Forest commons, vertical integration and smallholder's saving, and investment responses: Evidence from a quasi-experiment

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Forest commons, vertical integration and smallholder's saving and investment responses: Evidence from a quasi-experiment*

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Abstract

As the result of prohibitively high transaction costs, smallholder farmers are only partly integrated into agricultural and forest commodity markets, a situation that may leave them in a lower level of development equilibrium (i.e., a poverty trap). For the most part, many users of forest commons extract forest products, typically non-timber products, for subsistence use or safety net purposes. To overcome this problem, in recent years, collective vertical integration (VI) of forest product marketing cooperative structures have been promoted and, in some cases, adopted by users of forest commons. Although this type of program has been observed to raise smallholder incomes, there is little evidence available on saving/investment responses to such income gains. This paper investigates precautionary saving and investment responses to collective forest product marketing programs among users of forest commons in Ethiopian villages. To identify the causal effects of the program, I applied propensity score matching, difference-in-difference (DID) and change-in-change (CIC) estimators to household survey data collected from randomly selected households in the Gimbo district (south-western Ethiopia). I find strong evidence that participation in the program reduces savings in the form of livestock holdings and that effect is limited to non-poor households. When interpreted in terms of the Permanent Income Hypothesis (PIH), the results imply that participants felt the current income gains to be non-transient, which led to reduced precautionary savings and to a gain in consumption/welfare. Moreover, I found that the program has spurred investment in child education and participation in off-farm self-employment. These results point to the importance of the safety net/insurance channel of the program. Overall, the findings underscore

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the program's potential to raise the standard of living via ancillary mechanisms beyond directly raising income outcome.

Keywords: Forest commons; vertical integration; transaction cost; treatment effects; precautionary saving

JEL Codes: D02; D23; D14; Q

1 Introduction

Rural commodity markets in developing countries often operate in a constrained environment of prohibitive transaction costs. More specifically, prohibitively high transaction cost hampers smallholder farmers' participation in these markets (de Janvry et al, 1991; Barret, 2008 and Tadesse & Shively; 2013). As the result of this impediment to market participation, the majority of smallholder farmers are bound to engage in subsistence or semi-subsistence production, which, in turn, has caught them in a low-income equilibrium (poverty-trap) (de Janvry et al, 1991, Jayne et al., 2002 and Barret, 2008).[i]

Although transaction cost constraint is a pervasive phenomenon in forest product markets of developing countries, investigation of the interaction between common property forest users and markets has remained a missing link in common property right literature. The present research fills this gap by investigating forest commons users' precautionary saving response to the forest product marketing program of collective vertical integration (VI) governance.

Forest users face prohibitively high transaction costs arising from poor access to such public goods as physical infrastructure (roads, electricity, telecommunication) and institutional infrastructure (effective legal mechanisms to enforce contracts, standardization, and certification services and market information services) (Wunder, 2001). Typically, smallholder farmers in these areas sell forest and agriculture products to traders in their village local markets or in distant markets. In either case, they face considerable transportation and labour costs.[ii] Moreover, the remoteness of the villages means that the farmers face considerable uncertainty about prevailing central or regional market prices for the quality and quantity of their products (Tadesse & Bahiigwa, 2015; Tadesse & Shively, 2013). Faced with imperfect price information, farmers incur substantial searching costs to find a market or a buyer within a market that offers a higher price. Compared to farmers, traders/buyers are more informed about market prices.[iii] Due to such asymmetric information between traders and farmers, the former may take advantage of the latter's lack of market price information, seeking to extract a rent from them by offering very low prices for their products (Courtois & Subervie, 2014; Fafchamps & Hill, 2008; Tadesse & Shively, 2013). Farmers thus bear considerable transaction cost in the form of either receiving below-market prices for their output products or incurring sizeable costs in searching for a better price (Tadesse & Shively, 2013).

Moreover this transaction cost varies across transactions as a farmer faces a different buyer in each transaction. The variability of transaction cost thus translates into a farmer's income risk through its effect on the variance of the effective price received by the farmer. This adds to other sources of income risk including those arising from uncertainties associated with a health outcome, weather and market price.[iv]

Due to these constraints, smallholder forest users often recourse to extracting forest products, typically non-timber forest products (NTFPs), for subsistence use or safety net purposes rather than for market supply (Delacote, 2007). In light of such a constrained market environment, the ability of forest incentive policies and institutions to reduce poverty and provide the required incentive for sustainable forest management is considerably limited.[v]

To overcome this problem, in recent years, a collective vertical integration (VI) of forest product marketing cooperative structures, often referred to as Forest Users' Cooperatives (FUC), have been promoted and, in some cases, adopted by users of forest commons in a growing number of developing and transitional countries(Ameha, Nielsen, & Larsen, 2014; Antinori & Bray, 2005; Antinori & Rausser, 2008; Gelo & Koch, 2014; Gelo, Muchapondwa, & Koch, 2016; Tilahun et al., 2016; Vega & Keenan, 2014, 2016). FUCs have been observed to stimulate forest users' market participation through reducing transaction cost of accessing forest product markets (Antinori & Bray, 2005; Antinori & Rausser, 2008;Vega & Keenan, 2014, 2016).[vi] Thus, through improving smallholder forest users' participation in forest products markets, FUCs are expected to bolster economic incentives for sustainable forest management by forest-dependent people thereby promoting their livelihood (Kozak, 2007).

A handful of empirical studies in the wake of FUCs adoption have confirmed this proposition by ascertaining that FUCs have increased smallholders' income (Francesconi & Heerink, 2010; Gelo & Koch, 2014 and Tilahun et al., 2016) and improved forest cover (Ameha, Nielsen, & Larsen, 2014).

However, evidence on the effect of these program on saving and investments behaviors are hardly available. There are reasons to believe that FUC would impact on household's saving and investment (portfolio choice). Invariably, the FUCs have been instituted in contexts where income and health risks and shocks are pervasive phenomena among farming households of developing countries, who mainly depend on rain-fed agriculture as a large source of their income. Furthermore, these households find themselves in an economic environment in which financial markets; credit, insurance, and forward markets are either poorly developed or missing altogether, making it difficult to insure against income shortfall or to smooth consumption. In response, these households often recourse to self-insurance mechanisms, which include precautionary saving in liquid or productive assets (grain stock or livestock) (Fafchamps, Udry, & Czukas, 1998; Kazianga & Udry, 2006), extraction of non-timber forest products (Debela et al., 2012; Delacote, 2007), leaning on reciprocal social networks (Dercon & Krishnan, 2004), and cutting back on investment in child schooling (Jacoby & Skoufias, 1997; Jensen, 2000).[vii]

Studies of these informal risk-sharing and consumption-smoothing mechanisms have concluded that most households succeed in protecting their consumption from the full effects of the income shocks, although not by as much as would be obtained under a complete insurance market (Zimmermana &

Carter, 2003 and Kazianga & Udry, 2006), suggesting partial/imperfect self-insurance. Another strand of the literature has confirmed that accumulation of buffer stock for consumption smoothing comes at the opportunity cost of productive assets as well as at the cost of foregone consumption (Zimmermana, and Carter, 2003). More tellingly, such rational portfolio behaviour in the presence of uninsured risk can help perpetuate poverty traps, as it prevents households from undertaking profitable investments, especially if such investments are irreversible (Fafchamps & Pender, 1997; Jalan & Ravallion, 1999; Kaziang, 2012; and Langey & Reimersz ,2019).[viii] For instance, Rosenzweig and Wolpin (1993) confirmed that Indian farmers hold livestock as a buffer stock against risk even though more productive investment opportunities were available. Moreover, in testing for portfolio and other behavioural responses to idiosyncratic risk in rural areas of southwest China, Ravallion (2001b) confirmed that a sizeable share of wealth is held in unproductive liquid forms to protect against idiosyncratic income risk.

Public or market mechanisms that protect against downside shocks (income shortfall) are likely to mitigate precautionary saving in the form of holding a large share of relatively unproductive liquid buffer stock and consequently can break poverty trap (Gertler, Martinez, & Rubio-Codina, 2012).The FUC is one such mechanism as it reduces uncertainty about future income and consequently cuts households' demand for precautionary saving. The FUC decreases income risk through the following major ways; first, it eliminates the need to searching for the right price, the right buyer, the right standards ,and grades of the product by a farmer and bargaining. Note that these searches are not only costly but also vary by transaction, as the frequency of travel, repetition of loading and unloading to showcase their produce to buyers and brokers, and the level of information asymmetry between the farmer and the trader (a measure of the transaction cost of bargaining) are all random variables.

Mitigating these searching and bargaining transaction costs along with their variability through the FUC amounts to minimizing the income risk arising from the variability of the effective prices received by the farmers for forest products. Second, through affording assurance of markets and contingent pricing and, hence, stabilizing prices (Sexton, 1986), the FUC reduces income risk. As alluded to previously, the FUC not only decreases income risk, but also increases its members' income by reducing transaction costs and affording earning of dividend from the profit that the FUCT makes. It follows that increased expected income along with its reduced risk (variability) will increase current consumption and, thus, reduces the demand for precautionary saving in the form of holding more productive or liquid assets such as livestock, particularly if a household perceives the income gain as permanent (Ravallion & Chen, 2005).

Apart from these insurance effects, increased cash income from the FUC program can address liquidity constraints that exist because of future borrowing constraints (limited access to credit markets). For example, relaxing liquidity constraints help households afford the start-up costs associated with entrepreneurial activities (McKenzie & Woodruff, 2006) and meet the liquidity demands of seasonal agricultural production. Thus, by relaxing liquidity constraints, the program income gain can lower the demand for saving in assets such as livestock in order to self-finance production investments.

