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IMPACT OF MICROFINANCE ON HOUSEHOLD INCOME, LIVESTOCK HOLDINGS, AND LAND PRODUCTIVITY: THE CASE OF RURAL HOUSEHOLDS IN TIGRAY, NORTHERN ETHIOPIA

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ABSTRACT
Impact evaluation pinpoints the average effects of a program on participants using impact indicators by estimating the counterfactual from a control group of non-participants. It is marred by conceptual and methodological complexities. The paper uses a cross-sectional data collected from a quasi-experimental sample obtained from four rural sub-districts (tabias) in the northern Ethiopian region of Tigray for measuring impact of microfinance. Propensity score matching has been used to deal with selection bias and measure the average treatment effect on the treated (ATT). Household consumption expenditure, livestock possession, and land productivity have been used as impact indicators. Findings show that microfinance has had statistically significant positive impact on household consumption (food and non-food) expenditure and livestock holdings measured in Tropical Livestock Unit (TLU). Percapita household income also showed statistically significant impact on participating households. However, we did not find statistically significant impact on land productivity indicating that most of the benefits of microfinance may have been used for purposes of consumption rather than for investments intended to promote land productivity.

KEYWORDS
ATT, PSM, Tigray, counterfactual.

1. INTRODUCTION
Microfinance refers to the provision of mainly, but not exclusively, small loans and savings services to poor and low-income clients. It is considered as a crucial tool widely used all over the world to fight against poverty. Governments as well as non-governmental organizations utilize various policies and programs, microfinance being one of them, with the objective of attaining specified ends. Evaluating the actual impact of these interventions has been a point of academic and practical discourse for some time now. The most challenging part in measuring impact has been the complexities involved in controlling for selection bias (see Ravallion, 2001; Heckman et al., 1998).

In impact evaluation, the main focus is on finding the difference between what is happening with the program and what would have happened without the program, the latter is what is known as the counterfactual. A number of studies have been conducted to evaluate the impact of microfinance (see Sharma and Buchenrieder, 2002; Khandker, 2005; Brau and Woller, 2004; Coleman, 2006). Most of these studies point to a positive impact of microfinance on client income and welfare, hence on poverty reduction. Others are less enthusiastic on its income/consumption effects but stress on its impact in reducing vulnerability through income smoothing, consumption smoothing, and asset accumulation (for example see, Morduch, 1998; Zaman, 1999; Hulme, 2000). A widely cited study on the impact of microfinance group loans in Bangladesh by Pitt and Khandker (1998) produced significant impact on consumption (income). An article produced by Morduch (1998) using the same data set by employing an alternative method for controlling selection bias did not obtain significant improvement in income on participants showing the methodological difficulties of evaluating impact of programs.

In line with what has been found elsewhere in the world, most of the microfinance impact studies conducted in Ethiopia indicate significant positive impact on consumption/income (e.g., Zaid, 2008; Doocy et al., 2005; Borchgrevink et al., 2003; Kebede et al., 2002) although many of them fail to utilize appropriate methods to deal with selection bias. The main purpose of this study is to evaluate the impact of microfinance on household consumption (used as a proxy for income), livestock possessions, and land productivity using data gathered from rural households in the northern Ethiopian region of Tigray by employing bias corrected estimation techniques. We used the propensity score matching method introduced by Rosenbaum and Rubin (1986) to deal with problems associated with selection bias.

The rest of the paper is organized as follows. Section 2 outlines the dataset and method of analysis used for the study. Section 3 provides estimated results and discussion associated with the results, and Section 4 concludes.

2. DATA AND METHODOLOGY
2.1. DATA
Data used for this study were collected from 361 households in four rural sub-districts (*tabias*) located in three zones of Tigray region; namely, Eastern, Central, and South Eastern zones. Dedebit Credit and Savings Institution (DECSI) is the only microfinance (MFI) service provider in the stated *tabias*. Established in 1994, DECSI is one of the biggest and renowned MFIs operating in the country. Data collection was administered in 2009. It may also need to be noted that a similar dataset was collected in 2007 using the same questionnaire from the same study areas enabling comparative analysis of both datasets. A summary of sample households used for the study is shown in the table below disaggregated by *tabia*, participation, and gender of household head.

