.

Ghebru, H. H. and S. T. Holden (2008). Factor Market Imperfections and Rural Land Rental Markets in Northern Ethiopian Highlands. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of

Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

Hayes, J., M. Roth and L. Zepeda (1997). "Tenure Security, Investment, and Productivity in Gambian Agriculture: A Generalized Probit Analysis." American Journal of Agricultural Economics **79**(May): 369-382.

Holden, S. T., K. Deininger and H. Ghebru (2008). Impact of Land Certification on Land Related Conflicts. In. Working Paper, Norwegian University of Life Sciences. Ås.

Holden, S. T., K. Deininger and H. Ghebru (2009). "Impacts of Low-Cost Land Certification on Investment and Productivity." American Journal of Agricultural Economics **91**(2): 359-373.

Holden, S. T., K. Deininger and H. H. Ghebru (in press). "Tenure Insecurity, Gender, Low-Cost Land Certification and Land Rental Market Participation in Ethiopia." Journal of Development Studies.

Holden, S. T., K. Otsuka and F. M. Place (2008). Land Markets and Development in Africa. In: S. T. Holden, K. Otsuka and F. M. Place. The Emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency. Washington DC, Resource For the Future (RFF) publisher.

IFAD (2001). The Challenge of Ending Rural Poverty - Rural Poverty Report 2001. Rome, International Fund for Agricultural Development (IFAD).

Jacoby, H. G. and B. Minten (2007). "Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar." World Bank Economic Review **21**(3): 461-485.

Jaenicke, E. C. (2000). "Testing for Intermediate Outputs in Dynamic Dea Models: Accounting for Soil Capital in Rotational Crop Production and Productivity Measures." Journal of productivity analysis **14**(3): 247-266.

Janvry, A. d., G. Gordillo, J.-P. Platteau and E. Sadoulet (2001). Access to Land, Rural Poverty, and Public Action. In: A. d. Janvry, G. Gordillo, J.-P. Platteau and E. Sadoulet. Access to Land, Rural Poverty, and Public Action. Oxford, Oxford University Press**:** 1 - 26.

Johnson, O. E. G. (1972). "Economic Analysis, Legal Framework and Land Tenure Systems." Journal of Law & Economics **15**(1): 259-276.

Li, G., S. Rozelle and L. Brandt (1998). "Tenure, Land Rights, and Farmer Investment Incentives in China." Agricultural Economics **19 (1-2)**: 63-71.

Libecap, G. D. (1989). Contracting for Property Rights, Cambridge University Press.

Ostrom, E. (2001). The Puzzle of Counterproductive Property Rights: A Conceptual Analysis. In: A. d. Janvry, G. Gordillo, J.-P. Platteau and E. Sadoulet. Access to Land, Rural Poverty, and Public Action. Oxford, Oxford University Press**:** 129 - 150.

Pinckney, T. C. and P. K. Kimuyu (1994). "Land Tenure Reform in East Africa: Good, Bad or Unimportant." Journal of African Economies **3**: 1-28.

Place, F. and S. E. Migot-Adholla (1998). "The Economic Effects of Land Registration on Smallholder Farms in Kenya: Evidence from Nyeri and Kakamega Districts." Land Economics **74**(3): 360-373.

Shafiq, M. and T. Rehman (2000). "The Extent of Resource Use Inefficiencies in Cotton Production in Pakistan's Punjab: An Application of Data Envelopment Analysis." Agricultural Economics **22**(3): 321-330.

Sharma, K. R., P. S. Leung and H. M. Zaleski (1999). "Technical, Allocative and Economic Efficiencies in Swine Production in Hawaii: A Comparison of Parametric and Nonparametric Approaches." Agricultural Economics **20**(1): 23-35.

Sjaastad, E. and D. W. Bromley (1997). "Indigenous Land Rights in Sub-Saharan Africa: Appropriation, Security and Investment Demand." World Development **25**(4): 549-562.

Smith, R. E. (2004). "Land Tenure, Fixed Investment, and Farm Productivity: Evidence from Zambia's Southern Province." World Development **32**(10): 1641-1661.

Wadud, A. and B. White (2000). "Farm Household Efficiency in Bangladesh: A Comparison of Stochastic Frontier and Dea Methods." Applied Economics **32**(13): 1665-1673.