Over recent years, forest commons literature has produced rich evidences on the effects of forest user's cooperation on the resource base (i.e., the forest stock) and the attendant welfare and distributional outcomes. However, considerably less attention has been devoted to ascertaining the effects of this institutional shock on the income risk and the consequent saving and investment response among households of poor rural economies.

Moreover, a sizeable body of literatures has provided evidence on precautionary saving responses to public programs such as social safety net programs (Hubbar et.al, 1995), unemployment insurance (UI) (Engen & Gruber, 2001), National Health Insurance (NHI) (Chou, et al., 2003), New Cooperative Medical Scheme (NCMS)(Cheunga & Padieu, 2014) and universal health coverage (Ushijim, 2019). Within the developing country context, Gilligan and Hoddinot (2007) found that food aid in the form of the Productive Safety Net Program (PSNP) has slowed down the growth of livestock assets in Ethiopian villages, and Gertler, Martinez, and Rubio-Codina (2012) confirmed that conditional cash transfer spurred investment in higher return, albeit risky, ventures, which helped attain higher long-term living standards among Mexican households. Similarly, de Janvry et al. (2006) found that conditional transfers helped protect school enrolment, although it did not discourage parents from increasing child work in response to shocks. Ravallion and Chen (2005) showed that income gain from the World Bank's Southwest Poverty Reduction Project in southwest China spurred a larger saving response among program participants.

However, the question remains whether the same or a different set of conclusions emerge from vertical integration governance of forest products marketing that affords higher and stable environmental income. The present study is motivated to respond to this apparent lacuna in the literature. It aims to contribute to knowledge about saving and investment behavioural responses to a reduced risk of income gain from development-conservation programs in a poor rural economy. I investigated precautionary saving and investment responses to forest product marketing programs among users of forest commons. I applied propensity score matching (PSM), difference-in-difference (DID) and change-in-change (CIC) estimators to household survey data collected from randomly selected households in the Gimbo district (south-western Ethiopia) to identify the causal effect of vertical integration on saving. I find strong evidence that participation in the program reduces saving in the form of livestock holdings and that the effect is limited to non-poor households. Moreover, the triple difference-in-difference (TDD) analysis rejected the liquidity channel hypothesis but instead suggested that the insurance effect of the program decreases the demand for precautionary saving. I also have found that the FUC program instead raised investment in child education and participation in non-farm self-employment. These findings support the hypothesis that the program slashed precautionary saving, but stimulated willingness to take on risk and invest in risky but profitable ventures that can raise long-run living standards.

2 The Program and Its Assignment Mechanism

As in a number of developing countries, Ethiopia has recently implemented the decentralization of natural forest management following decades of deforestation under an unsuccessful state property regime and control of natural forests. This reform, commonly called Participatory forest management (PFM), involved devolving the use and management rights of state-owned forest areas (natural and planted) to local communities organized into forest user groups (FUGs) with the conditions that the forest should be maintained, and alienation rights are still held by the state (Ameha, Larsen, & Lemenih, 2014; Gelo & Koch, 2014). Its general objectives are to arrest deforestation while improving the welfare of those who are largely dependent on the forest for their livelihoods.

Apart from the government of Ethiopia, many NGOs (FARM-Africa and SOS-Sahel) and development agencies have participated in implementation of PFM programs as part of their local development strategies (Ameha, Larsen, & Lemenih, 2014; Gelo & Koch, 2014; Tesfaye et al., 2010). Against these backdrops, Farm Africa/SOS-Sahel has implemented PFM programs in the Bonga region of southwest Ethiopia; more than six PFM programs have been established to improve the management of about 80,066 ha of natural forest (Jirane et al., 2008). The programs have targeted forests that are threatened with deforestation and have high potential to produce non-timber forest products (Gelo & Koch, 2014). In essence, the implementation of these programs involved a series of steps including site (forest) selection, defining eligibility of farm households to participate in the program, crafting common property rights forest management institutions (rules), and setting up enforcement mechanisms of these institutions.[ix]

Selection project site (forests) involved consideration of the government's concern regarding the degree of forest exploitation. The overriding criterion, though, was the potential of each observed forest to produce non-timber forest products so that the program will bolster the economic benefits provided by the forests through the marketing intervention (Gelo & Koch, 2014; Gelo, Muchapondwa, & Koch, 2016).

Once forest units have been provisionally accepted, further efforts are undertaken. The location of the forest needed to be topographically identified, and then demarcated in the field. Further, information related to available forest resources was required, as was information related to past and present management practices. Finally, it was necessary to develop an understanding of prevailing forest management problems, attributes of forest users and their relations to deforestation (Lemenih and Bekele, 2008).

This multi-step process produced a number of observations (Gelo and Koch, 2014).

First, it was observed that forest using communities had generally engaged in the following portfolio of livelihood options; crop production, livestock production, forest extraction, and off-farm employment (Gobeze et al., 2009). As elsewhere in Ethiopia, livestock are kept for three purposes: as an income generator, as a buffer for consumption-smoothing (cushioning the effect of crop income shocks), and as a source of working capital of farm households (Andersson, Mekonnen, & Stage, 2011; Ayalew, 2015; Mogues, 2011; Gryseels & Anderson, 1983). Another key observation was the heterogeneous perceptions of customary rights to the forests among users of selected forests for the intervention. Specifically, it was observed that selected forests were used by communities of different ethnic and geographic origins, namely, the native population and the resettled population (those new settlers who arrived from outside). Perceptions of customary rights to forests varied across these groups. Native population considers that the forest belongs to them (as a group) and views state ownership as the government's attempt to take it over. However, from the new settlers' point of view, the forests should be used as an open-access resource. Note that such variation in perceptions of customary rights across the two groups of the forest using communities resulted from historical reasons (see Stellmacher, 2007).[x] Moreover, both federal and local governments considered such perception and the consequent forest use behavior as a violation of forest conservation rules, but they have failed to enforce these rules largely because of high transaction (monitoring and enforcement) costs and significant budget constraints. This had subjected the state forests of our study villages to an institutional vacuum in which no definite and enforceable institutions regulating access to the forests existed, the outcome often being *de facto* open access.

In light of these observations, FARM-Africa had to define eligibility criteria for PFM program participation. PFM membership is meant to include those who actually use a particular area of the forest regardless of their settlement configuration and ethnic/geographical origins. However, variation in perceptions and practices across native and new settler populations regarding the customary rights structure raised a critical question of eligibility. In consultation with local government and communities, FARM-Africa devised an eligibility criteria on the basis of whether the forest using community (native or settlers) are primary users of the forest, which in turn, was determined by proximity to the targeted forest and frequency of use (Ameha, Larsen, & Lemenih, 2014; Bekele & Bekele, 2005; Lemenih & Bekele, 2008).[xi] This criterion led to the inclusion of both the native population and the population of new settlers, (Stellmacher, 2007). However, the difference in the perception of customary rights is likely to drive variation in the PFM participation decision across the native and new settler population groups.

Program participation decision amongst eligible households, however, remained voluntary. Eligible households that chose to participate in the PFM program formed Forest User Groups (FUGs).However, those who chose not to participate in the program must recourse to using the nearest non-PFM forests, which, in effect, are managed under the *status quo* characterized by the *de facto* open-access regime (Ameha, Larsen, & Lemenih, 2014; Gelo & Koch, 2014).

Moreover, FARM-Africa observed that defining and enforcing common property rights through the FUG's collective action alone may not provide the required incentives for forest protection and promotes rural livelihoods. Particularly, it observed that pervasive market imperfection of forest products prevails in the program villages with the potential to undermine the ability of forest commons institutions to generate sufficient income that justifies participation in FUG's collective action.

Typically smallholder farmers in the study villages harvest three major non-timber forest products (NTFP), namely honey, spices, and forest coffee for commercial purposes (Gelo and Koch, 2014). They supply these products to local markets, where they lack access to large-scale buyers (wholesalers). Instead, they sell the products to local traders, which constitutes only a few buyers in these markets. Local traders buy the products from farmers, bulk up the volume and then sell to wholesalers at central markets. Local markets prices are governed by wholesale prices of central markets, typically Addis Ababa (Meaton, Abebe, & Wood, 2015).[xii]

When participating in local markets, the farmers largely lack information regarding the prices in central markets. However, local traders have better information about these prices as they glean them from contacts on their travels (Meaton, Abebe, & Wood, 2015) and use mobile phones (Tadesse & Bahiigwa, 2015).[xiii] This asymmetric distribution of price information means that the transaction price is determined through decentralized bargaining between the traders and the farmer (Tadesse & Shively, 2013). The bargaining is such that the trader offers a price, and the seller (farmer) would either accept or reject it.

If the farmer rejects the offered price, he/she must shop around in search of a better price, which entails frequent travel and repeated loading and unloading to showcase his product to another buyer (Tadesse & Bahiigwa, 2015). This leads to incurring considerable searching costs to find a market or a buyer within a market that offers a higher price. Thus, the farmer bears considerable transaction costs in the form of either incurring substantial costs in searching for a better price or receiving below-market prices for the product if he/she opts out such searching (Tadesse & Shively, 2013). The margin between this price and the market price constitutes a burden of transaction cost arising either from the trader's opportunist behavior or searching for a better price. This margin appears to be relatively higher for spices due to their perishability (temporal-specificity) and the consequent weak bargaining position of the farmers.

