**Evaluating the Impact of Market Information System on Coffee Producers' Revenues and Profits in Ethiopia**

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## 1. Introduction

Market information is an important input farmers use when determining production and marketing behavior, particularly for commodities facing extreme price fluctuations, such as coffee (ICC 2003). However, in fact, the majority of smallholder coffee farmers in developing countries have difficulty accessing market information regarding central wholesale markets (Getnet, Verbeke, D'Haese, Viaene, & D'Haese, 2011). Osborne (2005) claims that the productivity of smallholder coffee farmers is negatively affected by this lack of information on coffee prices.

Theoretically, having scant market information may affect producers negatively in at least two ways. First, the coffee farmers may suffer from information asymmetries, i.e., farmers uninformed of market coffee prices may suffer a loss when they transact with traders who are superior to the farmers in terms of market information access. Second, it is highly likely that smallholder coffee farmers lacking sufficient information to predict the coffee price fluctuations may overinvest or underinvest in their coffee farms. As a result, they can be burdened with a heavy debt and possibly even abandon their coffee farms.

In order to tackle such problems due to inaccurate information and information asymmetries, several African countries introduced the market information systems (MIS) and provided information regarding market prices to all market actors and intermediaries (Mader 2002; Muto 2013). MIS may improve smallholder farmers' welfare in theory, but it remains unclear if the majority of smallholder farmers, especially illiterate ones, will be able to benefit from using the new technologies. Thus, the question remains as to whether these MIS exert a positive effect on the farmers' farming and livelihood in practice. This study performs a quantitative estimation of the effects of MIS using the case of the Ethiopian coffee industry.

Although several studies have shown that MIS users are able to obtain higher revenues than non-MIS users (Muto 2013; Mukhebi 2004), their analyses are not complete as they did not evaluate other important outcomes, such as profits or productivity. Thus, this study tries to emprically examine the effect of an MIS on the smallholder coffee farmers' profits and productivity levels using primary data collected from 308 farmers in Ethiopia.

We find that MIS users indeed obtain higher revenues and profits than non-MIS users, with a close to 20 percent magnitude of increase for both variables. The results were robust to the different estimation methods employed. In addition, we find that this increase could be more attributed to an increase in harvest volumes by MIS users rather than an increase in their selling prices, as previously hypothesized. Although farm size is not statistically different between MIS and non-MIS users, MIS users harvest statistically higher amounts of coffee relative to non-MIS users. Our findings suggest that the price information obtained by MIS users can be used to improve their investment decisions and increase their productivity levels. Furthermore, although admittedly a crude estimate, we also found that MIS may also benefit traders as MIS users also exhibit higher sales volumes.

The next section describes price fluctuations in the coffee industry and their impact on Ethiopian farmers while section 3 reviews the literature on market competition, information asymmetries, and MIS usage in African countries. Section 4 explains the data used and presents summary statistics. Section 5 explains the estimation methods used, and the results are presented in Section 6. A conclusion follows in Section 7.

## 2. Ethiopian Coffee Industry and Coffee Farmers

Coffee production is a mainstay of the Ethiopian economy, and accordingly, the Ethiopian government has striven to improve the productivity, quality, and market efficiency of its domestic coffee crops since liberalizing its agricultural market in 1990. As a result, Ethiopia became the world's fifth largest coffee producer and Africa's top producer, with a production of 4 million metric tons during the crop year 2011–2012 (Overseas Development Institute (ODI) 2009; Information Commissioner's Office (ICO) 2014). Coffee accounted for more than 50 percent of Ethiopia's export revenues in 2006, and about 25 percent of total export earnings in the marketing year 2012–2013 (Cheng 2007; Tefera and Tefera 2013). Smallholder coffee farmers, most of whom farm less than half a hectare of land, produce more than 90 percent of the country's total coffee output. More than one million coffee-growing households and the livelihood of over 15 million people, directly or indirectly, depend on this commodity crop (Labouisse et al. 2008; LMC 2000; ODI 2009). Ethiopia's coffee crop currently holds a significant position as one of the national economy's major export commodities.

Although Ethiopian coffee producers play an important role in the national economy, the majority still live in extreme poverty. According to a study conducted by the ODI (2009), poverty incidence among coffee producers was 40 percent in 1999, slightly higher than the national average of 38.5 percent.

Figure 1-a shows the high volatility of coffee prices between 1990 and 2013. In September 2001, coffee prices hit a historic low of 41.17 US cents/lb. The lowest coffee price this year was less than half the average price during the 1990s. This global coffee crisis had a significant impact on the lives of more than 125 million people worldwide who work in the coffee industry, both directly and indirectly. The imbalance between the supply and demand for coffee was a principal cause of this observed slump in coffee prices (Osorio 2002).

In Ethiopia, the GDP growth rate dropped more than 6.5 percent in 2001 relative to the previous year, and the economy experienced a negative growth by 2.2 percent in 2002 due to the drop in coffee prices as depicted by Figure 1-b. In addition, Ethiopia's export revenues from coffee fell by 42 percent, from US$257 million to US$149 million. In the aftermath of this coffee crisis, the Ethiopian government suffered from severe fiscal constraints for that period and was forced to reduce the budgets for education, health programs, and ability to make debt repayments as a tight fiscal policy (Cheng 2007).

During the same period, some Ethiopian coffee farmers sold their coffee at prices below production costs, earning less than US$1 per day. As a result, some coffee growers, with their livelihoods in jeopardy, abandoned their coffee farms and attempted to migrate to Addis Ababa, Ethiopia's capital city, to seek jobs. Furthermore, a large number of smallholders were unable to pay for their children's education or basic medicines and had to cut back on food consumption, thereby increasing incidences of malnutrition (Osorio 2004; ICC 2003).

These cases provide sufficient evidence to conclude that coffee price fluctuations can adversely affect coffee growers' livelihood as well as financial status in Ethiopia. Although stabilizating coffee prices is considered a solution to the problem, in practice, this would prove extremely difficult as all coffee producing countries would need to build a cooperative system to enact such a plan. Reintroduction of a quota system,[1] which had been implemented by the ICO from 1962 to 1989, has been discussed by ICO member states. However, because both coffee producing countries and global coffee trade volumes have significantly increased since the agreement's breakdown, the cost of the quota system seems to be too high in practice to implement (Seo, 2009).

