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Are Smallholder Farmers Credit Constrained?

Evidence on Demand and Supply Constraints of Credit in Ethiopia and Tanzania

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ABSTRACT

Credit constraint is considered by many as one of the key barriers to adoption of modern agricultural technologies, such as chemical fertilizer, improved seeds, and irrigation technologies, among smallholders. Past research and much policy discourse associates agricultural credit constraints with supply-side factors, such as limited access to credit sources or high costs of borrowing. However, demand-side factors, such as risk-aversion and financial illiteracy among borrowers, as well as high transaction costs, can also play important roles in credit-rationing for smallholders. Using primary survey data from Ethiopia and Tanzania, this study examines the nature of credit constraints facing smallholders and the factors that affect credit constraints. In addition, we assess whether credit constraints are gender-differentiated. Results show that demand-side credit constraints are at least as important as supply-side factors in both countries. Women are more likely to be credit constrained (from both the supply and demand sides) than men. Based on these findings, we suggest that policies should focus on addressing both supply- and demand-side credit constraints, including through targeted interventions to reduce risk, such as crop insurance and gender-sensitive policies to improve women's access to credit.

Keywords: Adoption, Agricultural technologies, Credit constraints, Gender, Smallholders

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1. INTRODUCTION

Limited access to credit has been highlighted as a major impediment to agricultural technology adoption among smallholder farmers in developing countries (Feder et al. 1990; Feder and Umali 1993; Fernandez-Cornejo and McBird 2002; Carter and Olinto 2003; Guirkinger and Boucher 2008; Abate et al. 2016; Khandker and Koolwal 2016). Past research mostly identifies the principal factors behind credit constraints among smallholders as supply-side factors such as limited availability of alternative credit sources in local areas, unavailability of financial products that suit the needs of smallholders, or high costs of borrowing. Consequently, improving credit access through policies that mitigate these supply-side constraints is often recommended as an effective strategy to boost technology adoption and productivity. However, improving credit access via the easing of supply-side constraints may not necessarily increase credit uptake and technology adoption if it is not accompanied by efforts to tackle demand-side factors that could limit the demand for credit (de Janvry et al. 1991; Woutersen and Khandker 2013; Adjognon et al. 2017). In other words, limited credit uptake does not necessarily imply that farmers are unable to obtain credit; it could just be that they have sufficient liquidity to invest using their own resources or that high transaction costs may inhibit their participation in credit markets or that they are afraid of losing their collateral (Feder et al. 1990; Adjognon et al. 2017).

Even if supply-side constraints were removed, for example, by lowering the interest rate, farmers may not borrow for several reasons, including (i) collateral requirements and repayment schedules that most smallholders cannot afford, (ii) risk-aversion, specifically fear of an inability to pay back loans and the subsequent loss of collateral; (iii) farmers finding the option of investing in inputs using resources from crop sales or other off-farm income sources to be more economical than using loans; and (iv) high transaction costs associated with complex loan application procedures. In addition to supply-side constraints, these demand-side factors can play an important role in the functioning of agricultural credit markets and credit rationing to smallholder borrowers. When credit is rationed by factors other than interest rates, liquidity can become a binding constraint resulting in sub-optimal resource allocation (Feder et al. 1990; Boucher et al. 2008, 2009; Simtowe and Zeller 2006; Khandker and Koolwal, 2016).

Empirical evidence is lacking in our understanding of the nature and causes of credit constraints, whether credit constraints emanate from the supply- or the demand-side, and whether credit constraints are a limiting factor for adoption of agricultural technologies such as improved seeds and inorganic fertilizers. Empirical analyses of the credit-constraint status of smallholders, the factors that affect this status, and whether credit access could facilitate technology adoption would help build the evidence base needed to guide appropriate policy interventions to alleviate the different credit constraints facing smallholders. In this regard, for instance, if demand-side factors such as risk aversion are the main causes of low credit uptake, a financial product that integrates credit with an insurance mechanism can be considered (Shee and Turvey 2012; Shee et al. 2015; Shee

et al. 2019). On the other hand, if low demand for credit results from lack of business aspirations or limited knowledge about alternative credit sources, then improving farmers' financial literacy, access to relevant information, and their entrepreneurial skills can be important. Finally, supply-side constraints such as high interest rates may require interventions targeted at reforming the structure and conduct of rural financial intermediaries.

Using primary survey data collected from a sample of small-scale irrigators and non-irrigators in Ethiopia and Tanzania under the Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) project, the objectives of this study are to (1) identify the credit constraint status of smallholders; and (2) examine the factors affecting the credit-constraint status of smallholder farmers.[1] Study households are grouped into three categories based on their credit-constraint status: those who are not credit constrained, those facing supply-side constraints, and those facing demand-side constraints.

The remainder of this paper is organized as follows. Sections 2 presents a brief overview of the research literature on the linkages between credit constraints and agricultural technology adoption. Section 3 describes the methodologies (data and econometric models) used in the study. Sections 4 and 5 present our descriptive and econometric results, respectively. The final section concludes the paper with key policy recommendations.

2. LITERATURE REVIEW

The classical works of Singh et al. (1986) and de Janvry et al. (1991) suggest that with market imperfections, households' decisions on production and consumption simultaneously indicate that intensity of input use will be dependent on the availability of capital and initial endowments. Those who face binding credit constraints may well be able to afford only sub-optimal levels of input use that can translate into levels of productivity well below the first-best outcome. Farmers may be constrained to suboptimal low-risk/low-return agricultural investments (Dercon and Christiaensen 2011). This reduces output per unit of land, income, and ultimately welfare. Relaxing liquidity constraints and enhancing households' endowments (for example, family labor) will have a positive impact on households' productivity (Feder et al. 1990; Guirkinger and Boucher 2008).

