De-commoditizing Ethiopian coffees after the establishment of the Ethiopian Commodity Exchange: an empirical investigation of smallholder coffee producers in Ethiopia

RESEARCH ARTICLE

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Abstract

The repercussions of reforming an agricultural market are mainly observed at the most vulnerable segment of the value chain, namely, the producers. In the current commodity market created with trade through the Ethiopian Commodity Exchange (ECX), coffee is less traceable to its producers. Only cooperatives that sell certified coffee through the unions they belong to, are allowed to bypass the more commodified ECX market. This study aims to investigate if small-scale coffee producers in southwestern Ethiopia that sell coffee through the certified cooperative are better off. It is assumed that the coffee sales through, and membership of, a cooperative, allows farmers to improve their coffee production as well as to improve other aspects of their livelihood. A sustainable livelihood approach was used as the inspiration for the welfare indicators that needed to be considered, data collected amongst members and non-members of certified cooperatives, and a propensity score model to investigate the impact of cooperative membership on the livelihood indicators. Results suggest that members of certified cooperatives indeed receive, on average, better prices. Yet, no evidence was found that indicates that the higher price is translated into better household income. Furthermore, coffee plantation productivity of those members who were interviewed was lower than that of the non-members. This finding could explain the failure to find an overall effect. Since the majority of the producers' income emanate from coffee, a sustainable way of enhancing the productivity of the coffee could revitalize the welfare of the coffee producers.

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1. Introduction

Coffee constitutes the bulk of Ethiopia's exports and the sector comprised of 25-30% of the foreign exchange earnings in 2014 (Tefera, 2015). The coffee sub-sector also provides income for a large number of households. It is estimated that of the 91 million people who live in Ethiopia, more than 15 million rely on coffee for a considerable proportion of their income. In addition, the sector provides jobs to many Ethiopian people to carry out coffee-related activities such as coffee processing, transportation, and marketing (ECEA, 2013). Furthermore, Ethiopia produces and exports one of the best highland coffees in the world (Gebreselassie and Ludi, 2008).

The Ethiopian coffee industry underwent numerous structural changes as a result of transformations in the country's political and economic landscape. Prior to 1991, coffee markets were highly regulated and coffee producers were faced with implicit and explicit taxation (Worako *et al.*, 2008). Following this, a series of policy changes were introduced in 1992. These included a change in the macroeconomic policies of the country, involving stabilization, adjustment, and market liberalization programmes. The policies were largely aimed at leveling the playing field for all participants in the coffee market. However, the changes led to a concentration of power within the export market and unhealthy competition in the primary and auction markets (Gemech and Struthers, 2007; Petit, 2007; Worako *et al.*, 2008). Following a period of reorganization of the powers and duties of the institutions involved in the Ethiopian coffee sector, the Ethiopian government abolished its national auction in 2008 and established the Ethiopia Commodity Exchange (ECX). ECX intends to function as an organized marketplace, where buyers and sellers meet to trade, while being assured of quality, quantity, payment, and delivery. This contributes to more efficient and transparent market operations (ECX, 2008).

Prior to ECX Ethiopian coffee is exported and sold as several different types, including Harar, Yirgacheffe, Sidama, Wollega, Jimma, and Kaffa. Keeping the coffee types separate by region is an important strategic choice to preserve the reputation of Ethiopian coffee in the international market and to search for niche markets. However, ECX is structured in a way that prevents spatially separated markets from engaging in direct trade. The main ECX coffee trade is said to lead to commoditization, whereby coffees with considerable diversity in cup taste, and spatially grown are merged to homogenization. Some commodities such as oilseeds and pulses benefit from the homogenization of trade. Yet, coffee is not a homogeneous product because of quality (measured in cup tasting), production method and origin matter. Homogenization results in a loss of traceability[1].

In coffee, traceability systems could add value especially by transmitting information on quality that is obtained through certification, production system and origin (e.g. single origin coffee and rainforest alliance). Yet, critics argue that the way ECX handles its coffee trade operations is reducing traceability more than it is enhancing it. Coffee that passes through ECX becomes less distinct in cup taste and is non-traceable, neither in quality nor in grower origin. ECX-sourced coffee is a less differentiated product, although it may be of different quality at the farm level (Leung, 2014). According to Leung (2014), monetary losses can be substantial when origin labeling disappears, especially for well-known and reputable coffee varieties. Moreover, the Ethiopian government actually endorsed commoditization, as indicated in a 2011 directive that all export coffee should be shipped in bulk containers. Previously, the industry practice was to keep coffee in 60kg jute bags, which had the advantage that different coffee lots could be transported in a single container while maintaining lot separation. Shipment in bulk containers would require large overseas wholesalers to repackage coffee beans, and force many medium-sized distributors and specialty coffee roasters who used to buy small volumes out of market (Mezlekia, 2011).

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[1] Traceability is perceived as the ability to identify the origin of the coffee to the most relevant level of aggregation along the supply chain. Traceability is essentially information (ECX, 2010) that is transferred between actors throughout the whole supply chain: from the single plot within a farmer's landholding to a single farm household, the collective of farmers, the processing station, the supplier and the national market; and which can be traced backwards (ECX, 2010).

Traceability gained much importance for almost all agricultural products with the shift from quantity oriented agriculture to one where quality, safety, functionality and sustainability are important. Assuring the traceability of farm produce from farm to fork, implementing authenticity and diagnostic tests that detect and prevent farm produce safety hazards, as well as preserve the identity and freshness of food products, have become essential elements of agricultural supply chain management systems (Aung and Chang, 2014). Over the past decades a set of voluntary and regulative laws and initiatives were attempting to bridge the information gaps between farmers, retailers and consumers (Charlebois *et al.*, 2014). Such traceability systems aim to reduce production uncertainty, opportunism, and incidence of moral hazard for products where quality monitoring costs are high and the product traits are difficult to identify (Aung and Chang, 2014). Hence, traceability systems could contribute to increase transparency in the supply chain, reduce the risk of liability claims, improve effectiveness of recalls, enhance logistics, easier product licensing, reduction of information asymmetry, decrease transaction costs, increase trust levels, and facilitate contracting a price premium (Souza-Monteiro and Caswell, 2010).

ECX established the Direct Specialty Trade (DST) that traded fully traceable coffee. Prior to a monthly DST auction, ECX posted information on individual lots on its website, including the grower, geographic origin, and cup profile. With the resulting quality certificate in hand, producers and local traders were able to sell at the Specialty Trade platform. International buyers pre-register for the session, and prior to the bidding can participate in a cupping (coffee tasting) session (ECX, 2010; Leung, 2014). The platform was initiated in February 2010 but it did not fulfill expectations. ECX only held fifteen auctions on the platform and stopped operating in 2011. Yet, as a result, exporters were unable to process own specialty coffees (Mezui *et al.*, 2013).

In the aftermaths of market reform, including the demise of the DST, most of the smallholder coffee producers were left with no other options than to market their coffee through non-traceable channels. Some however found an alternative chain which got in place with the help of donor institutions and cooperative unions. A limited segment of coffee producers are able to reach out and market through the fully traceable market channels. The peculiarity of this alternative channels is that the cooperatives with certifications are provided with the traceability. The certification includes: fair-trade, organic, rainforest alliance and fair-trade-organic. The coupling of certification with traceability enables the cooperative members to widen their outlet options. The operation has the intention of shifting the coupling of certification with traceability from an alternative market channel to the mainstream market. However, the majority of the coffee production in the study area is traded through ECX commoditization process which completely lacks traceability and certification.