FARM-Africa transformed FUGs into Forest Users Cooperatives (FUCs to overcome these marketing constraints (transaction costs) and tap on lucrative demand in central markets for such products as spices, forest coffee, and honey. FUCs buy these products from their members, and then directly supply them to central markets, and distribute the resulting profit among its members on the basis of patronage (the number or volume of transactions of the member with FUC). Recent studies have confirmed that FUCs help their members receive better prices compared to non-FUC members. For example, Shumeta, Urgessa, & Kebebew (2012) documented that FUC members sell forest coffee at 87% higher prices than non-members. Moreover, FUCs have attracted Addis Ababa-based buyers (wholesalers), who provided training to their members regarding harvesting methods, quality assurance, and storage. Inter alia, this brought about the export of Ethiopian honey to Europe for the first time (Lowore, Meaton, & Wood, 2017; Meaton, Abebe, & Wood, 2015). Lowore, Meaton, and Wood (2017) observed that FUC-supplied honey saw a rise in its price from 5 Ethiopian Birr (ETB) ($0.60) per kg in 2005 to 50 ETB ($2.50) in 2015 in the Addis Ababa market and that increase well exceeded the rate of in?ation. A similar development of linking farmers to large buyers (wholesalers) through FUCs was observed in the spice sector as well, although value-adding interventions of processing and storing the products is still at the planning stage (Lowore, Meaton, & Wood, 2017). More importantly, the FUC program has raised annual per capita NTFP revenue by ETB 252–277 (an increase of more than 100% of the annual per capita NTFP revenue of ETB 235 for non-program farmers) (Gelo & Koch, 2014).

3 The Data

Data for the analysis was obtained from a household survey undertaken in October 2009 in 10 communities in the Gimbo district, which is in southwestern Ethiopia. Survey sites were purposive, in the sense that five FUC projects and another similar five non-PFM communities were selected from a list developed in consultation with the local government, as well as FARM-Africa/SOS-Sahel. The selected non-PFM communities were the closest available to the selected FUC groups.

The selection of sites was followed by going to the lower level of local government, the "Kebele", where we obtained sample frames of households for the selected sites. We randomly selected 200 households from FUC communities and 177 from non-FUC communities, making up a total of 377 households. Respondents provided information on household characteristics, such as age, education, gender, family size, household expenditure on various goods and services, and household earnings from the sale of forest products, as well as the labor allocated to harvesting forest products and to other activities. Additional information related to potential determinants of PFM participation was also collected.This information included household circumstances prevailing immediately before the inception of PFM, such as household's assets: livestock holding, landholding, the household head's education, and age, participation in off-farm employment, ownership of private trees, access to extension services, and experiences related to alternative collective action arrangements. We also gathered information related to the distance of the household from both PFM and alternative forests. Finally, data related to the community was gathered, including population, ethnic structure, forest status, and location. Information on livestock holdings was converted into tropical livestock units (TLUs), where 1 TLU is equivalent to 1.5 cattle, 10 sheep, 12 goats, 2 donkeys, or 1 horse. The number of TLUs was used as a proxy for the households' livestock assets (Le Houerou & Hoste, 1977).

Because of the absence of longitudinal data, we designed our questionnaire to collect recall data. These data included information on the following variables: household's circumstances that prevailed immediately before the inception of PFM in relation to the distance to PFM and alternative forests, household assets including livestock holding, the household head's education, and age, participation in off-farm self-employment, ownership of private trees, participation in extension services, and experience of participation in alternative collective actions arrangements. Furthermore, data on community-level variables such as population size, ethnic structure, forest status, and location were collected. However, we did not collect information on income and expenditure variables through recall design, as it is hardly possible to recall information on them. Table 1a and Table 1b present descriptive statistics of covariates used in the analysis. As these statistics are separated by participation status, their differences give some indication with respect to the vector of control variables to be used to estimate propensity scores. Therefore, the final column of Table 1a is the relevant column.

Participating households are located in areas that are nearly 40% more likely to incorporate individuals from the Menja tribe. In terms of potential observable controls for participation, there are a number of significant differences between participant and non-participant households. Participating households are located nearly 43 minutes closer to program forests, based on walking times; these same households are located just over 13 minutes closer, also based on walking times, to the nearest agricultural extension office. They are also nearly 10 minutes closer to the nearest road, again measured by walking time. However, these households are located 26 minutes (walking time) farther away from the nearest non-program forest. On the other hand, participating households were 5.7% more likely to have a household member working off of the farm, they had more working-age women in the household; and they were 10.5% more likely to have previously participated in other collective programs. Finally, they own more livestock, as measured in tropical livestock units.

4 Theoretical Framework

In this section, we develop a theoretical model to derive a testable hypothesis of the linkage between FUC intervention and farm household's saving response. First, we show that FUC intervention reduces the price risk of forest products, which, in turn, translate into lowered income risk.

Lemma 1. *Forest users' collective vertical integration (VI) through the FUC reduces income risk (variance).*

Proof. Assume that the producer's price (effective price), $\mathrm{p_{te0}}$, that a farmer receives at the local market in the absence of a FUC is given by the relation:

$$p_{te0} = p_t - \eta_t + \nu_t \tag{1}$$

where p_t is the competitive market price at the local market, η_t is the transaction cost incurred due to searching for a better price or opportunistic behavior of a traders or both, and ν_t is a market shock arising from market-specific demand or supply dynamics, either in the central market or local market or both. Note that η_t is time varying as a farmer faces a different buyer in each transaction across time and hence it has non-zero variance. We also assume that η_t and ν_t are independently distributed. The variance of producer price in (1) is given as $var(p_{te0}) = {\sigma_{pe0}}^2 = {\sigma_{pt}}^2 + \sigma_\eta^2 + \sigma_v^2$. Note that, by the assumption of independent distribution, the covariance between the last two terms in (1) must be zero (i.e.$cov\,(\eta_t, \nu_t) = 0$).

Now, we return to representing the producer price and its variance in the presence of FUC intervention as follows:

$$p_{te1} = p_t - \mu + \nu_t \tag{2}$$

where $\mu < \eta_t$ is a time-invariant as well as transaction-invariant FUC-specific transaction cost. Thus, the FUC's price variance is given by $var(p_{te1}) = \sigma_{pte1}^2 = \sigma_{pt}^2 + \sigma_v^2$ as $var\,(\mu) = 0$. Thus, comparing variances of the producer's prices under non-FUC and FUC regimes, we see that price variance is lower under FUC, as it eliminates or minimizes time-varying transaction cost. Consequently, it reduces variance (risk) of income that accrues from NTFP's commerce. Reduction or elimination of transaction cost is not the only way that FUC lowers income risk. It also reduces the variability of farmers' incomes through the pooling of their returns across products, time, and space (Ligon, 2009).

We now return to deriving the precautionary saving response to a reduction in income variance and an increase in mean income due to FUC intervention. We build on Deaton's (1991) canonical model of the intertemporal choice problem of a household that faces a stochastic income stream but has no access to financial markets.

Specifically, the consumer is assumed to solve the following decision problem:

$$Max_{c_t} \sum_{t=0}^{\infty} \beta u\,(c_t) \tag{3}$$

Subject to

$$x_t = A_t(1 + \eta_t) + y_t \tag{4}$$

$$c_t \leq x_t \tag{5}$$

$$x_{t+1} = (A_t + y_t - c_t)(1 + \eta_{t+1}) + y_{t+1} \tag{6}$$

$$A_t \geq 0,\ \forall t \tag{7}$$

where the current utility, $u(c_t)$, is assumed to follow a decreasing relative risk-aversion (DARA) and hence c_t is current consumption level and A_t is the stock of livestock holding at time t.

Cash on hand, x_t is defined as the sum of the value of livestock holding, A_t and return to holding it, $\eta_t A_t$, as well as income from other sources, y_t. Return to holding livestock, η_t, incorporates physical returns from cattle herding in the form of offspring, weight gains, by-products and loss through death as well as the contribution to crop and milk production (Fafchamps, Udry & Czukas,1998). Note also that y_t is given by $y_t = w_t + y_{ft}$, where ,w_t and $y_{ft} = p_t\bar{f}$ are respectively farming income and labor income from extraction of forest products, p_t is the net price of forest products (and $\bar{f}$ is fixed quantity of NTFP, the extraction of which is limited by the FUG rules).[xiv] Note that p_t (equivalently y_{ft}) is a stochastic variable due to idiosyncratic variability in the transaction costs of marketing forest products and other sources of risk, including fluctuation in forest products markets fundamentals. Moreover, w_t is a stochastic variable due to idiosyncratic variability of crop production, and covariate risks such as including fluctuations in crop markets fundamentals, weather and pest outbreaks.

Ordinarily, the expected return from livestock holding should exceed the return on the safe asset in order for risk averse agents to not avoid the risky asset in their optimal decision. Assume, though, that livestock is both production capital and the only saving instrument in this economy, yielding η_{t+1}. Equation (4) represents asset dynamics where the next period's asset level is simply the difference between cash on hand and consumption. The last equation is the non-negativity restriction on assets, signifying the borrowing constraint inherent under missing financial markets. Alternatively, the problem becomes one of solving the Bellman equation for a dynamic optimization problem, given by;

$$V(x_t) = Max_{s_t} u\left(x_t - s_t\right) + \beta EV\left(\bar{x}_{t+1}\right) \tag{8}$$

Future cash on hand is given by $x_{t+1} = (1+\eta_{t+1})s_t + y_{t+1}$ where saving/investment in livestock transferred into the second period is given by, $s_t = A_t + y_t - c_t$. We use saving as the only decision variable in the model. Observe that insofar as y_{t+1} and η_{t+1} are stochastic variables, x_{t+1} is also a stochastic variable with its mean and standard deviation given by;

$$\mu_{x_{t+1}} = \mu_{s_t} + \mu_{y_{t+1}} = \mu_{s_t} + \mu_{w_{t+1}} + \mu_{y_{ft+1}} \tag{9}$$

$$\begin{aligned} \sigma_{x_{t+1}} &= \sqrt{\sigma_{s_t}^2 + 2\rho\sigma_{s_t}\sigma_{y_{t+1}} + \sigma_{y_{t+1}}^2} \\ &= \sqrt{\sigma_{s_t}^2 + 2\rho\sigma_{s_t}\sigma_{w_{t+1}} + \sigma_{w_{t+1}}^2 + \sigma_{y_{ft+1}}^2} \end{aligned} \tag{10}$$

Of interest for us is the variability of forest income given by $\sqrt{\sigma_{y_{ft+1}}^2} = \sigma_{y_{ft+1}}$.