The rationale for expanding credit access rests on the notion that marginal returns to capital investments in developing countries are large enough to justify the costs of credit (de Mel et al. 2008; Fafchamps et al. 2011; Duflo et al. 2013). Credit access offers farming households the liquidity they require to purchase agricultural inputs, adopt technology, or undertake other investments that are associated with higher yields and to increase their capacity to make longer-term investments. Despite the flourishing of microfinance institutions (MFIs)

[1] ILSSI is an action-oriented, farmer-centered research project supported by the Feed the Future program through the United States Agency for International Development and implemented in Ghana, Ethiopia, and Tanzania. It aims to investigate and understand the technical and socio-economic factors, constraints, and opportunities of small-scale irrigation technologies towards achieving sustainability and efficiency in resource utilization (water, land and other resources) and enhance the livelihoods of smallholder farmers.

and the significant progress in many countries, most rural households in developing countries remain underserved (Karlan and Morduch, 2009; Karlan et al. 2010). This is particularly the case for countries like Ethiopia and Tanzania, where rural financial markets remain in their infancy and are mostly dominated by informal financing schemes. For instance, Amha and Peck (2010) reported that most households in Ethiopia remain underserved. A recent World Bank global financial inclusion study shows that only 22 percent of adults in Ethiopia have access to financial services, with corresponding figures for Africa south of the Sahara and the globe amounting to 29 percent and 62 percent, respectively (Demirguc-Kunt et al. 2015). Wiedmaier-Pfister et al. (2008) estimate that about 80 percent of the potential demand for financial services in Ethiopia remains unmet. Ironically, despite the estimated large unmet demand and the low coverage of microfinance, most households in the ILSSI survey report that they did not apply for loans because they either have enough money or do not need a loan (for instance 81 percent of sampled households in Ethiopia and 21 percent in Tanzania did not apply for loans because they reported they have enough money). There is some evidence that seems to support this. Adjognon et al. (2017) show that traditional credit use, formal or informal, is extremely low and farmers primarily finance modern input purchases with cash from nonfarm activities and crop sales. Tied output-labor arrangements appear to be a widely used form of credit for farming.

Recent empirical studies have shown that microcredit can stimulate agricultural investments, including use of modern agricultural inputs (Giné and Yang 2009; Zerfu and Larson 2010; Abate et al. 2016); facilitate the start-up of new enterprises (de Mel et al. 2008) and, at least in some cases, reduce poverty (Berhane and Gardebroek 2011). Hailu et al. (2014) report that credit access is important for the adoption of agricultural technologies. Liverpool and Winter-Nelson (2010) indicate that microfinance has positive effects on the use of improved technology, asset growth, and consumption. Abate et al. (2016) report that access to institutional finance (loans from cooperatives) has a significant positive impact on both the adoption and extent of use of agricultural technology in Ethiopia. Many studies suggest that credit access is an important determinant in adoption of irrigation technologies such as treadle- and fuel-powered motorized pumps (Adeoti 2009; Gebregziabher et al. 2014; Getachew et al. 2013). Namara et al. (2014) noted the upper quintile of farmers tend to adopt small-scale irrigation technologies, because poorer households are unable to afford them outright and lack access to finance.

In terms of methodological approaches, most of the studies reviewed above investigated the general determinants of adoption by including credit (loosely defined as an "access" vs. "lack of access" binary variable) as one of the variables affecting it, in multi-variate regression model frameworks. Such frameworks do not explain the nature of credit constraints among smallholders. A more elaborated study on credit and fertilizer adoption in Ethiopia, Croppenstedt et al. (2003), applies a double hurdle model and shows credit to be both supply- and demand-constrained. Boucher et al. (2009) developed a strategy to identify credit-constrained households and showed that credit constraints may take three forms: quantity rationing, transaction-cost

rationing, and risk rationing. Each form adversely affects household resource allocation and thus should be accounted for in empirical analyses of credit-market performance. The authors further outline a survey strategy to directly elicit households' status in the credit market as unconstrained or constrained and, if constrained, to further identify which of the three nonprice rationing mechanisms is at play.

Following the Boucher et al. (2009) direct elicitation approach of classifying constrained and unconstrained households, Ali et al. (2014) reported that unconstrained households have higher levels of purchased inputs use and yields, suggesting a link between access to credit and agricultural productivity. Following the same approach, Mukasa et al. (2017) reported that, using a panel of 5,308 smallholder farmers, around 66.6 percent were credit constrained, most of them (71.9 percent) due to risk factors and transaction costs (14.33 percent). Mukasa et al. (2017) indicate that access to financial information, increasing the number of branch offices of banks and MFIs in rural areas, and easing financial transaction costs might increase farmers' access to credit and significantly alleviate their credit constraints and would generate substantial productivity gains. Khandker and Koolwal (2016), using a household-level fixed effects model on household panel data spanning over 20 years in Bangladesh, show that institutional finance has benefited households with lower land ownings. Institutional finance has helped such households to raise agricultural income from activities, such as livestock rearing, that require less land and also helped all households with nonfarm income diversification, but with the strongest effect for landless or near-landless households. In this study, we adapted the Boucher et al. (2009) approach for identification of the credit-constraint status of smallholders based on the responses to the Women's Empowerment in Agriculture Index (WEAI) module in the ILSSI survey.

3. METHODOLOGY

3.1 Data

Data for these studies were collected in 2017 under ILSSI in Ethiopia and Tanzania. The Ethiopia survey covered 533 households drawn from 15 villages (*Kebeles*) and four districts (*Woredas*) in Ethiopia. The Tanzania survey collected data from 512 households drawn from 15 villages and three districts. The ILSSI surveys collected detailed data on household characteristics, land use and irrigation, plot-level input use, production, livestock ownership, and membership information of households, among others. In addition, the WEAI modules were implemented: data were collected from both the main male and female decision makers in the household, including data analyzed here on credit access and constraints. The richness of these datasets allows us to construct a typology of households based on the source of credit constraints (supply versus demand side). The WEAI datasets consist of 1,021 respondents in Ethiopia (only 45 households had a single respondent) of whom 51.8 percent were women; and 882 respondents in Tanzania (142 households had a single respondent) of whom 57.6 percent were women. This sample composition allows us to examine gender differences in credit constraints. Additional details about ILSSI surveys can be found in Mekonnen et al. (2019).

3.2 Conceptual framework

To guide the empirical analyses of credit constraints and their potential effects on technology adoption, we adapted the Boucher et al. (2009) framework for a household credit constraint identification strategy summarized in Table 1. The credit constraint status of a household can be unconstrained, supply-side constrained, or demand-side constrained.

(a) Unconstrained households consisted of either satisfied borrowers, that is, borrowers who obtained the amount requested; or non-borrowers who did not need loans or who preferred to work with their own liquidity.

(b) Supply-side constrained households consisted of rejected loan applicants; unsatisfied borrowers, that is, those who received less than the loan amount requested; or non-borrowers who perceived that their application, if made, would be rejected.

(c) Demand-side constrained households are risk-averse households or other non-borrowers that consider the transaction costs of acquiring a loan to be too high and hence not worth it.