TABLE 1: SAMPLE HOUSEHOLDS BY PARTICIPATION AND GENDER OF HOUSEHOLD HEAD

	Program Participants			Non Participants			Total Sample		
Tabia	M	F	T	M	F	T	M	F	T
Arato	56	14	70	9	7	16	65	21	86
Rubafeleg	33	39	72	9	10	19	42	49	91
Siye	32	15	47	29	10	39	61	25	86
Tsenkanet	50	25	75	9	14	23	59	39	98
Total	171	93	264	56	41	97	227	134	361

Arato is located in the Enderta *wereda* (district) of the South Eastern zone; Rubafeleg and Tsenkanet are found in the Eastern zone of the region, in Hawzen and Atsbi-Wenberta *weredas*, respectivfely. Tabia Siye is located in the Tanqua-Abergele *wereda* of the Central zone. DECSI started its microfinance loan provision using the classical Grameen Bank model of solidarity groups. It later introduced new modalities of loan delivery along with the group model and this enabled it to expand its client base tremendously. The major additions to the group loans are the package loans that are based on individual delivery modality and guaranteed by regional government budget and the microenterprise loans provided to a group of microenterprise operators or individuals on the basis of collateral (DECSI, 2007). The microenterprise credit scheme is designed to cater to the capital needs of small and microenterprises, targeting mainly urban clients and extended against asset collateral. The package loans are, however, designed to provide individual loans to farmers entitled for access to a package of services and inputs based on the integrated household oriented package program introduced in 2003 with a clear objective of raising household income and thereby reducing poverty. The introduction of package loans has attracted many clients in rural areas with the end result of majority of households becoming clients of DECSI. This is also reflected in our sample which is gathered on a proportional basis to the number of program participants/non-participants and gender composition of household heads in each of the study sites.

2.2. METHODOLOGY

As indicated earlier, the actual impact of program participation can be obtained as a difference of what is happening with the program and what would have happened without the program to program participants. In other words, after determining the impact indicator, say income, program impact can be computed as the difference between the current level of income (after program participation) and what the level of income would have been had the program participants did not take part in the program. The question here is how does one estimate the "what would have happened" part, also called the counterfactual, for those who are participating in the program as it is not observable.

Put in term of equations the average effect of treatment, or program impact, denoted by ATT, can be represented as follows:

$ATT = E(Y_1 – Y_0 / D=1)$ (1)

which is the same as:

$ATT = E(Y_{1i} \mid D_i = 1) – E(Y_{0i} \mid D_i = 1)$

The sample equivalent of this gives:

$$ATT = \frac{1}{n}\sum_{i=1}^{n}(Y_{1i} - Y_{0i}) \mid D_i = 1 \text{ or}$$

$$ATT = \frac{1}{n}\sum_{i=1}^{n}(Y_{1i} \mid D_i = 1) - (Y_{0i} \mid D_i = 1) \quad (2)$$

Where E refers to expected value or mean; Y_1 is outcome with the program; Y_0 is outcome without the program, and D_i shows program participation (or participation dummy) with D=1 showing participation and D=0 indicating non-participation. While the outcome of what has happened to the individual participating in the program (i.e., $(Y_{1i} \mid D_i = 1)$ is indeed observable, the outcome of what would have happened to the same individual without the program (i.e., $(Y_{0i} \mid D_i = 1)$) is not observable. This is because it would not be possible to observe the same person in different states at the same time. In other words, in a sample survey one can only observe outcomes for those participating in the program and/or for those not participating in the program. It would not be possible to observe outcomes regarding what would have happened without the program for those who are in the program; and outcomes regarding what would have happened with the program for those who are not in the program (Ravallion, 2001; Heckman et al., 1998; Cobb-Clark and Crossley, 2003).