Coffee price fluctuations are an important issue for both coffee producers and the Ethiopian economy. If coffee producers have the ability to forecast approximate coffee prices over the next year, they would be able to use this information to adjust the amount they spend on coffee cultivation, including inputs such as fertilizers, herbicides, pesticides, and personnel. These decisions regarding farming inputs may lead to higher profits, and those producers who use this knowledge may then invest their surplus money in adopting improved technologies to grow higher quality crops or shift from coffee cultivation to a higher value-added business.

However, Ethiopian coffee producers currently have difficulty accessing market information at central wholesale markets since the majority of smallholder coffee farmers are geographically isolated from such central markets.[2] Therefore, most Ethiopian coffee growers gather information from unofficial sources such as neighbors, friends, or traders and generally base their production decisions on expected future prices in order to optimize their price expectations by utilizing currently available price information (Getnet, Verbeke, et al. 2011). Considering the above circumstance, it is highly likely that Ethiopian coffee producers make uninformed decisions. Moreover, an environment with imperfect information, such as the Ethiopian coffee market, may

[1] The International Coffee Agreement was first signed in 1962. The agreement was designed to maintain exporting countries' quotas and keep coffee prices high and stable, but the quota system was abrogated in 1989 due to failure to agree on quota distribution (ICO n.d.).

[2] Approximately one-third of the rural population and more than a quarter of the total population are estimated to be engaged in coffee production (ODI 2009).

cause farmers to incur tremendous losses. Thus, a lack of regular and accurate market information can be considered a major obstacle facing not only Ethiopia's coffee market, but also its grain market (Wolday 2002; Getnet, Verbeke and Viaene 2005).

Furthermore, such an environment, in which producers depend on conversations with traders for market information, may magnify these problems because of information asymmetries between traders and producers. Since neighbors also obtain market information from traders, the information asymmetry problem is hard to solve even if a producer exchanges information on market prices with neighbors. According to a study by Osborne (2005), grain traders cheat farmers by paying too low a price for their grain. This phenomenon leads us to presume that producers who mainly use unofficial information may have weaker bargaining power relative to traders, and thus earn lower revenue than official information users.

**3. Market competition, information access, and MIS**

*3.1 Market competition and information asymmetries*

Market inefficiency has been reported and discussed in the context of many developing countries. For example, Osborne (2005), studying staple marketing in Ethiopia, found that traders' margins are higher in rural areas relative to the central market. Fafchamps and Hill (2008), studying coffee marketing in Uganda, found that price fluctuations in international markets are not transmitted to the local producer level. These studies empirically confirm the existence of imperfect competition in developing countries.

One major reason for the existence of imperfect competition is the presence of information asymmetries between buyers and sellers. Theories have been developed ever since Akerof's seminal paper (1970), and empirical studies have also followed. Recently, studies have evaluated whether the introduction of infrastructure, such as mobile phones, can overcome the problem of information asymmetry. Aker (2010) finds that producers with access to mobile phones receive better prices. Muto and Yamano (2009) find that the effect from introducing mobile phones on producers' prices is higher for perishable commodities relative to the impact on prices for storable staple crops.

This study attempts to add to this body of literature by focusing on theMIS, which has been introduced in several African countries to improve producers' access to information, using the case of Ethiopian coffee farmers.

*3.2 Ethiopia'sMIS*

Ethiopia launched a commodity exchange, called ECX, in May 2008. The ECX offered real time information on central wholesale prices to all market actors, including smallholder farmers.

The key market dissemination channels for ECX are rural-based market information tickers, mobile phone

Short Messaging Services (SMS), Interactive Voice Response (IVR) services, mass media (TV, radio, and newspaper), and the ECX's own website. This market information includes prices for commodities in different markets and commodity offers to sell and bids to buy, as well as short extension messages (ECX, 2009).

Since most smallholder coffee farmers live in rural areas where telecommunication or electronic infrastructure is not available and the total adult literacy rate is 38 percent (Unicef, 2013), radio seems to be the most popular among various MIS media by smallholder coffee farmers to obtain central wholesale coffee prices.

Getnet, Verbeke et al. (2011) used a quasi-rational expectation formation to provide convincing evidence on the potential benefit of real-time price information dissemination to farmers to assist farm-level forecasting and production, technology adoption, and marketing decisions. While this existing study suggests that Ethiopia's MIS is significantly able to improve farmers' forecasts, they do not examine the possibility that MIS can strengthen smallholder coffee farmers' bargaining power when negotiating with traders over the price of coffee.

### *3.3 MIS of other African Countries*

Muto (2013) evaluates the impact of an MIS-based program in Ghana on farmers' marketing performances and found that MIS users were able to sell maize at a price 10 percent higher than non-MIS users. This result indicates that the use of an MIS is able to increase farmers' bargaining power.

Another study, which researched Mozambique's Agricultural Market Information System (SIMA), found that people who have access to market information show greater participation in the marketing of cereals, beans, and peanuts (Mader 2002).

While these existing researches suggest that MISs are significant terms of increasing users' bargaining power and farmers' market participation, they do not fully analyze the benefits of MIS. For example, MIS may have an advantage in supporting producers' decisions on investments in production, which may lead to higher revenue and profit. In a study on SIMA, subjects' individual characteristics should also have been treated in order to identify the difference in market participation between MIS and non-MIS users due to the strong probability that people who use MIS are active in marketing even prior to the introduction of the MIS.

## 4. Data and Summary Statistics

In order to evaluate the impact of MIS on coffee producers' revenues and profits in Ethiopia, we conducted a household survey in March 2014 in the Jimma zone. We chose this zone, firstly, as a focus for our study due to its distance to Addis Ababa, which may make information access difficult for smallholders. Secondly, the Jimma zone is one of the Ethiopia's largest coffee exporters with about 20 percent of total coffee exports in 2013 and represents semi-forest coffee, which accounts for about 35 percent of total coffee production in Ethiopia (Bart et al. 2014; ESC 2002). Figure 2 presents a map of research areas. The survey covered 9 villages in 3 woredas, Limu Seka, Gera, and Kersa, which are 127 kilometers, 83.9 kilometers, and 34.7 kilometers from Jimma special zone, respectively. These were chosen considering their distance from Jimma special zone because the diffusion of market information is likely to be correlated with distance.

We collected information from 308 households in the study villages. Those 308 respondents were chosen randomly among inhabitants on the population lists were obtained from the Oromia Coffee Farmers Cooperative Union (OCFCU).[3] The data include information on coffee sales and input purchases from 2013 to 2014 as well as farmers' socio-economic characteristics.

Table 1 shows the share of sample farmers by location and gender. Each location has approximately the same share, but the percentage of males is much higher than the percentage of females.