From (2), we know that FUC reduces effective price variability and consequently the variance/standard deviation of forest income. From *Lemma 1*, we know that y_{ft+1} follows a distribution with higher variance under a non-FUC regime and a distribution with lower variance under the FUC regime. Let this difference be measured by a reduction in standard deviation (risk) of forest income given by ϵ such that the resulting forest income risk is $\sigma_{f=}\sigma_{y_{ft+1}} - \epsilon$ and the resulting standard deviation (risk) of future cash on hand is $\sigma_x = \sigma_{x_{t+1}} - \epsilon\psi$, where ψ is the measure of market integration intensity through FUC. Likewise we denote the impact of market integration on forest income by $\theta\psi$, giving rise to $\mu_{f=} = \mu_{y_{ft+1}} + \theta\psi$, which in turn yields $\mu_{x=} = \mu_{x_{t+1}} + \theta\psi$.

Following Meyer (1987) and Wagener (2002), I now formulate the second term of (8) as mean-standard deviation (M-S) preference, which will facilitate the comparative statics analysis of choice variable with respect to income risk or change in income risk. After removing the time subscript for ease of exposition and accounting for reduction for income risk, (8) is transformed into;

$$V(x_t) = Max_{s_t} U\left(x_t - s_t\right) + \beta V\left(\mu_x, \sigma_x\right) \tag{11}$$

Meyer (1987) showed the following properties of M-S preference; $V_{\mu_x}(\mu_x \sigma_x) > 0$, $V_{\sigma_x}(\mu_x \sigma_x) < 0$, $V_{\mu_x \mu_x}(\mu_x, \sigma_x) < 0$, $V_{\mu_x \sigma_x}(\mu_x, \sigma_x) > 0$. Note that the term $V_{\mu_x \sigma_x}$ is marginal rate of substitution (MRS) in μ_x and σ_x space. An agent is prudent (saves more when faced with riskier future income) if $V_{\mu_x \sigma_x} > 0$. This is equivalent to marginal utility of future income being convex (its third order derivative is positive) in von Neumann-Morgensten (VMN) preference to describe that an agent is prudent (Wagener, 2002).

Equation (11) yields the following first order necessary conditions for an interior solution;

$$U_c(x_t - s_t)(-1) + \beta(\eta_{t+1} - r_{t+1})V_{\mu_x}(\mu_x \sigma_x) = 0 \tag{12}$$

Proposition 1.*Forest users' collective vertical integration (VI) through the FUC decreases the demand for precautionary saving.*

Proof: The proof of this proposition is provided in Appendix 3.

Proposition 1 suggests that integration of forest products markets through the FUC program leads to lower equilibrium asset/livestock holding through the following major mechanisms. First, it reduces income risk, as was elucidated in the introduction. The assumption of prudence, thus, implies that reduced income variance/risk leads to more consumption and, hence, less saving (diminished motive for precautionary saving). Kimball (1990) defines prudence as a motive to save more in the face of uncertain future income and showed that it is the key theoretical requirement to produce precautionary saving. Second, increased price of forest products due to the program amounts to increased return to extraction of these products. This yields an income effect on precautionary saving through increasing household's willingness to accept risk *ceteris paribus* (it reduces the risk premium if we assume decreasing absolute risk-aversion-DARA preference). Moreover, as part of the knock-on effect, the portion of resources that is freed up from costly precautionary saving may still be deployed to an alternative high-return and higher-risk investment portfolio such as education and off-farm self-employment.

Third, the program reduces livestock holding through relaxing liquidity constraints and, as such, lowers the demand for saving through holding assets such as livestock in order to self-finance production investments. Addition of a liquidity constraint to the standard consumption/saving problem leads the resulting value function to exhibit an increased prudence around the level of wealth where the constraint becomes binding. More tellingly, the liquidity constraint induce precaution, mainly because constrained agents have less flexibility in responding to shocks because the effects of the shocks cannot be spread out over time; thus risk has a bigger negative effect on expected utility (or value) for constrained agents than for unconstrained agents (Deaton, 1991).The precautionary saving motive is, thus, heightened by the desire (in the face of risk) to make such constraints less likely to bind.

5 Empirical Strategy

Program impact refers to the difference between the observed outcome and the counterfactual outcome (the outcome that would have been obtained had the program not been taken up) (Cobb-Clark & Crossley, 2003; Heckman et al., 1998). As is well established in the program evaluation literature, we cannot observe counterfactuals because an individual is either in one state or the other at any point in time. In this study, we follow a quasi-experimental approach to identify the appropriate counterfactual, accepting that program participation is not random. As such, appropriately controlling for participation decisions is tantamount to identifying the program impact.

Following Roy (1951), we argue that farmers choose to participate in the program, provided that the benefit of doing so outweighs the benefit arising from the *status quo*. That choice entails not only a welfare outcome, but also a behavioral change matching that welfare gain. If farmer $i = \{1, 2, \ldots, N\}$ chooses to participate $(D_i = 1)$, the relevant household outcome, is Y_{1i}; Y_{0i} is the relevant outcome for non-participating $(D_i = 0)$ households. Therefore, in regression format, $Y_i = Y_{0i} + D_i\,(Y_{1i} - Y_{0i}) + \eta_i = \alpha + \tau D_i + \eta_i$. Since participation is voluntary, our data set presents major causal effect identification challenge. A farmer's assignment mechanism to the FUG, and equivalently to the FUC, is non-random. We can reasonably expect that farmers in treated communities self-selected into the program, which makes them systematically different from non-participants. As stated in the previous section, self-selection into the program is evident from lack of balance in baseline covariates as presented in Table 1a.

This means that there are differences in the distribution of pre-intervention observable and unobservable characteristics across treatment and control groups. The presence of such differences leads to biased estimates of the program's causal effects.

In responding to this econometric challenge, I drew on a broader set of identification strategies to evaluate the livestock holding, child education and off-farm employment (entrepreneurial self-employment venture) participation effects of FUC intervention. As a baseline, one can implement a propensity score matching (PSM) method assuming ignorable treatment assignment (conditional independence assumption, CIA). That is assuming that the distribution of outcome variables Y_{1i} and Y_{0i} are independent of treatment D_i, given a vector of covariates X_i, a propensity score matching estimator for the average; effect of treatment on the treated can be derived. Intuitively, the goal of matching is to create a control group of non-FUC participants that is as similar as possible to the treatment group of FUC participants, although the groups differ in terms of their participation. Identification of the average effect of FUC on the program participants, via propensity score matching (PSM), requires the strict ignorability of treatment, $(Y_{1i,'}\, Y_{0i}) \perp D_i | P(X_i)$.

However, if there are unobservable determinants of participation, meaning that treatment assignment is non-ignorable, then treatment effect results based on (PSM) estimators may be biased. In what follows, I carefully describe the causal effect of interest. The data is comprised of n observations, and two of outcome variable L_i, livestock holding is continuously distributed. There is a binary treatment variable, denoted by D_i, as well as an instrumental variable, Z For concreteness, from the matching section, we can re-specify the observed outcome variable as:

$$Y_i = Y_{0i} + D_i\left(Y_{1i} - Y_{0i}\right) + \eta_i \; = \alpha + \tau D_i + \{D_i(u_{1i} - u_{0i}) + u_{0i} \tag{13}$$

The average treatment effect on the treated is derived from (1) as follows, after certain algebraic manipulation:

$$\begin{aligned} E\left(Y_{1i} D_i = 1,\, X\right) - E\left(Y_{0i} D_i = 0,\, X\right) \\ = E\left(\tau \mid X\right) + \{E(u_{0i} \backslash D_i = 1, X) - \; E(u_{0i} \backslash D_i = 0, X)\} \end{aligned} \tag{14}$$

where the first term in the RHS of equation (2) is the average treatment on the treated (ATT). The second term in equation (2) is the difference in the untreated outcome variables between program participants (treated) and non-participants (untreated) individuals. If this term is zero, the treatment effect on the treated can be estimated using PSM. However, if this difference is greater than zero, it follows that the individuals who decided to participate in the program are those individuals who would have done well without program participation, in terms of unobservable, u_{0i}. In other words, cov $(u_{0i} \quad D_i) \neq 0$ leading to bias of the PSM estimate in equation (1). Identification is then achieved through either selection models, panel data models (DID), or instrumental variable (IV) method (Heckman & Vytlacil, 2005; Todd, 2008).

In the interest of testing robustness of the estimate to different identification assumptions, I employed PSM, DID, and generalized Roy model to identify treatment effect estimates in (2). Within the DID analysis, I estimated models that match treatment and control groups by adjusting for pre-program covariates (Blundell et al., 2001; Heckman, Ichimura, and Todd, 1997). I hypothesized that FUC has strong effects on liquidity-constrained participant households than on non-liquidity constrained participants. To test for this hypothesis, I refined the definition of the treatment group and considered a subset of program participants, who were liquidity-constrained prior to the program intervention as a new treatment group. To identify ATT for his group, I implemented a triple difference-in-difference (DDD) model by estimating the coefficient of higher-order interaction among program participation, credit constraint variable, and year variable. Specifically, I estimated DDD model specified in (3) below:

$$\begin{aligned} Y_{it} = \alpha + \beta_1 x_{it} + \beta_2 \tau_t + \beta_3 p_i + \beta_4 treat_i + \beta_5\left(\tau_t \times p_i\right) + \beta_6 \tau_t \times treat_i) \\ + \beta_7\left(p_i \times treat_i\right) + \beta_8\left(\tau_t \times p_i \times treat_i\right) + v_{it} \end{aligned} \tag{15}$$

where x_{it} is a vector of observable covariates, t is fixed year effect, p is fixed participation effect, and $treat$ is a dummy for treatment group (=1 if liquidity-constrained, 0 otherwise).