Our classification of credit constraint is based on responses to several credit-related questions included in the WEAI module. A direct elicitation method, like the Boucher et al. (2009) and Ali et al. (2014) studies, allows us to make comparisons between constrained and unconstrained borrowers. Borrowers who tried to get credit, whether they were successful or not, reveal their demand for credit, thereby allowing for an empirical analysis of their credit behavior. Similarly, households that would have liked to borrow but did not apply or attempt to borrow due to various factors, such as fear of risk, lack of collateral, or high transaction costs, also possess a positive, though unrevealed, demand for credit. Such households can also be classified as credit constrained due to demand-side constraints. Using the identification strategy portrayed in Table 1, we classified households either as "supply-side constrained," "demand-side constrained," or "unconstrained" and analyzed the factors that affect their credit status. This classification can also help to assess whether their credit status affects adoption of agricultural technologies.

Table 1. Identification strategy of credit constraint status of smallholders

Unconstrained		Constrained: Supply-side		Constrained: Demand-side		
					Due to risk-aversion	Due to transaction costs
Borrowers	Obtained amount of loan requested	**Applied or attempted**	*Rejected borrowers:* Applied or otherwise attempted to obtain a loan. Ready to pay the existing interest rate, but loan application rejected.	**Non-borrowers**	Afraid of taking risks, for example, afraid of losing collateral	Do not know any lenders, for example, lenders not located nearby
Non-borrowers	Do not need a loan; have enough money	**Borrowers**	*Unsatisfied borrowers:* Obtained less than the amount of loan requested; wanted a larger loan at same interest rate	**Non-borrowers**	Afraid that cannot pay the money back	Procedure too cumbersome, too much paperwork, too expensive
Non-borrowers	Prefer working with their own liquidity, that is, reason for not borrowing is "do not like to be in debt"	**Non-borrowers**	*Non-applicants who perceive themselves to "certainly be rejected":* Were certain that their loan application would be rejected due to inadequate collateral; past credit history; existing outstanding loans; or irregular income	**Non-borrowers**	Do not want to be worried; afraid.	Need to pay bribes, too much politics involved

Source: Authors' representation.

Some of the variables we used to categorize respondents into demand- or supply-side constrained households may be argued to belong to both categories. For instance, an interest rate (as a price for the loan) can be considered both as a demand- and supply-side constraint. Likewise, both borrowers and lenders can view transaction costs as a constraint. But as transaction costs are more of a borrower's actual or perceived factor hindering loan applications, we included transaction costs as demand-side constraints, consistent with past studies (Boucher et al. 2009; Ali et al. 2014). Importantly, only a handful of households in our survey reported to be credit constrained due to interest rates and transaction costs; thus, the classification does not substantially affect our identification strategy.

3.3 Econometric approach

A multinomial probit (MNP) model is a commonly used probability model when a categorical outcome (dependent) variable has more than two categories, for example, the type of insurance contract that an individual selects; the type of crop a farmer decides to grow; and the type of fertilizer applied. In such a situation, the dependent variable y is an unordered categorical variable and an individual may select or fall under one of the alternatives. The choices can be coded as $j = 0, 1, \ldots, m$, where m is the number of categories. We estimate an MNP assuming a standard normal probability density function of the model error term.

In our empirical analysis, we let y_{ij} be the categorical variable that takes values $j = 0, 1, 2$ that represent the credit constraint status—that is, unconstrained, supply-side constrained, and demand-side constrained,

respectively—of the i^{th} household. Defining y_{ij}^{*} as the unobserved propensity of the i^{th} household to be in credit constraint status j, we get Equation 1:

$$y_{ij}^{*} = x_i' \beta + \varepsilon_{ij} \quad (1)$$

The observed category is the one with the highest propensity. The MNP probability model in which the i^{th} household falls into the j^{th} credit constraint status can thus be (Equation 2):

$$P_{ij} = P(y_i = j) = P\left(y_{ij}^{*} > y_{ik}^{*}\right) = \Phi(x_i'\beta) + \varepsilon_i, \forall\, j \neq k \quad (2)$$

where P_{ij} represents the probability that the i^{th} individual falls into the j^{th} credit constraint category, x_i' is a vector of regressors, β is the parameters to be estimated, and Φ is a probit functional evaluator. The variables included in the empirical model are presented in Table 2.

4. DESCRIPTIVE RESULTS

Table 2 presents the descriptions and measurements of the variables used in the analysis. The variables used in the analysis include socio-demographic variables (such as respondents' age, family labor, and education level); household wealth (such as household income, livestock, and land ownership); social capital– and information-related variables (such as membership in local associations and market information); and financial capital (such as access to microcredit institutes and community savings/credit groups).

Table 1. Descriptions of the variables used in the study

Variable name	Variable type	Description and measurement
Credit constraint status variables		
ss_side_constrained	dummy	Supply-side credit constrained households *(=1; otherwise 0)*
dd-side_constrained	dummy	Demand-side constrained households *(=1; otherwise 0)*
credit_constraint_status	dummy	Credit constraint status: *(0=unconstrained, 1= ss-side constr., 2=dd-side-constr.)*
Credit_status_binary	dummy	Credit constraint status of a household *(0 = unconstrained; 1 = constrained)*
Socio-demographic variables		
head_female	dummy	Sex of the household head (*=1 if female, otherwise 0*)
sex_respondent	dummy	Sex of the respondent (*=1 if female, otherwise 0*)
head_age	continuous	Age of the household head (*in completed years)*
head_educ.	continuous	Years of formal schooling *(in completed years)*
Educ1560	continuous	Education attainment of adult members of the household (*average number of years*)
head_marital	dummy	Marital status of household head *(=1 if head is married, 0 otherwise)*
hh_size	continuous	Number of household members *(head count)*
hh_labour	continuous	Number of economically active members of the household (aged 15-65) *(head count)*
Wealth/assets indicators		
Log_income	continuous	Log of total estimated household annual income *(in Ethiopian Birr)*
TLU_total	continuous	Total livestock size *(tropical livestock unit [TLU])*
land_area	continuous	Total land size owned by the household *(ha)*
Local financial access indicators		
Iqub_member	dummy	Household belongs to an Iqub (community savings/credit) group *(=1 if member; 0 otherwise)*
MFI_member	dummy	Household belongs to a credit or microfinance group *(=1 if member; 0 otherwise)*
Social capital, information access, irrigation practice		
wateruser_member	dummy	Household belongs to a water users' group (*=1 if member; 0 otherwise)*
Nonwater_group	dummy	Household belongs to any local community association *(=1 if member; 0 otherwise)*
Irri_plot	dummy	Household has at least one irrigated plot *(1=yes; 0 otherwise)*
Irri_num_plot	continuous	Number of irrigated plots on the household farm *(#)*
Info_access_irri	dummy	Do you have access to information on irrigation options/methods? *(1=yes; 0 otherwise)*
Info_climate	dummy	Respondent has access to weather/climate-related information *(1= yes; 0 otherwise)*
Info_market	dummy	Respondent has access to market information *(1= yes; 0 otherwise)*

Source: Authors' collation of variables from Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) surveys.