Table 2 describes information sources in coffee cultivation. For the questions, respondents selected all applicable answers. 93 percent of all respondents answered that they obtained information from friends or neighbors, and 73 percent of all respondents obtained information from traders, but only 19 percent of all respondents, or 58 smallholder coffee farmers among 308 respondents, used the MIS provided by the ECX.

Table 3 summarizes the respondents' socio-economic characteristics. The average age of respondent coffee farmers is 46 years old, and most of them are male. About half of the respondents are literate and possess an average of about 14 years' coffee farming experience. Coffee farms averaged about 0.9 ha. We did not find much difference in these characteristics between MIS and non-MIS users. The only significant differences were found in radio coverage and possession of radios, which were both higher for MIS users than non-users.

Table 4 summarizes the characteristics of those respondents' coffee cultivation patterns. Although non-MIS users' sell their coffee for prices approximately 3.4 birr higher than MIS users, the revenue[4] per 0.1 hectare of MIS users averages 301 birr higher in comparison with non-MIS users' revenue since the MIS group harvested averagely 116 kg/0.1 ha lager than the non-MIS group. Furthermore, the profits[5] per 0.1 hectare of MIS users average 315 birr higher than those of non-MIS users. This is attributed to a marked difference in total expenditure on coffee cultivation[6] between the two groups. The MIS group's total expenditure on coffee cultivation was approximately 16 birr lower than that of the non-MIS group. This may indicate that MIS users are responding better than non-MIS users to changes in input costs as hypothesized.

## 5. Estimation Methods

[3] The cooperative not only had a list of cooperative members, but also the list of all small-coffee farmers in the Oromia region.

[4] The reduced form of the equation for those respondents' revenues is: $\mathrm{Revenue}_i = \mathrm{Sv}_i \times \mathrm{Cp}_i$

[5] The reduced form of the equation for those respondents' profits is:
$\mathrm{Profit}_i = \mathrm{Revenue}_i - \mathrm{Total\ expenditure}_i$

[6] The reduced form of the equation for those respondents' total expenditure on coffee farming is:
$\mathrm{Total\ expenditure}_i = \mathrm{Eof}_i + \mathrm{Eop}_i + \mathrm{Eoh}_i + \mathrm{Eolf}_i + \mathrm{Eolh}_i$

To examine these questions, this study statistically analyzes 1) the respondent characteristics that relate to the use of MIS, 2) the impact of MIS usage on coffee producers' revenues, and 3) the impact of MIS usage on coffee producers' profits.

Firstly, to examine the abovementioned hypothesis 1, we evaluate the marginal probability effects (MPE) of explanatory variables in a probit model and the odds ratios in a logit model with MIS usage as a dependent variable. Through the result of this analysis, we intend to define what factors are related to the use of MIS and suggest a policy able to boost the usage rate of MIS such as the diffusion of radios and mobile phones. We estimate

$$\begin{cases} \dfrac{\mathrm{P}(Dmis_i = 1|\mathrm{x}_i)}{\partial \mathrm{x}_{ij}} = \phi(\mathrm{x}_i'\beta)\beta_j & \text{MPE in probit} \\ \dfrac{\exp(\mathrm{x}_i'\beta)}{(1+\exp(\mathrm{x}_i'\beta)} \Rightarrow \dfrac{\mathrm{p}_i}{1-\mathrm{p}_i} = \exp(\mathrm{x}_i'\beta) \Rightarrow \ln\left(\dfrac{\mathrm{P}_i}{1-\mathrm{P}_i}\right) = \mathrm{x}_i'\beta & \text{Odds ratios in logit} \end{cases} \tag{1}$$

where $Dmis$ = 1 denotes the use of MIS and $Dmis$ = 0 denotes the non-use of MIS; $\mathrm{x}_{ij}$ contains household characteristics relevant to the use of the MIS; $\beta$ is the vector of coefficients to be estimated; and $\phi(\mathrm{x}_i'\beta)$ is the value of the standard normal probability density function at $\mathrm{x}_i'\beta$. $\mathrm{P}_i/(1-\mathrm{P}_i)$ in the logit model measures the probability that $Dmis$ = 1 relative to the probability that $Dmis$ = 0 and is called the odds ratio. If the odds ratio is 2, the odds of the use of MIS are twice as high as those concerning the non-use of MIS (Cameron & Trivedi, 2005).

Secondly, to estimate the abovementioned hypotheses 2 and 3, we employ several methods. First, we use the ordinary least squares (OLS) estimator as below:

$$\mathrm{Y}_i = \beta_0 + \beta_1 x_{ik} + \beta_2 \mathrm{Dmis}_i + u_i \tag{2}$$

where $\mathrm{Y}_i$ is revenue and profit by head of household *i*; $\chi_i$ contains head of household *i*'s age, sex, literacy (whether the *i* can read Amharic alphabet or not), coffee farming experience, coffee farm size, number of adults among family members, number of males among family members, number of females among family members, distance from each respondent's dwelling to the Jimma special zone, and annual rainfall in *k* village. $\mathrm{Dmis}_i$ is a dummy variable that indicates whether the *i* is an MIS user or non-MIS user. $u_i$ is the error term.

Third, because $\mathrm{Dmis}_i$ may be considered an endogenous explanatory variable in the simple regression model, we also conduct a two-stage least squares (2SLS) estimation. The first-stage regression is as follows:

$$\mathrm{Dmis}_i = \pi_0 + \pi_1 x_{ik} + \pi_2 \mathrm{hrdaio}_{ik} + \pi_3 \mathrm{di}_i + \nu_i \tag{3}$$

where $\chi_{ik}$ in Equation (3) contains the same explanatory variables as Equation (2) above. For the instrumental variable, we use $\mathrm{hrdaio}_{ik}$, radio holders' rate in *k* village, and $\mathrm{di}_i$, the number of crop damage by diseases or insects in the past 10 years. These are considered to affect Dmis, but not revenues and profits directly. Hence both those variables are selected as instrument variables for $\mathrm{Dmis}_i$.

