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Links between Tenure Security and Food Security: Evidence from Ethiopia

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ABSTRACT

While there exists ample studies that evaluate the impacts of land reform on household investment behavior, land productivity, and land rental market activities, the literature is thin in terms of showing the direct food securities impacts of land tenure reforms. This study uses five rounds of household panel data from Tigray, Ethiopia, collected in the period 1998–2010 to assess the impacts of a land registration and certification program that aimed to strengthen tenure security and how it has contributed to increased food availability and, thus, food security in this food-deficit region. Our first survey took place just a year before the intervention (the land certification program). Our panel data in combination with the "years of certificate ownership" variable allow us to assess the dynamic impacts on food (calorie) availability of strengthened tenure security. Anthropometric data also allow us to assess potential child nutrition impacts of the reform 8 to 12 years after its implementation. Results show that land certification appears to have contributed to enhanced calorie availability (calorie intake), and more so for female-headed households, either through enhanced land rental market participation or increased investment and productivity on owner-operated land. Results also show that members of households that accessed additional land through the land rental market had a significantly higher body mass index. Though results show that land rental market participation is enhancing production efficiency, high transaction costs in that market suggest there are still unrealized gains from trade. Thus, the recent restrictive regional land law that allows for only short-term rental contracts and does not allow more than 50 percent of land to be rented out may threaten future tenure security and may undermine the benefits from existing tenure reform.

Keywords: Tenure security, land certification, gender-differentiated food security, cost-of-basic-needs, Ethiopia

1. INTRODUCTION

Land tenure and food security have traditionally been two separate areas of research. Land tenure research is itself a vast and complex area due to the large variation and complexity of land tenure systems, which has contributed to the specialization of land tenure researchers. We see a similar tendency in the food security literature. In this paper we try to bridge these two strands of literature and assess how tenure security and land tenure reforms affect and are affected by household food security. Both these security issues are at the heart of the livelihoods of poor rural households in northern Ethiopia, who live in a land-scarce semiarid environment that has been exposed to recent land tenure reforms and food security interventions in the form of low-cost land certification and a productive safety net program. The environment is also characterized by rural households being both producers and consumers that are facing imperfect markets and idiosyncratic as well as covariate shocks, where the majority are net buyers of staple food and have limited off-farm employment opportunities.

The neoclassical literature on land titling reform has identified three potential benefits: (a) investment effects (due to higher tenure security); (b) credit access effects (because land may be used as collateral and provide security to lenders); and (c) transferability effects (land can be passed on to more productive producers) (Besley 1995; Haavelmo 1960; Jorgenson 1967; Feder 1988).

Ethiopia introduced a low-cost approach to land registration and certification that started in Tigray Region in northern Ethiopia in 1998. The implementation used young staff with limited training in a broad-scale implementation of land registration in a highly participatory approach where the intention was to register all individually managed household lands in agricultural highland communities without any modern technologies such as computers and GPS receivers. Simple forms were filled with information about the head of the household, name of place of each plot, plot size (measured with rope), land quality, and names of all bordering neighbors. Neighbors walked the fields jointly to identify plot owners and to agree on and demarcate plot borders. Afterward households received a single-page certificate with this relevant information for each of their plots, and the information was recorded in books that were kept at community and district levels. The cost of registration and certification was only about one dollar per farm plot, just a tiny fraction of the cost of traditional land titling upon demand (Deininger et al. 2008).

The novel contribution of this paper is to seek to analyze the link between household food security effects and a low-cost land certification program. We use five rounds of panel data from 400 households from 16 communities collected from 1998 to 2010 (during which time the interventions were introduced) to assess the impacts of a land registration and individual household land certification program that aimed to strengthen tenure security and how it has contributed to increased food availability and thus food security in this food-deficit region. However, due to dropout of respondents (mostly related to the Ethio-Eritrea border war, which started in 1998 and ended in 2000), this study is based on a balanced panel of 300 households. Respondent attrition was tested and minimal. Using the baseline data, we tested whether any of the key variables of interest (household demographic and endowment variables) are significant in determining the probability of attrition. None of them was found to be statistically significant. That the first-round survey

took place just a year before the intervention provides a unique opportunity to assess the potential welfare (food security) impacts of the land certification program using the 1997/98 survey as baseline information.

We assess food security effects by estimating the effect of land certification on the average calorie availability per adult equivalent per day in households. The calorie availability is weighted with the prices and the calorie intake from a food basket of the 14 most important food items consumed in the study areas. We use the duration for which households have had land certificates as a tenure security indicator to identify the dynamic effects of land certification on food availability and nutrition status of children. Our five-round panel data in combination with the "years of certificate ownership" variable allow us to assess the dynamic impacts of strengthened tenure security through land certification on calorie availability. Two rounds of biometric panel data also allow us to assess whether there are any significant impacts of the reform eight to 12 years after its implementation on household nutritional status.

To the best of our knowledge, this is the first study that investigates the longer-term food security impacts of a tenure-security-enhancing land tenure reform program based on household panel data. Overall we find positive effects of the program, which has enhanced individual household tenure security as well as food (calorie) availability and child nutrition measured by body mass index (BMI).

The rest of the paper is organized as follows. A brief description of the land registration and certification process in Tigray is presented in Section 2, whereas Section 3 reviews relevant literature on the concepts of tenure security and food security and how they are linked in developing countries with particular focus on our study country, Ethiopia. The conceptual model together with testable hypotheses are discussed in Section 4. The data and econometric methods applied in this study are discussed in Section 5, and Section 6 presents the descriptive analysis. Section 7 is devoted to discussion of the econometric results of the study. The last section (Section 8) summarizes the key findings.

2. THE LAND REGISTRATION AND CERTIFICATION PROCESS IN TIGRAY, ETHIOPIA

Ethiopia underwent a radical land reform in 1975, making all land state land and giving individual households limited user rights based on egalitarian principles as constitutional rights to land for production of food to satisfy household needs. Frequent land redistributions were implemented to maintain the egalitarian land distribution and provide land to new households; however, this resulted in tenure insecurity when land increasingly had to be taken from other households to satisfy the growing demand for land as population size increased.

With the overthrow of the Derg regime in 1991, a more market-friendly rural development policy was introduced, although land remained state property and land sales remained illegal. However, short-term land rental was allowed as was hiring of labor, and land redistributions were mostly abolished. The new national land proclamation of 1997 (FDRE 1997) provided the basis for regional land proclamations, and Tigray Region was the first region to develop its own land proclamation in 1997, providing the basis for implementing land registration and certification in the region.

The process of land registration in Tigray (and Ethiopia at large) has been a systematic rather than demand-driven process. In Tigray, the process was started by the Tigray People's Liberation Front (TPLF) in 1981 following the land redistribution practices during the guerilla war with the then socialist regime. During this period, the TPLF gave land title to the landholders on a simple piece of ordinary white paper named a *belbal,* which had no records of registry or book in which to store the parcel information. Land distribution by the TPLF affected only the cropland owned by individual farmers and in some areas groups of farmers who were organized without considering their interest. Challenges that faced the simple land registration system included these: the white paper was designed without considering a space for registering a land transfer resulting from transactions or succession; and the parcel demarcation lacked quality because it used natural or temporary boundary marks such as rivers, trees, roads, and so forth.

2.1. Decentralized and Participatory

Using the lessons learned from the land registration practice during the armed struggle (the practice encompassed the years 1981–1991) as a basis, the regional government launched a comprehensive rural land registration and certification of land rights program in 1996, where most of the sensitization and public consultation work was completed. The program has aimed to improve on past practice by taking into consideration the limitations of the *belbal*, such as the absence of a clear and reliable copy of data with the responsible body, the lack of important information, and inaccurate parcel boundary marks. The registration has been handled by the *tabia,* the lowest level of local government. The choice of *tabia*-level implementation of land registration in Tigray was the result of the long period of strengthening local government from that early beginning under the TPLF-led armed struggle (1974/75–1990/91). Hence, by the time land registration began in 1998/99, local governments in Tigray were relatively effective.

2.2. Low-Cost

The regional Bureau of Agriculture and Natural Resources, in collaboration with the regional administration, took on the responsibility of designing and duplicating the land registration forms. Agricultural bureau development agents, already assigned to work with each *tabia,* were trained in the purposes and procedures of registration and in the use of the forms. In addition, a much larger number of high school graduates were trained for six months at the multipurpose youth training center—Agibe. The training focused on how to work with smallholder farmers to measure fields and fill in the forms correctly. During the registration process conducted by the Agibe trainees, "traditional" land leaders were called on to witness what land belonged to whom when border disputes arose. Fees tended to be very low, the technology was simple, and the language used was accessible to most rural land users. As a result, the process has been described as low-cost, transparent, accessible, and more participatory as it was overseen by the local government (Deininger et al. 2008).

The registration process in Tigray has also been branded a best practice for its highly participatory and transparent approach (Holden et al. 2009). This is mainly the case since the Agibe technicians working together with the local agricultural development agent and community members (usually the older men who had been involved in the last land distribution, as well as the elected *tabia* assembly chairperson) performed an on-the-ground assessment of current land holdings, walking each land parcel as a group, and recording the land details on a preprinted form known as the Application Form. In almost all cases the findings of the study were then reviewed and verified publicly in detail with all the landholding members of the community, usually in a mass meeting.

Once reviewed and verified by the public, the land use certificate contains detailed information such as the single name of the head of household, male wherever present or female, recorded at the top of the page, together with the several plots of cultivated land held by the household. Below the name of the family head, the page lists all parcels of land held by the household, and indicates for each parcel its approximate size (in a local unit called a *tsimdi,* that is on average about 0.25 hectares), description of the quality of the land (generally as poor, medium, or fertile quality), parcel identification (usually the name of a locality within the community or a geographical landmark), and the names of four neighboring landholders on the north, south, east, and west sides.[1] That the names of the neighbors for each plot are written on the land certificates is the most essential element of the land registration process for addressing potential boundary disputes among smallholders in the region.

By 1998, approximately 80 percent of the arable land had been systematically registered and land certificates issued to smallholder farmers. One-fifth of farmlands remained without registration (farm households without certification) mainly because most *tabias* appear to have run out of certificate forms near the end of the initial registration or shortly thereafter. The implementation process was also stopped when the war with Eritrea broke out in 1999, especially in bordering communities.

Overall, the land registration system in the region was a one-off process of issuing land use certificates to improve local perceptions of tenure security, that is, mainly to mark the end of land redistribution. No provisions were implemented to allow for regular updating, to reflect transactions in rights, or to allow for registration of secondary interests in land. Despite receiving praise for being a low-cost approach, the land registration system generated early skepticism about its potential outcomes, suggesting there may be a trade-off between accessibility (which may require the use of simple technology that can be operated at the local level) and quality (the extent to which the registration system can provide precise and up-to-date information on land rights).

Despite these challenges, the Tigray system has made important achievements and provides some basic principles for a pro-poor registration system. Earlier studies indicate that the low-cost land certification program in the region has had positive investment effects (Holden, Deininger, and Ghebru 2009); allocative efficiency effects on rented land (Holden, Deininger, and Ghebru 2011; Holden and Ghebru 2011); welfare-enhancing effects, particularly for female-headed landlord households (Holden and Ghebru 2011); and positive effects in land boundary disputes (Holden, Deininger, and Ghebru 2010). The relative success of the land registration system in Tigray (normally described as pro-poor) is, thus, partly explained by this: the system builds on unique and strong local institutions that emerged in a particular sociopolitical and historical context.

3. LITERATURE REVIEW

This literature review assesses the concepts of tenure security and food security and the linkages between them both theoretically and empirically. The review of empirical studies concentrates on the situation in developing countries with the main emphasis on Ethiopia, where our own empirical study is concentrated.

[1] An image of the land use certificate is attached in Appendix B.

3.1. Definitions and Measurement

Tenure (In)security

Land tenure insecurity and security have been defined in several ways. Here are two definitions:

- The hazard of expropriation by the government (Jacoby, Li, and Rozelle 2002)
- The risk of encroachment or eviction versus the degree of protection by the government against such encroachment and eviction

These definitions illustrate that the government may be the source of the risk or the source of protection against the risk depending on the setting or the formal land rights (recognized by the government) that the land rights claimer has.

Land tenure (in)security can be measured at the farm plot, individual, household, group, or community level. With conflicting claims over land, the increase in the (in)security of one party may imply a reduction in the (in)security of another party or parties. The strength of (in)security can depend on traditional rights (customs, norms), legal protection (laws and law enforcement), duration of possession, social networks, political connections and power structure, the degree of scarcity (competition) and value of the land, and individual and group abilities.

Tenure (in)security may be defined as a perception variable where the beliefs are formed on the basis of past events and expectations about the future, in addition to information and knowledge about rights, legal restrictions, and various types of threats and protection opportunities. Legal documents that give rights to specific units of land to specific users or owners may enhance the perception of tenure security if such legal documents are accompanied with social recognition and protection. There is no guarantee, however, that such legal documents provide full tenure security. The width, depth, and duration of rights and legal restrictions of such rights also affect the degree of tenure security. The limited duration of user rights and the conditions for renewal of those rights matter for the degree of perceived confidence that the rights will be extended into the future.

Changes in tenure (in)security over time for individuals or households may depend on natural experiments in the form of policy interventions, direct exposure to encroachment or expropriation, or information about exposure by others that affects the perceived risk that the individual or household faces in the future. For analytical purposes it is important to identify such time-varying measures of tenure (in)security that can help identify its impacts on food (in)security while controlling for unobservable individual or household characteristics and endogeneity of tenure (in)security.

Food (In)security

The concepts *vulnerability* and *poverty* are related to food insecurity. Vulnerability may be defined as the inability to protect oneself against shocks. Food insecurity may also be seen as part of a wider concept of livelihood insecurity. Poor people spend a large share of their income, typically 60 to 80 percent, on food. Income generation to meet food needs, therefore, takes a lot of their resources. The inability to smooth consumption over time, including food consumption, therefore shows the close relationship between vulnerability and food insecurity, which may be defined as the inability to meet food needs over time. This also ties into the definition of food security as “secure access at all times to sufficient food for a healthy life” (Maxwell and Frankenberger 1992; Maxwell and Wiebe 1998). This concept is typically applied at the household level as households are the core units responsible for the welfare of household members. In this perspective food security is about access, vulnerability, and sustainability. Vulnerability also depends on the ability to cope when exposed to shocks and the types of coping strategies that are available.

The complexity of defining food insecurity also makes it hard to measure it empirically in a complete and objective way. The various measures suggested include variability in food consumption over time, the shortfall in food consumption versus the food requirement, the frequency and severity of “coping strategies” (Maxwell 1996), the availability of safety nets, access to credit and insurance markets and informal insurance, the number of meals and food consumed at specific times of the year (for example, before harvest), the nutritional status of children, the food stock of households, and asset poverty indexes (Dercon 2001). Furthermore, indicators of food security have been developed such as those based on per capita energy needs, food supply from various sources, income per capita, and income variability. Nutritional status in the form of weight-for-height or weight-for-age of children may be a good indicator of vulnerability or short-term food insecurity if the assessment is made after a shock has occurred. Height-for-age may be an indicator of chronic food insecurity.

3.2. Links between Tenure Security and Land Tenure Reforms

Here we briefly review the literature with emphases on the property rights school, the evolutionary theory of land rights, and four main types of land tenure reforms that have had implications for tenure security—land titling programs, tenancy reforms, radical land reforms, and land redistribution programs.

The property rights school (Alchian and Demsetz 1973; Coase 1960; Demsetz 1967; Johnson 1972; Posner 1986) emphasizes the importance of private property rights for economic development. The three main mechanisms are the investment effect, the credit access effect, and the land market enhancement effect.

Property rights development is also seen as an endogenous institutional change: "property rights develop to internalize externalities when the gains of internalization become larger than the costs of internalization" (Demsetz 1967, 350). This view is expressed by the evolutionary theory of land rights (Platteau 1996), where a logical chain reaction may be specified as follows:

> **Population growth and commercialization → Land scarcity → Competition for land → Land disputes → Demand for more secure land rights → Land titling and registration → Enhanced tenure security and reduced disputes → Lower transaction costs → More investment and higher land productivity → More active land markets → More efficient land use → Credit market development → More investment → Land tax revenue base, and so on (Platteau 1996)**

The role of the state or the government in this is to intervene at the appropriate time to facilitate the process.