This study is built on an earlier paper by Jena *et al.* (2012) who did a similar research in the Jimma zone. We are particularly interested in getting more insight into the coupling effect of certification with traceability. The study by Jena *et al.* (2012) is limited to the impact of certification and does not consider the impact of the market reform as a result of the establishment of ECX. Hence, this study investigates if producers' marketing through the alternative chain (coupled with certification and traceability) preserves a sustainable economic welfare and coffee farming than producer marketing through the ECX chain. The study further looks into the heterogeneity impact of the coupling effect.

The empirical research that studied the impact of traceability on the coffee sector is limited to macroeconomics perspectives, e.g. Allison (2009), Bjerga and Patton (2011), Frenette (2010) and Leung (2014). Over the last decade studies on coffee producing households have explored issues related to the impact of coffee certification on sustainable development, asset endowments, sustainability of certified coffee production, and poverty. These studies mainly showed the impact of different type of certification on the financial capital, productivity, natural resources, poverty and sustainability of the farm household (e.g. Barham and Weber, 2012; Chiputwa *et al.*, 2015; Donovan and Poole, 2014; Valkila, 2009). They also demonstrate the impact of trade marking and licensing on developing coffee trade. However, as far as known, there is no study that has explored the impact of coupling certification and traceability on the sustainability of coffee producer's welfare.

2. Conceptual framework

Defined as storing similar coffee in the same compartment without distinction to disregard the subtle differences in cup taste within a grade category, and specific spatial and grower origin, commoditization is one of today's coffee marketing problems brought on by failing to understand the coffee market (Leung, 2014). The commoditization process which trade commodities in bulk is more suitable for other crops like cereals, as it internalize advantage of economies of scale, while little attention paid to their origin.

In contrast, coffee drinkers increasingly care about coffee traceability, which is a prerequisite for coffee certification and a desirable characteristic of gourmet coffee. This information is lost through commoditization, and the mandatory trading of coffee through certification (Leung, 2014). Certification is an instrument to add value to a product. It addresses a growing worldwide demand for healthier and more socially and environmentally friendly products and is based on the idea that consumers are motivated to pay a price premium for products that meet certain precisely defined and assured standards (Wissel *et al.*, 2012).

In Ethiopia, where the smallholder coffee producers contribute for the majority of the coffee production, most of the coffee marketing is tunneled through the private traders. Coffee cooperatives which serve as an advocate for the producers offer an alternative market outlet in a fully traceable and certified manner. In Ethiopia coffee market certification is only provided for coffee cooperatives. However, the introduction of ECX poses a threat on the continuity of overseas buyer's direct contact with producers. This study considers the establishment of ECX as a reference in the commoditization and examines its impact on the welfare of smallholder coffee producers.

While selecting a certified and traceable cooperative or farmer, potential biases are expected. First, farmers' marketing through certified and traceable routes compared to the ECX route might vary in several community and household level characteristics that may have direct impact on producer's welfare. For example, farmers under certified and traceable value chains might have different average sizes of coffee holdings, work under different climates, market accesses, practices, and distances to input market conditions than farmers under ECX route. Hence, the differences observed between the two groups of producers may, either totally or partially, show the basic disparity between the two groups, rather than effects of the certification and traceability (Asfaw, 2010). Second, a self-selection bias could arise from an unobservable community or household characteristics. For instance, the existence of such certified and traceable cooperatives might be initiated particularly by active community leaders in their respective areas. At the farmer level, entrepreneurial spirit, motivation to prosper, a household's risk preference, or its relationship to other certified and traceable cooperative members may correlate with self-selection (McKenzie and Yang, 2010). Third, the externalities that arise from certified and traceable cooperatives on the decision and participation of the non-traceable and certified cooperative members may be important. For instance, certified and traceable cooperatives could influence the coffee price offered by other buyers (traders) to noncertified and traceable cooperative members (Bernard *et al.*, 2008). To overcome the above possible biases, this study used a propensity score matching. The matching procedure passed through three steps. First, areas with and without certified and traceable cooperatives were matched by accounting for important determinants (market access, agro-ecological potential, population density and remoteness). Second, certified and traceable cooperative members were matched to similar households living in other areas without cooperatives. The second problem – problem of self-selection into the certified and traceable cooperative – was minimized by selecting certified and traceable cooperatives which are only initiated by external partners (donors, in this case Technoserve). In this regard the establishments of the certified and traceable cooperatives were exogenous to the communities' unobservable characteristics. Third, the treatment and control group were linked to different local markets in order to control the spillover effects of sharing the same market.

3. Methodology

3.1 Study area

The focus was on the Jimma and Keffa zone in southwestern Ethiopia (Figure 1). The two zones are selected for their potential and long experience of coffee production. The areas are endowed with various indigenous vegetation and high genetic variation in natural coffee populations in the forest and semi-forest systems. The higher altitude of the study area ranging from 880 m to 3,360 meters above sea level makes it suitable for coffee production. Most of the time in the study area coffee grows at an altitude of 1,400-2,100 m above sea level (Boot, 2011). The study area is believed to be Ethiopia's largest basket of unwashed coffees (Woldemariam, 2015).

The Jimma Zone is composed of 13 weredas with a population of over 2.8 million (CSA, 2014). The elevation ranges from 880 m to 3,360 m above sea level and the zonal agro-ecological setting is stratified as highlands (15%), midlands (67%) and lowlands (18%). The zonal rain fall coverage ranges from 1,200 to 2,800 mm per annum. In normal years, the rainy season extends from February to October. Maize, teff, sorghum, barley, pulses, root crops and fruits are, next to coffee, the other major crops.

The Kaffa zone has a total surface of 10,602 km^2 and it lies at an altitude ranging from 500 to 3,500 m above sea level. The total population of the zone is 858,600 (2014) with a population density of 90 persons per km^2. Most land is midland (59%), followed by low land (29%) and highlands (11%). The mean annual temperature of the zone ranges from 10.1 to 27.5 °C and the mean annual rainfall of the zone ranges from 1,001 to 2,200 mm. Of the total area 23% is cultivated, 32% is forestland, 6% grazing land, 25% cultivable land and the remaining balance is uncultivable land (Chernet, 2008).
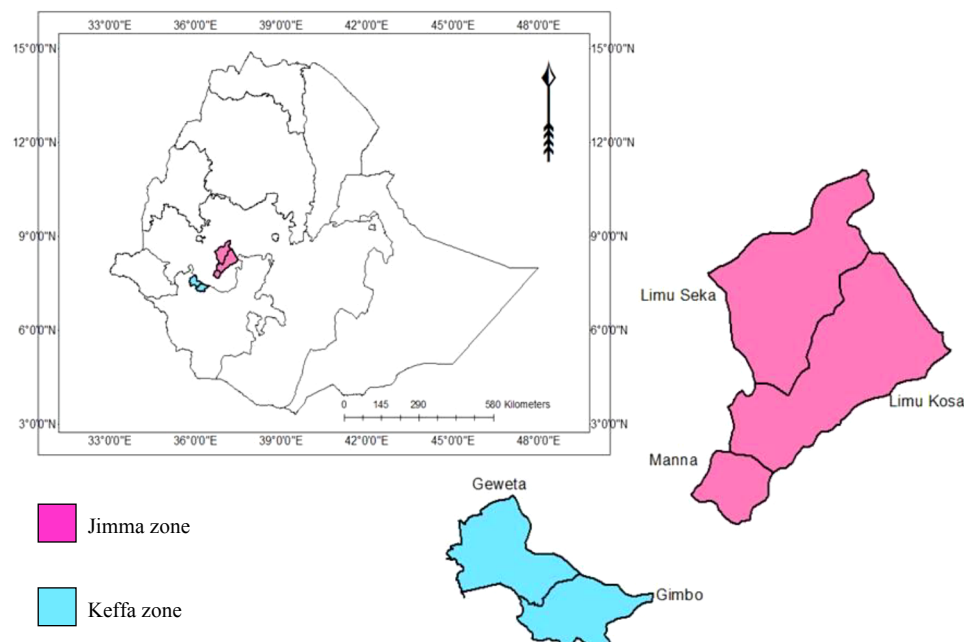