Table 2. Mean comparison tests for key household level Variables

	With Certificate		Without certificate		
Variables	**Mean**	**(std. Err)**	**Mean**	**(std. Err.)**	
Household demographic and endowment variables					
Sex of the household head	0.721	(0.0380)	0.750	(0.0411)	
Age of the household head	45.614	(1.1865)	45.045	(1.4799)	
Size of the household	5.086	(0.2084)	4.830	(0.2261)	
Male labor force	1.200	(0.0819)	1.080	(0.0852)	
Female labor force	1.250	(0.0650)	1.143	(0.0681)	
Number of dependents in the household	1.471	(0.1041)	1.598	(0.1116)	
Number of cows	0.936	(0.0825)	0.768	(0.0822)	
Number of oxen	1.164	(0.0933)	1.071	(0.0972)	
Other livestock endowment[+]	0.593	(0.0737)	0.357	(0.0738)	>**
Off-farm income opportunity[++]	0.079	(0.0228)	0.045	(0.0196)	
Long-term land investment and modern input use					
Investment in new conservation structures	0.943	(0.0197)	0.839	(0.0349)	>**
Maintenance of conservation structures	0.407	(0.0417)	0.286	(0.0429)	>**
Household's use of chemical fertilizer	0.621	(0.0411)	0.500	(0.0475)	>**
Household's use of organic fertilizer	0.636	(0.0408)	0.625	(0.0460)	
Households use of improved seed variatie	0.579	(0.0419)	0.464	(0.0473)	>*
Number of Obs.	161		135		

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; [+] TLU equivalent; [++] Off farm income sources excluding gifts, aid, remittance and other non-labor incomes.

Table 3. Mean comparison tests for key plot level Variables

	Plots with Certificate		Plots without Certificate		ttest
Variable	Mean	std. Err.	Mean	std. Err.	
Input intensity and output level					
Total Value of output/*tsimdi*[+] (Birr)	699.96	19.27	671.52	21.16	
Total labor/*tsimdi* (No. of Days)	34.53	1.02	33.23	0.99	
Oxen/*tsimdi* (No. of Days)	14.25	0.47	17.36	0.56	<***
Seed cost/*tsimdi* (Birr)	96.46	3.34	93.01	4.82	
Chemical Fertilizer/*tsimdi* (Kg)	12.67	0.79	13.79	0.89	
Long-term Land Investment and Modern Input use					
Long-term Land Investment	0.56	0.020	0.51	0.023	>*
Improved conservation structures	0.21	0.017	0.15	0.016	>***
Well-maintained structures	0.23	0.017	0.25	0.020	
Just-maintained structures	0.04	0.008	0.05	0.010	
Not-maintained structures	0.10	0.012	0.13	0.015	
Chemical Fertilizer (dummy)	0.53	0.021	0.46	0.023	>**
organic Manure/compost (dummy)	0.29	0.019	0.23	0.019	>**
Seed Type (1=improve, 0=otherwise)	0.22	0.017	0.20	0.018	
Log of output value	5.82	0.053	5.59	0.084	>*
Number of Obs.	566		476		

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%; [+] *Tsimdi* is a local area measurment which is equivalent to 0.25 hactare.

Table 4. Stochastic Production Frontier estimates - Pooled data (n=1042)

Variables	Coefficient (standard error)	
CONSTANT	5.3933	(0.1655)***
Log of cultivated area	0.3658	(0.0542)***
Log of labor man days	0.2092	(0.0329)***
Log of oxen days	0.0624	(0.0307)**
Log of seed cost - Birr	0.2343	(0.0284)***
Log of chemical fertilizer - Kg	0.0256	(0.0072)***
Certificate (plot with certificate=1)	0.1176	(0.0522)**
sigma2	3.7082	(0.2363)
lambda	9.8764	(0.0845)
Log-Likelihood	-680.11	
Technical efficiency score	0.45	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%.