4.1 Credit constraint status of smallholders

Following the identification framework depicted in Table 1, smallholders' credit constraint statuses in Ethiopia and Tanzania are presented in Table 3. A series of credit-related questions was asked in the WEAI module. These questions include whether anyone in the household applied for a loan, the reason(s) for applying or not applying for a loan, and the amount of loan received relative to what was requested. As noted above, responses to these questions were used to distinguish three types of households based on households' credit status: unconstrained, supply-side constrained and demand-side constrained.

Table 3. Credit constraint status among smallholder farmers (by country)

		Ethiopia	**Tanzania**
Applied or attempted to borrow (yes=1), (%) #		48.9	46.4
Average amount received (Ethiopian Birr, Tanzanian Shillings) *		9,507.4	455,000.0
Supply-side constrained households: (6.7% Ethiopia, 10.1% Tanzania) †	Rejected borrowers (as a % of applicants)	6.8	5.3
	Unsatisfied borrowers (as a % of applicants)	-	-
	Perceived "certainly rejected" nonapplicants (as a % of non-applicants)	6.9	1.4
Demand-side constrained households: (9.5% Ethiopia, 42% Tanzania) †	Due to risk-aversion behavior (as a % of nonapplicants)	15.3	69.6
	Due to high transaction cost (as a % of nonapplicants)	5.0	19.9
Unconstrained households: (86% Ethiopia, 54.6% Tanzania)	Received full amount wanted (as a % of applicants)	93.2	94.7
	Did not need a loan (as a % of nonapplicants)	80.5	20.5
Credit constrained households (yes=1) †	(% of sampled households) – either supply- or demand-constrained or both	14.0	45.4

Source: Authors' computations from Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey 2017 (Ethiopia and Tanzania).

#Yes/No to Women's Empowerment in Agriculture Index [WEAI] questions: (Y4.01) Did you attempt to borrow from any source (cash or in kind) in the last 12 months? & (Y4.04) Did members of your household attempt to borrow from [source] in the last 12 months?

*This average is in terms of Ethiopian Birr for Ethiopia and Tanzanian Shilling for Tanzania.

† The sum of supply-side and demand-side constrained households does not add up to total credit constrained households because some households are both demand and supply credit constrained.

Unconstrained farmers are those who have applied for loans and got approved for the amount they requested or farmers who did not apply for loans because they did not need the loan. This accounts for 86 percent and 55 percent of sampled farmers in Ethiopia and Tanzania, respectively. Forty-nine percent of sampled farmers in Ethiopia and 46 percent in Tanzania had applied for loans or attempted to borrow from different sources (Table 3). Of loan non-applicants, 81 percent in Ethiopia and 21 percent in Tanzania stated that they did not apply for a loan because they did not need one (Table 3). Of farmers who had applied for loans, 93 percent in Ethiopia and 95 percent in Tanzania received the loan amount they requested. The level of approval for the

full amount requested by farmers does not statistically differ between formal and informal sources of credit. The average loan amount was 9,507 Ethiopian Birr in Ethiopia (396.7 in USD) and 455,000 Tanzanian Shillings (203.4 in USD).

The second credit constrained group is supply-side constrained households and it is made up of farmers who have applied for loans but had their loan rejected or farmers who did not apply because they perceive that their loans will be "certainly rejected." Supply-side constrained households make up 6.7 percent and 10.2 percent of sampled farmers in Ethiopia and Tanzania, respectively.

The third credit constrained group is demand-side constrained households. For these households, constraint stems from risk-aversion behavior (such as the fear of losing collateral or not being able to make repayments in general) as well as high transaction costs (such as long distance from the financial intermediary) that can suppress demand for credit. Demand-side constrained households made up 9.5 percent and 42 percent of sampled households in Ethiopia and Tanzania, respectively. Constraints that stem from risk-aversion behavior are reported to be the most limiting demand-side constraints.

4.2 Purpose of loans and reasons for not applying or for loan rejection

Purchase of livestock is the single most frequent reason for farmers to take a loan in Ethiopia, where it accounts for 45 percent of total loans (Table 4). Purchases of agricultural equipment and inputs for crop production (such as land, tractors, fertilizer, seed, pesticide, and hired labor) account for 30 percent and 51.5 percent of the loans in Ethiopia and Tanzania, respectively. Irrigation-related costs such as the purchase of motor pumps or tube-wells account for 1 percent or less of the loans in the two countries. Credit for household consumption (both food and non-food) accounts for 10 percent and 18 percent of the loans in Ethiopia and Tanzania, respectively. This may be related to the fungibility of loans taken, since consumption loans are not common in both countries. Non-farm-business-related loans such as those for starting a non-farm enterprise and purchasing a business vehicle account for 11 percent and 15 percent of the loans in Ethiopia and Tanzania, respectively (Table 4). Other household expenses such as paying rents (for housing or for land) or taxes; paying for education, travel costs, and medical expenses; and paying off old loans or debts account for 18 percent and 30 percent of the loans in Ethiopia and Tanzania, respectively.

Inadequate collateral, bad credit history or a default history with the lender, and outstanding loans are some of the reasons for loan rejections, while no reason was provided for 46 percent and 64 percent of loan rejections in Ethiopia and Tanzania, respectively (Table 4). However, loan rejections are less frequent as only 28 loan applications out of 499 applications in Ethiopia and 17 out of 409 applications in Tanzania were rejected. Of farmers who did not request credit, 15 percent in Ethiopia and 69 percent in Tanzania did not do so due to the fear of the risk of default. In Tanzania, the fear of losing collateral and the overall fear that they may not be

able to pay back the loan taken were the key reasons not to apply for a loan for 46.5 percent and 35 percent of non-applicants, respectively.