Now the question is whether we can approximate the counterfactual from a similar group of persons not participating in the program. Under conditions of randomized program placement; that is, if participants were randomly selected to the program, then Y_1 for program participants and Y_0 for non-participants would be the same. However, if participants self-select to the program, these two will not be equal and our estimates will be biased and inconsistent due to selection bias. In terms of regression, selection bias occurs when one or more regressors are correlated with the error term. In other words, one or more of the regressors are not exogenous or are confounded resulting in biased estimates. Put in terms of standard econometrics formulation, outcome can be measured using the following equation:

$Y_i = \alpha + \beta D_i + \delta X_i + \varepsilon_i$ (3)

where Y_i is the dependent variable representing outcome or effect; D_i is the treatment indicator or participation dummy (D = 1 indicating participation, and D = 0 showing non-participation); X_i stands for the control variables such as age, family size, and other characteristics; α, β and δ are the parameters or coefficients and ε_i is the residual term capturing other determinants of Y_i as well as measurement errors.

For a participating individual (i.e., when D = 1), outcome will be equal to $\alpha + \beta D_i + \delta X_i + \varepsilon_i$. In the case of a non-participant (i.e., when D = 0), outcome will be measured by $\alpha + \delta X_i + \varepsilon_i$. The difference between the two, which is β, provides program impact. But this assumes that there is no selection bias.

In programs like the one under study where participants self select, impact evaluation requires the use of methods that correct for the bias. The methods widely used to generate bias corrected estimates under non-randomized program placement are instrument variable estimation, matching, and difference in difference methods (see for example, Ravallion, 2001; Cobb-Clark and Crossley, 2003). The alternative employed for this study to generate bias corrected estimates is the matching method using propensity score introduced by Rosenbaum and Rubin (1983). Propensity score is the conditional probability of participation given pretreatment characteristics. The basic tenet behind propensity score matching (PSM) is that since outcome is independent of participation given pretreatment characteristics, then it is also independent of participation given the propensity score (ibid.). Hence, observations with the same propensity score will have the same distribution of observable and unobservable characteristics irrespective of treatment (Becker and Ichino, 2002).

In PSM, program participants and non-participants are matched on the basis of their propensity score. The propensity score, P(x), provides the conditional probability of participation given a vector of pretreatment control variables (X_i) and, as a probability measure, its value ranges between zero and one ($0<P(x)<1$). It can be computed as:

$P(x) = Pr(D = 1 \mid X)$ (4)

where, D and X refer to participation dummy and a vector of pretreatment control variables respectively.

Once the propensity score is known impact or ATT can be estimated as shown in (5) below. Using the propensity score to deal with selection bias, equation (1) is thus modified as (Becker and Ichino, 2002):

$ATT = E (Y_{1i} – Y_{0i} \mid D_i = 1)$

$= E (E (Y_{1i} – Y_{0i} \mid D_i = 1, P(x_i)))$

$= E [E (Y_{1i} \mid D_i = 1, P(x_i)) – E (Y_{0i} \mid D_i = 0, P(x_i)) \mid D_i = 1]$ (5)

As a conditional probability of treatment, the propensity score is continuous and it is difficult to find observations with identical scores for matching. The best option is therefore to match observations on the basis of closeness of their propensity scores. And there can be different ways of determining nearness. The most widely used methods are the nearest neighbor, stratification, radius, and kernel matching. With each method having limitations of sort, joint consideration of these methods provides a way of judging the robustness of the estimates. In this study we use the matching estimators developed by Becker and Ichino (2002). The outcome indicators used to measure impact are household income using consumption (food and non-food consumption) as proxy, livestock holdings, & land productivity. We thus evaluate the impact of participating in the microfinance program using these indicators & the results are outlined in the subsequent section.