Fourth, this study employs Heckman's difference-in-difference (DID) method, which is a special version of the average treatment effect on the treated (ATT), because the method has features to estimate the distribution of unobserved errors and control for time-invariant unobserved heterogeneity (Guo and Fraser 2010; Heckman, et al. 1997, 1998). We perform the logit regression to match MIS and non-MIS users with similar characteristics. After the regression we use kernel-based matching to compute the differences between the outcomes of the treatment group and the weighted average differences in the outcomes for the controlled group. In addition, bootstrapping is used to draw statistical inferences. The strategy to test both hypotheses 2 and 3 is shown below:

$$\mathrm{DID} = \frac{1}{n_1} \sum_{i \in I_1 \cap S_P} \{(Y_{1ti} - Y_{0t'i}) - \sum_{j \in I_0 \cap S_P} W\,(i,j)(Y_{0tj} - Y_{0t'j})\} \tag{4}$$

where $n_1$ is the number of treated cases; $\mathrm{I}_0$, and $\mathrm{I}_1$ denotes the set of indices for non-MIS users and MIS users; $\mathrm{Y}_1$ includes MIS users' revenue and profit; $\mathrm{Y}_0$ is non-MIS user s' outcome; t denotes the year 2014; and $\mathrm{t}'$ is the year 2013. According to Guo and Fraser (2010), each treated participant has a difference $(Y_{1ti} - Y_{0t'i})$ and multiple matches have average differences of $\sum_{j \in I_0 \cap S_P} w(i,j)(Y_{0tj} - Y_{0t'j})$. The difference between the two values yields the difference in differences that measures the average change in outcome that is the result of MIS usage for a MIS user $i \in \mathrm{I}_1$.

## 6. Estimated Results

We first perfom MPE in the probit model and determine odds ratios in the logit model to examine the hypothesis 1 stated in section 5 regarding which respondent characteristics relate to MIS usage. Table 5 indicates that the numbers of adults and children are positive and statistically significant, while the numbers of males and females have negative and significant impacts. The explanatory variables on the number of crops, distance from each respondent's dwelling to the Jimma special zone, and the dummy variable on possession of a radio have positive and significant impacts. On the other hand, the dummy variable on being a member of a cooperative has negative and significant impacts on MIS usage.

Second, we use an OLS estimator to evaluate the impact of MIS usage on farmers' revenues and profits. The OLS results shown in Table 6 confirm that the dummy variable on MIS usage is significant at the 1 percent level and increases farmers' revenues by 270.1 birr per 0.1 hectare and profits by 272.3 birr per 0.1 hectare. In addition, the variables of being a male farmer and head of household's coffee farming exeperience have positive and siginificant impacts on both of the above. However, increasing either the number of adults among family members or the size of coffee farm significantly decreases their revenues and profits.

Third, Table 7 shows the IV-2SLS results regarding the impact of each variable on farmers' revenues and profits. As indicated in Table 7, farmers' revenues and profits per 0.1 ha both increase significantly by 427.6 birr and by 404.8 birr, respectively, supporting hypotheses 2 and 3 in Section 5.[7] Similar to the OLS results, the male dummy and coffee farming exeperience both increase farmers' revenue and profit significantly. Again, as in the OLS results, increasing either the number of adults among family members or coffee farm size significantly decrease both of the above. The results of the under- and over-identification test are presented in Table 7.

Fourth, in order to conduct the Heckman's DID, we estimate the propensity score of whether a farmer will use the MIS (Table 8). Using the logit, we match the MIS group with the non-MIS user group. Figures 3-a and 3-b provide the pre-matching distribution and matching situation. Through the matching, average bias decreases from 19.8 percent to 4.6 percent as depicted in Figure 3-c and only two treated observations out of 51 are off support. Thus, we confirm that our matching is valid for further estimation.

Table 9 shows the results from the DID method regarding hypotheses 2 and 3. We find that the difference in revenue between MIS and non-MIS users is 154.7 birr per 0.1 hectare and MIS users' revenues are 17 percent higher per 0.1 hectare. The difference in profit between both groups is 150.7 birr per 0.1 hectare and MIS users' profits are 20 percent higher per 0.1 hectare than those of non-MIS users'.

We also perform bootstrapping as a robustness check on these hypotheses. The results in Table 10 show that the difference in revenue between MIS and non-MIS users is 160.4 birr per 0.1 hectare, a finding significant at the 1 percent level. MIS users obtain 21 percent higher revenue per 0.1 hectare, a result also significant at the 1 percent level. The difference in revenue between both groups is 158.2 birr per 0.1 hectare, which is significant at the 5 percent level. MIS users' profits are 20 percent higher per 0.1 hectare, which is significant at the 5 percent level.

Lastly, we attempt to examine the effect of MIS on traders. Although a lack of trader data prevents us from fully calculating the benefit, we utilize available data to obtain a rough estimate. Assuming that a trader only purchases from one farmer, we compute the change in a trader's profit between the case in which he trades with an MIS-user and the case in which he trades with a non-MIS user. Using average prices and volumes sold, we compute

$$\Delta_1\, \widehat{\mathrm{Y}}_0^{\mathrm{T}} = \widehat{\mathrm{Y}}_1^{\mathrm{T}} - \widehat{\mathrm{Y}}_0^{\mathrm{T}} = \widehat{\mathrm{P}}^{\mathrm{M}}(\overline{\mathrm{O}}_1 - \overline{\mathrm{O}}_0) + (\overline{\mathrm{O}}_0 \bar{P}_o^{\mathrm{FG}} - \overline{\mathrm{O}}_1 \bar{P}_1^{\mathrm{FG}}) \tag{5}$$

where $\Delta_1\, \widehat{\mathrm{Y}}_0^{\mathrm{T}}$ is the expected revenue of the difference between a trader 1 trading with MIS users, and trader 0 who trades with non-MIS users. $\widehat{\mathrm{P}}^{\mathrm{M}}$ is the expected market price of coffee, whose price is uniformly set at 20birr. $\overline{\mathrm{O}}_1$ is the average output of MIS users and $\overline{\mathrm{O}}_0$ is the average output of non-MIS users. $\overline{\mathrm{P}}_1^{\mathrm{FG}}$ is the average farm-gate price for the MIS user and $\overline{\mathrm{P}}_o^{\mathrm{FG}}$ is the average farm-gate price for the non-MIS user.

[7] In the first-stage regressions of MIS for hypotheses 2 and 3, $\mathrm{hrdaio}_{ik}$ is significant at 1 percent level and $\mathrm{di}_i$ is significant at the 5 percent level. Other independent variables are insignificant.

We find that the profit of traders who trade with MIS users is 635.32 birr higher per 0.1 hectare than that of traders who trade with non-MIS users, suggesting that traders may have also benefitted due to the introduction of MIS.