Land Titling Reforms and Tenure Security

One of the intentions of provision of freehold tenure rights is to provide strong tenure security to landowners and thereby stimulate investment and efficiency of land use. Past failures of land titling programs to create such investment and tenure security effects may partly be due to inappropriate timing of such reforms (Bruce 1986; Roth 1993). Another explanation may be that some land titling reforms have caused marginalization of the poor and minority groups which may ultimately resulted in "elite capture". Inefficient and corrupt bureaucracies and high costs of conventional land titling have also caused rationing out of poor and vulnerable groups and favored the wealthy (Barrows and Roth 1989; Roth 1993; Platteau 1996; Benjaminsen et al. 2009; Cotula, Toulmin, and Hesse 2004). Other studies have revealed no significant investment or credit access effects of land titling (Migot-Adholla, Place, and Oluoch-Kosura 1994 for Kenya; Jacoby and Minten 2007 for Madagascar). Land registration and titling can create rather than reduce uncertainty and conflicts over land rights (Atwood 1990; Benjaminsen et al. 2009; Green 1987; Bruce 1986; Mackenzie 1993). Contradictions between customary land rights and new statutory land rights can create uncertainties and conflicts that enhance tenure insecurity for some groups and individuals (Mackenzie 1993).

Land-to-the-Tiller Policies and Tenure Security

Limiting ownership rights of landlords and strengthening rights of tenants, often called "land-to-the-tiller" reforms or tenancy reforms, have been important policy interventions in many Asian countries (for example, India, Nepal) (Otsuka 2007). Landlords face the risk that the land they rent to tenants is confiscated and ownership transferred to the tenants. In reality this reform has not resulted in the transfer of large land areas to tenants. Rather, their access may have become reduced as landlords have stopped or reduced their rental activity, renting to people they trust or for only one season at a time to avoid legal claims by tenants. Enhanced Marshallian inefficiency may be one of the outcomes of this policy as the threat of eviction cannot be used as a mechanism to enhance tenant effort and landlords may prefer to rent to less efficient tenants or not to rent out at all (Aryal and Holden 2011).

Market-Assisted Land Redistribution Reforms and Tenure Security

Market–assisted land redistributions have been identified as an alternative and peaceful approach to obtain more egalitarian land distribution in some countries with highly unequal land distributions (for example, Brazil, South Africa, Zimbabwe). Landless or land–scarce poor households interested in accessing land are assisted in buying land from willing sellers (large landowners) of land. Farming ability, capital constraints, market access, access to social services, restrictions in ownership, farm size, and collective management have limited the extent of success of these programs. They have also made only a small dent in the skewed land distribution in the countries where such reforms have been attempted (Simtowe et al. 2012; Wiig and Øien 2012).

Radical Land Redistribution Reforms and Tenure Security

Some countries have undergone revolutionary land tenure reforms where all land was made state land and land was to be farmed by collectives or state farms. The collectives in most cases did not function well, and user rights to land were therefore transferred to individual households. Such distribution of weak individual rights was in many cases done according to egalitarian principles (for example, China, Vietnam, Ethiopia, Eritrea). To retain the egalitarian land distribution over time, more or less frequent land redistributions were carried out within communities to provide land to new households and to adjust the land sizes to household sizes and needs. Such redistributions contributed to tenure insecurity (Deininger and Jin 2006; Holden and Yohannes 2002; Jacoby and Minten 2007).

Low-Cost Land Certification Reforms and Tenure Security

Low-cost land certification reforms were first implemented in some of the countries that underwent radical land reforms as a response to the problems of tenure insecurity due to frequent land redistributions and weak property rights that undermined incentives to invest and prevented land market development. Such reforms have therefore typically strengthened tenure security, investment, productivity, and land rental market activity (Holden, Deininger, and Ghebru 2009, 2011; Deininger et al. 2011; Khai et al. 2012).

Customary Tenure Reforms and Tenure Security

Various countries have attempted to strengthen and formalize customary land rights by registering customary land rights and providing customary tenure certificates to communities, clans, or kinship groups (for example, Tanzania, Malawi, Uganda). Formal recognition of customary land rights may also serve to strengthen tenure security where such customary rights are threatened for various reasons, for example, where certain minority groups' rights are not recognized by more powerful groups that aim to expand their land rights. There is therefore a high risk of elite capture in such customary tenure reforms.

Global Land Rush and Implications for Tenure Security

The sharp increase in demand for land since 2008 due to high food and energy prices has introduced new threats to the tenure security of people living in land-abundant areas exposed to the new, high demands for land. Weak national policies, weak and corrupt bureaucracies, unclear laws, and powerful interest groups have in many cases caused eviction of minority groups without proper compensation or provision of alternative livelihood options, therefore imposing severe livelihood and food insecurity threats to those groups (for example, Ethiopia, Mozambique, Sudan, Madagascar) (Deininger and Byerlee 2012). Such threats are typically highest in areas where customary land rights have dominated, but the customary rights were not developed to tackle such sharp increases in demand for land from investors and speculators. The short-term effect may be as follows:

> **Sharp increase in demand for land → Tenure insecurity → Food and livelihood insecurity for local populations**

Another problem may be that statutory laws do not acknowledge customary land rights, and politicians and bureaucrats may be ignorant about them. They may even themselves be rent-seekers trying to make a profit from the demand.

3.3. Tenure Security, Investment, and Agricultural Productivity

Whereas it is commonly agreed that tenure security can stimulate investment, the opposite may also be true—investments are made to enhance tenure security (Sjaastad and Bromley 1997; Brasselle, Gaspart, and Platteau 2002; Place and Otsuka 2001). We primarily focus on the first of these causal effects by investigating the empirical evidence of the following linked effects—(a) and (b)— that may be seen as two sides of the same coin:

a) **Weak land rights → Tenure insecurity → Poor land management → Land degradation → Reduced land productivity → Food insecurity**

b) **Land rights → Tenure security → Incentives to invest (conserve) → Reduced land degradation → Increased land productivity → Food security**

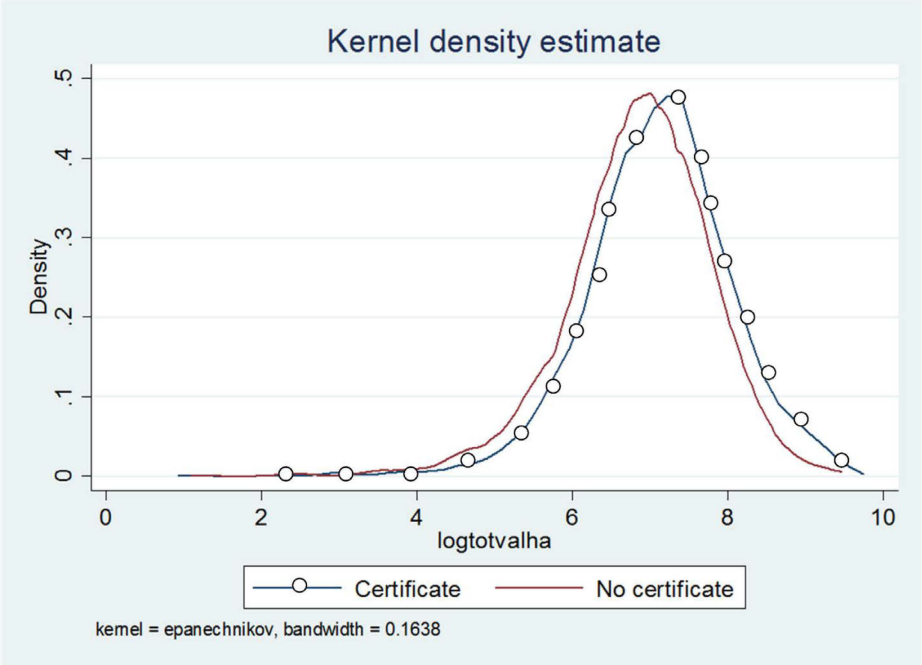
Much of the tenure literature hypothesizes that tenure insecurity has a negative impact on the propensity to invest in land improvements (Hayes, Roth, and Zepeda 1997) and likewise that making land rights more secure would stimulate long-term investments on the land (Atwood 1990; Feder and Feeny 1991; Besley 1995).

Gebremedhin and Swinton (2003) found that long-term investments in stone terraces are associated with secure land tenure, whereas more short-term investments in soil bunds are associated with insecure tenure in Tigray. In another study in the same area, Hagos and Holden (2006) found only a weak association between tenure security indicators and

the probability and level of investment in stone bunds and stone terraces at the farm plot level. In a study in southern Ethiopia, Holden and Yohannes (2002) found no significant effect of tenure insecurity on the probability of planting of perennials or on the probability and intensity of use of purchased farm inputs at the farm plot level. On the contrary, they found that resource poverty is associated with low investment in perennials. This indicates that tenure security is insufficient to ensure investments. Other factors also matter.

Deininger and Jin (2006) found that land transfer rights and tenure security are associated with higher investments in a study from 2001 covering four regions of Ethiopia, whereas Deininger et al. (2008) found a positive association between land certification and investment in a more recent cross-section survey in four regions in Ethiopia. Holden, Deininger, and Ghebru (2009) found significant positive effects of low-cost land certification on investment in trees and maintenance of soil conservation structures in Tigray Region, which was the first region to implement low-cost land certification in Ethiopia, using a household-plot panel with baseline data from just before land certification and the last survey round seven to eight years after the land registration and certification took place. They also found that land productivity had increased by about 40 percent on farm plots having a land certificate compared with plots without a certificate. The kernel density diagram below (Figure 2.1) shows that, on average, parcels with a land certificate registered higher productivity than plots for which households do not have a land use certificate.

Figure 2.1—Kernel density graph of log of plot-level land productivity per hectare for plots with and without land certificate



Source: Holden, Deininger, and Ghebru (2009).

Place and Hazell (1993), in their assessment of indigenous tenure systems in Sub-Saharan Africa, found that lack of credit access, insufficient human capital, and labor shortages have adverse effects on investment decisions more often than tenure insecurity has. One may therefore question whether customary tenure systems provide sufficient tenure security to enhance investments.

Hayes, Roth, and Zepeda (1997) found that the probability of long-term investments in fences, wells, and trees is positively correlated with complete land tenure rights (individual right to sell and right to use) and that higher long-term investments are positively associated with higher commercial input use and higher land productivity in a study in three villages under customary tenure in Gambia. Place and Hazell (1993) showed that land rights have less effect on choice of improvement than on the probability of undertaking an improvement of the land.

These findings indicate that tenure security may be a necessary but insufficient condition for land investments and it may be relevant to investigate the following related pathways:

a) **Poverty and vulnerability → Inability to invest (high discount rates) → Land degradation**

b) **Poverty reduction → Strengthened ability to invest → Increased investment → Reduced land degradation → Increased land productivity**

Holden, Shiferaw, and Wik (1998), in their study in Ethiopia, Indonesia, and Zambia, found a strong association between poverty and high discount rates and that liquidity and capital constraints explain the very high discount rates of poor rural households in the study areas. Holden and Shiferaw (2002) found a strong association between poverty, discount rates, and willingness to pay in cash or with own labor to conserve own farmland in a study in Debre Zeit in Ethiopia. Shiferaw and Holden (1998; 2001) found limited incentives to conserve own farmland to protect against land degradation and future losses in land productivity when such labor-intensive investments produce only limited or negative short-term returns. Poverty and land scarcity are associated with a stronger tendency to use soil-mining practices such as removal of soil conservation structures to access fertile soils in the structures.

Several studies in the Ethiopian highlands have shown that land degradation in combination with population growth and stagnant technology with imperfect marketslead to increasing food insecurity unless targeted policy interventions that improve markets and stimulate technology adoption are introduced (Shiferaw and Holden 1999; Holden and Shiferaw 2004). Market imperfections cause inseparability of production and consumption decisions within households, and plot-level investment and input use decisions depend on household characteristics such as wealth, ability, and market access (Holden, Shiferaw, and Pender 2001).

Several studies in Latin America have demonstrated positive investment impacts of land titling (Alston, Libecap, and Schneider 1995; Deininger and Chamorro 2004; Lopez 1997), and the same is the case for some case studies in Asia (Feder 1988; Do and Iyer 2002). However, studies of land titling in Africa have found no evidence of investment impacts (Migot-Adholla, Place, and Oluoch-Kosura 1994; Pinckney and Kimuyu 1994).

Based on this brief review, we may deduce that tenure security may be an important but insufficient condition for the existence of conservation and investment incentives.

Technological change in agriculture is associated with population increase and market development. Increasing population pressure may induce investment and intensification and that could lead to more sustainable land management and improved welfare, as has been experienced in many parts of the world. This is the “Boserupian development pathway” (Boserup 1965):

> **Increasing population pressure → Land scarcity (land poverty) → Land use intensification and investment incentives → Increased market participation → Economic development → Food security**

Improved tenure security is an implicit part of this development pathway as land rights tend to become more individualized and formalized. The failure to develop secure property rights in this process may therefore threaten this positive pathway.

Another important aspect of the relationship between tenure security is the fact that there may be reverse causality:

> **Investment → Tenure security**

This means that tenure security is endogenous. A positive correlation between tenure security and investment could thus occur because people invest to become more tenure secure (Sjaastad and Bromley 1997; Brasselle, Gaspart, and Platteau 2002; Place and Otsuka 2001). Homesteading was used as an explicit policy in the United States in the 19th century. Settlers had to settle on and develop the land in order to claim property rights to it. This makes both land rights and tenure (in)security endogenous and adds methodological challenges to the need to establish causality and the estimation of unbiased causal effects.

Land rights restrictions and obligations may also contribute to this type of reverse causality. Laws that impose land use and maintenance obligations such as the recent land law reforms in Ethiopia (Holden and Ghebru 2012) are a good example. Those 2006 laws require that land is farmed and not left idle, that only 50 percent of the land can be rented out, that land should be properly conserved, and that households’ land can be confiscated without compensation if the household leaves the land for more than two years. The ultimate penalty for not using and not conserving the land is eviction. Failure to conserve, excessive renting out of the land, and migration, which could be behavioral responses to shocks, poverty, and vulnerability causing food insecurity, therefore can result in tenure insecurity and loss of land and livelihood security. On the other hand, such a law may create incentives for the able-bodied to take better care of their land, enhance land productivity, and thus enhance food security.

3.4. Climatic Risks, Land Degradation, Investment Incentives, and Land Productivity

Weather risks, such as droughts, floods, frost, hailstorms, and other natural hazards such as pests and diseases, are important elements of the production environment of farm households. Such risks tend to be higher in areas without

irrigation and with lower levels of average annual rainfall. Rainfall variability relative to mean rainfall tends to increase with decreasing mean rainfall. The vegetation cover tends to be poorer the lower the mean rainfall, and the frequency and severity of droughts tend to be higher. Intensive rains tend to cause more damage when vegetation cover is limited and cause severe land degradation and crop damage. Climate risks are therefore one of the main factors contributing to food insecurity in dryland (semiarid and arid) areas. At the same time, such risks affect the behavioral responses of farm households that have such risky environments as their livelihoods. Such households are typically risk averse and use combinations of ex ante behavioral strategies and ex post (after weather shock) coping mechanisms to survive and maximize their welfare as they live in environments and face market imperfections such as missing or highly restricted insurance and credit markets. Flexible tenure systems that allow mobility of people and animals represent one of the institutional responses in the most arid areas dominated by pastoralism. Imposing individual, exclusive property rights and fencing in such areas would severely threaten food and livelihood security. Strengthening of communal land rights and collective action may be a better approach than promotion of individual tenure rights.

We may thus summarize these relationships as follows:

Droughts → Low land productivity → Food insecurity

Erratic rainfall/Floods → Rapid land degradation → Loss of land productivity → Food insecurity

Increased climatic risk → Increased land degradation → Increased short-term and long-term food insecurity

Arid environment → Food and livelihood insecurity → Flexible tenure system → Mobility and improved security

Secure communal land rights → Community investment in soil and water conservation → Reduced land degradation → Improved livelihood security and sustainability

3.5. Agricultural Productivity, Household Income, and Consumption Expenditure

Rural households may derive income from agricultural as well as nonagricultural activities, and they may obtain food by producing it themselves or buying it from the market. With better market integration the links between food production on own farm and household food security become weaker. However, the link between household food production and food security is stronger in environments that are poorly integrated into markets and where particularly food and labor markets are poorly developed and subsistence production dominates. Agricultural production risks affect income risk and may cause various forms of income diversification strategies to smooth income over time.

Deaton (1991) assumes that households maximize intertemporal expected utility where the utility in each period is concave in consumption and marginal utility is convex, giving a precautionary (risk-averse) motive. At the same time households are assumed to be impatient and discount future utility, and this limits willingness to save and invest unless the expected rate of return is higher than the discount rate. This also limits asset accumulation. Such households facing production and income risk will adjust assets and income in order to smooth consumption over time.