3. RESULTS AND DISCUSSION

As indicated in the preceding section, estimation of program impact or ATT by using propensity score matching involves these steps; (1) estimating the propensity score, (2) matching observations using their propensity score, and (3) computing the mean difference between the outcome of the treated subjects and that of the control units. The propensity score is estimated using participation (1=participant; 0=non-participant) as a dependent variable regressed on a number of explanatory variables.

The regressands used for propensity score estimation are those that are not affected by program participation. Microfinance participation does not affect the land holding size of households as land in Ethiopia is a public property without any relation to microfinance. Land distribution took long time ago in the study area before microfinance was introduced. Moreover, we have excluded land rented in, which may have some relationship with microfinance participation. Similarly, household size and age of the household head have little to do with microfinance participation. Moreover, literacy and level of schooling have little, if at all, relation with participation in the program because they have more to do with availability of schools in the study areas or their vicinity. The location dummies (i.e., the study *tabias* that we have included in the explanatory variables) will obviously have no relationship with participation in the program as the program is universally available for all rural villages in the region. After running the model, we found that the balancing property is satisfied and the estimated results are provided in the table below. We used robust standard errors to ensure that the problem of heteroskedasticity is taken care off.

TABLE 2: PROBIT ESTIMATION OF THE PROPENSITY SCORE (PROBABILITY OF PARTICIPATION)

Variables	Description	Coef.	Robust Std. Err.	P>z
Land Size	Household Landholding size in *tsimad* (continuous)	0.0440	0.0352	0.211
Irrigated Land	Availability of irrigated land (dummy)	0.2789	0.2162	0.197
Household Size	Household size (continuous)	0.1227***	0.0466	0.008
Age of HHH	Age of the household head (continuous)	0.0645**	0.0326	0.048
Age Squared	Age squared (continuous)	-0.0007**	0.0003	0.032
Literacy	Literacy of household head (dummy)	0.2430	0.1964	0.216
Pre-secondary School	Family members with pre-secondary education (continuous)	0.0495	0.0688	0.472
Post-Elementary School	Family members with post-elementary education (continuous)	0.2893*	0.1480	0.051
Dependency Ratio	Dependency ratio (continuous)	0.3622	0.3750	0.334
Tabia Arato	Arato sub-district (dummy)	-0.0460	0.2625	0.861
Tabia Siye	Siye sub-district (dummy)	-0.9931***	0.3021	0.001
Tabia Tsenkanet	Tsenkanet sub-district (dummy)	-0.3187	0.2278	0.162
Constant		-1.6689**	0.7316	0.023

*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level
Number of Obs. = 361
LR chi2(12) = 68.56
Prob > chi2 = 0.0000
Pseudo R2 = 0.1632

Once the propensity score is estimated the next step would be to match observations based on their propensity score and then obtaining the impact as a difference of the outcomes for treated and control observations. Following Becker and Ichino (2002), we used four matching alternatives; namely, nearest neighbour, stratification, radius, and kernel. In nearest neighbour matching each treated observation is matched with a control observation with the nearest propensity score. In the case of stratification, matching the data set is divided into various intervals or blocks with each block containing treated and control observation with, on average, the same propensity score. In radius matching, each treated observation is matched with those control observations that fall within a pre-specified radius of the propensity score of the treated observation. Kernel matching is that method of matching where all treated observations are matched with a weighted average of all control observations. In the case of kernel matching, we used bootstrapping to be able to obtain a large number of matches. After treated and control observations are matched, the ATT is found by summing the differences in outcomes between the treated and control observations in each of the matched groups. Note that some observations from the control units are omitted while conducting the matching because they could not obtain appropriate matches from the treated units, and this is more so in the case of nearest neighbour matching which, as explained above, is based on a one to one matching.