Table 5. Stochastic Production Frontier estimates of plots with and without certificate

	Without Certificate (n=476)		With Certificate (n=566)	
Variables	Coefficient (std. error)		Coefficient (std. error)	
CONSTANT	5.1009	(0.2312)***	5.8103	(0.2099)***
Log of cultivated area	0.3081	(0.0835)***	0.4179	(0.0676)***
Log of labor man days	0.272	(0.0790)***	0.2025	(0.0392)***
Log of oxen days)	0.1019	(0.0859)	0.0266	(0.0359)
Log of seed cost - Birr)	0.2624	(0.0404)***	0.1539	(0.0374)***
Log of chemical fertilizer - Kg)	0.0195	(0.0103)*	0.0276	(0.0094)***
sigma2	4.2082	(0.2963)	2.2778	(0.1562)
lambda	11.5764	(0.0935)	4.1102	(0.0687)
Log-Likelihood	-720.11		-758.44	
Technical efficiency score	0.41		0.47	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%.

Table 6. Malmquist Index for Comparison of Group performance (M_i^{12}) between Farms with and without Land Use Certificate

Groups/Scenarios	Arithmetic Mean		Geometric Mean	
1 \ 2	No Certificate	With Certificate	No Certificate	With Certificate
No Certificate	1	1.2367	1	1.1669
With Certificate	0.8086	1	0.8570	1

Table 7. A Component of the Malmquist Index for Comparison of Within-group efficiency spread (M_{12}^{e}) in Farms with and without Land Use Certificate

Groups/Scenarios	Arithmetic Mean		Geometric Mean	
1 \ 2	No Certificate	With Certificate	No Certificate	With Certificate
No Certificate	1	1.0059	1	1.0451
With Certificate	0.9941	1	0.9568	1

Table 8. Percentiles of the Within-group (program) efficiency distribution of farms with and without certificate

Farm Evaluated	Percentile 5%	Geometric Mean	Percentile 95%	Efficiency Range after eliminating 5% of both extremes
Farms No Certificate (i=1=NC)	0.0615	0.3732	1	0.867
Farms with Certificate (i=2=C)	0.1133	0.39	1	0.864

Table 9. A Component of the Malmquist Index for Comparison of Productivity between the two group frontiers (M_{12}^{f})

Groups/Scenarios	Arithmetic Mean		Geometric Mean	
2 / 1	No Certificate	With Certificate	No Certificate	With Certificate
No Certificate	1	1.2294	1	1.1165
With Certificate	0.8134	1	0.8957	1

Table 10: Test results of first-order stochastic dominance of (Two-sample Kolmogorov- Smirnov test)

Group	Reference Technology	Performance Evaluation of:	Efficiency Scores Mean/(sd)	P-values for two-sample Kolmogorov-Smirnov test†				
				Overall productivity difference		Difference in technical efficiency	Technology gap (Frontier differences)	
				Group - A Vs Group - B	Group - C Vs Group - D	Group - B Vs Group - C	Group - B Vs Group - D	Group - A Vs Group - C
				(1)[i]	(2)[ii]	(3)[iii]	(4)[iv]	(5)[v]
A	Without certificate	With certificate	0.51 (0.329)	0.042	0.056	0.637	0.05	0.017
B	Without certificate	Without certificate	0.451 (0.25)					
C	With Certificate	With certificate	0.446 (0.234)					
D	With Certificate	Without certificate	0.422 (0.27)					

Note: †H_0: distributions are equal against; H_1: distribution of first group stochastically dominates distribution of second .

[i] Specifically tests if the first quotient of the Malmquist index in Equation (5),

i.e., $\left[\left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}} \Big/ \left(\prod_{j=1}^{C_w} D^1\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}\right] = E_{12}/E_{11}$ is significantly greater than one or not.

[i] Specifically tests if the second quotient of the Malmquist index in Equation (5), i.e.,

$\left[\left(\prod_{j=1}^{C_n} D^2\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}} \Big/ \left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}\right] = E_{22}/E_{21}$ is significantly greater than one or not.