Table 4: Summary of the reasons for loan request, loan rejection, and loan non-request (by country)

	Applicants (received)	
Purpose of loan (loan utilization) *	(Ethiopia =441)	(Tanzania=396)
Agric-crops	30.20	51.50
Irrigation-related	0.00	1.30
Livestock purchase	44.90	0.30
Construction/housing/assets	2.30	4.30
Consumption	9.80	18.20
Non-farm business	10.90	14.90
Social	1.80	0.50
Others	18.40	30.10
	Applicants (rejected)	
Reasons for rejection	(Ethiopia=28)	(Tanzania=17)
Inadequate collateral	64.30	29.40
Bad credit history	3.60	11.80
Outstanding loan	7.10	5.90
Default history with lender	0.00	11.80
No reason given	46.40	64.70
	Non-applicants	
Reasons for not attempting to borrow	(Ethiopia=522)	(Tanzania=473)
No need for loan/have enough money	80.50	20.50
Afraid of losing collateral	8.00	46.50
Cannot pay the money back	12.30	34.70
Inadequate collateral	3.60	10.60
Had outstanding loan	2.90	1.10
Past history of default	0.00	1.50
Bad credit history	0.40	1.90
Interest rates too high	3.80	11.60
Lenders not located nearby	0.40	3.20
Procedures too cumbersome	0.80	7.00
Need to pay bribes	0.00	0.40
Family dispute in borrowing	0.40	2.70
Others	1.00	5.30

Source: Authors' computations from Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey 2017 (Ethiopia and Tanzania).

* Note: In the Women's Empowerment in Agriculture Index (WEAI) survey instrument, we had long lists of items under the "purpose of loan." We clustered the lists into the following categories (the numbers in the parentheses are the codes used in the survey instruments for each item):

- *Agricultural—crops* = (1) Agricultural production; (2) Purchase of agricultural land; (3) Purchase of tractor; (4) Purchase of thresher; (6) Purchase of other farm equipment; (14) To buy farm inputs (seeds, fertilizers, pesticides); (12) To pay hired labour.
- *Irrigation-related* = (5) Purchase of tube-well; (7) Purchase of irrigation pumps
- *Agricultural—livestock* = (13) To buy livestock
- *Construction/housing/assets* = (17) Purchase/improvement of family dwelling; (23) To buy a car
- *Consumption (food and non-food)* = (9) To buy food/household goods; (16) Other consumption
- *Non-farm business* = (19) For start-up of a non-farm enterprise(s); (20) For new investment in a non-farm enterprise(s) (difference between start-up and new investment); (24) To buy a business vehicle
- *Social* = (21) To pay for a wedding; (22) To pay for a funeral
- *Others* = (8) To pay rent (for housing or for land) or taxes; (10) To pay for education; (11) To pay for travel costs; (15) Medical expenses; (18) To pay off old loans/debts; (25) Other, specify.

4.3. Characteristics of loan seekers and non-seekers

Tables 5 and 6 summarize the comparative statistics of loan seekers and non-seekers by household- and respondent-level characteristics, with some statistically significant differences. In Ethiopia, loan seekers are about 3.5 years younger, more likely to be in male-headed households (by about 5 percentage points), operate a smaller land size (by about 22 percent), have lower non-employment income (by about 38 percent), and are more likely to have access to information about irrigation, markets, and agricultural production compared to non-seekers. In addition, loan seekers are less likely to be irrigators or to be a member of an *Equb*[2], and more likely to be members of MFIs and other group memberships compared to non-seekers (Table 5). In addition, female-headed households, households with older heads, and low-income households are more credit constrained in Ethiopia (Table 5). Female-headed households are more credit constrained by about 5 percentage points than male-headed households. Households with access to local MFIs are less likely be credit constrained (by about 16 percentage points) compared to those that do not have access to MFIs. Farmers that actively participate in several social and local groups are less credit constrained in Ethiopia.

In Tanzania, loan applicants are about 2 years younger, have lower gross expenditure per year (by about 18 percent), have a slightly larger household size, and are more likely to be members of MFIs, water users' groups and other types of groups compared to non-applicants (Table 6). In both Ethiopia and Tanzania, loan applicants are more likely to be poorer (as measured in land size, annual gross expenditure, or access to irrigation) than non-applicants. In addition, households with older and less educated heads, and those with lower livestock income, are more credit constrained in Tanzania (Table 6). Irrigators in Tanzania are less likely (by about 9 percentage points) to be credit constrained compared to non-irrigators.

[2]*Equbs* are community-based revolving savings and credit associations that provide credit and insurance outside the formal financial sector.

Table 5. Characteristics of respondents (by application and constraint status), Ethiopia

Variables	Non-applicants (n=548)	Applicants (n=473)	Difference	p-value	Unconstrained (n=878)	Constrained (n=143)	Difference	p-value
Female-headed household (yes=1)	0.112	0.061	0.051	0.005	0.081	0.133	-0.052	0.042
Household head age (years)	47.943	44.387	3.557	0.000	45.919	48.599	-2.679	0.013
Household head education (years)	3.273	3.506	-0.233	0.357	3.351	3.563	-0.212	0.560
Household size	5.974	6.104	-0.129	0.321	6.070	5.818	0.252	0.178
Dependency ratio	0.556	0.535	0.021	0.078	0.543	0.563	-0.019	0.268
Operated land area (ha)	1.716	1.345	0.369	0.000	1.558	1.457	0.101	0.352
Livestock owned (TLU)	91.722	88.485	3.237	0.952	94.114	66.331	27.783	0.716
Employment income (ETB)*	13906.820	14594.071	-687.251	0.959	10848.550	34957.400	-24108.850	0.203
Livestock income (ETB)	5475.901	4878.753	597.149	0.278	5328.399	4406.364	922.035	0.243
Gross income (non-employment) per year (ETB)	49967.350	31185.080	18782.270	0.004	43517.860	27440.350	16077.510	0.090
Information access on:								
Irrigation (yes=1)	0.788	0.873	-0.085	0.001	0.835	0.783	0.051	0.130
Climate (yes=1)	0.692	0.664	0.028	0.344	0.683	0.650	0.033	0.433
Crop production and management (yes=1)	0.831	0.909	-0.079	0.000	0.872	0.839	0.032	0.294
Livestock production and management (yes=1)	0.803	0.902	-0.099	0.000	0.864	0.762	0.101	0.002
Market (yes=1)	0.725	0.788	-0.064	0.018	0.753	0.762	-0.009	0.809
Equb membership (yes=1)	0.295	0.239	0.057	0.042	0.272	0.252	0.021	0.610
MFI membership (yes=1)	0.230	0.588	-0.358	0.000	0.418	0.259	0.159	0.001
Mater users' group membership (yes=1)	0.186	0.177	0.009	0.725	0.180	0.196	-0.016	0.649
Number of group membership	3.567	4.277	-0.710	0.000	3.968	3.454	0.513	0.001
Irrigation status (irrigator=1)	0.427	0.336	0.091	0.003	0.389	0.363	0.025	0.573
Total fertilizer use (kg)	181.582	172.214	9.367	0.389	179.323	164.465	14.858	0.341
Total improved seed use (kg)	34.715	35.129	-0.414	0.952	32.888	47.309	-14.421	0.139
Total pesticide cost (ETB)	886.524	671.399	215.125	0.014	812.320	630.559	181.761	0.149