TABLE 3: ATT RESULTS (IMPACT) BASED ON FOUR MATCHING METHODS

Variables	Matching Method	No. of Treated Obs.	No. of Control Obs.	ATT	Std. Err.
Food Consumption Expenditure	Nearest Neigbour	264	64	175.58*	100.543
	Stratification	264	90	206.2***	77.94
	Radius	264	90	179.47**	88.664
	Kernel	264	90	174.19*	90.31
Non Food Expenditure	Nearest Neigbour	264	64	113.967***	30.727
	Stratification	264	90	115.261***	18.83
	Radius	264	90	106.927***	21.198
	Kernel	264	90	99.207***	22.352
Total Expenditure	Nearest Neigbour	264	64	289.55**	140.636
	Stratification	264	90	321.469***	86.032
	Radius	264	90	286.393***	97.639
	Kernel	264	90	273.4***	94.441
Percapita Total Expenditure	Nearest Neigbour	264	64	52.55**	21.749
	Stratification	264	90	18.426	21.619
	Radius	264	90	43.113*	24.916
	Kernel	264	90	49.405***	16.026
Tropical Livestock Unit (TLU)	Nearest Neigbour	264	64	1.31*	0.682
	Stratification	264	90	0.981***	0.392
	Radius	264	90	0.937**	0.454
	Kernel	264	90	0.999**	0.414
Land Productivity	Nearest Neigbour	264	64	65.993	455.032
	Stratification	264	90	-27.399	479.115
	Radius	264	90	-7.322	251
	Kernel	264	90	65.706	442.205

**** = significant at 1% level; ** = significant at 5% level; *=significant at 10% level

As indicated earlier, the outcome indicators we used to measure the impact of microfinance participation are household consumption expenditure (as a proxy for income), livestock holdings in TLU, and land productivity per hectare. Instead of using one or two, we employed all four matching methods as a means of testing the robustness of results. As shown in the table above, the results of the analysis show that microfinance participation has brought statistically significant gains on income/welfare and livestock ownership but not on land productivity. A participant household has gained between 273 to 321 ETB (Ethiopian Birr) of monthly consumption/income that is attributable to microfinance. Disaggregated in terms of food and non-food consumption, the gains amount to between 174 to 206 ETB, and between 99 to 117 ETB of monthly consumption, respectively, as a result of participation in the program. Not only overall household consumption levels but also per capita consumption levels have displayed positive gains to participating households amounting to between 43 to 52 ETB of monthly consumption.

Similarly, household livestock holdings show positive gains as a result of participation in microfinance. Thus, participating households gained about an ox equivalent (i.e., 1 TLU) of livestock compared to non-participant households. However, we did not find significant gains in land productivity in favour of participating households. This may be because of the fact that whatever gains households obtain from microfinance most of it is used for consumption purposes rather than land improvement related investments. A previous study conducted in the same study area using the same questionnaire also show similar findings indicating the robustness of the results (Zaid, 2008). We may thus learn from the findings that the benefits obtained from microfinance are mainly used for purposes of consumption smoothing rather than long term investments geared towards increasing land productivity.

CONCLUSION

The microfinance industry that has flourished all over the world today began as a movement against the highly subsidized and unsustainable agricultural credit of the 1960s and 1970s. Since the early 1980s, provision of credit to the poor started to emphasize on financial discipline, institutional sustainability, and the belief that the poor are bankable. And there have been many tales of success stories associated with microfinance. An important question in relation to this is “how does one measure the actual benefit or impact associated with the program?” Measuring the impact of microfinance, and for that matter any program, is replete with conceptual and methodological difficulties. In this study, we have attempted to evaluate the impact of microfinance using a cross-sectional data collected from the northern Ethiopian region of Tigray. We used income (using consumption expenditure as proxy), livestock ownership, and land productivity as impact indicators. In terms of methodological approach, we applied the propensity score matching to deal with selection bias associate with programs where participants are not randomly assigned. We found in the study that microfinance has had statistically significant impact on program participants in terms of income and livestock ownership. However, the impact of microfinance on land productivity was not found to be statistically significant.

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