The existence of covariate risk in remote rural areas with high transaction costs and information asymmetries causes credit and insurance markets to fail to function and limits households' ability to smooth consumption over time, making them vulnerable. Households use precautionary savings in the form of assets and income diversification strategies to help protect against such covariate shocks. However, such mechanisms also involve risk as asset values, such as livestock prices, tend to be correlated with covariate production shocks (Dercon 2001). Holden and Shiferaw (2004) estimated that the value of a direct production loss due to drought could be less than the loss in livestock value that households face because they must sell animals at a lower price to buy food at a higher-than-normal price. This terms-of-trade risk limits the ability of households to smooth consumption via self-insurance through asset savings. One response may be that households cut their consumption to very low levels rather than sell their assets when the asset terms of trade are very unfavorable. This was observed in Ethiopia in the 1984/85 famine (Dercon 2001). In such cases land assets of households may also be under threat of being sold or rented in the form of distress sales or rentals at unfavorable prices. Severe covariate shocks causing food insecurity and famine may therefore also result in tenure insecurity and the selling of land entitlements as one desperate coping strategy.

3.6. Household Income and Nutrition Status

It follows from the previous paragraph that nutrition status may be an indicator of vulnerability and food insecurity in risky environments where households are imperfectly insured and therefore have limited ability to smooth consumption over

time. The choice to go hungry to protect assets may be an adaptive strategy to enhance consumption in the longer run. The alternative coping strategy would be to sell assets at a low price to increase short-term food production at the high cost of reduced future consumption.

Nutritional research has shown that young children in particular are vulnerable to nutritional shortages. Such shortages result not only in weight loss and stunting but also in brain underdevelopment with lifetime consequences. Malnutrition of children can therefore lead to permanent human capital losses that can affect the ability to work in more than one way.

The alternative options available to vulnerable households can be stated as follows:

Covariate shocks → Food insecurity → Selling of assets → Loss of future income opportunities

Covariate shocks → Food insecurity → Malnutrition → Permanent human capital losses → Reduced ability to work → Less investment and productivity

Households may choose from many alternative coping strategies. The availability and combination of such coping strategies may be an indicator of food (in)security (Maxwell 1996). Such coping strategies tend to be location and household specific. There may also be a hierarchy of alternatives from the most preferred to the least preferred (most costly) options.

Gebregziabher and Holden (2011) found that distress land rental under fixed-rent contracts as a coping response to shocks came as a last resort after all other means of coping had been exhausted in Tigray Region, illustrating the central role of land in this environment. The stated coping strategies included (a) daily labor; (b) migration; (c) selling animals; (d) selling firewood; (e) selling household assets; (f) looking for aid; (g) reducing consumption; and (h) renting out land for cash. Households were less likely to use distress land rental as a coping strategy if they sold livestock or assets to cope, but distress land rental was positively associated with the collection and sale of firewood. The latter two strategies were chosen only after depletion of other household resources and could be seen as more desperate strategies.

The following effects could be envisioned from the migration and reduced consumption coping strategies, which may have negative future effects on investment, land productivity, and food security and contribute to a vicious spiral but could also be a way to reestablish a sustainable livelihood by reducing the family size, as migrating members find alternative livelihoods and may even contribute remittances:

Shock → Migration of household members → Loss of on-farm labor → Less investment → Food insecurity

versus

Shock → Migration of household members → Reduced family size and food needs → Food security

Shock → Poor nutrition → Inability to work → Less investment and productivity → Food insecurity

3.7. Land and Land Markets as a Safety Net

Access to land is an important indicator of household welfare in agrarian economies with limited off-farm employment opportunities. Land distribution can in such economies be an important policy instrument to enhance or change welfare distribution. This is also an important reason for emphasis on more egalitarian land distribution and avoidance of landlessness because the most land-poor and landless tend to be the poorest in such agrarian economies. Various forms of land tenure reforms have been implemented to achieve a more egalitarian land distribution, such as radical land tenure reforms, land-to-the-tiller policies, and market-assisted land redistributions. Such radical land tenure reforms have for example been implemented in China, Vietnam, and Ethiopia. India and Nepal are examples of countries that have attempted land-to-the-tiller policies, and Malawi, South Africa, Zimbabwe, and Brazil have introduced market-assisted land redistributions.

Ethiopia implemented a radical land reform in 1975. All land was made state land, and a new constitution was established granting all residents user rights to land to meet their basic household needs. Land was allocated based on household size within each community (peasant association) after land had been divided into land quality classes. Each household received a share of each land quality class. This was done to enhance household food security and reduce dependency on markets as land renting and hiring of labor were prohibited. To retain the egalitarian land distribution and provide land to new households, land redistributions were implemented, first by allocating the remaining collective and parts of the communal land to new households and later by taking land from the most land rich (for example, households that had experienced a reduction in their family size) for redistribution to the most land-poor and landless new

households. Paradoxically, the constitutional right to land therefore resulted in tenure insecurity, and that may have undermined investments on land (Alemu 1999; Holden and Yohannes 2002; Deininger and Jin 2006).

After the overthrow of the Derg regime in 1991, Ethiopia adopted a more market-friendly policy. Although land renting and hiring labor were allowed, selling land remained illegal and access to land remained a constitutional right. However, the country realized that the administrative redistribution policy had negative effects on tenure security and investments, and that policy was therefore halted, with a few exceptions, and land registration and certification was introduced to enhance tenure security and provide perpetual user rights to land. Land was allowed to be bequeathed to children, but a minimum farm size of 0.25 hectares - was introduced to prevent excessive land fragmentation. The combination of prohibition of land sales, the minimum farm size, and continued population growth in the densely populated highlands with limited communal land for redistribution has created an excess demand from young landless households in search for a livelihood based on their constitutional right to access land. This growing excess demand for land is one of the main challenges faced, and in 2006 Ethiopia introduced a new land law and policy stating that land can be expropriated from households that have migrated from the community for more than two years and from households with permanent off-farm income. One of the debated issues is whether households that migrate for desperate livelihood security reasons should risk losing their land and become destitute landless households. The new law therefore reintroduces tenure insecurity that may hurt some of the poorest households that have been forced to migrate (Holden and Ghebru 2012). Overall we see an evolution where increasing land scarcity erodes the capacity of land to serve as a safety net. More desperate migration is inevitable, and a basic question is whether policies should aim at facilitating or preventing migration out of such overpopulated rural communities. The current policy in Ethiopia of prohibiting land sales and prohibiting households from renting out more than 50 percent of their land hinders rather than facilitates migration. It contributes to the creation of rural poverty traps and increases the burden on public safety net programs.

We may compare the Ethiopian policy with that of Uganda, which allows land sales. There households may decide to sell their land if they live in a particularly land-scarce area where land prices have become very high. This gives them starting capital to move to another area and establish a new livelihood. That could be another rural area where land is less scarce and land prices lower, such that they can get more land for the sales value they received for their land in their area of origin. Or they may choose to go to an urban or peri-urban area and establish some other form of business. The land market therefore creates more flexibility and may reduce the existence of rural poverty traps and the need for public safety net programs.

3.8. Access to Safety Net Programs and Impact on Agricultural Production and Investment

Provision of public safety net programs has been one of the most important public responses to food insecurity at household and community levels in countries with severe food insecurity problems such as Ethiopia. Ethiopia has been a leading recipient country for food aid. The country has decided to supply 80 percent of its food aid through public safety net programs (FDRE 1996).

Such programs include (a) provision of food aid to targeted households and communities that have been identified as in need of such support; (b) provision of food-for-work (FFW) and cash-for-work (CFW) opportunities to targeted communities where the payment in food or cash has been so low that it could facilitate self-selection by the poor into the program, thus reducing the need for administrative targeting; (c) employment generation schemes providing employment opportunities with payment in food or cash in areas exposed to shocks (climatic or other shocks); and (d) productive safety net programs targeted to chronic food-insecure areas guaranteeing access to the program for eligible households for a longer period (five or 10 years in Ethiopia) to allow households to build assets and climb out of poverty.

These types of programs enhance household food security for targeted households in the short run. It reduces their need to resort to alternative and more costly coping strategies in case of shocks such as depletion of their livestock resources (Legesse and Holden 2012). Public safety net programs may also help households build assets. Legesse and Holden (2012) found that participation in PSNPs in Tigray helped households rebuild their livestock endowments and contributed to children's education. The study also showed that there are diminishing returns to livestock accumulation and the limited land endowment is critical for provision of feed for the animals. This limits the potential of livestock accumulation as a strategy to climb out of poverty. Investing in children's education may be a better long-term strategy, but it also depends on the availability of sufficient off-farm employment opportunities. Legesse and Holden (2012) found that participation in public safety net programs enhanced the nutritional status of children.

What are the potential feedback effects from safety net programs to agricultural production and tenure issues? Do the safety net programs create disincentive effects and increased dependency? That depends on the community-level and broader effects of such programs as well as the household-specific responses. First, such programs may be used to invest in public goods such as conservation of communal lands, tree planting, road construction, irrigation investments,

school construction, and so forth, which have direct positive effects on the local livelihoods. Second, such investments can contribute to internalizing negative externalities such as land degradation and create positive externalities such as enhanced incentives to invest on private land because households do not have to resort to other adverse coping strategies. Third, there may be a demonstration effect of such highly participatory public works projects in terms of individual skill creation and development of community organizational skills.

Holden, Barrett, and Hagos (2006) and Hagos and Holden (2006) showed that some of the benefits from FFW and CFW opportunities in Tigray had been provision of technical assistance, labor mobilization, and conflict resolution in relation to reducing the land degradation problem and implementation of coordinated soil and water conservation. These problems also caused a demand for FFW and CFW activities to conserve private farmland because of the spatial externalities requiring coordinated efforts across farm borders and a communal land conservation plan. Hagos and Holden (2006) found that public conservation programs stimulated private investments in stone terraces and soil bunds on private land. Such effects may also come because households were food secure and did not have to migrate or sell their productive assets and were therefore more capable of investing on their land. The protection of current consumption also helps prevent undernourishment and illness and associated costs of taking care of the sick. Allocation of time for FFW or CFW activities may, however, be at the expense of time used for other productive activities. Indeed, in Tigray Region a requirement exists that all able-bodied adults should work for free for the community in order to qualify for participation in the FFW and CFW activities. This may be seen as a labor tax that is linear in the adult labor force of households, but it will be tougher for the more labor-poor households, such as female-headed households with only one adult (female) laborer. It could have a negative effect on their other household responsibilities, including productive work such as cultivation of own farmland. A large share of such female-headed households has resorted to renting out most of their land through sharecropping contracts. With the new land law making it illegal to rent out more than 50 percent of their land, they may become more tenure insecure. We may summarize this potential linked effect for labor-poor households as follows:

> **Compulsory labor requirement to qualify for safety net → Less time for own production → More renting out of land → Tenure insecurity due to law restriction on land renting**

Another argument is that the safety net is like a sleeping pillow and reduces the incentive to work because households are drudgery averse. Private work efforts are therefore crowded out. There is an attempt to minimize such negative effects by scheduling FFW and CFW activities at times of the year when the work competes least with other productive activities.

Although scholars have focused on the disincentive effects of food aid (Lentz 2003; Lentz, Barrett, and Hoddinott 2005), we find few rigorous empirical studies. In a study in Kenya, Barrett, Bezuneh, and Aboud (2001) found that for the poorest half of households, FFW was negatively associated with sale of animals and positively associated with crop income and off-farm income. Abdulai, Barrett, and Hoddinott (2005), using data from 42 Sub-Saharan countries and applying a vector autoregressive model, found that food aid has a positive effect on food production with up to two years' lag. They explained this as the income effect of food aid that relaxed the factor market constraints and liquidity constraints that may limit food production. Bezu and Holden (2008) assessed the impact of FFW on the adoption and intensity of fertilizer use in Tigray. They found that FFW had a significant positive influence on the decision to adopt fertilizer and no significant effect on the intensity of fertilizer use.

3.9. Migration, Cultivation, and Tenure Security

The relationship between migration, cultivation, and tenure security is affected by how well land and labor markets function and land rights and obligations of land rights holders. Restrictions on land sales and rentals in combination with cultivation requirements may reduce the extent of migration but also make migrants more tenure insecure as follows:

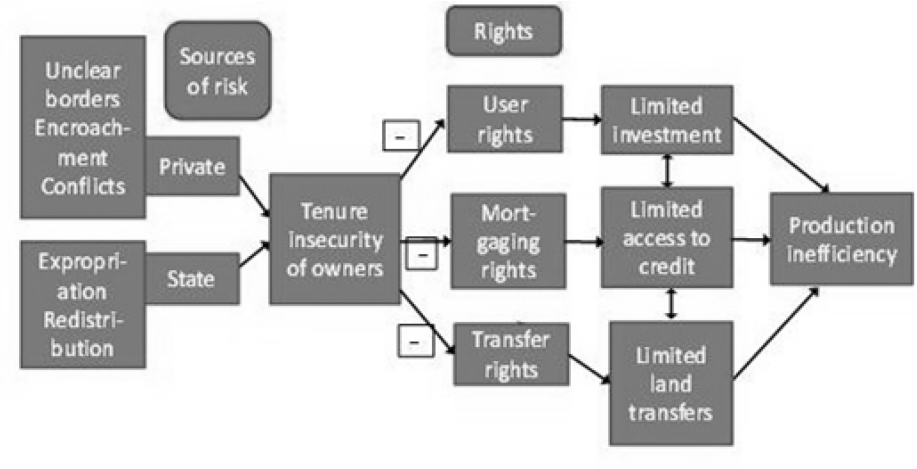
> **Migration/Off-farm employment → Renting out of own land → Tenure insecurity**

These causal relationships are established by law in Ethiopia. Households that have migrated out of their community for more than two years (Tigray Region) can have their land expropriated without compensation. The law also states that households are not allowed to rent out more than 50 percent of their land, which may cause tenure insecurity for households doing so. Especially female-headed, weak, and vulnerable households are those renting out more than 50 percent of their land because of a lack of capacity to cultivate the land efficiently themselves (Holden and Ghebru 2012).

4. CONCEPTUAL FRAMEWORK

Figure 4.1 shows a simple conceptual model of the determinants of tenure insecurity and how tenure insecurity may affect land rights and thus land use and production. Tenure insecurity of owners can be the result of border (encroachment) disputes due to unclear plot boundaries (that is, the source of insecurity is private) or fear of loss of land due to government expropriation (public or state source).

Figure 4.1—General model for sources of tenure insecurity and their effects on land use and production



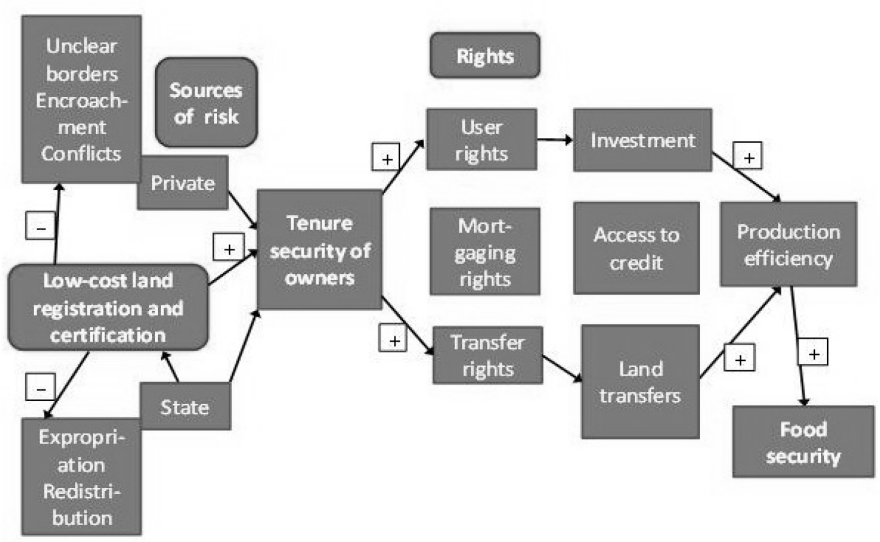
Source: Holden, Otsuka, and Deininger (forthcoming).

The specific effects of the land registration and certification program in Ethiopia included plot border demarcation and identification of owners with neighbors as witnesses. This (as Figure 4.2 shows) should reduce the risks of encroachment and the probability of land border disputes. Holden, Deininger, and Ghebru (2010) document such effects. The land law reform that accompanied the land registration and certification reform stated that land redistributions should stop. Receipt of land certificates that grant perpetual inheritable user rights to the land should therefore reduce the fear of land redistributions. It may also reduce the fear of expropriation or fear of expropriation without compensation.

The nonfreehold land certificates provided in Ethiopia provide use rights and limited transfer rights (land-renting rights for limited periods of time, no rights to sell) and no mortgaging rights. We expect more secure use rights to enhance investments on the land. Furthermore, land rental rights may help to reallocate land to more efficient users, and that may enhance input use and input use efficiency. It is uncertain whether such short-term rental contracts create incentives for enhanced investment on rented land.