Source: Authors' computations from Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey 2017 (Ethiopia and Tanzania).
Note: *ETB (Ethiopian Birr) =the currency of Ethiopia (1 USD = 37. 60 ETB, in November 2020); MFI = microfinance institution; TLU = tropical livestock unit.

Table 6. Characteristics of respondents (by application and constraint status), Tanzania

Variables	Non-applicants (n=465)	Applicants (n=417)	Difference	p-value	Unconstrained (482)	Constrained (n=400)	Difference	p-value
Female-headed household (yes=1)	0.103	0.124	-0.021	0.316	0.127	0.098	0.029	0.176
Household head age (years)	49.764	47.638	2.126	0.011	47.780	49.938	-2.158	0.011
Household head education (years)	7.052	7.418	-0.366	0.132	7.515	6.879	0.636	0.009
Household size	5.144	5.475	-0.331	0.013	5.375	5.209	0.166	0.218
Dependency ratio	0.524	0.525	-0.001	0.956	0.533	0.515	0.018	0.191
Operated land area (ha)	2.264	2.078	0.185	0.205	2.188	2.161	0.027	0.853
Livestock owned (TLU)	0.569	0.663	-0.095	0.775	0.640	0.580	0.060	0.856
Employment income (TZS)*	2270000.000	1740000.000	538000.000	0.322	2030000.000	2014225.320	15774.680	0.977
Livestock income (TZS)	72134.410	95262.590	-23128.180	0.186	96922.200	66376.250	30545.950	0.082
Gross expenditure per year (TZS)	10277431.000	8467410.000	1810021.000	0.045	9120000.000	9790000.000	-670000.000	0.457
Information access on:								
Irrigation (yes=1)	0.795	0.818	-0.022	0.409	0.814	0.797	0.016	0.555
Climate (yes=1)	0.880	0.842	0.038	0.104	0.851	0.875	-0.025	0.297
Crop production and management (yes=1)	0.787	0.803	-0.017	0.551	0.814	0.772	0.041	0.136
Livestock production and management (yes=1)	0.465	0.518	-0.053	0.113	0.518	0.455	0.064	0.060
Market (yes=1)	0.533	0.489	0.044	0.191	0.498	0.530	-0.032	0.344
MFI membership (yes=1)	0.159	0.362	-0.203	0.000	0.328	0.168	0.161	0.000
Water users' group membership (yes=1)	0.222	0.285	-0.064	0.029	0.286	0.210	0.076	0.009
Number of group membership (a maximum of 16 groups)	7.348	7.333	0.015	0.931	7.542	7.100	0.442	0.011
Irrigation status (irrigator=1)	0.342	0.341	0.002	0.965	0.382	0.292	0.089	0.005
Total fertilizer use (kg)	79.739	143.334	-63.596	0.463	137.750	76.134	61.616	0.478
Tot improved seed use (kg)	21.581	23.059	-1.477	0.781	23.496	20.815	2.681	0.615
Total pesticide cost (TZS)	55066.160	49666.090	5400.070	0.481	57574.720	46413.780	11160.940	0.147

Source: Authors' computations from Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey 2017 (Ethiopia and Tanzania).

Note: * TZS (Tanzanian TZS)= the currency of Tanzania (1 USD= 2317.50 TZS in November 2020); MFI = microfinance institution; TLU = tropical livestock unit.

5. ECONOMETRIC RESULTS

5.1 Determinants of credit constraint status of households

Using the identification strategy depicted in Table 1, smallholders were classified into credit unconstrained, supply-side credit constrained, and demand-side credit constrained. Table 7 reports the results from the MNP regression model with the unconstrained group used as a base category. Hence, the likely effect of each covariate on the credit constraint status is interpreted against this base category. A set of explanatory variables including socio-demographics (such as respondents' age, family labor, and education level); wealth/asset indicators (such as household income, livestock, and land ownership); social capital and information-related variables (such as membership in local associations and market information); and financial capital (such as access to microcredit institutes and community savings/credit groups) were among the conditioning variables we considered. To capture gender-differentiated credit constraints, we introduced two indicators of gender: "*Respondent_female*" and "*head_female*." As described in section 3, the WEAI module of the ILSSI surveys was designed to collect responses from both members (male and female) of the couple heading the household.

As shown in Table 7, the two important gender variables, being either a "*female respondent*" or a "*female-headed household,*' are statistically significant in affecting the credit constraint status of a household in both study countries. In Ethiopia female respondents are more likely to be supply-side credit constrained (that is, lenders are less likely to lend to female applicants) and in Tanzania female respondents are more likely to be demand-side credit constrained either due to risk perception or transaction costs. This model prediction is consistent with the descriptive statistics reported in Section 5.1. Such gender-differentiated credit constraints in rural Africa are well documented in previous studies. For instance, in a study in northern Ghana, Balana (2016) reports that as a result of local traditions, culture, and norms, women have less access to collateral, such as land and livestock, which gives them lower chances of getting loans; the loan terms and conditions were too rigid to suit women's needs; and women have relatively limited knowledge about credit and are more often illiterate and unable to complete the paperwork needed for formal credit. In addition, married households in Ethiopia are more likely to be both supply-side and demand-side constrained in accessing credit, possibly indicating increased risk aversion.

Examining the common set of factors (both supply-side and demand-side) that determine credit constraint status in the two study countries, we see that access to MFIs and having an established social network (proxied by membership in local associations) are important factors in easing credit constraints (Table 7). Households with better access to MFIs and those with established social networks are less likely to be credit constrained from both the supply and demand sides (significant at the 1 percent to 10 percent levels). Further, female-headed households are less likely to be demand constrained in Ethiopia and less likely to be supply-constrained in Tanzania, relative to male-headed households.