Figure 1. Map study area.

3.2 Data collection and sampling

The research population existed of coffee producers and their families whose productive units are small and, who are currently producing coffee in small scale under homogeneous environmental and social conditions. In southwestern Ethiopia the major coffee growing areas are the districts of Jimma and Keffa, where farmers allocate a majority of the cultivable land to coffee production. Then, from these districts, an additional filtering was applied to identify the existence of certified coffee cooperatives as well as whether these coffee cooperatives were participating in traceable coffee market. From the two zones, five traceable and certified cooperatives from Keffa and 22 from Jimma were identified. Using the list of cooperatives from each zone, the cooperatives were categorized according to their certification system; organic, fair trade, organic and fair trade, rainforest alliance and forest coffee. However, rainforest alliance certification started during the survey year and this was not considered while categorizing the cooperatives into the different types. For the treatment group, cooperative participating in the certified traceable coffee market for less than two years and cooperatives which did not pay dividend for their members were excluded. Once the certified traceable cooperatives in the two zones were classified into the different types, the classified cooperatives were further classified into 'small', 'medium' and 'large' according to the number of members of the cooperative. Furthermore, the number of members in a cooperative which might have an impact on the effect of participation was also considered.

From the identified set of traceable cooperatives, a proportional number of cooperatives were randomly selected from each zone, i.e. three cooperatives from Keffa and six cooperatives from Jimma. Finally, from the identified certified and traceable cooperatives a proportional number of coffee producers were randomly selected by using the cooperatives' member list. While selecting treatment groups, cooperative members with consistent sales of a reasonable amount (30-40%) of their coffee production for the past two years were considered.

After minimizing the possible sampling biases, the propensity scores that were used to match the 292 household members in the certified and traceable cooperatives were estimated. Among the comparison groups 332 households were selected according to the sample size determination table at alpha 0.05 (Bartlett *et al.*, 2001). Then, for each household a propensity score (explained as the probability that a household would participate in a certified and traceable cooperative, given a set of observable characteristics) of joining a certified and traceable cooperative was estimated. The estimation was done using a probit model where the dependent variable was 'participation in certified and traceable cooperative'.

3.3 The propensity score matching method

In this paper, a semi-parametric matching estimation technique is applied in order to evaluate the impact of certification and traceability. More specifically, the paper is interested to examine the producers' impact of marketing under certified and traceable channels. Matching estimations are mostly used to evaluate the aftermaths of policy reforms at different stages. As such intervention estimations consider the comparison of the results obtained by the treatment group with those obtained by a control group. Hence, it is assumed that the difference in outcomes between the two groups may be attributed to the coupling of certification with traceability (Stuart, 2010).

Let $Z_J(0)$ be the welfare of producer J if it had not participated in certified and traceable channels and $Z_J(1)$ is the welfare of the same producer if it had participated in traceable channels. If both results were simultaneously observed, the impact of certification and traceability on the welfare of producer J, $Z_J(1)-Z_J(0)$, would be directly observable. The main problem with this measure is that $Z_J(1)$ and $Z_J(0)$ are not simultaneously observable. That is, as Wooldridge (2002) explains, because an individual cannot be in both conditions, so a counterfactual cannot be measured.

Basically, what would be difficult to observe are the outcome variables for producers marketing through certified and traceable channels, in case they did not market through certified and traceable channels. The propensity score matching (PSM) model suggested by Rosenbaum and Rubin (1985) controls for self-selection by creating the counterfactual for the set of producers marketing through certified and traceable channels. PSM constructs a statistical comparison group by matching producers on certified and traceable channels with producers marketing through ECX with similar characteristics. Following Heckman *et al.* (1997), let Z_i be the value of producer's welfare when producer *i* is subject to treatment, i.e. certified and traceable channel (Q=1) and Z_0 are the same variable when it does not market through certified and traceable channel (Q=0). The observed producer's welfare is:

$$Z = Q\,Z_1 + (1 - Q)\,Z_0 \tag{1}$$

When (Q=1) we observe Z_1; when (Q=0) we observe Z_0. The average effect of treatment on the treatment (ATT) is defined as the mean difference between those actually treated (coffee producer under traceability) and their counterfactuals (coffee producers under non traceable channel):

$$ATT = E\,(Z_1 - Z_0 \mid Q=1) = E\,(Z_1 \mid Q=1) - E\,(Z_0 \mid Q=1) \tag{2}$$

Hence, the outcome variable of producers marketing can only be observed through certified and traceable channels $E\,(Z_1 \mid Q=1)$. However, the outcome of those producers marketing could not be observed through the traceable channels if they did not market through traceable channels $E\,(Z_0 \mid Q=1)$. Therefore, the matching estimation matches the treatment and control based on counterfactual analysis. The three primary assumptions underlying matching estimators are: (1) the balance property of the propensity scores; (2) the conditional independence assumption, and; (3) the common support requirement. The balancing property of the propensity score assumption relies on the fact that the matching property is genuine and says that treatment (0=1) and control (0=0) groups with the same propensity score e(y) have the same distribution of the observed covariates 'x' (Rosenbaum and Rubin, 1985). The assumption behind 'balancing property' is that, while we make a comparison between two groups, it is necessary to control the propensity score (p). This allows to effectively turn the research population into groups of subjects with the same propensities. Equation 3 means that the treatment Q has to be independent of all observations *y* conditional on the probabilities e(*y*) when they would receive the treatment.

$$Pr\,\{y \mid Q=1,\,e(y)\} = Pr\,(x \mid Q=0,\,e(x)\} \tag{3}$$

The three assumptions required for conducting matching propensity scores are: conditional independence assumption (CIA), common support condition (CSC) and overlap assumption. CIA implies that, based on a set of covariates that are not affected by the certification and traceability, disparity in outcomes between participant and non-participant result from certification and traceability. Hence, the selection of the set of covariates is crucial in the process of matching estimators (Wooldridge, 2002). Caliendo and Kopeinig (2008) further suggested that covariates that are considered to include in the estimation process should simultaneous determine the treatment and the outcome variable. This can be written as:

$$(Y_0, Y_1) \perp Q \mid X \tag{4}$$

CSC is the other important requirement for conducting the matching between the treatment and control group. Heckman *et al.* (1997) stated that comparable observations X can be matched only in the overlapping subset of the participant and non-participant groups. The overlap condition is defined as follows:

$$0 < P\,(D=1 \mid X) < 1. \tag{5}$$

The overlap assumption explains that individuals with the same X values have the probability to be considered as a member and non-member (Caliendo and Kopeinig, 2008). However, failure to satisfy the condition of CSC is a main source of bias due to incomparable individuals (Heckman *et al.*, 1997).