Thus, based on the theory and empirical literature discussed in Sections 2 and 3, Figure 4.2 shows the conceptual framework for understanding the links between land tenure, production, and food security in the particular study context.

Figure 4.2—Conceptual model of the relationship between low-cost land registration and certification, tenure security, and food security



Source: Holden, Otsuka, and Deininger (forthcoming).

Hypotheses

Earlier studies in the same region and partly drawing on the same data have identified investment and land productivity effects on owner-operated land (Holden, Deininger, and Ghebru 2009) and allocative efficiency effects on rented land (Holden, Deininger, and Ghebru 2011; Holden and Ghebru 2011). Holden and Ghebru (2011) also found positive consumption expenditure effects of land certification, particularly for female-headed landlord households. Holden Deininger, and Ghebru (2010) found significant reduction in land border disputes after land registration and certification in the same region using data from local conflict mediators. The novel contribution of this paper is to test the following broad hypothesis:

H1: Land certification has enhanced household food security.

We assess food security effects by estimating the effect of land certification on the average calorie availability per adult equivalent per day in households. The calorie availability is weighted with the prices and the calorie intake from a food basket of the 14 most important food items consumed in the study areas. This measure of food consumption is affected not only by the agricultural production and income of the household but also by the access to safety net programs and the various coping strategies that are used to stabilize consumption or reduce consumption when that is preferred to protect assets or make investments. We derive the following subhypotheses that we aim to test:

H1a: Land certification has enhanced food security in the form of calorie availability for households.

H1b: Land certification has in particular enhanced calorie availability through strengthened use rights and investments.

H1c: Land certification has enhanced calorie availability through enhanced participation in land rental markets.

H1d: Land certification has in particular enhanced the calorie availability of female-headed households.

H1e: Land certification has enhanced the nutritional status of family members.

5. DATA AND METHODS

5.1. Data

The data used in this study come from a survey that sampled 400 households in 16 communities in Tigray Region. The first survey round took place in 1998, just before the land registration and certification reform was implemented. The sample villages were stratified to capture the main variations in market access, population density, irrigation access, and zonal agroecological variation in the highland areas of the region, where most of the population lives. Land registration

and certification was not implemented in the drier lowlands, where population densities are much lower and pastoralism is common. Data were collected not only for a wide range of household-level variables but also for each farm plot of households, including land characteristics, input use, investments, and outputs.

The households were resurveyed in 2001, 2003, 2006, and 2010, and that gives us a five-round household panel to use for analysis at the household level. However, due to dropout of respondents (mostly related to the Ethio-Eritrea border war, which started in 1998 and ended in 2000), this study is based on a balanced panel of 300 households. Respondent attrition was tested and minimal. Using the baseline data, we tested whether any of the key variables of interest (household demographic and endowment variables) are significant in determining the probability of attrition. As Table A.1 (see Appendix A) shows, none of those variables was found to be statistically significant.

That the first survey took place just a year before the intervention provides a unique opportunity to assess the potential welfare (food security) impacts of the land certification program using the 1997/98 survey as baseline information. Comparability of the dataset over time is ensured because the data collection process relied on a standardized questionnaire. Multipurpose questionnaires were used to gather a host of household demographic variables, information on household farm and off-farm income, consumption expenditure, access to public services, and 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). Anthropometric data for children up to 16 years old were used as indicators of food intake. We have such data for the children in the household sample for 2006 and 2010. We also have data for weight, height, and age of parents in 2010. We have calculated the BMI as an indicator from those data.

Welfare Indicators and Measuring Food Security

We had several concerns when identifying the most appropriate indicators for food (in)security. First, we needed to link it to the food needs of households and individuals in households. Second, we needed to measure the availability of food or intake of food in efficiency units as reliably as possible and relate those measures to the need. Third, we needed a big enough sample that could be related to the treatment, land certification, over space and time. Fourth, we would prefer to have continuous variables with nice properties that allow us to use stronger econometric tools for our analysis.

Based on those concerns, we decided to use two main variables as measures of food security. The first is calorie availability per adult equivalent per day as a household-level variable. After inspecting its distribution we decided to log-transform to minimize skewness and get a continuous variable with a nice bell-shaped distribution. We were able to construct this variable for all five survey rounds based on the consumption data that are based on own production, purchased food, and food obtained from safety net programs and other sources (such as through various coping strategies). The second variable is the BMI for household members. An important limitation is that we have such data (height, weight, and age) only for children for 2006 and 2010 (the two last survey rounds) and only for the parents in 2010. That may limit our ability to identify impacts of land certification on nutritional status. The advantage of this indicator may, however, be that it is measured with higher accuracy than calorie availability.

We will elaborate on how the calorie availability approach is implemented. It is closely tied to the cost-of-basic-needs (CBN) approach (Ravallion and Bidani 1994), where food insecurity is defined in terms of inadequacy of consumption of basic needs such as food. As the objective of these alternative food security or insecurity indicators 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 nonfood items—that is adequate to meet the recommended (or minimum) nutritional requirements and estimating the cost of purchasing that consumption bundle. 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 CBN approach because this is the variable we are able to track over all rounds of the panel. Although we decided to use the average daily per capita availability as the dependent variable, it is easy to see that this variable is closely tied to food insecurity in the form of a calorie gap indicator by subtracting the standard Food and Agriculture Organization of the United Nations (FAO)–recommended daily nutritional requirement of 2,100 kilocalories (kcal) per day. To ensure that we have a dependent variable that is continuous and with strictly positive values we preferred to use estimated daily per adult equivalent consumer calorie availability. The calorie gap would have both negative and positive values or would be truncated at zero.

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 (based on each administrative zone) 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 composition to control for variations in demographic composition across households.

We also explored the different types of stated coping strategies used by the households in the baseline year in response to moderate and severe droughts. We present some descriptive statistics on this.

Tenure Security Indicators

To explore the tenure security status of households, we used household-level perception data on perceived tenure security (based on responses to whether they feared losing their land to government expropriation) in the baseline survey in 1998. Furthermore, households' perceptions on the impacts of land certification on tenure security - that is, we used households' response to whether they believe land certificates have an effect on reducing land-related disputes; enhance women's tenure status; and/or increase chances of getting compensated during times of possible expropriation as tenure security indicators. To assess whether demand is growing for more secure property rights, we used household responses to hypothetical questions about their willingness to pay for further government actions aimed at improving tenure security.

The policy instrument used to enhance tenure security was land registration and provision of land certificates at the household level with detailed information about each farm plot for which households were given the user rights into perpetuity. This information included the name of the location of the plot, its size, its land quality, and the names of the neighbors who were also jointly witnessing and agreeing on the demarcation of the plot borders during the land registration process. Holden, Deininger, and Ghebru (2010) have shown that land registration and certification has substantially reduced the extent of land border disputes in the Northern highlands of Ethiopia, by far the most common type of land-related dispute before land registration and certification took place.

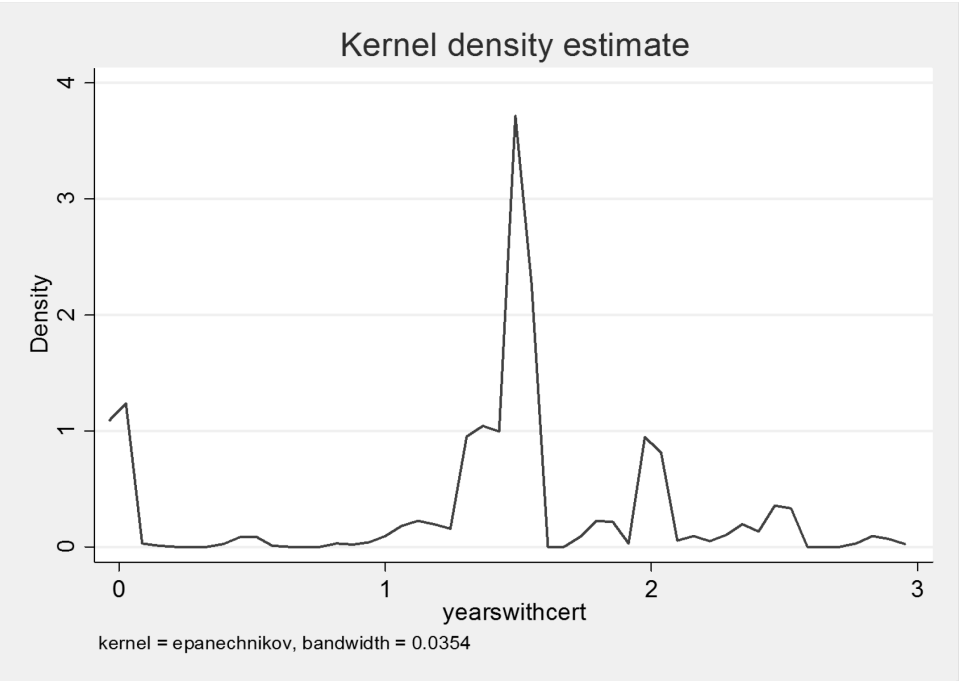
Tenure security itself, its causes, and its impacts are dynamic. It may not only take time from the implementation of land registration until households receive the land certificates but also take time until they realize the importance of the certificates and change their behavior related to their land as a consequence of an increased tenure security. In addition, impacts of land certification program on land management, investment, and land rental decisions may be gradual, and the outcome effects on land productivity, income, and food security are likely to materialize more or less gradually. To capture and assess this gradual effect we use the time period (in years) that the individual households have possessed their land certificates.

5.2. Estimation Strategy

Identification Strategy

Although the broad, low-cost land registration and certification process was administered by young staff with limited training and no modern equipment, it was very participatory, was not captured by local elites, and was implemented on a broad scale within a short period of time in 1998 through1999. The implementation process stopped when the war with Eritrea broke out in 1999. By then close to 85 percent of the targeted areas had been registered, and most of those households received their land certificates. This resulted in some variation in the timing of allocation of land certificates, largely determined by administrative constraints that facilitate use of a "pipeline approach" to delivering the land certificates. Figure 5.1 shows that although the land certification process was a one-off project, there was significant variation in the timing of issuance of certificates during the period between the start of the land project (1998) and three years after the program was launched (2001). We have therefore used the household-level "years of ownership of land certificate" as the treatment variable to identify the impact of land certification on food security. This variable is used in combination with household fixed effects to control for other potential unobservable household and farm characteristics that may create bias in the analysis. We have tested for attrition bias in the data as about 25 percent of the initial sampled households have been lost over the years of the panel. Although we have found significant attrition bias in some models with limited dependent variables where we could not use household fixed effects, the attrition bias became insignificant in models with continuous dependent variables when we used household fixed effects, attesting to the ability of the fixed effects estimator to control for this type of bias.

Figure 5.1—Distribution of the "years with certificate" variable in 2001 panel round



Source: Authors' computation.

Our five-round panel data in combination with the "years of certificate ownership" variable allow us to assess the dynamic impacts of strengthened tenure security through land certification on calorie availability. The two-round panel with individual nutrition status also allows us to assess whether there are any significant impacts of the reform 8–12 years after its implementation. It is, however, possible that we may see a catching-up effect after so many years such that the "years of certificate ownership" variable becomes insignificant. To test this we tested the effect of reducing the panel length in the models with calorie availability from five rounds to four, to three, and to two rounds by stepwise leaving out rounds from the first round and onward. By inspecting both the size of the parameters in this process and the significance levels, we learn something about the dynamic effects.

Inclusion of additional control variables in this type of panel data may lead to more rather than less bias in the estimates (Wooldridge 2010, 974), and we have therefore left out many potentially relevant variables such as access to the Productive Safety Net Programme and other food-security-enhancing programs. We have therefore cautiously added the relevant variables to test our key hypotheses related to the pathways for food security impact from enhanced tenure security.

Two approaches were used to attempt to separate the management and investment effects from the land rental market participation effects. Since land sales and the mortgaging of land are illegal, we do not expect any effects along this otherwise potential third line of the impact chain. Holden, Deininger, and Ghebru (2011) showed that land certification enhanced land market participation by households in our study area as landlord households (predominantly female) became more tenure secure and therefore more willing to rent out their land. This also resulted in better access to land for (potential) tenants in the land rental market. First, we ran models without and with the "operational farm size/own farm size" variable to see whether that variable had a separate effect on calorie availability. Second, we split that variable for landlords and tenants and ran separate models for landlords, tenants, and autarkic households as well as a joint model. The joint model was also run with an alternating number of survey rounds for assessment of the dynamic changes. Also, we attempted to run separate models for landlords, tenants, and autarkic households with a varying number of survey rounds, but some of those suffered more from shrinking sample sizes when we reduced the number of survey rounds and we have therefore not included those models in the report.

Land rental market participation is clearly endogenous and that also causes the "operational farm size/own farm size" variable to be endogenous. Ideally we should therefore instrument for this variable; however, it is very hard to think of a variable that affects land rental market participation but that is not correlated with unobservable time-variant heterogeneity. We have therefore resorted to running models without and with this variable, and we split it into two variables, one for landlords and one for tenants, and then interpret the results with care and compare with the models without this variable. In general, households that participate in the land rental market as tenants tend to have more nonland resources that make them more able to use land efficiently. Given that they access land (which still is

constrained under a sharecropping system), there is likely to be a positive correlation between how much land they access relative to their own farm size and the amount of nonland resources they have. This could lead to an upward bias in the identified effect of land access on food availability of tenant households due to selection bias. This needs to be kept in mind when interpreting the results. Similarly, on the landlord side, the poorer a landlord is in nonland resources the more of her land she is likely to rent out given that she feels tenure secure. However, through sharecropping she will typically get 50 percent of the output from the rented-out land and that should be good for her food availability. Selection bias on this side of the market may therefore cause an underestimation of the food availability effect of the "operational farm size/own farm size" variable. Without selection bias, the variable should have a negative and significant parameter value for landlords and a positive and significant parameter value for tenants given that land rental market participation enhances food availability of both landlords and tenants.

An interaction variable, interacting the "years with certificate" variable with the "sex of household head" dummy variable, was used to test hypothesis H1d that land certification had a stronger positive impact on calorie availability of female-headed households than that of male-headed households. The reason for this hypothesis is that female-headed households are assumed to be more tenure insecure initially and more dependent on renting out their land, and they are therefore expected to gain more from the reform through participation in the land rental market as landlords (Holden, Deininger, and Ghebru 2011).

These tests rest on there not being any time-varying unobservable variables causing households with certificates to have a stronger trend in food security improvement than households without certificates (common trend assumption). The same assumption is required for female-headed versus male-headed households. We cannot think of any such variables that would cause stronger welfare improvement over time for female-headed households.

The general specification of the estimated models is as follows for the calorie availability and the BMI models:

$$CA_{ht} = \beta_0 + \beta_1 A_{ht} + \beta_2 CY_{ht} + \beta_3 S_{ht} + \beta_4 CY_{ht} * S_{ht} + \frac{\beta_5 OP_{ht}}{A_{ht}} + \beta_6 D_t + \vartheta_h + e_{ht} \quad (1)$$

$$BMI_{iht} = \beta_0 + \beta_1 A_{ht} + \beta_2 CY_{ht} + \beta_3 S_{ht} + \beta_4 CY_{ht} * S_{ht} + \frac{\beta_5 OP_{ht}}{A_{ht}} + \beta_6 D_t + \beta_7 X_{iht} + \vartheta_h + e_{iht} \quad (2)$$

The dependent variable (CA_{ht}) is specified as the real calorie availability of household *h* in year *t* per adult equivalent. A_{ht} is the farm size per adult equivalent, CY_{ht} is the number of years the household has had its land certificate, S_{ht} is a dummy for the sex of household head, OP_{ht} / A_{ht} is the operational holding size divided by the own holding size, D_t is a vector of year dummies, BMI_{iht} is the body mass index for individual *i* in household *h* in year *t*, X_{iht} is individual characteristics such as age and sex, ϑ_h is the unobservable time-invariant household, farm, and village characteristics that can be controlled for using household fixed effects, and e_{ht} is the error term. The year dummy variables control for the general trend effect such that the effect of certification on those households that received certificates can be identified.

6. DESCRIPTIVE ANALYSIS

6.1. Assessment of the 1998 Baseline Data

Tenure (In)security Perceptions

Our baseline data from 1998 are from just before land registration and certification was implemented in the region and therefore give a good representation of the state of land tenure security before land certification was implemented. Table 6.1 gives an overview of perceptions in 1998 by zone in the region.

Table 6.1—Perceptions on land tenure security and land conflicts in 1998 (baseline data)

Question	Response	Zone (% of respondents)				All
		Central	Eastern	Southern	Western	%
Fear of loss of land	Yes	56	45	42	61	51
Does the fear affect land management?	Yes	3	8	20	13	11
Land conflicts solved in a good way?	No	0	1	10	25	9

Source: Hagos and Holden (2002).