Table 7. Estimation results of MNP regression models

	Ethiopia						Tanzania					
	Supply-side constrained			Demand-side constrained			Supply-side constrained			Demand-side constrained		
Independent variables	Coeff.	Std. err.	p-value	Coeff.	Std. err.	p-value	Coeff.	Std. err.	p-value	Coeff.	Std. err.	p-value
Respondent_female *(=1)*	0.299*	0.170	0.078	0.178	0.174	0.306	-0.130	0.166	0.432	0.332**	0.134	0.013
head_marital *(married=1)*	1.025**	0.478	0.032	1.627***	0.457	0.000	-0.336	0.283	0.236	0.052	0.248	0.834
head_female *(=1)*	-0.779	0.477	0.102	-0.857*	0.466	0.066	-0.676*	0.338	0.045	-0.116	0.273	0.670
head_age *(years)*	0.004	0.009	0.685	0.012	0.008	0.149	0.003	0.007	0.691	0.015***	0.006	0.008
head_edu *(years)*	0.019	0.031	0.549	-0.016	0.029	0.582	0.036	0.029	0.203	-0.002	0.022	0.943
edu1560 *(#)*	0.035	0.038	0.360	0.077**	0.040	0.058	-0.098**	0.039	0.012	-0.137***	0.031	0.000
hh labor *(#)*	0.003	0.060	0.965	0.030	0.066	0.648	-0.146**	0.071	0.041	0.035	0.056	0.529
log_gross_income	-0.183*	0.104	0.079	-0.132	0.129	0.307	-0.012	0.012	0.315	-0.017**	0.010	0.082
TLU_total	-0.079***	0.033	0.017	-0.033	0.037	0.361	0.003	0.017	0.846	0.006	0.014	0.675
land_area *(ha)*	0.035	0.077	0.646	-0.130	0.096	0.178	0.001	0.038	0.983	0.034	0.032	0.295
groupmem_num *(#)*	-0.103*	0.061	0.092	-0.306***	0.093	0.001	-0.085***	0.032	0.008	-0.026	0.027	0.328
info_access_market *(yes=1)*	0.221	0.226	0.328	0.196	0.195	0.316	0.248	0.176	0.159	-0.269*	0.140	0.055
info_process *(yes=1)*	0.085	0.210	0.688	-0.544**	0.244	0.026	-0.056	0.183	0.758	-0.383***	0.147	0.009
micro_member *(yes=1)*	-0.363*	0.201	0.071	-0.287	0.202	0.156	-0.448**	0.199	0.025	-0.814***	0.157	0.000
equb_member *(yes=1)*	0.007	0.213	0.974	0.572***	0.244	0.019	-	-	-	-	-	-
Constant	-1.965	1.198	0.101	-2.145	1.429	0.133	0.754	0.617	0.222	-0.302	0.503	0.548
Mean dependent var	0.210			SD dependent var:	0.556		Mean dependent var:	0.800		SD dependent var:	0.925	
Number of obs	1008			Chi-square:	81.465		Number of obs:	851		Chi-square:	109.522	
Prob > chi2	0.000			Akaike crit. (AIC):	974.585		Prob > chi2:	0.000		Akaike crit. (AIC):	1542.018	

Source: MNP regression results using Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey data (Ethiopia and Tanzania)
Note: *** p<0.01, ** p<0.05, * p<0.1. hh = household; MNP = multinomial probit; TLU = tropical livestock unit.

Livestock ownership is an important factor (statistically significant at the 1 percent level) in easing supply-side credit constraints of smallholders in Ethiopia. However, in Tanzania livestock is not a significant factor in determining either the supply-side or demand-side credit constraint status of a household. As livestock is an important measure of household assets or wealth in Ethiopia, ownership of livestock could either substitute for credit or could serve as an indicator of the household's capacity to borrow or bear risks (Croppenstedt et al. 2003), hence lenders may be more willing to lend to applicants with large livestock holdings. Interestingly, the size of landholding is not statistically significant in influencing either the demand- or supply-side constraint status of a household. This may reflect land-tenure insecurity (for example, in Ethiopia) where land cannot be used as collateral. Table 7 further shows that members of *Equb* in Ethiopia are more likely to be demand constrained, possibly because an *Equb* can serve as an alternative source of financing.

The results further reveal that there are specific sets of factors that differentially affect demand-side and supply-side constrained households. For the demand-side constrained households, a key factor that influences credit constraint status is the level of access to information (proxied by "*info-market"* and "*info-processing"* variables). Households having good access to information are less likely to be demand-side credit constrained. Similar findings have been reported in previous studies in Nigeria. For instance, Wossen et al. (2017) show a positive relationship between credit access and information integrated into extension services. This relationship has a practical policy implication because rural borrowers do not appear to be well connected to information sources to inform their credit decisions. They may lack adequate information on sources of credit, on the terms and conditions for obtaining credit, or on interest rates. Given these findings, key policy questions include: How to improve rural information and communication systems, including for agricultural production and marketing? How to enhance households' access to information technologies, including telephone and internet services?

5.2 Marginal effects of covariates on credit constraint status of households

Tables 8 and 9 report predicted marginal effects, that is, the effect of a one-unit change in an explanatory variable on the percentage probability of a household being in each of the credit constraint categories. At the bottom of both Tables 8 and 9 are the predicted probabilities of households being credit unconstrained, supply-side constrained, and demand-side constrained. The predicted probabilities are consistent with the actual descriptive summary statistics reported in Table 3. Based on predicted results, demand-side credit constraints are equally or even stronger than the supply-side constraints in both countries. In Ethiopia, supply-side factors are almost as important as demand-side factors (6.3 percent and 4.7 percent, respectively). In Tanzania, however, only 10 percent of households are supply-side constrained whereas 34 percent of households are predicted to be demand-side constrained (Table 9). This is an interesting finding in that many studies highlight that the credit constraints smallholders face are mostly due to supply-side factors—for instance, an absence of accessible credit sources in local areas, an absence of credit products that meet the needs of smallholders, and a high cost of borrowing. Consequently, improving credit access by mitigating these supply-side constraints has

been recommended as an effective policy to boost agricultural technology adoption. However, our findings show that credit constraints are not only from supply-side factors but from demand-side factors as well. In our data, the demand-side factors appear to be even stronger than the supply-side factors in Tanzania and are comparable with the supply-side factors in Ethiopia. Thus, improving credit access by easing supply-side constraints may not necessarily address potentially suboptimal uptake of credit among smallholders in Tanzania and Ethiopia without equally addressing demand-side factors (de Janvry et al. 1991; Woutersen and Khandker 2013; Adjognon et al. 2017). The reason some non-borrowers do not participate in the credit market may not necessarily be due to inability to obtain credit but, rather, due to risk aversion or lack of access to information on potential sources of credit or on the terms of the credit that is available. Our empirical findings provide strong evidence on the wide prevalence of demand-side credit constraints in the two countries.