**7. Conclusion**

Solving problems arising due to asymmetric information between producers and traders is considered as an important strategy to improve smallholder farmers' welfare and market efficiency in developing countries. In Ethiopia, the ECX has been providing all market and market intermediaries with market prices using its own MIS to help ensure information symmetry. Although the MIS's introduction is indeed a remarkable attempt to solve the aforementioned problems, only a few studies have examined the impact of this MIS in Ethiopia.

For the above reason, we conducted a survey to collect information from 308 farmers in Ethiopia and verified statistically that the MIS had significant and positive effects on smallholder coffee farmers' revenues and profits. Theoretically, the MIS improves smallholder farmers' bargaining power; thus if farmers uses an MIS, they may sell their products at a farm-gate price higher than that obtained by a non-MIS user. However, Our finding in Ethiopia is that the MIS users' average farm-gate price is 3 birr lower than that of non-MIS users. This is different from the theory, thus, we suggest that the MIS is not necessarily improving users' farm-gate prices. In contrast, MIS users in Jimma zone are able to obtain higher revenues and profits despite this lower farm-gate price because their users' average yeilds and sales volumes are higher than those of non-MIS users. We find that the MIS has a positive effect improving users' productivity, and this advantage leads to increases in their revenues and profits. In addition to this advantage, the MIS is likely to increase traders' profits due to the increase in MIS users' sales volume and competitive selling prices. It should be noted that the MIS has another advantage of increasing the profits of both farmers and traders.

Despite these benefits, however, only 19 percent of all respondents use the MIS. This lack of use can be attributd to non-user respondents not knowing the system or not realizing the advantages of the MIS. Taking this matter into account, the discussion now turns to what steps can be taken to boost the use of MIS.

Based on our findings, we suggest that the Ethiopian government should introduce its advantages and supply radios to smallholder farmers, especially those who live in remote areas, to induce farmers to use the MIS. It can be seen from the evidence in this study that these policies have significant and positive effects on both household and national finances.

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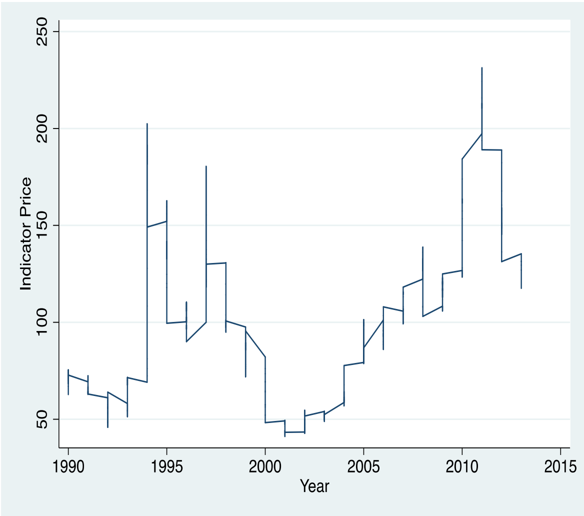
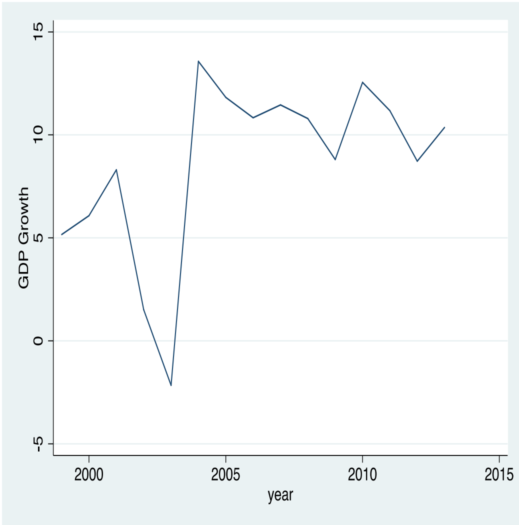
**Figure 1-a and 1-b The Indicator Prices of Coffee and The GDP Growth of Ethiopia (Annual %)**