The fixed effects control for the time-series changes in livestock holding (β_2), the time-invariant characteristics of the program participants (β_3), and the time-invariant characteristics of the treatment group (liquidity-constrained) (β_4). The second-level interactions control for changes over time for the participants (β_5), changes over time common to the entire liquidity-constrained group (β_6), and time-invariant characteristics of the treatment group (liquidity-constrained) within the program participants group (β_7).[xv]

The third-level interaction (β_8) estimates all variation in livestock holding specific to the treatments (relative to controls) in within program participants (relative to the non-program participants) in the endline year (relative to baseline year). In other words, it captures how different the difference-in-difference estimate is for observations considered more sensitive. This is the DDD estimate of the effect of FUC on livestock holding of liquidity-constrained participants.

Although our DID models are likely to perform well, as they account for selection biases arising from time-invariant unobservable factors (fixed-effects), a selection bias due to time-varying unobservable factors may not be resolved. Thus, in the interest of robustness, I implemented a parametric generalized Roy model following Heckman, Urzua, and Vytlacil (2006) and Basu et al. (2007).

At this point, it is noteworthy that all of the models outlined above consider mean treatment effects of the program.[xvi] However, evaluating mean treatment effect conceals heterogeneous saving responses of farmers to the program intervention. To account for treatment effect heterogeneity, I implemented quantile treatment effects (QTT) methods under different identification strategies; quantile difference-in-difference (DID) and change-in-change (CIC), both of which allow us to account for endogeneity bias.[xvii]

Moreover, in the interest of robustness, I tested whether the saving response has been translated into consumption response. In effect, I evaluated the program's effect on household consumption outcome. I estimated the QTT of the program on household's consumption outcome using an IV method to account for endogeneity bias.[xviii]

6 Results and Discussion

6.1 Determinants of the FUC program participation

In this subsection I present the estimates of the determinants of program participation are presented in Table 2. The results show that a lack of balance for some baseline covariates across participants (the treatment group) and non-participants (the comparison group) is evident, suggesting a non-random program assignment mechanism. Results suggest that the household characteristics and village-level factors described in the foregoing section are statistically significant determinants of the decision to participate in the program, and I also found that these results resonate with the mean differences highlighted in Table 1a. Consistent with that discussion, the distance between the program forest and agricultural extension service office is negatively associated with household participation, suggesting that proximity to the extension office could have influenced the government's program location decisions and, thus, influenced participation. Similarly, households residing closer to the program forest were more likely to join the program, while those residing farther from alternative forests were also more likely to have joined, suggesting that opportunity costs associated with distance do matter. Those households that have experience with other collective action programs are more likely to participate, presumably due to positive experiences. Moreover, if a household member was engaging in off-farm employment before the program began, the household was more likely to participate in the program, presumably due to being less dependent on forests for their livelihoods. Households headed by older men are less likely to participate; possibly, older individuals are more set in their ways and have a shorter time horizon over which to gain from the program, while female-headed households may either not be in a position to sacrifice in the short-term or might be discriminated against. The latter hypothesis derives from Agrawal (2001); she finds a significant proportion of women were excluded from community forestry programs in India and Nepal. Finally, households headed by those with more education are more likely to participate. It is possible that education allows for a better understanding of the importance of the program, or that program would more likely to be internalized by the more educated.

6.2 Saving and investment effects of the FUC program

Before unpacking the FUC program impacts, I tested whether the FUC program reduced forest income variability among the program participants. Using a Re-centered influence function (RIFs) estimator, I found that FUC program participation reduced the variance of NTFP income by standard deviation of ETB417.29. This suggests that the FUC mitigated the income variability (inequality) that arises from variation in transaction costs and its variability among the program participants. The statistical significance of this estimate confirms that there is treatment (program) shock that leads to ensuing behavioral responses such as saving and investment choice among the program participants.

In what follows, I present the impact of program participation on livestock holding, child education, and off-farm self-employment. Table 3 presents results from panel data (DID) models and the parametric generalized Roy model for livestock holding, all of which estimate the average treatment effect on the treated (ATT). Table 3 reports estimates of ATT, along with standard errors, and significance at the 5% and 10% levels. Each of the columns of Table 3 corresponds to a different model. We start the presentation with results from the difference-in-difference (DID) models (see columns 1, 2, and 3).

In an intervention with a random treatment assignment mechanism, a conventional DID estimator can identify the average treatment effect on the treated (ATT), which, in our case, is the average effect of FUC participation on livestock holding. Random treatment assignment means that, in the absence of the treatment, the average outcomes for treated and controls would follow parallel paths as covariates would be balanced across the treatment groups. However, in observation data, where subjects self-select themselves into treatments, average outcomes may not follow the parallel trend as pre-treatment characteristics that are thought to be associated with the dynamics of the outcome variable are unlikely to be balanced between the treated and the untreated groups (Abadie, 2005). We, thus, estimated three DID models to restore randomness and overcome potential selection biases by controlling for pre-treatment covariates. In column (1) of Table 3, we present the ATT estimate from the DID model, referred to as DID1, in which we controlled for a vector of time-varying covariates that may affect participation in FUC. The covariates included are the age of household head,, household's size, household's male and female labor forces, and the number of households in the village. DID1 estimate shows a statistically significant decrease in livestock holding by -1.273 TLU.

In column (2) of the table, I present an estimate of DID2. In this model, I accounted for possible selection on observables, by using propensity score matching that limits the sample to participating farmers and their matches, and then compute conditional difference-in-differences. I used kernel matching and utilized only the time-invariant baseline (pre-treatment) covariates to avoid the risk that the program influenced observables during the program. The ATT estimate of this model shows a statistically significant decrease in livestock holding by 1.219 TLU. Indeed, this estimate is of the same order of magnitude as the estimate from DID1.

Finally, I estimated DDD to test for a liquidity effect of FUC participation. In this analysis, I controlled for covariates including the size of land cultivated and owned, distance to the nearest town, distance to the nearest paved road, distance to the nearest village market, household size, and age of household head.The third column of Table 3 presents the estimates of the DDD analysis from (3). The analysis shows that the estimate of β_7 is statistically significant. This estimate indicates that livestock holding fell by 1.156 TLU for liquidity-unconstrained participants.

However, the estimate of the third-level interaction, β_8, is 0.793 TLU, which is statistically insignificant. This estimate suggests that FUC's effect on livestock holding of liquidity-constrained participants is not any different than its effect on liquidity-unconstrained participants. Overall, our DID analysis confirmed that the point estimates

of ATT are all negative and statistically significant across alternative models. When I controlled for sample selection bias using the parametric generalized Roy model, a statistically significant ATT estimate of - 1.457 TLU obtains, which is in the same order of magnitude as DD estimates.

In what follows, I present the results of alternative cross-section data models of PSM for all three outcome variables; livestock holding, child education expenditure, and off-farm self-employment.[1] In fact, my discussion of the parameters of interests is based on the estimates of PSM especially for the program effects on child education and off-farm self-employment as there is no repeated time observation (panel data) on these outcomes.

The PSM results are presented in Table 4. The analyses yielded treatment effect estimates of -1.441TLU, ETB 95.45 (42.44%) and 0.78% respectively for

[1] Our sensitivity analysis of matching estimates suggests the presence of selection bias.

livestock holding, expenditure on education and off-farm self-employment participation, all of which are statistically significant.[xix]

Finally, I tested treatment effect heterogeneity along the livestock holding distribution. I estimated quantile treatment effect models firstly using a quantile DID estimator.

However, DID suffers from functional form dependence and failure to allow the effects of both time and the treatment to differ systematically across individuals. To account for these drawbacks, I estimated a change-in-change (CIC) estimator following (Athey and Imbens, 2006). Table 4 present estimates of quantile treatment effects on treated both for livestock holding and per capita consumption.

The results from both DID and CIC estimations suggest that the program has heterogeneous effects on saving. Specifically, the treatment effects are concentrated in a few of the top quantiles of the saving distribution with no effects in lower quantiles. By the same token, I found that the program effect on consumption is concentrated in the upper half of the per capita consumption distribution. This suggests that reduction in precautionary saving is partly translated into increased consumption, pointing to alternative channels through which income gains from programs increase households' living standard.

Overall, the analysis revealed that FUC cuts household's the demand for holding livestock as buffer stock and that result is robust to a broader set of identification strategies. Specifically, the result supported the hypothesis that stable (less variable) program income gain has crowded out livestock holding as a source of ex-post consumption insurance (precautionary saving). The result corroborates Gilligan and Hoddinott (2007), who uncovered that public insurance in the form of the Safety Net Program has slowed down the growth of livestock asset in Ethiopian villages. Moreover, it lends support to evidences of precautionary saving response to social public safety net program (Hubbar et.al, 1995), unemployment insurance IU (Engen and Gruber, 2001), National Health Insurance NHI(Chou, et.al, 2003) and New Cooperative Medical Scheme (NCMS) (Cheunga, and Padieu, 2014).

When interpreted in terms of the permanent income hypothesis (PIH), my finding implies that FUC participant households felt that the program income gains was likely to be non-transient (permanent). However, this finding stands at variance with Ravallion and Chen (2005), who found that the Southwest China Poverty Reduction Project substantially raised household's income, but the vast bulk of that income gain was saved. As a result, the authors found little or no impact on household's consumption. The authors attributed this result to variability (risk) of program income gain, which made the program participants infer that a large share of the income gains was likely to be transient (Ravallion & Chen, 2005).