We see from Table 6.1 that 51 percent of the surveyed households feared future land redistributions and 11 percent indicated that this fear affected their land management. In the western and southern zones, 25 percent and 10 percent, respectively, of the households were critical of the way land conflicts were resolved. Reasons in relation to the fear or lack of fear for land redistribution were also recorded for some households. We summarize those in Table 6.2.

Table 6.2—Reasons for fear or no fear of future land loss

Response by those fearing/not fearing land loss: Those fearing:	Zone (% of respondents) Central	Eastern	Southern	Western
Increasing landlessness	0	4	7	0
Increasing population pressure	1	0	6	0
Fear of losing land	3	5	7	3
Loss of income, become poorer	3	2	1	0
Land shortage	3	3	5	1
Those not fearing:				
More equitable distribution	0	0	2	3
All should have a share	4	0	0	0
Landless can get land	13	13	5	3
I can share with others	0	0	1	7
It will go to my children	4	10	9	0
I will have a share/I have a small area/I will not lose land	8	9	7	2
I am too old	0	3	2	0
I accept government decision	9	2	10	5
Land will no more be redistributed	0	4	2	0

Source: Hagos and Holden (2002).

Increasing landlessness is apparently both a cause of fear of future land redistributions as well as an important reason many do not fear but rather hope for more land redistributions because they or their children have little or no land. Some even stated their willingness to share their land with others. Others expressed that they accept the government's decisions on this, whereas very few thought that there will be no more land redistributions, although that is the current official policy.

Food (In)security, Adaptive Strategies, and Coping Strategies in Case of Drought

Household ex ante risk-reducing strategies are summarized and ranked in Table 6.3. The choice of drought-resistant crops and short-duration crops and varieties were considered the most important risk reduction strategies, followed by water harvesting and investment in irrigation. Other strategies included investment in soil conservation. Using savings of cash and animals appeared only as the third and fourth ranked for some of the households. Very few put off-farm income higher than in the fourth rank. The reason may be that such activities are primarily chosen for other reasons than as an insurance system, which thus may be just a byproduct.

Table 6.3—Ranking of ex ante risk insurance strategies used by households (% by zone)

Strategy	Rank 1				Rank 2				Rank 3				Rank 4			
	C	E	S	W	C	E	S	W	C	E	S	W	C	E	S	W
Drought-resistant crops	53	51	48	58	20	25	28	23	15	6	0	9	5	4	3	1
Drought-resistant varieties	10	16	3	13	54	41	32	51	15	14	24	10	4	3	8	2
Short-duration crops	34	30	39	28	11	20	20	18	50	38	24	47	0	1	3	0
Diversify crop production	1	1	2	1	2	1	0	0	1	11	3	1	11	8	2	4
Avoid use of risky inputs	0	0	0	0	0	2	0	1	2	2	1	0	9	8	5	10
Avoid use of expensive inputs	0	0	0	0	0	0	0	0	0	0	3	0	0	1	1	2
Use stone mulch	0	0	0	0	0	0	0	0	2	3	6	0	0	1	5	0
Stone bunds/terracing	0	0	0	0	4	0	0	1	5	11	1	10	9	12	5	11
Water harvesting/ irrigation	0	0	3	0	5	4	13	0	3	0	6	3	8	8	20	8
Other land management	1	0	2	0	0	1	0	0	2	1	5	0	8	6	3	2
Animals as insurance	0	0	0	0	0	2	0	0	0	4	1	1	2	3	10	3
Exchange of animals	0	1	0	0	1	0	2	0	0	0	0	0	0	3	2	0

Table 6.3—continued

Strategy	Rank 1				Rank 2				Rank 3				Rank 4			
	C	E	S	W	C	E	S	W	C	E	S	W	C	E	S	W
Planting of trees	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0
Cash/bank savings	0	0	0	0	2	1	1	3	3	5	4	9	12	11	1	16
Off-farm activities	0	0	2	0	0	0	0	1	0	1	0	1	16	14	9	4
Rely on food aid	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2

Source: Hagos and Holden (2002).
Notes: Zones: C = central zone, E = eastern zone, S = southern zone, W = western zone.

Households were asked about their ex post coping strategies in case of moderate and severe droughts. Tables 6.4 and 6.5 show the responses for a moderate drought and a severe drought, respectively.

Table 6.4—Ranked ex post coping responses to moderate drought by zone (% of respondents)

Strategy	Rank 1				Rank 2				Rank 3				Rank 4			
	C	E	S	W	C	E	S	W	C	E	S	W	C	E	S	W
Sell animals	46	39	45	51	6	6	5	3	3	3	2	6	3	1	3	2
Sell trees	9	7	7	3	10	1	11	15	5	2	0	0	0	0	2	2
Food-for-work	23	35	38	14	38	11	35	11	11	4	6	1	5	0	0	1
Cash-for-work	1	2	1	4	20	27	12	15	19	16	13	5	6	2	8	1
Employment inside *woreda*	2	2	0	0	4	4	12	3	7	18	13	13	11	8	5	1
Employment elsewhere in Ethiopia	3	2	2	4	5	5	7	7	16	10	21	4	11	18	17	10
Employment in Eritrea or Saudi Arabia	1	1	0	0	0	2	1	0	2	3	3	0	6	5	2	0
Off-farm income	1	1	1	5	0	3	2	8	10	5	7	5	1	4	3	4
Borrow from relatives	4	6	2	15	11	16	7	21	17	14	18	23	27	22	22	13
Borrow from others	5	0	0	2	1	3	4	4	1	11	3	12	6	4	6	19
Use cash/bank savings	0	1	1	0	0	0	0	0	0	0	1	0	1	1	1	1
Reduce expenditure	3	2	2	1	0	2	3	3	0	1	2	0	4	6	0	4
Beg for help from relatives	0	1	0	0	0	0	0	0	0	0	2	0	0	0	4	4

Source: Hagos and Holden (2002).
Notes: Zones: C = central zone, E = eastern zone, S = southern zone, W = western zone.

Table 6.5—Ranked ex post coping responses to severe drought by zone (% of respondents)

Strategies	Rank 1				Rank 2				Rank 3				Rank 4			
	C	E	S	W	C	E	S	W	C	E	S	W	C	E	S	W
Sell animals	44	41	36	35	3	10	3	2	11	7	5	30	6	5	4	16
Sell trees	0	4	4	0	10	3	1	6	1	1	0	9	7	4	5	10
Food-for-work	5	13	16	7	27	24	25	15	21	11	3	11	12	1	3	2
Cash-for-work	1	2	3	9	6	6	12	4	25	22	20	12	7	5	3	9
Employment inside *woreda*	4	7	1	3	7	2	7	8	3	4	9	3	2	5	2	12
Employment elsewhere in Ethiopia	6	3	3	7	1	7	6	4	8	3	15	10	12	19	19	11
Employment in Eritrea or Saudi Arabia	1	1	0	0	1	4	1	0	7	7	3	0	3	4	1	0
Off-farm income	1	2	0	1	6	2	2	20	1	3	2	1	6	5	0	7
Borrow from relatives	14	6	5	18	20	6	8	24	11	23	6	12	16	10	8	12
Borrow from others	15	2	5	11	10	20	6	7	1	3	5	3	3	2	2	4
Use cash/bank savings	2	1	0	1	2	1	0	0	0	0	1	0	0	0	0	0
Reduce expenditure	2	3	7	0	0	0	1	0	1	0	2	1	3	70	4	3
Beg for help from relatives	4	15	2	6	0	4	0	0	0	4	1	0	0	2	5	2

Source: Hagos and Holden (2002).
Notes: Zones: C = central zone, E = eastern zone, S = southern zone, W = western zone.

Sale of animals was the first-priority coping strategy, followed by FFW in the case of modest drought. Other commonly stated coping responses in decreasing order of importance were borrowing from relatives, CFW and other employment locally or elsewhere in Ethiopia, and borrowing from other than relatives. Some stated that the selling of trees was an important response. Very few said that they would use cash or bank savings, beg for help from relatives, or reduce expenditure. FFW was relatively less important in the western zone, where borrowing from relatives was relatively more important. That zone has the highest and most reliable rainfall indicating less need for and availability of FFW employment opportunities.

As for a severe drought, the sale of animals was again the most important response. FFW and CFW appeared relatively less important than in the case of moderate drought, whereas borrowing from relatives and others were stated to be relatively more important. The selling of trees was relatively less important, whereas begging for help from relatives became more important.

The farm households were also asked whether there had been any changes in their strategies to cope with risk now compared with five years ago. Table 6.6 shows the responses.

Table 6.6—Changes in risk-coping strategies during the last five years before 1998

Change in coping strategies	Zone			
	Central	Eastern	Southern	Western
Percentage saying there has been a change	61	54	57	39
Types of change (new activity recorded)	**Percentage of respondents reporting the change**			
Use of irrigation	18	15	17	7
Soil conservation	37	29	19	32
Food-for-work	11	18	10	10
Cash-for-work	6	11	1	8
Off-farm income	5	9	9	2
Use of fertilizer	3	0	1	3

Source: Hagos and Holden (2002).

More than half of the respondents in the central, eastern, and southern zones reported a change in risk-coping strategies over the last five years. Almost 40 percent in the western zone also reported such a change. The most widespread changes were investment in soil and water conservation and investment in irrigation. FFW and CFW had become more

important. A few in the western and central zones stated that the use of fertilizer was a way of coping with risk. These are the zones with the highest rainfall and where fertilizer use is least risky.

6.2. Dynamics in Food (In)security and Tenure Status of Households

Impact of the Land Certification Program on Perceived Tenure Status of Households

In an attempt to evaluate the impacts of the land certification program on perceived tenure security of households, respondents were asked about their "fear of loss of land due to administrative interventions." The question was asked just before the intervention was implemented (baseline year of 1997/98) and more than 10 years after the intervention (2009/10). Table 6.7 summarizes the responses on the perceived risk of land loss through administrative redistribution. Overall, results suggest that perceived tenure security among farm households was higher during the post-intervention period (in 2009/10) than was reported before the intervention was implemented. As shown, although 53 percent of households at baseline feared losing their land through redistributive measures, after the intervention significantly fewer numbers of households (22 percent) reported that fear. Comparing household responses with respect to their possession of land use certificates, only 4 percent of the households that no longer feared losing their land in 2009/10 (that is, those reporting fear of losing their land in 1997/98 but not in 2009/10) had no land use certificates issued for any of their farm plots (that is, 96 percent of those did have land use certificates). On the other hand, among those farm households who reported having fear of losing their land in 2009/10, the share of households without a land use certificate is significantly higher—26 percent have no land use certificate. Overall, results show that the certification program did not eliminate perceived tenure insecurity but helped reduce it significantly. The empirical evidence from the table supports our first hypothesis (H1) that land certification has enhanced tenure security of households.

Table 6.7—Impact of certification on perceived land tenure security

			Fear of loss of land due to administrative interventions				
			2009/10				
			No		Yes		
Fear of loss of land due to administrative interventions	1999/98 (Baseline)	No	**99**		**27**		**126 (47%)**
			With Cert.	No Cert.	With Cert.	No Cert.	
			90%	10%	74%	26%	
		Yes	**112**		**32**		**144 (53%)**
			With Cert.	No Cert.	With Cert.	No Cert.	
			96%	4%	56%	44%	
			211 (78%)		**59 (22%)**		

Source: Authors' computation using data from the 1998–2010 UMB-MU joint panel rural household survey.
Note: With Cert.: Proportion of households with land use certificate. No Cert.: Proportion of households without land use certificate.

Comparing the baseline welfare (food security) status of households with their situation in the survey periods of 2006 and 2010, Table 6.8 shows an improvement in the household calorie consumption and overall level of nourishment (measured by alternative nutritional anchors of 1,800 and 2,100 kcal used by the FAO to capture the minimum and recommended nutritional levels, respectively). The means comparison test (comparing the baseline indicators with sample means of the indicators in the subsequent years) shows that the overall prevalence of severe undernourishment (energy consumption less than 1,800 kcal/day) in our sample has been significantly reduced from 81 percent in 1997/98 to only 49 percent in 2009/10. The overall welfare status of households shows consistent results—with a reduction in poverty head count ratio from 90 percent in 1997/98 to 65 percent in 2009/10.

A disaggregated comparison of households according to their status in the land rental market indicates, over time, a significantly higher welfare (food security) improvement of landlord households compared with nonparticipant households. There was no significant difference in welfare (food security) status of the two groups during the baseline. As shown in column (3) of Table 6.8, even if landlord households managed to satisfy 68 percent of the recommended energy requirement of 2,100 kcal/day during the baseline (1997/98), the average calorie availability level of landlord households increased to a 26 percent surplus in the year 2009/10. Over the same period (1997/98–2009/10), the prevalence of food insecurity in terms of a gap in calorie availability among landlord households fell from 78 percent to only 27 percent while the head count ratio was reduced from 90 percent to 48 percent, respectively. In contrast with this, 51 percent of nonparticipant households remained food insecure, whereas almost 75 percent of those in an autarkic position (pure owner-operators) were still below the poverty line in the year 2009/10. Showing the positive role

Table 6.8—Summary statistics of welfare (food security) status of farm households

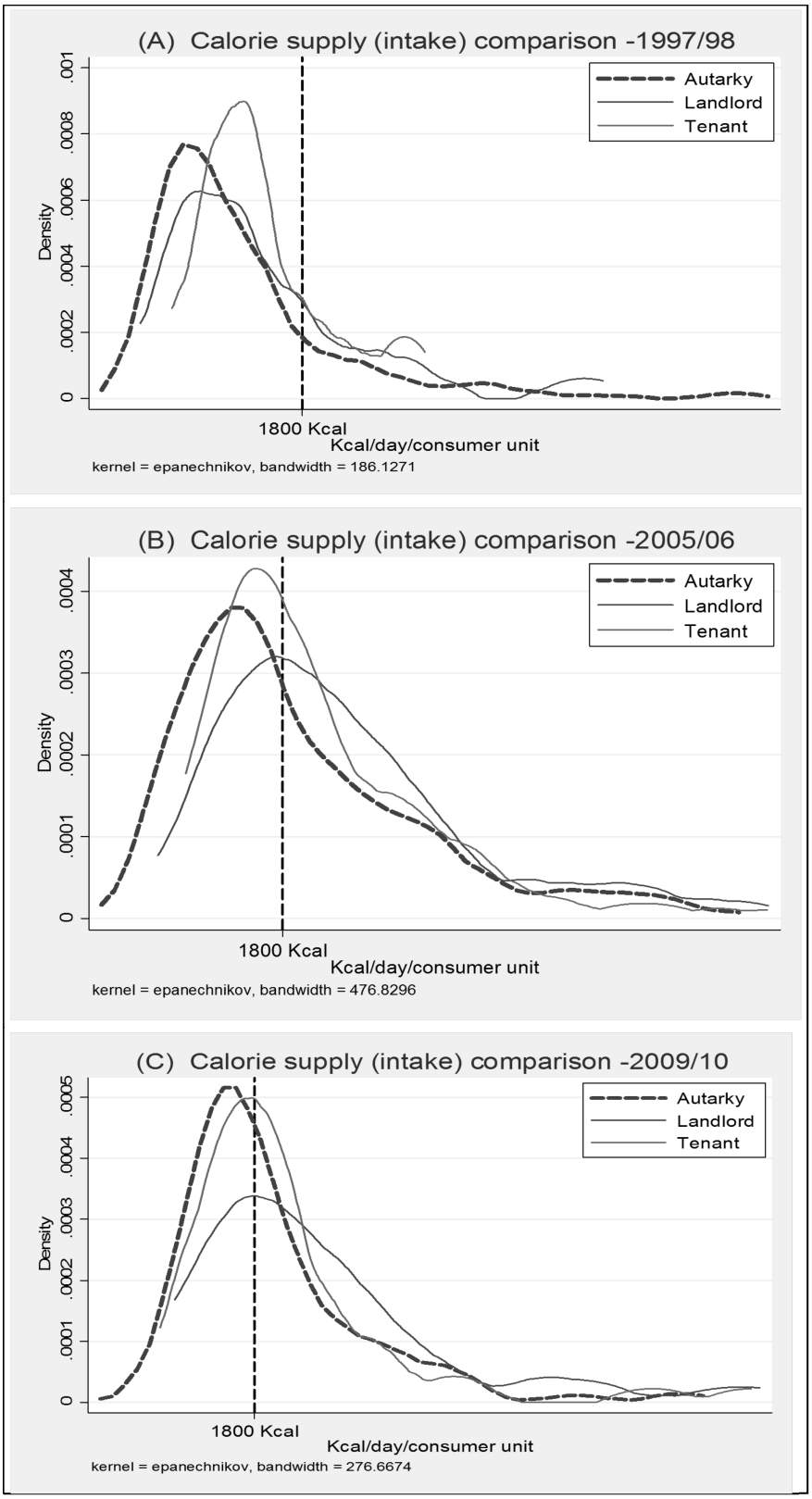
Variable Name	Year	Overall		Sharecroppers		Landlords		Mean comparison[a]	Owner-operators	
		Mean	(Std. err.)	Mean	(Std. err.)	Mean	(Std. err.)		Mean	(Std. err.)
Average daily calorie availability (kcal/day per adult equivalent consumer)	1997/98	1391	(100.4)	1444	(121.85)	1420	(110.32)		1375	(140.33)
	2005/06	2263	(94.13)	2224	(151.17)	2544	(172.58)	*	2115	(152.83)
	2009/10	2297	(116.65)	2621	(465.16)	3123	(415.12)	***	2084	(116.48)
Mildly undernourished, share of sample (below 2,100 kcal/day)	1997/98	0.84	(0.02)	0.84	(0.07)	0.79	(0.05)		0.86	(0.02)
	2005/06	0.60	(0.03)	0.63	(0.05)	0.47	(0.06)	***	0.65	(0.04)
	2009/10	0.61	(0.03)	0.62	(0.07)	0.44	(0.07)		0.66	(0.04)
Severely undernourished, share of sample (below 1,800 kcal/day)	1997/98	0.81	(0.02)	0.76	(0.09)	0.78	(0.05)		0.83	(0.03)
	2005/06	0.51	(0.03)	0.51	(0.06)	0.41	(0.05)	**	0.57	(0.04)
	2009/10	0.49	(0.03)	0.43	(0.07)	0.35	(0.07)	***	0.55	(0.04)
Food insecure (proportion of households below the food poverty line)	1997/98	0.84	(0.02)	0.84	(0.07)	0.78	(0.05)		0.86	(0.02)
	2005/06	0.49	(0.03)	0.52	(0.06)	0.35	(0.05)	***	0.56	(0.04)
	2009/10	0.45	(0.03)	0.4	(0.07)	0.27	(0.06)		0.51	(0.04)
Poor (proportion of households below the poverty line)	1997/98	0.90	(0.02)	0.88	(0.07)	0.9	(0.04)		0.91	(0.02)
	2005/06	0.68	(0.03)	0.70	(0.05)	0.59	(0.05)	*	0.72	(0.04)
	2009/10	0.65	(0.03)	0.62	(0.07)	0.48	(0.07)	***	0.72	(0.03)

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.