3.4 Treatment of heterogeneity

Addressing the issue of self-selection bias in impact studies has been a major challenge. Such bias could emanate from unobservable producer household characteristics. Such bias includes producers' self-selection in the certified and traceable channel staking into consideration the cost and benefits of certification and traceability, their risk-taking capacity or the social relationship with other coffee producers. As a result of these unobserved household heterogeneity, one cannot guarantee that the treatment will have a homogeneous impact on the producers. To avoid the self-selection bias at the producer level Xie *et al.* (2011) propose two methods namely: (1) the stratification multilevel-heterogeneous treatment effect (SM-THE), and (2) the matching smoothing-heterogeneous treatment effect (MS-THE).

The SM-HTE estimation method first estimates the propensity scores based on the given covariates and splits the whole range of propensity score obtained into different strata and assumes homogeneity within strata. The effects of the treatment are interpreted through the comparison of each outcome between the treatment and control group across each strata. Then after the estimation of each strata a linearity trend is estimated to show if the treatment has established a positive or negative functional effect over the propensity scores. MS-HTE is established based on the weakness of the SM-HTE method. The SM-HTE considers homogeneity within each strata and uses the treatment and the control variables interchangeably as it assumes there is no heterogeneity within each strata. The other weakness considered is the linearity assumption between the ranges of strata to detect the treatment heterogeneity. The MS-HTE estimation method proceeds after estimating the propensity score of the treatment and match the treatment with the control observation. Then individual level treatment control comparisons are constructed. The heterogeneity pattern is revealed through a nonparametric model by estimating the treatment effect as functions of the propensity score (Brand and Thomas, 2013).

4. Result and discussion

4.1 Farm characteristics and matching coffee producers

As shown in Table 1, the farm area allotted for coffee production is higher for the certified and traceable producers and the farm area covered by other crops is relatively higher in the case of the control coffee producers. Producers marketing through the certified and traceable channels have larger numbers of productive and regenerating coffee trees, as well as a higher share of their income from coffee. They are relatively better educated and have more years of experience in coffee farming. While producers under the control group have more active family labor. Generally, producers under certified and traceable channels mobilize much of their resources for coffee production and the PSM will test if this mobilization brought changes.

A matching algorithm proposed by Rosenbaum and Rubin (1985) is used. It identifies a set of producers who are similar with treated producers in pertinent household and farm characteristics except from participation to the cooperative and hence participation in the certified and traceable chain. A test to validate the matching procedure is done by comparing the household's characteristics within the treatment group with the similar characteristics of the comparison group. A statistical forward method which was suggested by Black and Smith (2004) is also used to choose variables.

The unmatched sample is not in a position to fulfill the balancing properties in which there is a significant difference between households in treatment and control group in most of the household and farm characteristics (Supplementary Table A1). However, the absence of significant differences after matching between the treatment and control group revealed that the household and farm characteristics variance is controlled and any

Table 1. Mean difference in household and farm characteristics between treatment and control group.[1]

Variable	Mean		Mean significance (*t*-test)
	Treatment	Control	
Sex of the household head (0=male, 1=female)	0.07	0.05	1.28
Age of the household head (number)	45.01	43.85	1.56
Education level of the household head (number)	4.67	3.11	6.61*
Family size (number)	5.67	5.09	3.31*
Dependency ratio (number)	0.37	0.36	0.45
Years of experience in coffee farming (number)	17.73	16.57	1.52
Radio ownership (0=no, 1=yes)	0.83	0.68	4.12*
Asset value up to 2009 (number)	53147	36748	3.23*
Coffee share of total income (number)	0.78	0.76	1.23
Wet coffee price in 2010 (birr)	9.71	9.27	3.71*
Coffee area in 2010 (ha)	1.05	0.77	4.40*
Other crop area in 2010 (ha)	0.83	0.95	-2.07*
Total regenerating coffee tree in 2010 (number)	818.02	583.55	1.03
Total productive coffee tree in 2010 (number)	3280.70	2282	4.59*
Total coffee production in 2009 (kg)	1812.60	1445	2.29**
Wet coffee production in 2009 (kg)	683.69	441.39	2.99*
Distance to the market (minutes)	4.10	4.44	-0.94
Distance to the credit institution (minutes)	22.90	12.43	4.77*
Extension contact (number)	3.56	3.38	1.13
District (0=Jimma, 1=Keffa)	0.61	0.77	-4.45*

[1] Levels of significance at 1%* and 5%**.

of the outcome differences should emanate from the intervention which is certification and traceability. After matching the treatment sample with the control, the propensity score (predicted probability of participating in certified and traceable market channel) for treatment and control producers was estimated.

The study limits the sample to the common support region. These common regions are constructed after removing the observations in the control group with a p-score of less than the minimum p-score in the treatment and observations of the treatment group with a p-score higher than the maximum p-score in the control group. Of the treatment group, 17 observations fall outside of the common region (Figure 2). Whereas, all the control group observations fall within the common region.
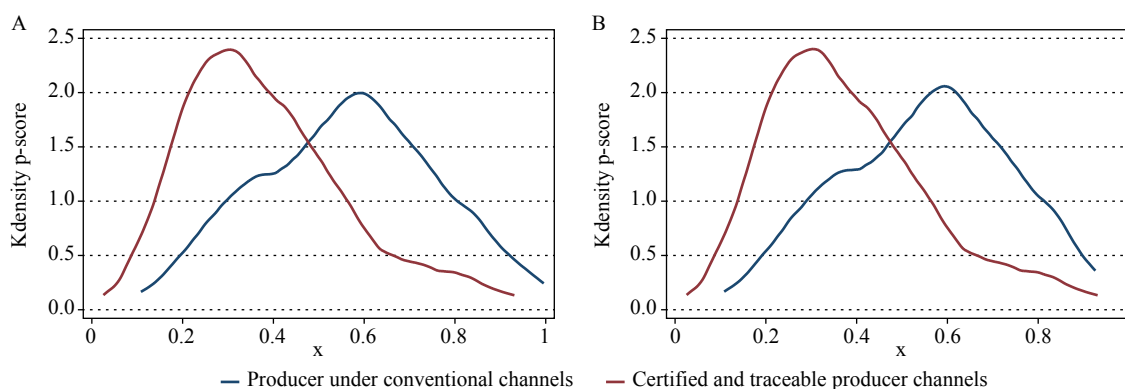

Figure 2. Propensity (p) scores distribution for traceable and non-traceable coffee producers before (A) and after (B) matching (Kdensity: kernel density, a non-parametric density estimator).

To further check the robustness of the result, three matching techniques were used: (1) kernel matching (KM); (2) nearest neighbor (NN) matching, and (3) radius caliper. Based on the matching procedure, a comparison was made between treated producers and control producers and the heterogeneity among the treated producers towards participating in certified and traceable channels was checked.