**Source: ICO (2014) and World Bank (2014)**

**Figure 2 The Map of Research Areas**

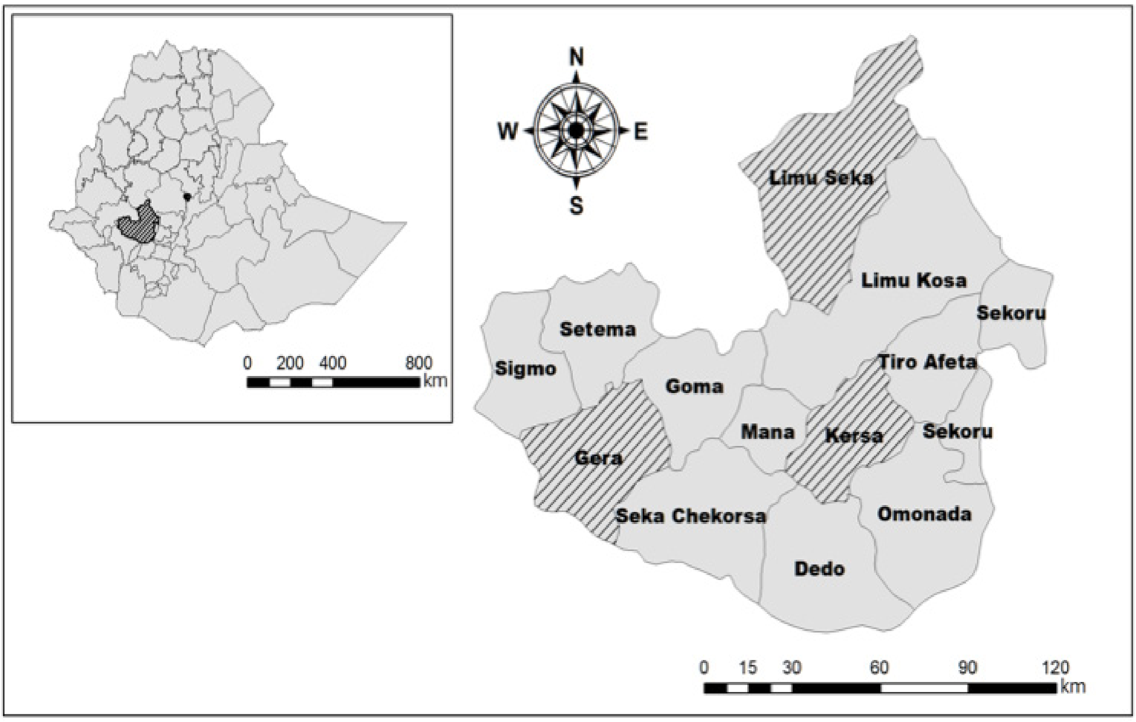
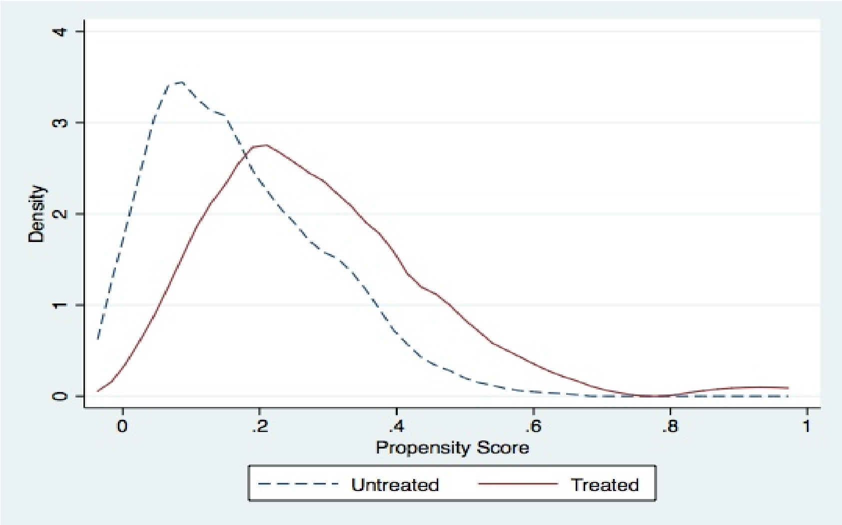
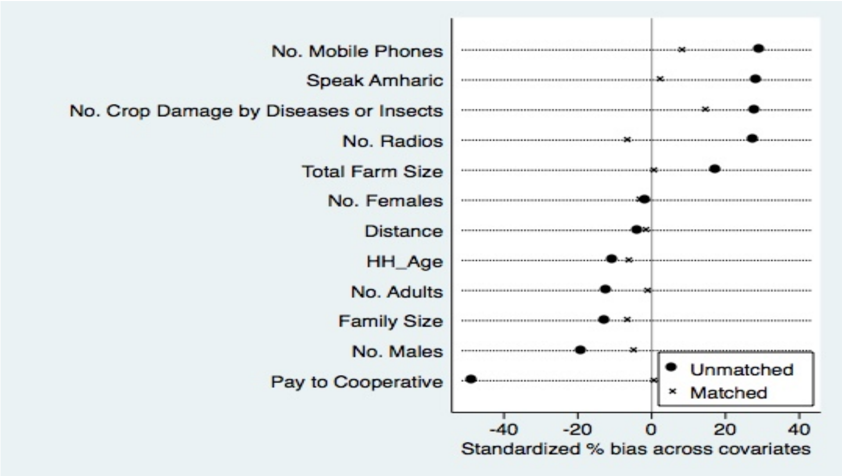


**Figure 3-a, 3-b, and 3-c. Propensity Score, Matching Result, and Standard % Bias**



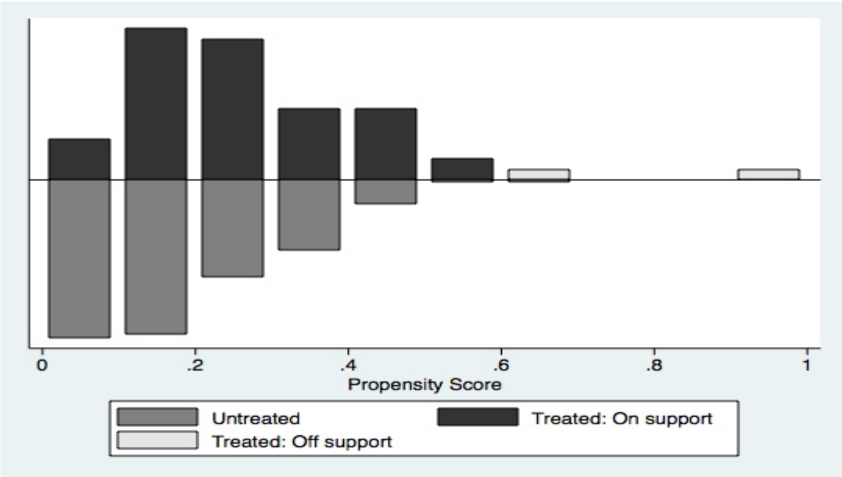



**Table 1 The characteristics of farmers, share of total observations**

| | Number of households | Share (%) |
|---|---|---|
| Gera | 99 | 32 |
| Limu Seka | 109 | 35 |
| Kersa | 100 | 32 |
| Total | 308 | 100 |
| Males | 298 | 97 |
| Females | 10 | 3 |
| Total | 308 | 100 |

**Table 2 Types of Information Sources for Coffee Cultivation in each Household (Multiple answers allowed)**

| | Number of households | Share (%) |
|---|---|---|
| Brokers | 29 | 10 |
| Cooperative | 52 | 17 |
| Extension Workers | 28 | 9 |
| Family member | 203 | 67 |
| Friends | 282 | 93 |
| MIS users | 58 | 19 |
| Relatives | 229 | 75 |
| Traders | 221 | 73 |