With regard to portfolio choice response to the program, the analysis revealed that FUC program spurred investment in child education and participation (investment) in off-farm self-employment both of which are risky ventures, but have potential to raise long-term living standards. These results are consistent with findings of Gertler, Martinez, and Rubio-Codina (2012), who confirmed that conditional cash transfer spurred investment in higher return, albeit risky ventures, which helped attain higher long-term living standards among Mexican households. Moreover, the positive effect of FUC program on child investment corroborates de Janvry et.al (2006), who found that conditional transfers helped protect school enrolment. In a nutshell, I make the observation that programs that aim at a combination of increasing returns to forest commons and reduction of variability (risk) of this return not only reduce costly precautionary saving demand, but also raises long-term living-standard, which amounts to leveraging rural poverty reduction.

7 Conclusions

A growing number of developing and transitional countries have recently adopted a collective vertical integration (VI) of forest product marketing cooperative structures, often referred to as forest users' cooperatives (FUCs), to ignite increased smallholder forest users' participation in forest products markets. While this type of program has been observed to raise smallholder incomes, there is a dearth evidence on saving and investment responses to such income gains.

This study examines forest commons users' precautionary saving and investment response to a forest product marketing program of collective vertical integration (VI) governance in rural Ethiopia. I identified the causal effect of this program by applying, difference-in-difference (DID) and change-in-change (CIC) estimators to household survey data collected from randomly selected households in Gimbo district (south-western Ethiopia). I also employed a propensity score matching (PSM) estimator and parametric generalized Roy model to examine the robustness of the estimated treatment effects to various identification assumptions. Moreover, I tested the program effect heterogeneity by using quantile treatment effect analysis.

The analysis revealed that average livestock holding is smaller for program participants than non-participants. This result is robust to different specification problems and assumptions. Moreover, the analysis rejected the liquidity channel hypothesis and instead suggested that the insurance effect of the program decreases the demand for precautionary savings in the form of livestock. This result corroborated my theoretical prediction. Results from the quantile treatment effect analysis showed that this insurance effect of the program is limited to non-poor households. When interpreted in terms of the PIH, our results imply that participants felt that the income gain was likely to be non-transient, leading to reduced precautionary savings and increased consumption/welfare gains. Importantly, this behavioral response points to the program's potential to raise the standard of living via ancillary mechanisms beyond directly raising income outcome. This is made possible by crowding out costly consumption smoothing mechanisms that households adopt in lieu of imperfect or missing insurance and credit markets. Moreover, resources freed up from precautionary saving appeared to have spurred investment in child education and participation in off-farm self-employment. Specifically, the program has raised spending on child education and off-farm self-employment respectively by 42.44% and 0.78%.

These results point to a broader set of rural development implications of forest commons management. First, it raises concerns about possible policy choice dilemmas. On the one hand, forest commons decentralization policies are intended to save forests from deforestation through investment in the form of stewardship of existing forest stock (restricting excessive forest harvest and giving up agricultural land expansion). Spurring this investment required providing incentive basis through increasing economic benefits afforded by forests themselves. One possibility, perhaps innovative, is increasing the income from forest products along with reducing its variability (risk) via improving market linkage, which has been observed to crowd out livestock holding. On the other hand, livestock is productive asset, in addition to being buffer stock, which makes it an important government policy target to bolster agricultural outputs. Livestock depletion thus, raises concerns as much as deforestation does. These conflicting outcomes point to the conservation-development policy choice dilemma underscoring the importance of careful design and implementation of either of the policies. One possibility is promoting the adoption of improved livestock breeds and feeds technology to make up for agricultural output drops that may arise from falling demand for livestock as a buffer. Perhaps, an interesting rural development implication of FUC and similar programs is their ability to encourage households to take on risk and participate in risky ventures, such as off-farm self-employment and investment in child education, both of which have potential to raise long-term living standards.

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Table 1a: Descriptive statistics of baseline covariates used in the analysis

Variable	Description	PFM participant		Non-participant		
		Mean	SE	Mean	SE	Mean difference
totexp	Total household consumption expenditure in Ethiopian Birr (ETB)	9531.32	389.593	9000.756	337.464	530.564
cpc	Per capita consumption expenditure in Ethiopian Birr (ETB)	1732.09	66.5836	1686.69	59.263	45.397
ageb	Age of household head	36.905	0.997	35.887	1.030	1.017
gender	Household head gender	0.932	0.018	0.943	0.016	-0.010
hhedu	Education (grade attained) of household head	2.290	0.218	2.352	0.229	-0.061
dstpfm	Household distance to programme forest (in minutes)	23.083	2.042	65.85	4.962	-42.768***
offrmb	Whether a household participated in off-farm employment (yes=1)	0.128	0.025	0.071	0.018	0.057*
lndsz	Household landholding size in hectare	2.275	0.125	2.381	0.122	-0.106
wdlot	Whether a household owned private woodlot (yes=1)	0.497	0.037	0.530	0.035	-0.033
tlub	Household livestock ownership converted to TLU	4.120	0.283	3.447	0.202	0.673**
othpartcp	Whether a household ever participated in other collective actions (yes=1)	0.156	0.027	0.051	0.015	0.105***
dstextn	Household distance to extension office (in minutes)	38.223	3.845	51.61	4.530	-13.393**
dstothfrst	A household distance from a non-programme (alternative) forest	55.729	7.15	29.728	2.866	26.000***
mlfrc	Household labour-force (men)	1.284	0.048	1.266	0.041	0.018
fmlfrc	Household labour-force (women)	1.346	0.050	1.153	0.038	0.192***
Menja	Whether Menja people are present in one's (study unit's) village (yes=1)	0.798	0.030	0.403	0.035	0.395***
hhdstwnmin,	Distance to town in minutes	69.379	3.509	72.454	2.693	-3.074
hhdstroadmin	Distance to nearest road in minutes	23.639	1.935	32.295	2.614	-8.656***
N		200		177		

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1b: Descriptive statistics of endline covariates used in the analysis

Variable	Description	FUC participant		Non-participant		
		Mean	SE	Mean	SE	Mean difference
cpc	Per capita consumption (ETB)	1732.09	66.5836	1686.69	59.263	45.397
per_ntfp	Per capita NTFP income (ETB)	276.276	44.031	280.8564	43.0887	-4.5797
sex	Household head sex (male=1)	0.932	0.018	.943	0.016	-0.010
agea	Age of household head in years	43.916	1.019	43.244	1.023	-0.671
hhsize	Household size (number of members)	5.899	0.165	5.7346	0.154	0.164
tlua	Household livestock ownership converted into TLU (total livestock units)	4.256	0.193	4.501	0.215	-0.244
lndsza	Household landholding size in hectares	2.300	0.110	2.412	0.114	-0.111
edumax	Number of households in the village	6.257	0.220	6.707	0.220	-0.450
offrma	Whether a household participated in off-farm self-employment activities (yes=1, no=0)	0.145	0.026	0.082	0.019	0.063**
wealth	Whether a household has a corrugated house (yes=1, no=0)	0.251	0.032	0.239	0.030	0.011
hhedua	Education (grade attained) of household head	4.5	0.208	5.108	0.307	-0.608*
hhdsttown	Household distance to the nearest town (in minutes)	69.379	3.509	72.454	2.693	-3.074
hhdstroad	Household distance to the nearest road (in minutes)	23.639	1.935	32.295	2.614	-8.656***
malefa	Household labor force (men)	1.449	0.055	1.478	0.059	0.028
femalefa	Household labor force (women)	1.378	0.051	1.338	0.046	0.04
crdta	Whether a household has participated in credit market (yes=1, no=0)	0.307	0.034	0.219	0.029	0.087**

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Logit model estimates of the determinants of program participation

VARIABLES	coefficient	Marginal effect
Household head’s age	-0.008	-0.002
	(0.011)	(0.002)
Household head’s gender	-0.336	-0.083
	(0.553)	(0.137)
Household head’s education	0.022	0.005
	(0.052)	(0.012)
Female labor force	0.848***	0. 208***
	(0.307)	(0. 075)
Male labor force	-0.230	-0.056
	(0.258)	(0. 063)
Land holding size in ha	0.010	0.002
	(0.085)	(0.021)
Off-farm employment	0.842*	0.207*
	(0.490)	(0. 115)
Distance to agro_extension office	-0.004*	-0.001*
	(0.002)	(0.001)
Woodlot ownership	-0.511*	-0.125*
	(0.282)	(0.068)
Livestock holding size in TLU	0.122***	0.030**
	(0.049)	(0. 012)
Distance from FUC forest	-0.028***	-0.006***
	(0.005)	(0.001)
Experience of other collective action	1.400***	0.329***
	(0.509)	(0 .103)
Distance from nearest town	-0.005*	-0.001*
	(0.003)	(0 .001)
Distance from nearest road	-0.008**	-0.002**
	(0.004)	(0.001)
Constant	0.281	
	(0.761)	

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.