It was assumed that the sustainable livelihood framework is a basis to measure the impact of certification and traceability on the welfare of the coffee producers. In this respect the five livelihood criteria were considered: human, social, natural, physical and financial capital. The human capital included skills, knowledge, and ability to labor. The social capital refers to networks, memberships, and relationships. The natural capital is explained by natural resource stock. While the physical capital is defined by basic infrastructure, and producer goods. Finally, financial capital is explained by the available stocks, and regular flows of money.

Most producers are reluctant to adopt production techniques that require excessive operational expenses (in most cases hard work). Their negligence is related to the decision whether to reinvest their coffee earnings with the superior strategies or to proceed with the primary production practices. However, the sustainable sort of coffee production within the place previous to the intervention helps the implementation of human capital. The effect of the intervention on human capital is incomplete with regard to the improvement of family contributors. The short period of the intervention and the prioritization of investing the limited household earnings make the family human improvement insignificant.

There are producers who choose to avoid risk and who may not be willing to reinvest their coffee profits into coffee manufacturing. Hence, training and strengthening human capital is of top notch importance. The probit model indicated that producers with higher stages of education are more likely to be members of a certified cooperative. Yet, the propensity score result did now not show any sizable differences.

4.2 Average impact of certification and traceability on producer's welfare

This section attempts to answers the question on the role of certification and traceability, whether certification and traceability is only about sustainable coffee farming or also about economic welfare of producers. The overall benefits of marketing through certified and traceable channels are not clear on the human capital variables except for the enrolment of male education. The estimated impact was statistically significant at a 95% confidence level for NN matching while it is not significant for the KM method. Most producers are reluctant to adopt production techniques that require high operational costs (mostly labor). Their negligence is linked to the decision whether to reinvest their coffee income on the advanced techniques or proceedings with the basic production practices. However, the sustainable type of coffee production in the area prior to the intervention helps the implementation of human capital. The impact of the intervention on human capital is incomplete on the development of household members. The relatively short period of the intervention and the prioritization of investing the limited household income make the household human development insignificant.

The impact of certification and traceability on the physical capital of the coffee producers is clearer. The negative impact on coffee yield is found at a 99% confidence level for both KM and NN. Yields for non-cooperative producers is found to be significantly higher with an ATT of 1,425.12 kg. The older age (average more than 20 years) of the coffee trees remains a true challenge. An effort to replace the old and unproductive coffee trees with improved varieties is lagging behind the fact that 70% of the household incomes solely comes from coffee production. The old coffee trees are characterized for their high production volatility. Producers following the certified and traceable lines are obliged to follow sustainable production and harvesting procedures commanded by the coffee cooperatives (Ruben and Fort, 2012).

On the other side, there is an imbalance between the production of red and dry cherry. This is explained by the negative causality between certification and traceability with dry coffee production. In this regard most of the cooperatives are equipping themselves with washing stations. Since the washing machineries are

expensive, the purchases of the machineries are undertaken from loan. The purchase of the machineries has two implications. First, since cooperatives pay back the loan (in longer interval) from the premium they get every year, the benefit distribution to member producers is limited. Second, those cooperatives that finalized the loan repayment are able to market large amount of quality coffee and able to fully distribute the dividend to their members. Further, these cooperatives are more likely to be selected by other certifying agencies.

After controlling the asset difference between the treatment and control producers before 2010 (before joining the certified and traceable market), the asset value of producer since 2010 (after joining certified and traceable channel) was found to be significantly higher for treated producers than for control producers with an ATT of 14,575 kg. The higher value of asset is a result of the higher durable assets owned by the producers (Kamau *et al.*, 2010). Moreover, the results are not very conclusive on how certification and traceability increase agricultural assets.

To explain the impact of specialty coffee on smallholder coffee producers Vellema *et al.* (2015) opted to consider the portfolio of income-generating activities rather than coffee income. In this case the contribution of coffee for the household is less than 50%. However, in this study on average more than 70% of the household incomes is solely obtained from coffee. For a farm community which is mainly dependent on coffee, the prime focus of the impact should be on price, yield, income and factors that could directly affect price and yield. This does not mean that the contribution of other activities was ignored.

Since much of the impact of certification and traceability on the economic well-being of the producer emanates from the coffee price that the producer receives, Figure 3 compares the variance in price of wet and dry coffee between treated and control producers. Most of the producers marketing though certified and traceable channels are trading in a narrow range of price, while the conventional producers receive price which differ more. However, the figures above do not clearly show if the treated producers receive a better price than producers under conventional channels. From Table 2 the average treatment effect of certification and traceability for wet coffee price is positive suggesting a significantly higher price compared to the conventional channel. Even though treated producers receive a better average wet coffee price, this difference is not large enough to bring the member farmers a higher gross coffee income. This is for at least two reasons; first due to the low productivity (coffee yield per hectare) of certified and traceable producers. Second, some producers reinvest the dividend money they receive in the development of cooperatives' fixed assets, like coffee depulping machineries. Hence, this can lead to the conclusion that the price variation between the control and treatment group is not significantly larger than the difference in yields.

The high dependency of the producer on income generated from coffee makes household decisions critical. To fully capture the financial position of the household the net cash return from coffee was estimated. The impact of membership on net cash return is not significant. Coffee price, yield and cost per hectare were taken into consideration to calculate net cash returns from coffee. Yet, again, the impact of relatively higher price of certified and traceable coffee producers is not sufficient to overcome lower yields and higher costs.

The matching estimation results reveal that certified and traceable producers have significantly lower incomes from other crops than conventional producers. Participation in certified and traceable market channels appears not to result in statistically significant differences in non-farm income and income from livestock sales. On the other hand, interestingly, treated producers have significantly more savings compared to the control producers. Moreover, no statistically significant difference is found in gross household income between treated producers and producers in the control group.

The basic building blocks of certification and traceability rely on the shoulder of sustainable coffee production which can be realized through the development of natural capital. Growing coffee under shade trees is becoming the basic requirement and recommended type of production in the current international coffee sector. In this respect, treated producers are highly involved in selective tree planting that are appropriate for coffee.

Table 2. Average impact of certification and traceability on coffee producer's welfare.[1,2,3]