**Table 3. Socio-economic characteristic of farmers**

| Variable | Unit | Obs | Total Mean | Non-MIS Mean | MIS Mean | Dif. (t-value) |
|---|---|---|---|---|---|---|
| HH_Age | Years | 303 | 46.02 | 46.07 | 46.02 | 0.06 |
| | | | (12.11) | (11.85) | (12.96) | (0.03) |
| HH_Gender | Female=0 | 303 | 0.97 | 0.97 | 0.98 | -0.02 |
| | Male=1 | | (0.16) | (0.18) | (0.13) | (-0.6) |
| HH_Literacy | No=0 | 296 | 0.45 | 0.44 | 0.53 | -0.09 |
| | Yes=1 | | (0.5) | (0.5) | (0.5) | (-1.23) |
| HH_Experience | Years | 295 | 13.88 | 14.3 | 12.74 | 1.56 |
| | | | (8.1) | (8.61) | (6.03) | (1.29) |
| Adults | Number | 303 | 3.06 | 3.11 | 2.93 | 0.18 |
| | | | (1.28) | (1.29) | (1.21) | (0.95) |
| Males | Number | 303 | 3.09 | 3.14 | 2.8 | 0.24 |
| | | | (1.33) | (1.27) | (1.52) | (1.25) |
| Females | Number | 303 | 2.86 | 2.86 | 2.9 | -0.03 |
| | | | (1.22) | (1.22) | (1.24) | (-0.19) |
| Coffee Farm Size | ha | 304 | 0.86 | 0.9 | 0.82 | 0.08 |
| | | | (0.61) | (0.66) | (0.57) | (0.88) |
| Distance | km | 297 | 72.43 | 72.58 | 72.96 | -0.38 |
| | | | (21.43) | (21.47) | (21.12) | (-0.12) |
| The Average Annual | mm/2013 | 304 | 4.91 | 4.92 | 4.86 | 0.06 |
| Rainfall | | | (0.95) | (0.96) | (0.91) | (0.45) |
| Radio Coverage | %/village | 304 | 0.69 | 0.67 | 0.76 | -0.09*** |
| | | | (0.11) | (0.11) | (0.08) | (-5.62) |
| Crop Damage | Number | 301 | 2.84 | 2.77 | 3.14 | -0.37 |
| by Diseases or Insects | | | (1.51) | (1.5) | (1.54) | (-1.7) |
| Mobile Phone | Number | 308 | 1.4 | 1.35 | 1.62 | -0.27 |
| | | | (1.14) | (1.14) | (1.14) | (-1.62) |
| Radio | Number | 308 | 0.71 | 0.68 | 0.86 | -0.18* |
| | | | (0.5) | (0.5) | (0.48) | (-2.52) |

t statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

**Table 4 Production Sales Performances of Farmers**

| Variable | Unit | Obs | Total Mean | Non-MIS Mean | MIS Mean | Dif. (t-value) |
|---|---|---|---|---|---|---|
| Size of coffee farms | ha | 308 | 0.88 | 0.9 | 0.81 | 0.08 |
| | | | (0.64) | (0.66) | (0.57) | (0.88) |
| Harvest quantity | kg/0.1ha | 299 | 79.38 | 70.7 | 116.23 | -45.53*** |
| | | | (65.77) | (59.99) | (76.33) | (-4.88) |
| Sales volume | kg/0.1ha | 273 | 64.82 | 54.71 | 105.83 | -51.12*** |
| | | | (61.63) | (53.45) | (74.87) | (-5.78) |
| Coffee price | birr/kg | 270 | 13.86 | 14.59 | 11.20 | 3.39*** |
| (Cp) | | | (5.90) | (5.84) | (5.59) | (3.86) |
| Expenditure on fertilizer | birr/0.1ha | 308 | 10.08 | 12.06 | 1.53 | 10.53 |
| (Eof) | | | (160) | (177.56) | (8.2) | (0.45) |
| Expenditure on pesticide | birr/0.1ha | 308 | 0.01 | 0 | 0.04 | -0.04* |
| (Eop) | | | (0.12) | (0) | (0.28) | (-2.09) |
| Expenditure on herbicide | birr/0.1ha | 308 | 1.15 | 1.42 | 0 | 1.42 |
| (Eoh) | | | (6.44) | (7.13) | (0) | (1.51) |
| Expenditure on labors in the | birr/0.1ha | 308 | 11.37 | 11.06 | 12.74 | -1.68 |
| farming season (Eolf) | | | (40.06) | (36.25) | (53.84) | (-0.29) |
| Expenditure on labors in the | birr/0.1ha | 308 | 21.28 | 22.41 | 16.44 | 5.97 |
| harvesting season (Eolh) | | | (78.70) | (78.44) | (80.32) | (0.52) |
| Total expenditure | birr/0.1ha | 308 | 43.89 | 46.94 | 30.74 | 16.2 |
| | | | (191.60) | (202.53) | (135.35) | (0.58) |
| Revenue | birr/0.1ha | 273 | 742.59 | 683.07 | 983.95 | -300.9*** |
| | | | (492.20) | (456.79) | (557.71) | (-4.14) |
| Profit | birr/0.1ha | 272 | 698.68 | 636.2 | 950.93 | -314.7*** |
| | | | (533.63) | (496.6) | (604.5) | (-3.99) |

Notes:

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001

$\text{Total expenditure}_i = \text{Eof}_i + \text{Eop}_i + \text{Eoh}_i + \text{Eolf}_i + \text{Eolh}_i$

$\text{Revenue}_i = \text{Sv}_i \times \text{Cp}_i$

$\text{Profit}_i = \text{Revenue}_i - \text{Total expenditure}_i$

**Table 5. Determinants of the MIS Usage**

| Variable | Marginal Effects in Probit | Odds ratios in Logistic |
|---|---|---|
| HH_Age | 0 | 0.01 |
| | (0) | (0.02) |
| HH_Literacy | 0.06 | 0.38 |
| | (0.05) | (0.34) |
| HH_Experience | -0 | -0.02 |
| | (0) | (0.03) |
| No. Adults | 0.32* | 2.07* |
| | (0.18) | (1.07) |
| No. Children | 0.33* | 2.18** |
| | (0.18) | (1.07) |
| No. Males | -0.35* | -2.32** |
| | (0.18) | (1.07) |
| No. Females | -0.34* | -2.23** |
| | (0.18) | (1.06) |
| Coffee Farm Size | -0.05 | -0.38 |
| | (0.05) | (0.34) |
| No. Crops | 0.08*** | 0.55*** |
| | (0.02) | (0.17) |
| Distance | 0.002* | 0.02* |
| | (0.001) | (0.01) |
| Dummy_Member of Cooperative | -0.15*** | -1.25** |
| | (0.04) | (0.5) |
| Dummy_Radio | 0.09* | 0.68* |
| | (0.05) | (0.4) |
| Dummy_Mobile Phone | 0.05 | 0.42 |
| | (0.06) | (0.48) |
| Constant | | -4.02*** |
| | | (1.1) |
| Observations | 283 | 283 |
| Wald chi2(13) | 30.85 | 28.45 |
| Pseudo R2 | 0.11 | 0.11 |
| Log-likelihood | -126.07 | -126.03 |