Table 3: ATT estimates of alternative DID model and LIV estimator

Variables	DID1	DID2	DDD	LIV
Treatment	0.864	1.163	1.483	-1.457
	(0.434)**	(0.347)***	(0.577) ***	(0.649)***
Treatment*year	-1.273	-1.219	-1.156	
	(0.422)***	(0.491)**	(0.411)**	
Treatment*year*liquidity constraint			0.793	
			(0.945)	
Treatment*liquidity constraint			-0.846	
			(0.668)	
Liquidity constraint*year			-1.207	
			(0.667)***	
Liquidity constraint			-0.434	
			(0.449)	
Year	-0.414	-0.056	1.928	
	(0.405)	(0.348)	(0.570)***	
R-squared	0.11	0.03	0.184	
95% CI	[-2.278,0.2674]	[-2.20,-0.237]	[3.063,0.117]	[2.555,0.29]
Observation	742	594	739	155

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4: ATT estimates of PSM estimator

Variables	livestock holding	child education	off-farm employment
treated	-1.441***	95.45*	0. 078***
	(0.596)	(42.222)	(0. 0706)
95% CI	[-2.610, -0.272]	[12.698, 178.206]	[-0.0602, 0.216]
Observations	352	356	356

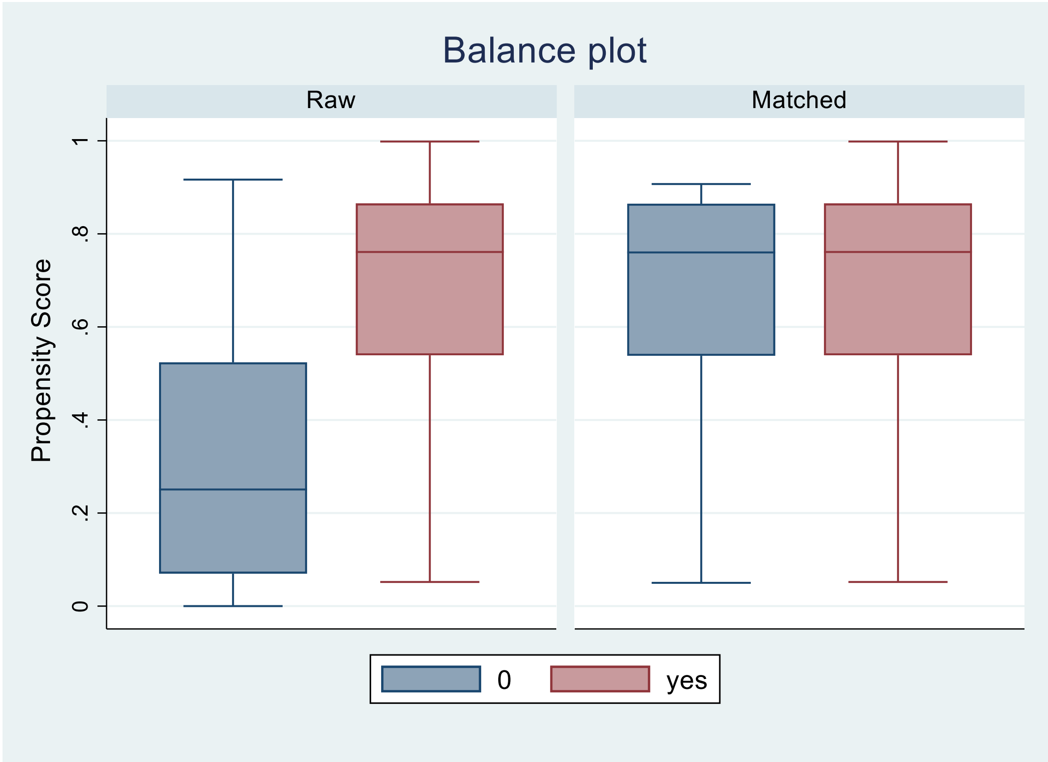
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5: Quantile treatment effects (QTT) of FUC on saving and consumption outcomes

VARIABLES	DD-QTT-saving	CIC_QTT-saving	QTT_consumption
Quantile_1	-0.179	-0.104	-159.0
	(-0.591)	(-1.087)	(340.7)
Quantile_2	-0.0757	-0.0700	-95.40
	(-0.214)	(-0.387)	(261.5)
Quantile_3	-0.111	-0.0753	207.2
	(-0.313)	(-0.259)	(309.8)
Quantile_4	-0.0718	-0.0479	229.7
	(-0.133)	(-0.0948)	(357.4)
Quantile_5	-0.0697	-0.0162	653.4
	(-0.155)	(-0.0165)	(414.4)
Quantile_6	-0.390	-0.359	863.4**
	(-0.941)	(-0.277)	(388.4)
Quantile_7	-1.290***	-1.147	896.5*
	(-3.268)	(-1.258)	(489.4)
Quantile_8	-2.006***	-1.983**	806.0*
	(-3.911)	(-2.146)	(426.7)
Quantile_9	-2.658***	-2.538***	1,268**
	(-27.21)	(-2.687)	(539.0)
Compliance %			38.7
Observations	741	741	741

T-statistics in parentheses for columns 1-2; *** p<0.01, ** p<0.05, * p<0.1

Appendix I: Figure 1. Propensity score balance plot



Appendix II: Proofs of proposition 1

Proof 1: The first order condition in (12) yields the existence of interior solution and the associated saving choice function ${s_t}^* = f(\Delta)$, where $\Delta = [\psi, \eta, \mu, \sigma, \beta]$ is a vector of parameters in the model. Differentiating (12) with respect to ψ results in

$$[U'' + \beta(1+\eta_{t+1})^2 V_{\mu_x \mu_x}]\frac{\partial s_t}{\partial \psi} + \left[\left(V_{\mu_x \mu_x} * \theta + V_{\mu_x \sigma_x} * (-\epsilon)\right) * (1+\eta_{t+1})\right] \equiv 0 \quad \text{(A1).}$$

Rearranging (A1) to obtain the comparative statics gives;

$$\frac{\partial s_t}{\partial \psi} = -\frac{\left[\left(V_{\mu_x \mu_x} * \theta + V_{\mu_x \sigma_x} * (-\epsilon)\right) * (1+\eta_{t+1}) * \beta\right]}{[U'' + \beta(1+\eta_{t+1})^2 V_{\mu_x \mu_x}]} < 0 \qquad \text{(A2)}$$

Concavity of utility function of the first period, U, and value function of mean-standard deviation preference, V , guarantees that denominator in (A2) is negative by the second order condition. Likewise, the concavity of value function of mean-standard deviation preference and a positive mixed derivative, $V_{\mu_x \sigma_x}$ guarantees that the numerator in (A2) is negative for $\theta > 0$ and $\epsilon < 0$.

Note that market integration has two effects on saving; (i) income/portfolio effect measured by $(V_{\mu_x\mu_x} * \theta)$ and precautionary saving effect measured by $V_{\mu_x\sigma_x} * (-\epsilon)$. As a unit increase in a measure of market integration ψ increases return to forest product extraction labor by ,θ, it decreases investing in livestock by $(V_{\mu_x\mu_x} * \theta)$ and we can call this effect an income effect. Returning to the second effect, the second term in (A2) shows that a unit reduction in standard deviation (income risk) reduces prudence measure (motive to save more) by $V_{\mu_x\sigma_x}$. Thus, via reducing the income risk by ϵ, a unit increase in a measure of market integration, ψ, reduces the motive to save by $V_{\mu_x\sigma_x} * (-\epsilon)$ and hence the income risk reduction effect of the program.

Proof 2

Consider the situation without the project where there is no rise in income and reduction in its risk such that $\sigma = \sigma_{x_{t+1}} - 0$ and $\mu = \mu_{x_{t+1}} + 0$. This gives rise to the FO.C being; $u_c(x_t - s_t)(-1) + \beta(\eta_{t+1} - r_{t+1})V_\mu(\mu, \sigma) = 0$. An agent is prudent if he cuts back savings upon a reduction in risk if $V_\mu(\mu, \sigma) > V_\mu(\mu, \sigma - \epsilon)\ \forall\ 0 < \epsilon < \sigma$(Meyer and 1987, Wagener, 2002), and equivalently Kimball (1990) for VNM preference. This amounts to $V_{\mu\sigma} > 0$ or equivalently the third partial derivative of VNM utility function being positive. Armed with this set of information, let us define a precautionary premium $\pi(\mu, \epsilon)$ for a reduction in risk by (A3) below;

$$V_\mu(\mu - \pi(\mu, \epsilon), \sigma - \epsilon) = V_\mu(\mu, \sigma) \qquad \text{(A3)}$$

Note that precautionary premium is directly proportional to precautionary saving (Kimball, 1990). Taking the first order condition on both side of (A3) and rearranging we have that;

$$\frac{\partial \pi}{\partial \epsilon} = \frac{V_{\mu\sigma}(\mu, \sigma)}{V_{\mu\mu}(\mu - \pi(\mu, \epsilon), \sigma - \epsilon)} < 0 \qquad \text{(A4)}$$

In (A4), prudence preference implies that $V_{\mu\sigma} > 0$. Concavity of mean-standard deviation preference (utility function) guarantees that $V_{\mu\mu} < 0$ and hence $\frac{\partial \pi}{\partial \epsilon} < 0$, which amounts to a reduction in precautionary saving by the direct proportionality property.