[i] Specifically tests if the quotient of the decomposed Malmquist index in Equation (7), i.e.,

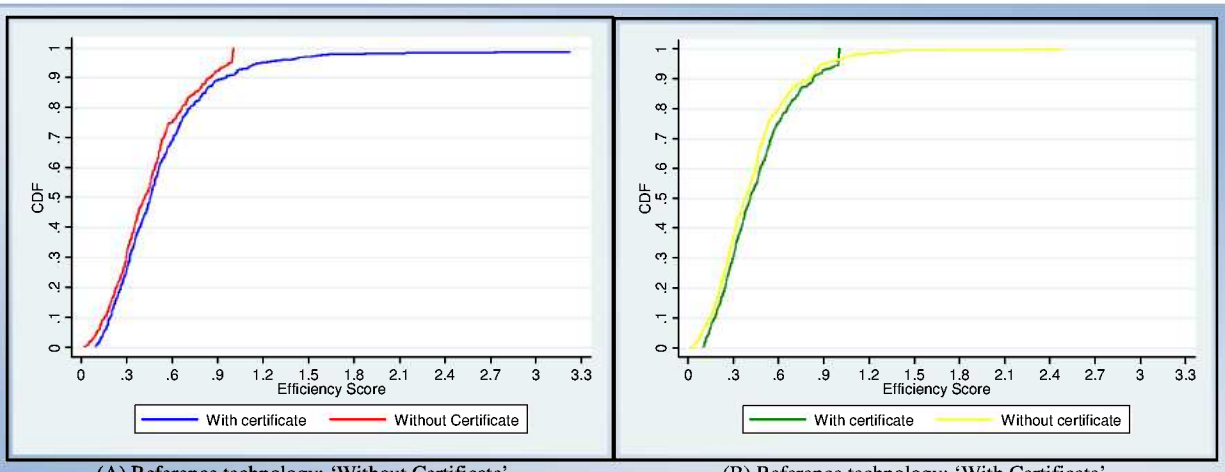
$\left[\left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}} \Big/ \left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}\right] = E_{22}/E_{11}$ is statistically greater than one or not.

[i] Specifically tests if the first quotient of the decomposed Malmquist index in Equation (8), i.e.,

$\left[\left(\prod_{j=1}^{C_n} D^2\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}} \Big/ \left(\prod_{j=1}^{C_n} D^1\left(Y_j^1, X_j^1\right)\right)^{\frac{1}{C_n}}\right] = E_{11}/E_{21}$ is greater than one or not.

[i] Specifically tests if the second quotient of the decomposed Malmquist index in Equation (8), i.e.,

$\left[\left(\prod_{j=1}^{C_w} D^2\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}} \Big/ \left(\prod_{j=1}^{C_w} D^1\left(Y_j^2, X_j^2\right)\right)^{\frac{1}{C_w}}\right] = E_{12}/E_{22}$ is greater than one or not.



(A) Reference technology: 'Without Certificate' (B) Reference technology: 'With Certificate'

Figure 1: CDF for the overall productivity effects of land certificate (First order stochastic dominance)

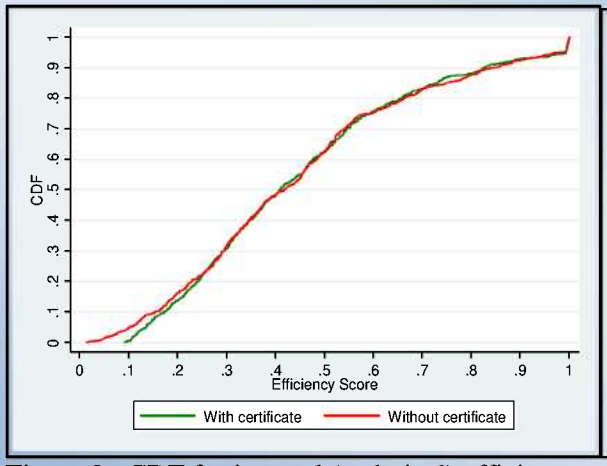


Figure 2: CDF for internal (technical) efficiency effects of land certificate (First order stochastic dominance)