Variable	Kernel		Five nearest neighbors matching		Radius caliper	
	ATT	*t*-stat	ATT	*t*-stat	ATT	*t*-stat
Human capital						
Male children education enrolment	-0.07 (0.048)	-1.60	-0.09*** (0.05)	-1.75	-0.06 (0.05)	-1.40
Female children education enrolment	-0.00 (0.04)	-0.16	0.05 (0.05)	1.13	0.01 (0.03)	0.21
Family labor used for coffee production	-3.39 (1.99)	-1.51	-3.19 (2.64)	-1.17	-3.98 (2.14)	-1.62
Decisions made by male	0.00 (0.03)	0.10	-0.00 (0.05)	-0.01	0.00 (0.40)	0.00
Decisions made by female	0.01 (0.02)	0.70	0.02 (0.02)	0.79	0.02 (0.02)	0.82
Physical capital						
Coffee yield (kg/ha)	-1,425.12** (537.62)	-2.43	-915.78 (662.14)	-1.37	-1,303.25** (527.50)	-2.03
Wet coffee production	123.87 (97.85)	1.18	123.54 (135.71)	0.96	150.08 (110.18)	1.33
Dry coffee production	-405.27* (233.79)	-3.33	-358.17** (235.86)	-2.38	-373.96* (236.12)	-2.82
Asset value since 2010	14,575.13* (3000)	4.91	14,211.06* (4544.51)	3.80	14,366.66* (3,222.6)	4.61
Durable asset since 2010	14,470.07* (2568.93)	4.88	14,105.58* (4,466.19)	3.77	14,267.59* (3,074.87)	4.58
Agricultural asset since 2010	15.96 (15.91)	0.79	7.41 (17.98)	0.35	22.34 (15.78)	1.14
Financial capital						
Gross coffee income per hectare	-11,070.83 (6765.73)	-0.79	-7,699.98 (6,466.92)	-1.15	-5,952.81 (6,546.47)	-0.44
Cash cost per hectare	-41.43 (76.65)	-0.50	-94.05 (85.63)	-1.08	-80.19 (79.39)	-0.95
Net cash revenue per hectare	-11,029.40 (6903.72)	-0.79	-7605.92 (6478.93)	-1.14	-5,872.62 (6,362.63)	-0.43
Income from other crops	-4,371.99* (1373.46)	-2.78	-3425.49* (1,335.72)	-2.97	-5,098.65* (2,081.62)	-2.93
Non-farm income	229.44 (765.57)	0.28	491.26 (976.81)	0.53	453.84 (706.85)	0.53
Saving amount	3,187.35* (813.13)	4.17	2,566.66* (821.00)	3.37	3,266.91* (780.90)	4.11
Total gross income	-36,386.99 (18798.47)	-0.58	-16,411.68 (14,490.04)	-0.40	-31,922.26 (23,654.19)	-0.45
Average wet coffee price	0.39*** (0.19)	1.87	0.59* (0.19)	3.22	113.58 (0.22)	0.85
Average dry coffee price	0.66 (0.48)	1.29	0.69 (0.62)	1.17	0.90 (0.47)	1.58
Natural capital						
Practice land conservation practices	0.17* (0.02)	5.32	0.12* (0.039)	3.39	0.18* (0.03)	5.40
Number of trees planted	42.85* (13.37)	2.96	42.77** (21.82)	2.24	47.35* (14.26)	3.12
Use organic fertilizer	0.09*** (0.05)	1.82	0.04 (0.076)	0.86	0.09*** (0.05)	1.79
Social capital						
Participation in social organization	-0.32 (0.75)	-0.33	-1.79 (1.35)	-1.43	-0.78 (0.74)	-0.71
Satisfaction in social organizations	6.20 (4.34)	1.52	3.05 (2.14)	1.62	6.40 (4.80)	1.51
Association membership	0.12* (0.01)	6.68	0.14* (0.023)	6.56	0.13* (0.02)	6.35

[1] Levels of significance at 1% *, 5% ** and 10% ***.

[2] ATT = average treatment effect on the treated producers.

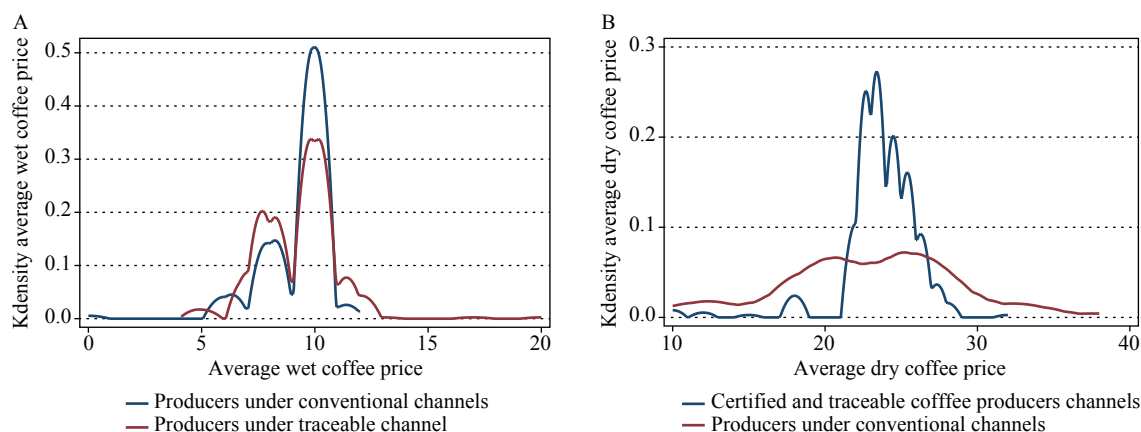[3] In parenthesis standard deviations are presented.

Figure 3. Price variance in wet (A) and dry coffee (B) between treated and control producers (Kdensity: kernel density, a non-parametric density estimator).

The conservation extends to land conservation practices and organic fertilizer application, focusing on compost and mulching. The investments on the natural capital are witness by the price producers are receiving. However, due to the lack of long-term faming loan producers are cautious from making a complete coffee tree renovation.

4.3 Sensitivity analysis: robustness of matching algorithms

Since every matching algorithm has its own operational limitations, Baser (2006) suggests to check the robustness of the estimated ATT for the different matching algorithms. Bryson *et al.* (2002) and Stuart (2010) further stressed the need of checking the robustness in the framework of attaining a well-balanced sample to satisfy the common support condition. The different matching methods are tested for covariate balance and as shown in Table 3, the different algorithms are robust. From the robustness result the Pseudo-R^2 values after matching become significantly lower (approaching zero) than before matching for the different algorithms. The mean standardized bias diminishes significantly for all algorithms after matching. The other supportive testimony is that, after matching the different covariates are not any longer jointly significant.

Table 3. Robustness of the different matching algorithms.

Matching method	Kernel matching	Nearest neighbor (1)	Radius caliper (0.01)	Nearest neighbor (5)	Radius calliper (0.01)
Replacement	Yes	Yes	Yes	Yes	Yes
Common support	Yes	Yes	Yes	Yes	Yes
No. of treated	292	292	292	292	292
No. of control	332	332	332	332	332
Pseudo R^2 before matching	0.171	0.171	0.171	0.171	0.171
Pseudo R^2 after matching	0.010	0.032	0.021	0.018	0.017
$P > \chi^2$ before matching	0.000	0.000	0.000	0.000	0.000
$P > \chi^2$ after matching	0.981	0.140	0.889	0.951	0.804
Mean standardized bias before matching	21.7	21.7	21.7	21.7	21.7
Mean standardized bias after matching	4.8	8.3	6.1	5.4	5.6

4.4 Sensitivity of the effect of treatment on the treated producers to hidden bias

The matching algorithm model performed above is based on the assumption that the difference between treated and control producers is because of the difference in observable household and farm characteristics keeping the unconfoundedness assumption. However, due to unobservable farm and household characteristics the comparison groups might differ and may cast doubt on the real impact of certification and traceability on the welfare of the coffee producers (Caliendo and Kopeinig, 2008).Therefore, the Rosenbaum (2002) bounds sensitivity test is performed to test if the assumption that certification and traceability impacts are distorted by hidden factors that were not observed in the data set is true (Table 4).