Notes: [a] Landlords with owner-operators

* significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%.

Figure 6.1—Kernel density graph of log of the value of total food supply (from owner-operated and transacted) parcels of tenant, landlord, and nonparticipant households



Source: Authors' computation.

participation in the land rental market plays in improving the welfare status of households, such findings of higher welfare gains by landlord households is shown in the kernel density graphs in Figure 6.1.

Comparing the food security levels of female-headed households versus male-headed ones, nonparametric results from Figure 6.2 show that the welfare improvement is stronger for female-headed households than for male-headed households. Contrary to the baseline year status, the kernel density diagrams show that female-headed households, on average, have lower food deficits (calorie gap) in the later years (in the years 2006 and 2010) versus male-headed households. The nonparametric K–S test shows that these differences are statistically significant. This result is consistent with earlier findings by Holden and Ghebru (2012), Holden, Deininger, and Ghebru (2011), and Ghebru and Holden (2009).

Figure 6.2—Kernel density graph of daily calorie intake per consumer unit of female- and male-headed households

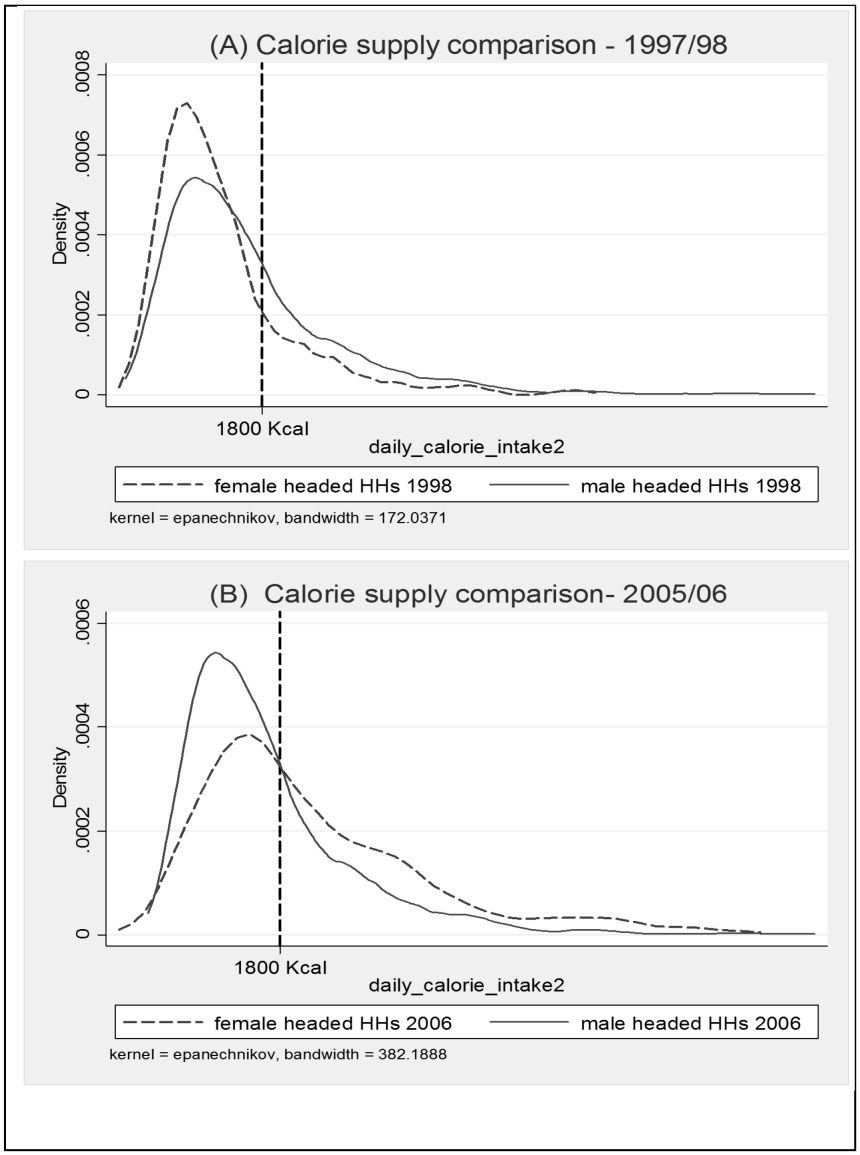
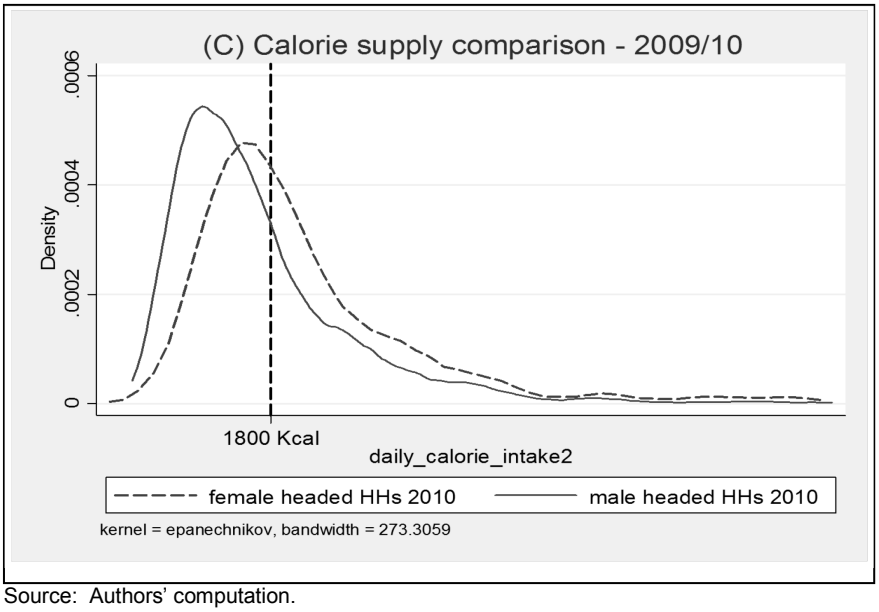


Figure 6.2—Continued



Source: Authors' computation.

Figure 6.3 compares the changes over time in the distribution of calorie availability for landlord, tenant, and pure owner-operator households. Landlord households appear to have had the strongest improvement in calorie availability compared with tenant and pure owner-operator households from 1998/98 to 2009/10.

Figure 6.3—Kernel density graph of log of the value of total food supply (from owner-operated and transacted) parcels of tenant, landlord, and nonparticipant households

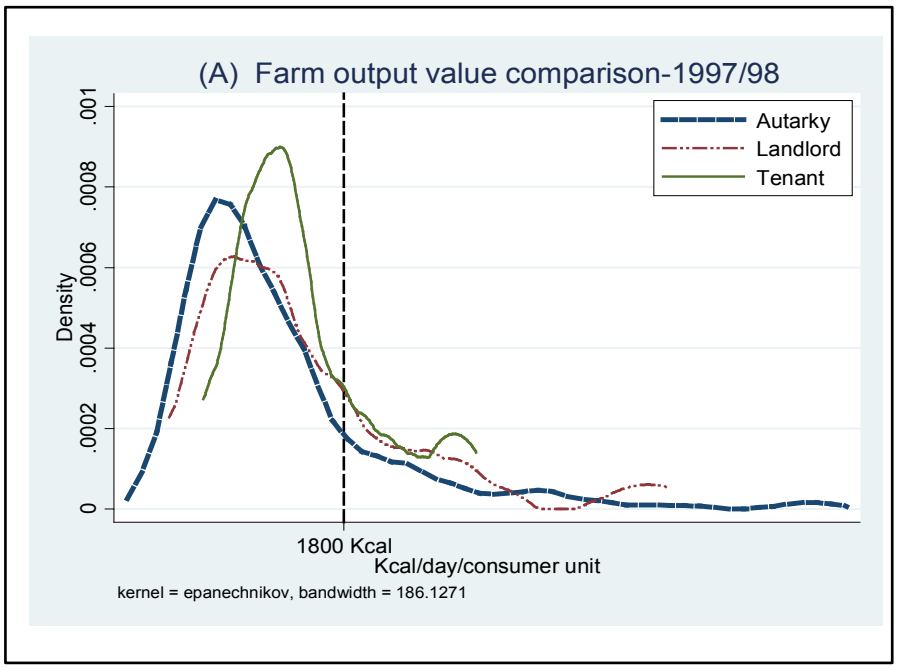
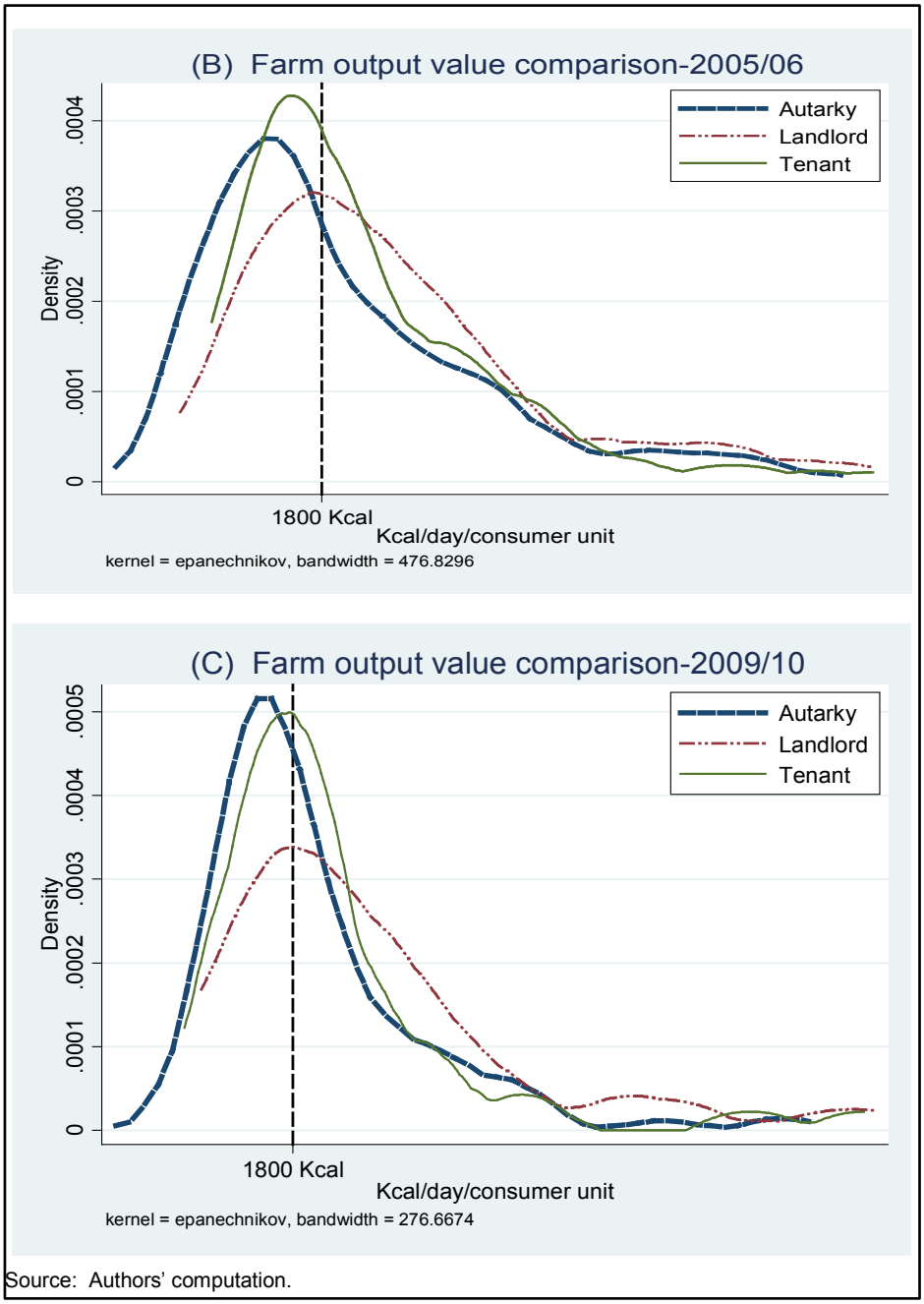


Figure 6.3—Continued



Source: Authors' computation.

Table 6.9 shows a comparison of household characteristics based on households' 1997/98 perception of tenure security of their land holdings. Results show that out of the 156 farm households that stated they fear losing their land to redistribution, nearly three-quarters were households not participating in the land rental market. This is significantly higher than the sample average proportion of nonparticipant households.

Table 6.9—Summary statistics of farm households' perception of tenure security (baseline—1997/98)

Variable	Household's fear of losing land (1997/98) No Mean (St. err.)	Yes Mean (St. err.)	Overall Mean (St. err.)
Daily available calorie per consumer unit	1542.44	1251.51	1391.16
	(195.58)	(67.54)*	(100.4)
Real consumption expenditure/consumer unit	609	488.68	546.44
(in Ethiopian birr)	(71.31)	(26.48)*	(36.99)
Poor household (if per capital consumption	0.88	0.93	0.9
expenditure is below the poverty line)	(0.03)	(0.02)	(0.02)
Calorie gap (per capita calorie intake divided	0.73	0.6	0.66
by recommended calorie intake—2,100 kcal)	(0.09)	(0.03)	(0.05)
Gender of the household head (1 = female)	0.15	0.12	0.13
	(0.03)	(0.03)	(0.02)
Age of the household head	49.86	49.12	49.48
	(1.19)	(1.31)	(0.89)
Family size (in adult equivalent)	4.09	4.23	4.16
	(0.16)	(0.15)	(0.11)
Farm size (in *tsimdi*)	4.05	3.96	4
	(0.27)	(0.19)	(0.16)
Farm size per consumer unit	1.23	1.11	1.17
	(0.12)	(0.07)	(0.07)
Tenant (household that leased in land)	0.13	0.04	0.08
	(0.03)	(0.02)***	(0.02)
Landlord (household that leased out land)	0.26	0.19	0.23
	(0.04)	(0.03)*	(0.02)
Autarky (household that does not participate	0.6	0.77	0.69
in the land rental market)	(0.04)	(0.03)***	(0.03)
Observations	144	156	300

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: * significant at 10%; ** significant at 5%; *** significant at 1%; and **** significant at 0.1%.