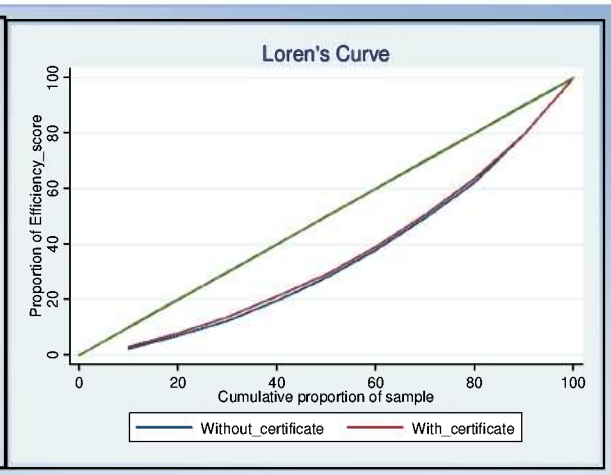
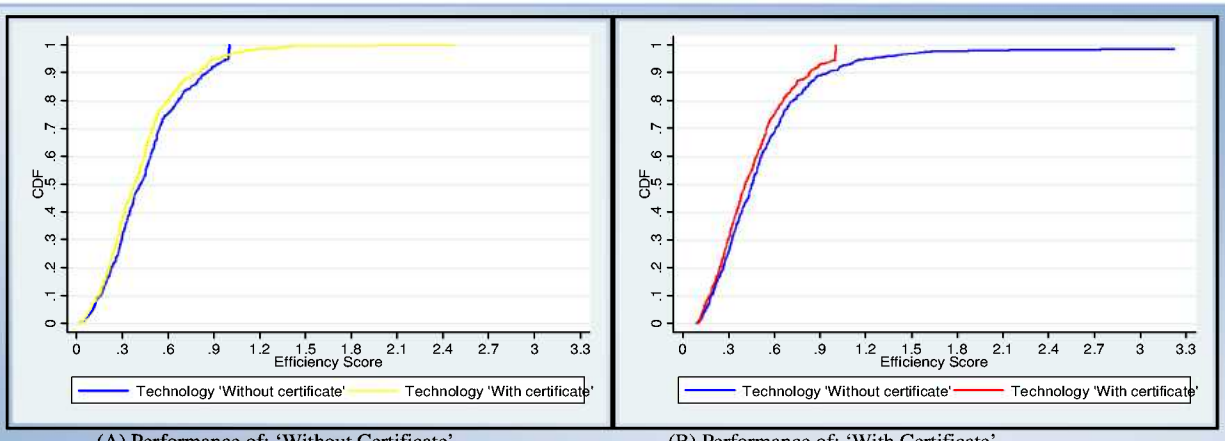


Figure 3: Lorenz curve comparing inequality between efficiency score of the two groups



(A) Performance of: 'Without Certificate' (B) Performance of: 'With Certificate'

Figure 4: CDF for technology (frontier shift) effects of land certificate (First order stochastic dominance)

APPENDIX 1: Stata program output of propensity score matching of plots with and without land use certificate observable characteristics

```
**************************************************
Algorithm to estimate the propensity score
**************************************************

The treatment is certificate

      1=yes |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        488       45.61       45.61
          1 |        582       54.39      100.00
------------+-----------------------------------
      Total |      1,070      100.00

Estimation of the propensity score

note: ss_mid dropped due to collinearity
note: st_hutsa dropped due to collinearity
Iteration 0:   log likelihood = -735.35329
Iteration 1:   log likelihood =  -704.6413
Iteration 2:   log likelihood = -704.35032
Iteration 3:   log likelihood = -704.30895
Iteration 4:   log likelihood = -704.29787
Iteration 5:   log likelihood = -704.29462
Iteration 6:   log likelihood = -704.29362
Iteration 7:   log likelihood =  -704.2933
Iteration 8:   log likelihood = -704.29319
Iteration 9:   log likelihood = -704.29316
Iteration 10:  log likelihood = -704.29314
Iteration 11:  log likelihood = -704.29314
Iteration 12:  log likelihood = -704.29314
Iteration 13:  log likelihood = -704.29314
Iteration 14:  log likelihood = -704.29314
Iteration 15:  log likelihood = -704.29314
Iteration 16:  log likelihood = -704.29314

Probit regression                                 Number of obs   =       1067
                                                  LR chi2(12)     =      62.12
                                                  Prob > chi2     =     0.0000
Log likelihood = -704.29314                       Pseudo R2       =     0.0422

------------------------------------------------------------------------------
 certificate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
area_planted |   .2039935   .0866108     2.36   0.019     .0342395    .3737476
   homestead |  -.7245097    .124592    -5.82   0.000    -.9687055   -.4803138
     ss_flat |  -.5960804   .1655965    -3.60   0.000    -.9206435   -.2715173
     ss_foot |  -.3077846   .2125602    -1.45   0.148    -.7243951    .1088258
    ss_steep |   .0630793   .3894655     0.16   0.871     -.700259    .8264176
  sd_shallow |   5.845854   .2492593    23.45   0.000     5.357314    6.334393
   sd_meduim |   5.954099   .2566176    23.20   0.000     5.451137     6.45706
     sd_deep |   5.934536   .2507117    23.67   0.000      5.44315    6.425921
   st_baekel |   .0301215    .208445     0.14   0.885    -.3784233    .4386662
    st_walka |   .1354379   .1993868     0.68   0.497     -.255353    .5262288
  st_mekeyih |   .1511897   .1850235     0.82   0.414    -.2114497    .5138291
    distance |  -.0094768   .0022706    -4.17   0.000    -.0139271   -.0050266
       _cons |   -5.25226          .        .       .            .           .
------------------------------------------------------------------------------
Note: the common support option has been selected
The region of common support is [.18766866, .8727433]
```