Now I show that the income rise due to the program reduces precautionary saving. In the same way as above, taking the first order of (A3) with respect to μ and rearranging, we have that;

$$\frac{\partial\pi}{\partial\mu} = \frac{V_{\mu\mu}(\mu-\pi(\mu,\epsilon)\,,\sigma-\epsilon)-V_{\mu\mu}(\mu,,\sigma)}{V_{\mu\mu}(\mu-\pi(\mu,\epsilon)\,,\sigma-\epsilon)} < 0 \qquad \text{(A5)}$$

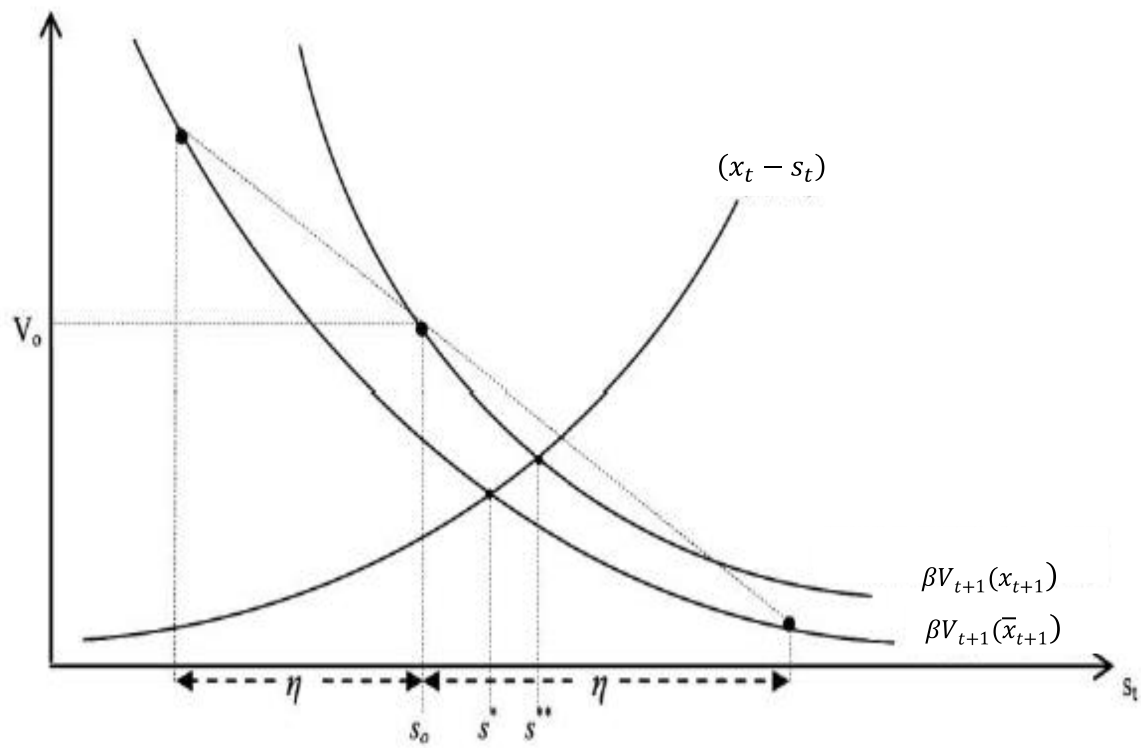
Inequality (A5) holds if and only if its numerator,

$$V_{\mu\mu}(\mu - \pi(\mu,\epsilon)\,, \sigma - \epsilon) - V_{\mu\mu}(\mu,,\sigma) > 0 \qquad \text{(A6).}$$

In turn, (A6) holds if and only if the index of prudence developed by Lajeri (2002); $\mathrm{T} = \frac{-V_{\mu\sigma}(\mu,,\sigma)}{V_{\mu\mu}(\mu,,\sigma)}$, is a decreasing function of μ (for proof of this claim see Wagener, 2000). This means that a decreasing index of prudence guarantees (A5), which amounts to claiming that an increase in income decreases the demand for precautionary saving.■

For more illustration of this total effect, let $s_t{}^{*}$,, be the level of saving with the project and $s_t{}^{**}$ without project. Then the difference $s_t{}^{**} - s_t{}^{*} < 0$ is the project effect.

Figure 2. Precautionary saving behavior under varying income risk



Appendix III: Endnotes

I. The subsistence production, often characterized by low specialization, rudimentary technology (low productivity) and thus lower income, has caught smallholders in a low income equilibrium (poverty trap) across eastern and southern Africa (Barret, 2008).

II. Recent studies indicate that transportation costs are much higher in sub-Saharan Africa than in other regions (Teravaninthorn & Raballand, 2009). It has also been noted that transportation costs over short distances (e.g., from the farm to the local market) are much higher than long-distance transportation costs, presumably because the vehicles are smaller and road quality is poorer (World Bank, 2009).

III. Tadesse and Bahiigwa (2015) note that, in the Ethiopian context, prices vary both across markets and traders (buyers), causing farmers to have to search for and choose the higher price among the different buyers within the markets.

IV. Market price uncertainty refers to covariates fluctuation of market fundamentals i.e. market-wide shocks in demand and supply side factors, as opposed to the idiosyncratic effective price uncertainty resulting from the variability of transaction cost.

V. Recent years have seen proliferation of forests governance decentralization to local communities across developing countries (Bluffstone & Robinson, 2015, Ameha, Nielsen, & Larsen, 2014, Agrawal & Gibon, 1999 and Agrawal, Chhatre & Hardin, 2008). However, the ability of this reform to reduce poverty and provide the required incentive for sustainable forest management is limited by pervasive market imperfection of forests product markets resulted from prohibitively high transaction costs of participating in these markets.

VI. FUC involves organizing users of forest commons into community forest enterprises (CFE) in the form of forest users' cooperatives (FUCs) to promote forest products marketing. FUCs enable farmers to integrate down the marketing chain and reduces transaction costs in the following ways. First, it reduces information asymmetry and the associated opportunism by taking the position of the buyer (Bijman & Wollni, 2008). Second, by its ability to practice contingency pricing through patronage refunds (Valentinov, 2007), introducing quality grades and standards (Bijman & Wollni, 2008), and counterbalancing the market power of traders (Cook, 1995; Staatz, 1987), the FUC allows its members to receive a higher price. Finally, through scale economy, it also reduces the initial fixed costs of access to the markets, which includes storage costs, transport costs, and bargaining and searching costs (Kirsten & Sartorius, 2002). Overall, by lowering transaction costs, equivalently increasing effective prices, the FUC increases its members' income.

VII. When faced with greater income risk in the absence of functioning insurance and credit markets, a high level of risk aversion would engender encourage households to save for the future in order to smooth consumption, even if they have high discount rates. This behavior is commonly christened 'precautionary saving' in the literature (Deaton, 1989, 1991).

VIII. One such investment venture is child schooling. As education is an irreversible investment with delayed and possibly risky and non-linear returns (Schultz, 2003), a household is likely to divert child time away from education towards other activities in order to generate immediate income and compensate for anticipated or realized negative income shocks (Dehejia & Gatti, 2005 and Jacoby & Skoufias, 1997). Moreover, forgone current consumption to hedge against a future reduction in consumption has detrimental effects on nutrition and health outcomes of family members, which in turn undermines the productivity of a household's labor force.

IX. At an operational level, these rules span: (i) stipulations relating to quantity and the types of forest products allowed for use by members; (ii) stipulations concerning disposal procedures for commercially valuable NTFPs; (iii) enforcement rules surrounding protection from fire, vandalism (including unauthorized tree cutting), and agricultural encroachment (clearing forest for agricultural land acquisition); and (iv) forest development (management) rules regarding the planting of new trees for the enrichment of the existing forest (Gelo & Koch, 2014). For example, subject to management committee approval, the designated forest can be used for livestock production (grazing livestock through the forest is allowed), collecting wood (including energy and farm implement construction), harvesting forest coffee, spices, and beekeeping (forest honey production).

x. Historical episodes led to this variation in perceptions of customary rights. Prior to the 1974 Ethiopian revolution, forests in the Kaffa region were managed under a feudal system. The landlords had come into the regions from north and central Ethiopia and legally owned forest lands (Stellmacher, 2007). They granted long-term use rights to local peasants, the present native population (Menjas), who were living within or adjacent to the forests, and, in turn, received use "fees" paid in kind (mainly honey). The management of forest coffee and other forest products followed informal rules and regulations, traditionally laid down in the local institutional system. The new military government, commonly called the Derg, which emerged from the 1974 revolution, dissolved the feudal system and landlords were dispossessed in 1975 through nationalization of all land resources, including farm land, grazing land, and forests (Stellmacher, 2007). From this time onward, the forest resources of Kaffa and other regions fell under direct possession of the state, which caused longstanding negative impacts on the relationship between government and local communities (Stellmacher, 2007). However, the Menjas and Kaffa people (native population) in the Bonga and Kaffa zones continued to perceive the forests as theirs and to use them in a situation of tolerated illegality (Stellmacher, 2007). Another relevant historical episode in the Bonga/Kaffa zone was government-initiated resettlement (villagization) programs in the 1980s. In response to famine, the Derg government resettled people from drought-stricken areas of Ethiopia to wet and widely forested areas of the country, including Bonga and Kaffa (Alemneh, 1990). The new settlers are heterogeneous in terms of ethnic and geographic origin, which made them less likely to perceive the forests as belonging to anyone, instead seeing them as open access resources and using them accordingly.

xi. Primary users are those who use the forest more frequently, permanently, or directly, whereas secondary users are those with less frequent use and who are far from the forest boundary (Lemenih & Bekele, 2008).

xii. Local markets are best described as a derived producer-buyer market.

xiii. Although a significant proportion of farmers may have price information in today's mobile phone era, their remote village markets are poorly integrated, implying imperfect competition (few buyers) within these markets (Gabre-Madhin, 2001). This entails location specificity, which undermines the farmers' bargaining power and subjects them to the opportunistic behavior of a trader/buyer with monopsony power (de Janvry, Fafchamps, & Sadoulet, 1991).

xiv. I assume that w_t accrues from farming or self-employment or both.

xv. Note that β_5 is the DID estimate for liquidity-unconstrained participants.

xvi. The focus on mean effects is common in much of the program evaluation literature, as mean outcomes have traditionally received more attention than the distribution of outcomes (Firpo, 2007).

xvii. Note that QTE's/QTT's ability to characterize heterogeneous impacts of treatments across the outcome distribution makes it appealing in many economic applications (Firpo, 2007; Frölich & Melly, 2010), including this one.

xviii. This will help us check whether consumption of effect of the program comprehensively tracks that of saving response.

xix. I have also implemented Genetic matching (machine learning method counter-part of PSM) and obtained similar results (not reported here).