Results from Table 6.9 also reveal that those who feared losing their land (less tenure-secure households) had, on average, an inferior level of welfare status (lower calorie consumption and overall per capita consumption expenditure) than those with no fear of losing their land (more tenure-secure households). Even five years after the baseline (during 2002/03), the level of food deficit is significantly higher for those afraid of losing land in 1998 compared to those with no perceived risk of losing their land (with per capita calorie gap of 90 percent and 74 percent, respectively).

Table 6.10 provides data on households' perceptions regarding the impacts of land certification on household tenure security and household demand for actions of improving tenure security. Indicating the positive role land certificates play in enhancing household tenure security, results from 2005/06 show that a majority of our sample respondents stated that they believe land certificates enhance the chances of getting compensation during times of land expropriation (81 percent), increase the tenure security of women (92 percent), and reduce disputes related to inheritance (85 percent). Similarly, 65 percent of respondents in 2005/06 perceived land certificates to have a positive effect in reducing disputes related to encroachment of parcel boundaries.

Table 6.10—Household perception of the effects of land certificates and tenure security (2005/06–2009/10)

	Household tenure security perceptions			
	2005/06		2009/10	
Variables	**Mean**	**(St. err.)**	**Mean**	**(St. err.)**
Willingness to pay for lost certificate	0.89	(0.02)	1.00	(0.00)
Having a certificate reduces land border disputes	0.61	(0.03)	0.58	(0.03)
Having a certificate encourages tree planting	0.81	(0.02)	0. 69	(0.03)
Having a certificate reduces inheritance-related disputes	0.85	(0.02)	0.69	(0.03)
Having a certificate enhances chances of receiving compensation during expropriation	0.81	(0.02)	0.95	(0.01)
Having a certificate improves women's rights to land	0.92	(0.02)	0.92	(0.02)
Fear of losing land due to administrative redistribution			0.22	(0.03)
Observations	300		277	

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Note: Numbers in the table denote share of households responding positively.
St. err. = Standard error

Table 6.11 reports results of summary statistics of key variables of interest across the five survey periods based on households' status of participation in the land tenancy market. As shown, across the survey periods (that stretched for more than a decade), results show that a greater and greater proportion of female-headed households managed to join the supply side of the tenancy market by leasing out their land. The proportion of female-headed landlord households increased from only 32 percent in 1997/98 to 56 percent in the 2009/10. Similarly, older groups of heads of household (who otherwise are less able to cultivate their own farm) have managed to lease out their land (become landlords) as the average age of landlord households jumped from nearly 47 years in 1997/98 to 57 in the 2009/10 survey period. More important, perhaps as evidence of the transferability effects of the land certification program, an increasing number of land-scarce households managed to access more land via the tenancy market. This is shown by the per capital landholding of tenant farm households reducing from 1.22 *tsimdi* in 1997/98 to 0.84 *tsimdi* in 2009/2010.

Table 6.11—Descriptive summary of key variables of interest (by year and tenancy group)

		1997/98		2000/01		2002/03		2005/06		2009/10	
Household_calorie_gap	Landlord	-3395.94	(443.83)	-2624.12	(582.20)	-1269.82	(422.42)	190.22	(473.83)	288.43	(512.95)
	Tenant	-3362.17	(696.84)	-2983.6	(508.59)	-2376.7	(738.03)	-75.84	(732.36)	11.45	(956.52)
	Autarky	-4276.27	(302.03)	-5159.9	(394.75)	-3006.37	(477.2)	-1894.69	(510.0)	-1577.94	(325.64)
	All	**-4000.56**	**(239.14)**	**-3864.61**	**(283.17)**	**-2386.45**	**(322.55)**	**-838.9**	**(334.54)**	**-929.47**	**(283.61)**
Female-headed household	Landlord	0.32	(0.057)	0.49	(0.058)	0.51	(0.057)	0.49	(0.055)	0.56	(0.07)
	Tenant	0.08	(0.055)	0.08	(0.028)	0.02	(0.017)	0.06	(0.028)	0.04	(0.03)
	Autarky	0.07	(0.018)	0.22	(0.036)	0.27	(0.038)	0.32	(0.04)	0.29	(0.035)
	All	**0.13**	**(0.019)**	**0.24**	**(0.025)**	**0.26**	**(0.0250**	**0.3**	**(0.027)**	**0.29**	**(0.027)**
Age of household head (years)	Landlord	46.87	(1.794)	50.79	(2.028)	57.05	(1.993)	56.46	(1.775)	57	(2.218)
	Tenant	48	(3.068)	50.6	(1.459)	52.1	(1.428)	53.29	(1.286)	57.17	(1.948)
	Autarky	50.51	(1.079)	55.51	(91.188)	54.28	(1.198)	55.89	(1.277)	57.18	(1.053)
	All	**49.48**	**(0.888)**	**52.84**	**(0.867)**	**54.39**	**(0.858)**	**55.36**	**(0.838)**	**57.18**	**(0.849)**
Farm size per consumer unit	Landlord	1.47	(0.173)	1.63	(0.191)	1.54	(0.12)	1.53	(0.136)	2.45	(0.313)
	Tenant	1.22	(0.231)	0.95	(0.064)	0.89	(0.074)	0.86	(0.105)	1.44	(0.3460
	Autarky	1.07	(0.074)	1.03	(0.075)	1	(0.064)	0.94	(0.081)	1.02	(0.063)
	All	**1.17**	**(0.068)**	**1.16**	**(0.064)**	**1.11**	**(0.05)**	**1.09**	**(0.062)**	**1.36**	**(0.097)**
Operational holding size per consumer unit	Landlord	0.75	(0.109)	0.62	(0.123)	1.51	(0.121)	0.51	(0.08)	0.71	(0.057)
	Tenant	2.01	(0.378)	1.55	(0.098)	0.95	(0.073)	1.26	(0.13)	1.03	(0.074)
	Autarky	1.07	(0.074)	1.03	(0.074)	1	(0.064)	0.94	(0.081)	1.02	(0.063)
	All	**1.2**	**(0.092)**	**1.08**	**(0.058)**	**1.12**	**(0.049)**	**0.91**	**(0.057)**	**1.00**	**(0.049)**
Years with certificate	Landlord			1.29	(0.087)	3.9	(0.19)	6.61	(0.28)	8.84	(0.683)
	Tenant			1.47	(0.071)	3.97	(0.187)	6.52	(0.32)	10.14	(0.575)
	Autarky			1.37	(0.056)	4.01	(0.134)	6.6	(0.217)	10.35	(0.277)
	All			**1.38**	**(0.04)**	**3.97**	**(0.094)**	**6.58**	**(0.151)**	**10.06**	**(0.236)**

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.

7. ECONOMETRIC RESULTS AND DISCU1SION

Table 7.1 shows the first econometric models. These models include the "years with certificate" variable and its interaction with the "sex of household head" variable, and we have gradually reduced the number of survey rounds included from left to right in the table. The "years with certificate" variable is significant and positive in all models and has an increasing parameter size as more survey rounds are dropped, except for the last model. The results indicate that for the whole period 1998–2010, one extra year of land certificate ownership increased the food availability by 3.1 percent. And that effect was as high as 7 percent in the period 2003–2010, although it may have dampened off from 2006 as the coefficient fell to 5.3 percent in the 2006–2010 panel model, although the difference is not significant. Female-headed households appeared to have an additional 1.5 to 2 percent higher increase in food availability than male-headed households for each extra year of land certificate ownership. The interaction variable between "years with certificate" and "sex of household head" is significant and positive in the first three models, whereas the "sex of household head" variable is significant and positive in the second and the last models. Based on this we cannot reject hypotheses H1a and H1d. Land certification appears to have contributed to enhanced calorie availability and more so for female-headed households. Farm size per adult equivalent is also a strong determinant of calorie availability, showing the reliance on farming for food security.

Table 7.1—Impact of land certification on log of calorie availability per consumer unit, household fixed effects models with varying number of survey rounds included

Variable	1997–2010	2000–2010	2003–2010	2006–2010
Years with certificate	0.031***	0.035***	0.070****	0.053*
	(0.010)	(0.01)	(0.02)	(0.03)
Sex of household head	0.096	0.126*	0.133	0.253**
Female = 1, male = 0	(0.06)	(0.07)	(0.08)	(0.12)
Farm size per consumer unit	0.081****	0.065****	0.051***	0.016
	(0.01)	(0.02)	(0.02)	(0.02)
Sex of household head*Years	0.013*	0.020**	0.020*	0.015
with certificate	(0.01)	(0.01)	(0.01)	(0.03)
Year dummy for 1997	-0.192*			
	(0.11)			
Year dummy for 2000	-0.226**	-0.171		
	(0.10)	(0.12)		
Year dummy for 2003	-0.079	-0.046	0.164	
	(0.07)	(0.09)	(0.12)	
Year dummy for 2006	0.082	0.097	0.217***	0.135
	(0.06)	(0.06)	(0.08)	(0.11)
Constant	7.069****	7.021****	6.688****	6.879****
	(0.10)	(0.13)	(0.18)	(0.31)
Prob > chi^2	0	0	0	0
Number of observations	1,459	1,161	863	565
R-squared	0.252	0.244	0.157	0.049

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$.
Bootstrapped standard errors, resampling households. Models use data from 2003, 2006, and 2010.
The Productive Safety Net Programme was implemented beginning in 2005.

Table 7.2 presents the results from models to which the "operational farm size/own farm size" variable has been added, but otherwise the models are as in Table 7.1. The new variable becomes significant at the 5 or 10 percent level in three of the four models and has a positive sign in all models. This implies that households that have managed to increase their operational farm size through participation in the land rental market also have significantly higher calorie availability. The parameters on the "years with certificate" variable are slightly reduced with the inclusion of this new variable, possibly indicating that part of the positive land certification effect on calorie availability is due to land rental market participation. However, this does not tell us anything about the possible differentiated effect on the two sides of the land rental market.

Table 7.2—Impact of land certification on log of calorie availability per consumer unit, household fixed effects models including land rental market participation (operational holding/farm size), alternative number of survey rounds included to assess the dynamic effect of land certification

Variable	1997–2010	2000–2010	2003–2010	2006–2010
Years with certificate	0.029***	0.033**	0.071****	0.045
	(0.01)	(0.01)	(0.02)	(0.03)
Sex of household head	0.114*	0.139**	0.146*	0.272**
Female = 1, male = 0	(0.06)	(0.07)	(0.09)	(0.12)
Farm size per consumer unit	0.082****	0.066****	0.051***	0.017
	(0.01)	(0.02)	(0.02)	(0.02)
Sex of household head*Years with certificate	0.013	0.020**	0.020*	0.008
	(0.01)	(0.01)	(0.01)	(0.03)
Operational holding size/Farm size	0.055**	0.068*	0.052	0.138*
	(0.03)	(0.04)	(0.06)	(0.08)
Year dummy for 1997	-0.221**			
	(0.11)			
Year dummy for 2000	-0.254***	-0.207*		
	(0.10)	(0.12)		
Year dummy for 2003	-0.098	-0.072	0.166	
	(0.07)	(0.09)	(0.12)	
Year dummy for 2006	0.069	0.08	0.214***	0.087
	(0.06)	(0.06)	(0.08)	(0.12)
Constant	7.037****	6.982****	6.625****	6.853****
	(0.11)	(0.14)	(0.20)	(0.32)
Prob > chi^2	0	0	0	0
Number of observations	1,445	1,148	853	559
R-squared	0.257	0.248	0.159	0.061

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$.

To assess the possible different effects on the two sides of the land rental market that is characterized by the dominance of sharecropping, separate models for tenants, landlords, and autarkic households were run and compared with a joint model where the "operational farm size/own farm size" variable was specified separately for tenant and landlord households. Table 7.3 shows the results. For tenants a positive significant (5 percent level) correlation between the "operational farm size/own farm size" variable and calorie availability is found but the "years with certificate variable" was insignificant, possibly indicating that the main effect of land certification on tenant households is improved access to land through the land rental market (Holden, Deininger, and Ghebru 2011). Ghebru and Holden (2008) have shown that tenants in the study area typically are constrained in their access to rented land, something that may be explained partly by the dominance of sharecropping, which prevents market clearing through the price mechanism. Interestingly, for landlord households the sign of the variable is negative although insignificant.

Although we would expect poorer and weaker landlords to rent out more of their land, a larger area rented out is weakly associated with higher calorie availability. This could be the case because of the dominating sharecropping contracts where the landlord typically receives 50 percent of the crop on the rented-out plots. Furthermore, the "years with certificate" variable was significant at the 5 percent level and with a higher positive parameter than in the other models, showing the importance of land certificates for landlord households that depend on renting out their land. The pure owner-operator (autarkic) households also had a positive and significant (at the 5 percent level) "years with certificate" variable with a parameter size closer to the model with the whole sample. Furthermore Table 7.3 provides evidence that the farm size per adult equivalent enhances calorie availability significantly more for tenant and landlord households than for autarkic households. This may indicate that land rental market participation enhances production efficiency but also that high transaction costs still exist in the market such that there may still exist unrealized gains from trade.

Table 7.3—Land certification and land rental market participation models, 1997–2010, household fixed effects models

Variable	Tenants	Landlords	Pure owner-operators	All
Years with certificate	-0.012	0.058**	0.037**	0.031***
	(0.02)	(0.02)	(0.02)	(0.01)
Sex of household head	-0.183	0.135	0.148	0.097
Female = 1, male = 0	(0.25)	(0.12)	(0.09)	(0.06)
Farm size per consumer unit	0.183****	0.150****	0.055***	0.082****
	(0.04)	(0.03)	(0.02)	(0.01)
Sex of household head*Years with	0.056	-0.005	0.006	0.014*
certificate	(0.04)	(0.02)	(0.01)	(0.01)
Operational holding size/Farm size	0.068**			0.076***
tenants	(0.03)			(0.03)
Operational holding size/Farm size		-0.137		-0.027
landlords		(0.15)		(0.07)
Year dummy for 1997	-0.466	-0.029	-0.127	-0.190*
	(0.30)	(0.23)	(0.18)	(0.11)
Year dummy for 2000	-0.386	0.105	-0.364**	-0.235**
	(0.24)	(0.21)	(0.16)	(0.10)
Year dummy for 2003	-0.242	0.222	-0.027	-0.069
	(0.18)	(0.19)	(0.12)	(0.07)
Year dummy for 2006	0.029	0.234*	0.075	0.076
	(0.13)	(0.12)	(0.09)	(0.06)
Constant	7.313****	6.823****	6.977****	7.006****
	(0.27)	(0.23)	(0.17)	(0.12)
Prob > chi^2	0	0	0	0
Number of observations	326	370	784	1,459
R-squared	0.259	0.325	0.28	0.257

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$.

To further inspect the dynamic disaggregated effect through the land rental market, we ran the model with all households for a reduced number of survey rounds (Table 7.4). The "operational farm size/own farm size" variable remains significant and with an increasing parameter size as the early survey rounds are removed, whereas an opposite effect exists for own farm size, possibly pointing toward an increasing dependency on the land rental market for tenants. No similar trend is observed as the "operational farm size/own farm size" variable remains insignificant and with a negative sign for landlord households. The "years with certificate" variable remains highly significant and with a positive sign in the first three models, whereas the "years with certificate*sex of household head" interaction variable is significant and with a positive sign in the first two models.

Table 7.4—Models separating land rental market participation by tenants and landlords, otherwise as models in Table 7.2

Variable	1997–2010	2000–2010	2003–2010	2006–2010
Years with certificate	0.031***	0.035***	0.071****	0.052
	(0.01)	(0.01)	(0.02)	(0.03)
Sex of household head	0.097	0.122*	0.136	0.251**
Female = 1, male = 0	(0.06)	(0.07)	(0.08)	(0.12)
Farm size per consumer unit	0.082****	0.066****	0.050***	0.016
	(0.01)	(0.02)	(0.02)	(0.02)
Sex of household head*Years with certificate	0.014*	0.021**	0.019	0.011
	(0.01)	(0.01)	(0.01)	(0.03)
Operational holding size/Farm size, tenants	0.076***	0.121***	0.137*	0.182**
	(0.03)	(0.05)	(0.07)	(0.09)
Operational holding size/Farm size, landlords	-0.027	-0.048	-0.076	-0.048
	(0.07)	(0.08)	(0.09)	(0.14)
Year dummy for 1997	-0.190*			
	(0.11)			
Year dummy for 2000	-0.235**	-0.193*		
	(0.10)	(0.12)		
Year dummy for 2003	-0.069	-0.034	0.19	
	(0.07)	(0.09)	(0.12)	
Year dummy for 2006	0.076	0.085	0.206***	0.107
	(0.06)	(0.06)	(0.08)	(0.12)
Constant	7.006****	6.933****	6.593****	6.756****
	(0.12)	(0.15)	(0.21)	(0.33)
Prob > chi^2	0	0	0	0
Number of observations	1,459	1,161	863	565
R-squared	0.257	0.25	0.163	0.064

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$.