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

**Table 6. Determinant of Farmers' Revenue and Profit per 0.1ha: OLS**

| Variable | Revenue/0.1 | Log Revenue | Profit/0.1 | Log Profit |
|---|---|---|---|---|
| HH_Age | -1.78 | 0.00 | -2.06 | 0.01 |
| | (-3.02) | (-0) | (-3.8) | (-0.01 |
| HH_Gender | 364*** | 0.49*** | 429.7*** | 0.84*** |
| | (-95.88) | (-0.18) | (-83.33) | (-0.19) |
| HH_Literacy | -29.14 | 0.04 | -36.5 | 0.01 |
| | (-59.97) | (-0.08) | (-61.83) | (-0.09) |
| HH_Experience | 7.29** | 0.01 | 7.78** | 0.01 |
| | (-3.62) | (-0.01) | (-3.75) | (-0.01) |
| No. Adults | -72.86*** | -0.12*** | -65.7** | -0.1** |
| | (-24.81) | (-0.05) | (-25.32) | (-0.04) |
| No. Males | 13.85 | 0.01 | 15.06 | 0 |
| | (-23.02) | (-0.04) | (-24.38) | (-0.04) |
| No. Females | -1.11 | 0 | 5.13 | 0.01 |
| | (-28.67) | (-0.04) | (-30.18) | (-0.04) |
| Coffee Farm Size | -160.9*** | -0.17* | -186.5*** | -0.25*** |
| | (-59.44) | (-0.09) | (-58.05) | (-0.09) |
| Distance | -0.79 | -0.01 | -2.36 | -0.01 |
| | (-2.9) | (-0) | (-2.94) | (-0) |
| Rainfall | -76.93 | 0 | -33.01 | 0.04 |
| | (-57.09) | (-0.08) | (-58.82) | (-0.09) |
| Dummy_MIS | 270.1*** | 0.38*** | 272.3*** | 0.4*** |
| | (-74.9) | (-0.08) | (-79.74) | (-0.09) |
| Constant | 1,106*** | 6.5*** | 897*** | 5.82*** |
| | (-221.5) | (-0.35) | (-224.3) | (-0.43) |
| Observations | 255 | 255 | 254 | 250 |
| R-squared | 0.19 | 0.18 | 0.19 | 0.19 |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

**Table 7. Determinant of Farmers' Revenue and Profit per 0.1ha: IV-2SLS**

| Variable | Revenue/0.1ha | Log Revenue | Profit/0.1ha | Log Profit |
|---|---|---|---|---|
| HH_Age | -1.74 | 0 | -0.26 | 0.01 |
| | (-3.02) | (-0.01) | (-3.05) | (-0.01) |
| HH_Gender | 354*** | 0.49*** | 446.3*** | 0.82*** |
| | (-101.5) | (-0.18) | (-83.66) | (-0.18) |
| HH_Literacy | -40.41 | 0.03 | -57.57 | 0.02 |
| | (-58.89) | (-0.08) | (-58.46) | (-0.09) |
| HH_Experience | 7.3** | 0.01 | 7.6** | 0.01 |
| | (-3.72) | (-0.01) | (-3.79) | (-0.01) |
| No. Adults | -73.27*** | -0.121*** | -69.38*** | -0.0939** |
| | (-24.65) | (-0.05) | (-24.51) | (-0.04) |
| No. Males | 17.28 | 0.01 | 11.72 | 0.01 |
| | (-23.01) | (-0.04) | (-22.84) | (-0.04) |
| No. Females | 0.03 | 0.01 | -1.23 | 0.01 |
| | (-28.68) | (-0.04) | (-28.49) | (-0.04) |
| Coffee Farm Size | -162.2*** | -0.17* | -193.2*** | -0.25*** |
| | (-58.9) | (-0.09) | (-56.47) | (-0.09) |
| Distance | -0.27 | -0.01 | -1.49 | -0.01 |
| | (-2.93) | (-0) | (-2.89) | (-0) |
| Rainfall | -89.84 | -0.01 | -51.81 | 0.03 |
| | (-57.93) | (-0.08) | (-58.41) | (-0.09) |
| Dummy_MIS | 427.6** | 0.46** | 404.8** | 0.41* |
| | (-174.2) | (-0.21) | (-177) | (-0.22) |
| Constant | 1,101*** | 6.51*** | 864.2*** | 5.86*** |
| | (-222.4) | (-0.35) | (-218.7) | (-0.41) |
| Observations | 252 | 252 | 251 | 248 |
| R-squared | 0.18 | 0.19 | 0.2 | 0.19 |
| Underidentification | 0.00 | 0.00 | 0.00 | 0.00 |
| Overidentification | 0.63 | 0.83 | 0.65 | 0.92 |

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

**Table 8. Logit Results for Propensity Score Matching**

| Variable | Logit |
|---|---|
| HH_Age | -0.01 (-0.02) |
| No. Adults | -0.14 (-0.2) |
| No. Males | -1.9(-1.14) |
| No. Females | -1.86(-1.14) |
| Family Size | 1.82 (-1.15) |
| No. Radios | 0.55 (-0.35) |
| No. Mobile Phones | 0.3* (-0.18) |
| No. Crop Damage by Diseases or Insects | 0.09 (-0.11) |
| Distance | 0.01 (-0.01) |
| Pay to Cooperative | -0.02* (-0.01) |
| Speak Amharic | 0.89** (-0.38) |
| Total Farm Size | 0.2* (-0.1) |
| Constant | -2.93*** (-0.97) |
| Observations 290 | |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

**Table 9. Determinant of Farmers' Revenue and Profit: DID**

| Variable | Revenue | | Log Revenue | | Profit | | Log Profit | |
|---|---|---|---|---|---|---|---|---|
| Sample | Unmatched | ATT | Unmatched | ATTT | Unmatched | ATT | Unmatched | ATT |
| Treated | 172.72 | 167.89 | 0.21 | 0.20 | 172.73 | 167.90 | 0.25 | 0.24 |
| Controls | -5.16 | 13.14 | -0.01 | 0.02 | 0.71 | 17.15 | 0.01 | 0.04 |
| Difference | 177.87 | 154.75 | 0.22 | 0.17 | 172.02 | 150.75 | 0.24 | 0.2 |
| S.E. | 55.58 | 56.16 | 0.07 | 0.07 | 55.62 | 56.95 | 0.08 | 0.09 |
| T-stat | 3.2 | 2.76 | 2.93 | 2.53 | 3.09 | 2.65 | 2.83 | 2.15 |

**Table 10. Determinant of Farmers' Revenue and Profit: DID using Bootstrapping**

| Variable | Revenue | Log Revenue | Profit | Log Profit |
|---|---|---|---|---|
| ATT | 160.4*** | 0.21*** | 158.2** | 0.2** |
| | (50.79) | (0.0781) | (62.12) | (0.0811) |
| Observations | 245 | 245 | 245 | 239 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1