Rosenbaum bounds (rbounds) test estimates the gamma level to test the hypothesis that the treatment impact is not affected by unobserved selection biases. Gamma level is explained as the odds ratio of differential treatment assignment due to an unobserved covariate. The critical levels of gamma (Γ) are shown in the last column for the different welfare indicators that show significant differences between the two groups. As shown in Table 4 the lowest critical value of sensitivity analysis is 1.35-1.4, whereas the largest critical value is 10.6-10.75. The gamma level of 1.35-1.4 shows that producers that have similar covariates must differ in their odds of certification and traceability by a factor of 35-40% to offset the positive significant effect of certification and traceability on durable assets and savings. The critical levels appear to be sufficiently high. Hence, as suggested by the sensitivity tests, the ATT estimates for the welfare indicators seem robust to unobservable covariates.

4.5 Heterogeneous impact of certification and traceability

While computing the ATT it is assumed that certification and traceability have a homogeneous effect on the coffee producers. However, different findings (Abebaw and Haile, 2011; Bernard *et al.*, 2007; Brand and Davis, 2011; Mutuc *et al.*, 2013; Verhofstadt and Maertens, 2014) show that even farm households under the same social groups (treatment group) differ in their response to the same interventions. To critically evaluate the heterogeneity effect of the treatment, the heterogeneity models developed by Xie *et al.* (2011) were used. The two methods proposed are: (1) the stratification multilevel-heterogeneous treatment effect (SME-HTE); and (2) the matching smoothing-heterogeneous treatment effect (MS-HTE).

Table 4. Robustness test of matching algoritms.[1]

Variable	Producers under certified and traceable channels	Producers under conventional channels	ATT	Critical value of gamma
Coffee yield (kg/ha)	2,936.31	4,361.43	-1,425.12 (537.62)	4.8-4.85
Dry coffee production (kg)	595.54	1000.82	-405.27 (233.79)	5.1-5.15
Asset value since 2010 (number)	22,164.44	7,589.30	14,575.13 (3,000.006)	1.4-1.45
Durable asset since 2010 (number)	22,077.82	7,607.74	15.96 (15.91)	1.35-1.4
Income from other crops (number)	1,375.08	5,747.07	-4,371.99 (1,373.46)	10.6-10.7
Saving amount (number)	3,258.94	71.58	3,187.35 (813.13)	1.35-1.4
Membership in social organizations (yes/no)	0.30	0.17	0.12 (0.017)	4.95-5
Practice land conservation practices (yes/no)	0.47	0.30	0.17 (0.02)	3.1-.3.15
Trees planted (number)	126.19	83.34	42.85 (13.37)	1.7-1.75

[1] ATT: average treatment effect on the treated producers.

■ *Stratification multilevel-heterogeneous treatment effect*

Following the SME-HTE method the certification and traceability effect on the producer's welfare across the strata was estimated by the following ordinary least squares (OLS) estimation:

$$O_{ab} = D_b + O_a T_i,$$ (6)

Where O_{ab} is the expected value for an outcome variable, O, for the ath coffee producer in the bth propensity score strata, D_b is the level 1 intercept and T_i represents a variable for producer under certification and traceable channels. After estimating equation six, the slope is then used to estimate the heterogeneity pattern across the different strata:

$$O_a = \alpha_0 + \Phi_i + \varepsilon_i,$$ (7)

Where O_a are the estimated level 1 slopes, α_0 is the level 2 intercept, Φ_i is the level 2 slope, and ε_i represent an error term.

As shown in Table 5, the wet coffee production increases significantly with increasing propensity to engage in certification and traceability. Those producers between strata 3 and 6 increase their wet coffee production at a rate of 136.33 kg for every unit change of the propensity score. However, there is no statistically significant impact of dry coffee production observed in the propensity to engage in certification and traceability. Whereas, the financial capital of the coffee producers in terms of total assets, durable assets and income from other crops was not found to be different by the propensity to engage in certification and traceability. However, there is an increase in the non-farm income effects of certification and traceability as their propensity increases and the increasing effect is mainly observed in the higher order of the propensity strata (4-6). In the level 2 slope the non-farm increasing effect of certification and traceability increases at 1,154.09 birr for every unit change in the propensity strata.

The strongest significant effect of certification and traceability is observed on producer's savings level. Under level 1, the effect on savings is explained in all the propensity strata except strata 1. The level 2 slope for producer's savings significant increases at a rate of 1,087.93 for every unit change in propensity strata (rank). On the natural capital perspective, level 2 slope for the certification and traceability indicates a 13.23 unit increment in the tree planting. The tree planting increasing effect reaches its maximum level at the highest strata, strata 5.

■ *Matching smoothing heterogeneous treatment effects estimation*

The MS-HTE method has certain advantages over the SME-HTE method. Its advantage is that the method, unlike SME-HTE which assumes different strata, MS-HTE assumes homogenous strata and makes continues propensity score lines. The assumption of linear propensity scores enables variables that are insignificant to become apparently significant (Xie *et al.*, 2011). In this regard, the variables 'coffee yield', 'dry coffee production', 'total assets', 'durable assets', 'income from other crops', 'organizational membership' and 'practices land conservation' were not significant under the SME-HTE approach but they become significant with the MS-HTE method (Supplementary Figure A1 and A2). The reducing effect of certification and traceability on coffee yield is more important at higher propensity scores.

Certification and traceability cooperative membership seems to reduce dry coffee production significantly as it approaches the highest propensity score. This is consistent with the SM-HTE results. Regarding asset, both ownership of total and durable assets are higher amongst producers with certification and traceability. The reducing effect of certification and traceability on income from other crops decreases significantly as it moves to higher propensity scores. Membership of social organizations increase as the propensity increases. Finally, certification and traceability have a positive effect on land conservation practices but diminishes

Table 5. Treatment effects by strata stratification multilevel-heterogeneous treatment effect.[1,2]