Table 7.5 shows the results for the BMI models with data from 2006 and 2010. The preceding models demonstrated that the "years with certificate" variable became less significant and tended to have a smaller parameter value when we used data from 2006 and 2010 only. This may be due to a catching-up effect as well as a consequence of shrinking sample size causing increasing standard errors. Two advantages of using the BMI as a dependent variable are that it is measured with higher accuracy (less measurement error) and that we have several observations per household as we used individual data. We can still control for unobservable household and farm characteristics with household fixed effects.

Table 7.5 shows that the "years with certificate" variable is significant and positive (at the 5 and 10 percent levels) in the models where the interaction variable for "years with certificate" and "sex of household head" was not included. Although the interaction variable also was insignificant, it had positive parameter values, and the short panel may therefore imply a type 2 error. The "operational farm size/own farm size" variable is significant at the 5 and 1 percent levels and with positive parameter values. Households that accessed additional land through the land rental market had household members with a significantly higher BMI.

We have avoided including more time-varying household endowment variables due to endogeneity and the difficulty of finding good instruments. Land rental market participation is itself endogenous and affected by supply-side and demand-side variables and possibly time-varying observable and unobservable variables.

Table 7.5—BMI models for 2006 and 2010 without and with "sex of household head" and "years with certificate" interaction and "operational farm size/own farm size" variables

Variable	Model 1	Model 2	Model 3	Model 4
Sex of person, 1 = female	0.058	0.085	0.048	0.069
	(0.19)	(0.19)	(0.20)	(0.19)
Age of person	0.150****	0.150****	0.145****	0.145****
	(0.02)	(0.02)	(0.02)	(0.02)
Age of person, squared	-0.001****	-0.001****	-0.001****	-0.001****
	0.00	0.00	0.00	0.00)
Years with certificate	0.350**	0.277	0.311*	0.255
	(0.17)	(0.18)	(0.18)	(0.19)
Sex of household head	-0.349	0.064	-0.601	-0.249
Female = 1, male = 0	(0.54)	(0.61)	(0.55)	(0.61)
Farm size per adult	-0.422	-0.401	-0.456	-0.449
equivalent	(0.49)	(0.50)	(0.50)	(0.51)
Year dummy for 2010	-0.92	-0.856	-0.653	-0.626
	(0.60)	(0.58)	(0.63)	(0.62)
Sex of hh head*Years with		0.321		0.287
cert.		(0.22)		(0.23)
Operational holding size/Farm size			0.065***	0.057**
			(0.02)	(0.02)
Constant	13.976****	13.921****	14.213****	14.138****
	(1.13)	(1.12)	(1.15)	(1.14)
Prob > chi^2	0	0	0	0
Number of observations	1,578	1,578	1,563	1,563
R-squared	0.114	0.117	0.114	0.116

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$. Models use data from children 0 to 18 years old from 2006 and 2010 and parents from the 2010 survey.

8. CONCLUSION

We have studied the impacts of the non-freehold land registration and certification program in Ethiopia that provided conditional use rights into perpetuity for households that continue to use their land or rent out part of their land, or both, for short periods of time. Household perception data indicate that household tenure security has been enhanced by the land tenure reform program. Two indicators of food security—calorie availability and BMI of children—were used to assess the impacts of the program on food security. Using the number of years of land certificate ownership for identification of impacts and otherwise controlling for unobservable household and farm characteristics by using household fixed effects models, we found significant positive effects of certificate ownership on food availability and BMI of children. The positive food security effects were associated with land rental market participation, which has been enhanced not only by the land certification program (Holden, Deininger, and Ghebru 2011) but also by increased investment and productivity on owner-operated land (Holden, Deininger, and Ghebru 2009). Our analysis provides evidence of both types of effects by combining the "years with certificate" variable and the "operational farm size/own farm size" variable and doing separate analyses for tenant, landlord, and pure owner-operator households. The rental market effect is strongest for tenant households, whereas landlord households benefit from both the investment and rental market effects, and the pure owner-operator households benefit only through the investment effects of the program.

There still appear to be unreleased benefits from trade through the land rental market that may be explained by law restrictions allowing for only short-term rental contracts, not allowing more than 50 percent of land to be rented out, and not allowing households to migrate for more than two years without losing their land without compensation. Those laws appear to threaten future tenure security and may undermine the benefits from the existing tenure reform.

APPENDIX A: SUPPLEMENTARY TABLES

Appendix Table A.1—Test results for attrition bias using base year data (1997/98)

Variable	Probability of attrition B (St. err.)
Gender of head of the household (female = 1, male = 0)	0.414 (0.52)
Age of the household head	-0.002 (0.01)
Education status of the head of household	0.013 (0.39)
Number of adult females in the household	0.238 (0.25)
Number of adult males in the household	0.213 (0.24)
Size of the household	-0.042 (0.33)
Number of oxen	-0.195 (0.15)
Livestock endowment (tropical livestock unit, or TLU)	-0.143 (0.09)
Size of household land holding	0.000 (0.02)
The household is a tenant household	0.175 (0.38)
The household is a landlord household	-0.134 (0.34)
The household has access to irrigation	-0.827 (0.53)
Income generated from self-employment	-0.000 (0.00)
Income generated from wage employment	-0.002 (0.00)
Income generated from transfers and remittances	0.000 (0.00)
Household per capita consumption expenditure	-0.000 (0.00)
Intercept	0.165 (0.63)
Pseudo R-squared	0.1868
Wald χ^2 (16)	33.78***
Number of obs.	400

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Note: * significant at 10%; ** significant at 5%; and *** significant at 1%.
Standard errors, corrected for clustering at the household level, are included in parentheses.

Appendix Table A.2—Variables correlated with years with certificate in 2001

Variable	Dependent variable: Years with certificate
Lost land dummy	-0.063
	(0.090)
Land dispute experience dummy	0.271*
	(0.160)
Age of household head	0.016
	(0.020)
Age of household head, squared	0.000
	(0.000)
Oxen per adult equivalent	0.017
	(0.240)
Other livestock per adult equivalent	-0.158
	(0.210)
Male labor force per adult equivalent	0.202
	(0.370)
Female labor force per adult equivalent	-0.284
	(0.270)
Operational/Own farm size	0.046
	(0.100)
Own farm size/Adult equivalent	-0.030
	(0.040)
Sex of household head	0.040
	(0.180)
Household size	0.003
	(0.020)
Constant	1.089**
	(0.480)
Prob > chi^2	0.317
Number of observations	295
Number of left censored obs.	41

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.

Note: * significant at 10%; ** significant at 5%.

Appendix Table A.3—Models with additional time-variant household characteristics and separate operational/own farm holding size for tenants and landlords

Variable	1997–2010	2000–2010	2003–2010	2006–2010
Years with certificate	0.028**	0.030*	0.065****	0.043
	-0.010	-0.020	-0.020	-0.030
Sex of household head	0.119*	0.156*	0.156*	0.277*
Female = 1, male = 0	-0.070	-0.080	-0.090	-0.150
Sex of household head*Years with	0.017*	0.023**	0.017	0.019
certificate	-0.010	-0.010	-0.010	-0.030
Farm size per consumer unit	0.065***	0.049*	0.034	-0.005
	-0.020	-0.030	-0.030	-0.020
Operational holding size/Farm size	0.075****	0.119**	0.133***	0.170****
tenants	-0.020	-0.050	-0.050	-0.040
Operational holding size/Farm size	-0.045	-0.067	-0.095	-0.126
landlords	-0.070	-0.080	-0.100	-0.150
Age of household head	-0.019**	-0.014	-0.013	-0.033
	-0.010	-0.010	-0.010	-0.020
Age of household head, squared	0.000**	0.000	0.000	0.000
	0.000	0.000	0.000	0.000
Oxen per adult equivalent	0.136*	0.047	0.036	0.230
	-0.080	-0.080	-0.100	-0.160
Other livestock per adult equivalent	0.116***	0.134***	0.154***	0.144**
	-0.040	-0.040	-0.050	-0.070
Male labor force per adult equivalent	0.233**	0.281**	0.213*	0.361*
	-0.090	-0.110	-0.120	-0.190
Female labor force per adult equivalent	0.098	0.097	-0.002	0.295*
	-0.120	-0.130	-0.160	-0.160
Year dummy for 1997	-0.172			
	-0.130			
Year dummy for 2000	-0.196*	-0.166		
	-0.120	-0.150		
Year dummy for 2003	-0.047	-0.024	0.176	
	-0.080	-0.110	-0.110	
Year dummy for 2006	0.096	0.097	0.202***	0.129
	-0.060	-0.070	-0.080	-0.120
Constant	7.346****	7.173****	6.929****	7.462****
	-0.270	-0.360	-0.410	-0.690
Prob > chi^2	0.000	0.000	0.000	0.000
Number of observations	1459	1161	863	565
R-squared	0.284	0.274	0.194	0.149

Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.
Notes: Significance levels: * indicates $p < 0.10$, ** indicates $p < 0.05$, *** indicates $p < 0.01$, **** indicates $p < 0.001$.
Cluster-robust standard errors.

APPENDIX B: COMPUTATION OF COST PER CALORIE AND FOOD AND NONFOOD 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 that objective through defining a consumption bundle—incorporating food and nonfood items—that is adequate to meet the nutritional requirements and estimating the cost of purchasing that consumption bundle.

The important question related to this method is that of how to estimate the nonfood component of the poverty line, in such a way that it captures the basic nonfood requirements. A standard approach, recommended by a number of researchers, has been to estimate the nonfood 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.

Deriving the Cost per Calorie and the Food Poverty Line

The method implemented to derive the *cost per calorie* and *food poverty line* is as follows:

Step 1: The reference group is identified.

Households in the bottom 50 percent considering their consumption expenditure per capita in the year 2000—a relatively stable year in terms of farm production and price stability—are chosen as a reference group.

Step 2: All food consumption items of the reference group for which information on expenditure, quantity, and estimated calorie value is available are selected to compute the calorie intake and cost of food consumption.

Step 3: Aggregates of food consumption expenditures (that is, quantity multiplied by per unit price of items consumed) and calorie intakes (quantity consumed multiplied by per unit calorie value of items consumed) are calculated.

Step 4: The *expenditure-to-calorie* conversion factor (*cost per calorie*) is computed.

Cost per calorie is generated using the monetary cost of the consumption bundle (the food basket) divided by the calorie value of this bundle.

Step 5: The *calorie gap* per consumer unit (food deficit indicator) is computed.

The *consumption-to-calorie* conversion factor (that is, cost per calorie) is, then, used to convert the real food consumption expenditure of households (which is adjusted for temporal and spatial price fluctuation using the year 2000 southern zone price as reference) into daily per capita calorie intake of households—that is, [calorie intake = (food consumption expenditure) * (cost per calorie)]. Using the FAO-recommended nutritional anchor of 2,100 kcal per day, the calorie gap indicator is computed as the gap between actual calorie intake and the recommended anchor—that is, [calorie gap = (daily per capita calorie intake) – (the recommended daily nutritional anchor of 2,100 kcal)]. To evaluate the severity of undernourishment, the minimum calorie intake level of 1,800 kcal per day is also used to compute a more conservative calorie gap (food deficit indicator).

Step 6: The *food poverty line* is computed.

The food poverty line is computed as a product of the per calorie cost and the recommended nutritional anchor (2,100 kcal):

food poverty line (/adult eqv./year) = (cost per calorie) * (nutritional anchor per year)
= [(0.0009636) * (2,100 kcal per day) * (365 days)]
= ETB (Ethiopian birr) 738.60

The food poverty line obtained above has to be translated into an absolute poverty line that also incorporates the expenditure required to attain basic nonfood needs. Details of how the nonfood component of the poverty line is generated are now described.

Derivation of the Nonfood Component of the Poverty Line

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

The lower bound of the nonfood poverty line is defined as the *average per capita nonfood 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' nonfood expenditure should be considered as absolutely necessary for sustaining the minimum living standards, simply because any amount of spending on nonfood 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 nonfood 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 nonfood 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 nonfood poverty line is chosen from the range between the aforementioned 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 nonfood poverty line.

To estimate the upper and lower bounds, we use a simple nonparametric approach. For estimating the upper bound, the reference group is selected as households whose per capita food expenditures are within an interval of (+/−) 10 percent around the food poverty line (that is, between 664.74 and 812.46). The median per capita nonfood expenditure of the 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 nonparametric estimates (allowances) for the upper and lower boundaries for the nonfood expenditure are as follows:

Upper boundary: ETB 298.15

Lower boundary: ETB 182.89

Table B.1 summarizes all the poverty lines at 2000 southern zone prices.

Appendix Table B.1—Poverty lines estimated

Poverty line	Ethiopian birr/year
Food poverty line	738.6
Lower poverty line	921.49
Upper poverty line	1,036.75
Absolute poverty line (avg. of 2 and 3)	979.12

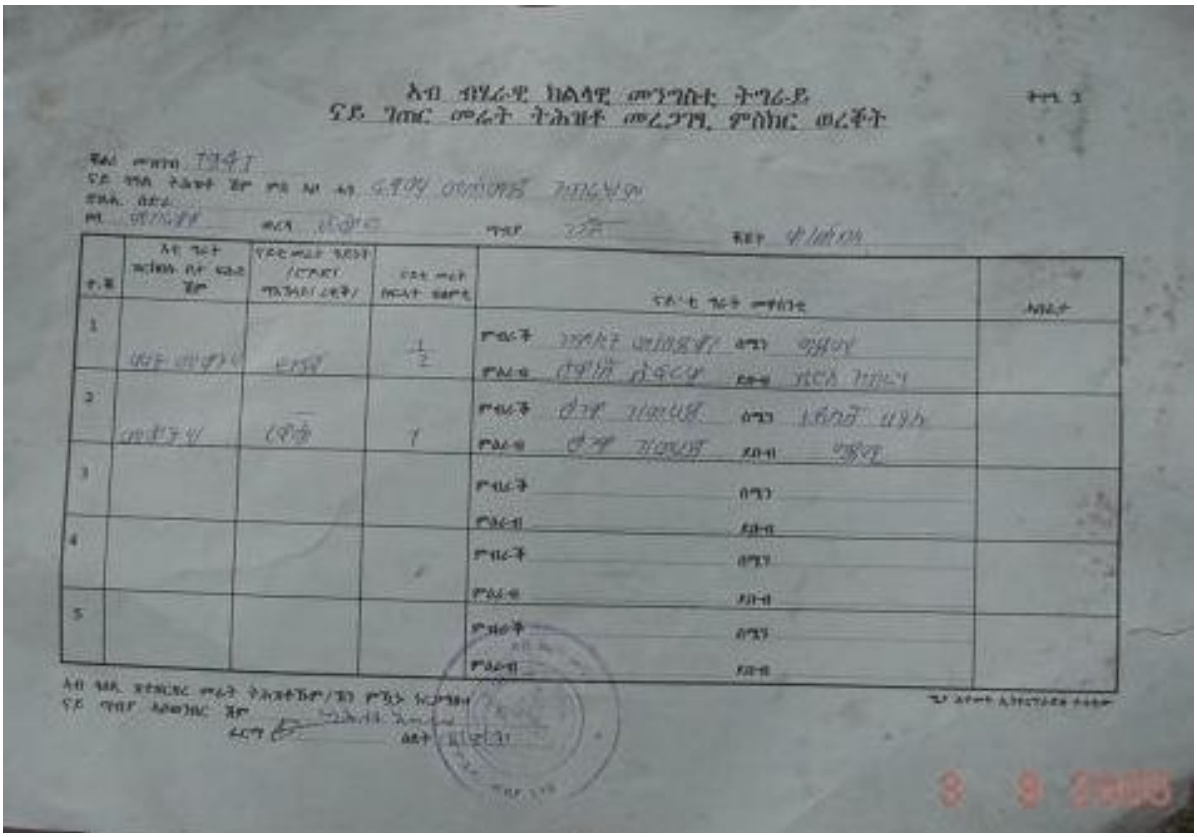
Source: Authors' computation using data from the 1998 - 2010 UMB-MU joint panel rural household survey.

Appendix Table B.2—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 and Krishnan (1998).

Figure B.1—Image of the land registration certificate from Tigray, Ethiopia



Source: Authors (2006).

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The Ethiopia Strategy Support Program II is an initiative to strengthen evidence-based policymaking in Ethiopia in the areas of rural and agricultural development. Facilitated by the International Food Policy Research Institute (IFPRI), ESSP II works closely with the government of Ethiopia, the Ethiopian Development Research Institute (EDRI), and other development partners to provide information relevant for the design and implementation of Ethiopia’s agricultural and rural development strategies. For more information, see http://www.ifpri.org/book-757/ourwork/program/ethiopia-strategy-support-program or http://essp.ifpri.info/ or http://www.edri-eth.org/.

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