Description of the estimated propensity score
in region of common support

Estimated propensity score

	Percentiles	Smallest		
1%	.2682985	.1876687		
5%	.340772	.1876687		
10%	.3849107	.1876687	Obs	1042
25%	.4865958	.2163665	Sum of Wgt.	1042
50%	.5619563		Mean	.5468721
		Largest	Std. Dev.	.1133412
75%	.6095591	.8437406		
90%	.662875	.8535808	Variance	.0128462
95%	.7397664	.8675736	Skewness	-.284585
99%	.8179659	.8727433	Kurtosis	3.537612

****
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****

The final number of blocks is 6

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each block

****
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
****

The balancing property is satisfied

This table shows the inferior bound, the number of treated
and the number of controls for each block

Inferior of block of pscore	1=yes 0	1	Total
.1666667	33	15	48
.3333333	130	98	228
.5	297	370	667
.6666667	14	79	93
.8333333	2	4	6
Total	476	566	1,042

Note: the common support option has been selected

****
End of the algorithm to estimate the pscore
****

Hosaena Ghebru

Department of Economics
and Resource Management
Norwegian University of
Life Sciences

P.O.Box 5003
N_1432, Aas, Norway

Telephone: +4764965701

e-mail: ior@umb.no

http//www.umb.no

ISSN:

ISBN:

Hosaena Ghebru was born in Mekelle, Ethiopia in 1976. He holds a B.A. degree in Economics from Mekelle University, Ethiopia (2000) and and MSc degree in Economics and Resource Management from Agricultural University of Norway (2004).

This dissertation investigates issues related to land tenancy transactions and economic impacts of secure land rights. It involves a total of five independent studies which have been carried out using farm household data from the northern highlands of Ethiopia. The first three papers focus on understanding factors determining the participation of households in the informal land rental markets and identify the poverty, equity and efficiency implications the land tenancy market. The last two papers are devoted to evaluate the long-term investment and land productivity effects secure land rights taking the case of land certification program in the Tigray region of Ethiopia.

Paper I assesesses factors that derive farm household participation in the land rental market and evaluate the equity implications of the market. The analysis revealed that participation is mainly driven by imperfection in the non-land factor markets. Paper II examines how participation in the land rental market affects the welfare of poor and vulnerable groups. Results show participation in the land rental market was found to have an important role as a saftey net for poor landlords while imperfection in the land rental market limits the benefits to poor tenants. Paper III aimed at bridging the lack of clarity on the Marshallian disincentive effects of share tenancy contract. The analyses show that sharecroppers' strategic response to variations in bargaining power and tenure security status of landowners explain the mixed result on the efficiency implications of share tenancy arrangements. Paper IV assesses the longterm investment and overall productivity impacts of the low-cost land certification program while Paper V focused on the direct efficiency (input use intensity) and productivity (technological adoption) differential effects. In the last paper, an attempt has been made to identify how the investment effects (technological gains) would measure up against improvements in input use intensity (technical efficiency). Overall results show land certification has contributed to increased investment in trees, better management of plot coservation structures and enhancement of land productivity.

Professor Stein T. Holden was Hosaena's advisor.

Hosaena Ghebru is a lecturer at the departnemt of Economics, Mekelle University (Ethiopia)

Telephone: (+251)-344410639/(+251)914706104
e-mail: *hosaenag@yahoo.com*