Variable	Level 1 slopes[3]						Level 2 slopes
	1	2	3	4	5	6	
Coffee yield (kg/ha)	-4,576.68 (0.15)	-2,021.1** (0.03)	-1,973.4*** (0.05)	-798.48 (0.14)	82.51 (0.94)	-3,035.33** (0.02)	279.35 (0.41)
Wet coffee production (kg/ha)	-65.4 (0.82)	-166.90 (0.28)	120.99 (0.52)	230.39 (0.31)	263.75 (0.26)	608.27 (0.28)	136.33*** (0.05)
Dry coffee production (kg/ha)	-566.08 (0.16)	-221.74** (0.03)	-66.45 (0.66)	-286.51*** (0.05)	-211.77 (0.39)	-2,460.19** (0.04)	-13.55 (0.83)
Total assets (birr)	2,383.83 (0.78)	6,992.78** (0.02)	11,789.6* (0.00)	10,705.8 (0.26)	14,802.6*** (0.05)	17,702.9 (0.30)	2,937.39 (0.15)
Durable assets (birr)	2,366.44 (0.78)	6,983.94** (0.02)	11,773.84* (0.00)	10,556.22 (0.27)	14,579.56*** (0.05)	17,676.54 (0.30)	2,892.60 (0.15)
Income from coffee (birr)	2,496.18 (0.62)	-4,532.71 (0.15)	-2,042.8** (0.02)	-3,415.15* (0.00)	-7,906.22* (0.00)	-2,498.83** (0.04)	-289.07 (0.53)
Nonfarm income (birr)	-2,643.77 (0.47)	-1,711.26 (0.15)	-1,757.90 (0.10)	317.31 (0.76)	1,325.31 (0.52)	4,301.76 (0.36)	1,154.09** (0.04)
Saving amount (birr)	-38.84 (0.50)	1,158.25* (0.00)	3,605.43** (0.04)	2,236.68*** (0.05)	4,800.94 (0.10)	9,145.81 (0.21)	1,087.93* (0.00)
Trust in social organizations (yes/no)	0.18 (0.83)	1.41* (0.00)	0.85** (0.01)	0.46 (0.24)	0.98* (0.00)	0.51 (0.43)	-0.12 (0.30)
Participation in social organizations (yes/no)	0.05 (0.50)	0.12* (0.00)	0.14* (0.00)	0.05 (0.22)	0.14* (0.00)	0.08 (0.28)	0.001 (0.93)
Practice land conservation (yes/no)	0.23** (0.04)	0.05 (0.24)	0.16* (0.00)	0.10*** (0.09)	0.24* (0.00)	0.13 (0.27)	0.02 (0.19)
Tree planting (number)	19.27 (0.62)	9.88 (0.45)	43.01* (0.00)	50.39 (0.45)	43.23*** (0.05)	91.00*** (0.03)	13.23*** (0.05)
Use of organic fertilizer (yes/no)	0.04 (0.82)	-0.04 (0.53)	0.11 (0.20)	-0.03 (0.77)	0.19*** (0.06)	0.08 (0.64)	0.04 (0.18)

[1] Levels of significance at 1%*, 5%** and 10%***.

[2] In parenthesis standard deviations are presented.

[3] 1, 2, 3, 4, 5, 6 represent the propensity strata (rank); Level-2 slopes is linear trend evaluated across the strata.

as it reaches the highest propensity level. The reluctance of the producers to engage in advanced coffee production management limits them in achieving the highest possible conservation level.

5. Key findings and policy recommendations

The development of certification and traceability is becoming the mainstream market in the global coffee industry. Interventions involving certification and traceability to enhance the livelihood of the coffee producers have a multidimensional impact. The intervention in southwest Ethiopia has brought a change in the limited dimension of coffee producers. The key findings navigate over the different components of the household

changes step by step. Microeconomics policy interventions should be evaluated by including the economic dimensions to which stakeholders give more priority. The focal points in the livelihood of coffee producer households are linked to sustainability of the coffee farm and coffee returns. The analysis is made to verify to what extent the different interventions (certification and traceability) could help the farmer achieve the different goals. Both certification and traceability initiators strongly believe that the development of human capital is a linking bridge for a sustainable partnership between producers and international buyers. In this regard, most of the treated producers acquire the basic production knowledge and skills for attaining the minimum quality standards set by the international buyers. Most producers are reluctant to adopt advanced production techniques.

Despite the fact that the sustainable production activities are intensively practiced by the certified and traceable producers, their coffee yield is much lower than that of the control producers. Results also showed a skewed balance between the production of wet and dry coffee by the treated producers. The focus and promotion of wet coffee production by the international coffee buyers made cooperatives to gear their resources towards wet coffee production. Engagement in the certified and traceable coffee channels enables producers to fetch a better and more stable price for their wet coffee supply. Yet, this higher price is not sufficient to substantially increase coffee income. This is due to the fact that the price variation between the control and treatment group is not significantly larger than the difference in yields. Yet, also net cash returns were not different between the two groups studied. The other productivity element that determines the level of net cash returns is the cost of production (input and labor cost). However, the results show that the cost of production is not high enough to realize a significant change in net cash returns between treated and control producers.

Producers under certified and traceable markets engage themselves more in land conservation practices, tree planting and organic fertilizer application (focusing on compost and mulching) than the control producers. Training and creating awareness among members of certified and traceable coffee cooperatives enables them to follow sustainable coffee production practices.

The impact of interventions differed much between the treated producers. The heterogeneity was analyzed by comparing the different livelihood elements with producers' propensity to engage in certification and traceability. The heterogeneity tests revealed that a higher volume of wet coffee supply of producers that are engaged highly in the certification and traceability signals the high demand of wet coffee in the certified and traceable coffee markets. The other result that supports the assumption that treated producers highly involved in the coffee production is the income from other crops. The estimation shows that producers which are engaged in higher level of propensity are most likely to limit themselves towards the production of other crops.

The capital formation behavior of the producer has a direct linkage towards the certification and traceability. This is explained by the higher level of savings towards producers in the highest strata. The transformation of capital into asset development, mainly durable is also illustrated in the final strata. Finally, certification and traceability have an increasing effect on land conservation, but the conservation starts to diminish before the final strata.

Previously, the ECX made two attempts in improving the traceability of coffee through the establishment of Direct Specialty Trade (DST) in 2010 and the tagging system, both of which failed. The tagging system failed in 2015 due to a lack of trust between the coffee traders and the government. This is an indication that the ECX is not the most convenient institution to execute traceability. Furthermore, the availability of donor supported traceable systems for a small segment of the coffee producers that are marketing through cooperatives cannot guarantee a sustainable supply of traceable coffee to the international market. Thus, the cooperative traceability system should be internalized in the government cooperative system and should not depend on the certification systems only. In addition, since the commoditization process along the coffee value chain influences the predictability of the price movement and widens the price gap between producers and traders, policy instruments that promote de-commoditization have the power to mitigate such problems.

Furthermore, market transparency through the provision of market information at the producer level alone is not sufficient to empower the coffee producers. The financial bargaining position of producers could be enhanced through supporting producers' associations, which are subsequently serving as a market outlet. Moreover, supporting individual coffee producers at the farm level was not and is still not a cost-effective way for an agrarian based economy.

The relatively higher coffee price received by producers marketing through traceable and certified cooperatives could not secure a higher income. This leads to the main problem of lower yields per hectare. Since replacing the aging tree stock with a new and improved variety takes time, during which no harvest is possible, stakeholders could grant producers a long-term loan to smooth out the financial gap until the new trees mature. In this regard, the recent work of root capital rehabilitation and renovations in Nicaragua, Peru, Mexico, and Honduras serves as a successful example for replacing the aging coffee trees. Moreover, the Colombian government, in partnership with the Federación Nacional de Cafeteros de Colombia renovation program, is another success story that could be adopted (Rootcapital, 2016).

Another particularly important issue that still deserves attention is the sustainable use of water during wet processing of coffee. Wet-processed coffee is high in demand in the international coffee market, which forces cooperatives and private suppliers to expand their washing stations. Thus, the issue of sustainable use of the water and treating the waste water deserves due attention. Alternative washing stations could drastically reduce the need for water. Therefore, internalizing the sustainability issue in the licensing procedure of cooperatives washing stations could be a feasible recommendation. In addition, the introduction of ecosystem service payment schemes could enhance the well-being of the coffee farmers, and subsequently protect the ever-increasing threat posed by global climate changes on the coffee growing regions of Ethiopia.

Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2018.0047.

Table A1. Balancing tests of matched samples.
Figure A1. Stratification-Multilevel (SM) Heterogeneous traceable effects.
Figure A2. Matching-Smoothing (MS) Heterogeneous certification and traceability effect.

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