Table 8. Marginal effects of regressors on probability of a household being credit constrained (Ethiopia)

Independent variables	**Unconstrained households**			**Supply-side constrained**			**Demand-side constrained**		
	dy/dx	Std. err.	P>z	dy/dx	Std. err.	P>z	dy/dx	Std. err.	P>z
Respondent_female *(=1)*	-0.035*	0.019	0.069	0.026*	0.015	0.096	0.010	0.013	0.438
head_marital *(married=1)*	-0.185***	0.055	0.001	0.076*	0.043	0.080	0.109***	0.036	0.002
head_female *(=1)*	0.084***	0.026	0.001	-0.046**	0.021	0.031	-0.038	0.016	0.015
head_age *(years)*	-0.001	0.001	0.278	0.000	0.001	0.808	0.001	0.001	0.152
head_edu *(years)*	-0.001	0.003	0.883	0.002	0.003	0.499	-0.001	0.002	0.508
edu1560 *(#)*	-0.008*	0.004	0.086	0.002	0.003	0.489	0.005*	0.003	0.070
hh labor *(#)*	-0.002	0.007	0.765	-0.000	0.005	0.986	0.002	0.005	0.646
log_gross_income	0.023*	0.013	0.075	-0.015	0.009	0.104	-0.008	0.009	0.412
TLU_total	0.008**	0.004	0.026	-0.007**	0.003	0.020	-0.002	0.003	0.544
land_area *(ha)*	0.005	0.009	0.571	0.005	0.007	0.502	-0.010	0.007	0.152
groupmem_num *(#)*	0.011	0.008	0.143	-0.013**	0.005	0.021	-0.024***	0.006	0.000
info_access_market *(yes=1)*	-0.029	0.022	0.189	0.017	0.018	0.342	0.012	0.013	0.367
info_processinfo *(yes=1)*	0.021	0.023	0.361	0.013	0.020	0.513	-0.035***	0.013	0.006
micro_member *(yes=1)*	0.046**	0.021	0.029	-0.029*	0.017	0.082	-0.017	0.014	0.226
equb_member *(yes=1)*	-0.043	0.029	0.129	-0.006	0.018	0.725	0.050**	0.023	0.033
Pr(credit constraint status):	Pr(0)=0.8890			Pr(1)=0.0631			Pr(2)=0.0478		

Source: Post-estimation marginal effects (after MNP regression) using Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey data (Ethiopia).
Note: *** p<0.01, ** p<0.05, * p<0.1. dy/dx = discrete change of dummy variable for a unit change in a regressor; hh = household; MNP = multinomial probit; TLU = tropical livestock unit.

Table 9. Marginal effects of regressors on probability of a household being credit constrained (Tanzania)

	Unconstrained households			Supply-side constrained			Demand-side constrained		
Independent variables	dy/dx	Std. err.	P>z	dy/dx	Std. err.	P>z	dy/dx	Std. err.	P>z
Respondent_female *(=1)*	-0.062*	0.036	0.087	-0.037*	0.021	0.082	0.099***	0.035	0.004
head_marital *(married=1)*	0.020	0.067	0.766	-0.055	0.045	0.221	0.036	0.062	0.567
head_female *(=1)*	0.069	0.072	0.334	-0.067***	0.026	0.009	-0.002	0.071	0.978
head_age *(years)*	-0.003**	0.002	0.021	-0.000	0.001	0.576	0.004***	0.001	0.006
head_edu *(years)*	-0.003	0.006	0.664	0.005	0.004	0.164	-0.003	0.006	0.653
edu1560 *(#)*	0.038***	0.009	0.000	-0.006	0.005	0.258	-0.032***	0.008	0.000
hh labor *(#)*	0.004	0.015	0.795	-0.022**	0.009	0.016	0.018	0.015	0.213
log_gross_income	0.005*	0.003	0.077	-0.001	0.001	0.656	-0.004	0.002	0.113
TLU_total	-0.002	0.004	0.679	0.000	0.002	0.963	0.001	0.004	0.694
land_area *(ha)*	-0.007	0.009	0.391	-0.002	0.005	0.711	0.009	0.008	0.266
groupmem_num *(#)*	0.013*	0.007	0.082	-0.010**	0.004	0.013	-0.002	0.007	0.728
info_access_market *(yes=1)*	-0.078**	0.038	0.038	0.019	0.022	0.403	0.060*	0.036	0.096
info_processinfo *(yes=1)*	0.087**	0.039	0.028	0.014	0.024	0.566	-0.100***	0.036	0.006
micro_member *(yes=1)*	0.204***	0.038	0.000	-0.018	0.024	0.441	-0.186***	0.035	0.000
Pr(credit constraint status):	Pr(0)= 0.5588			P	Pr(1)=0.1000		Pr(2)=0.3410		

Source: Post-estimation marginal effects (after MNP regression) using Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) survey data (Tanzania). Note: *** p<0.01, ** p<0.05, * p<0.1. dy/dx = discrete change of dummy variable for a unit change in a regressor; hh = household; MNP = multinomial probit; TLU = tropical livestock unit.

With regard to the marginal effects of the covariates, those variables with significant effects on the likelihood of credit constraint status (see Table 7) are also important in terms of their effects on influencing the credit constraint condition of a respondent or a household to be either unconstrained or supply-side constrained or demand-side constrained. For instance, being a female respondent increases the likelihood of being supply-side constrained by 2.6 percent in Ethiopia. In Tanzania, being a female increases the likelihood of demand-side constraint by 9.9 percent. Households that are members of local associations are less likely to be credit-constrained from the supply-side in Ethiopia and Tanzania (by 1.3 percent and 1 percent, respectively) while they are less likely to be credit-constrained from the demand-side in Ethiopia by 2.4 percent. MFIs have a large statistically significant marginal effect in Tanzania, that is, MFIs reduce the likelihood of a household being credit constrained by 18.6 percent. Other statistically significant covariates (in Tables 8 and 9) can be interpreted similarly.

6. CONCLUSION AND POLICY SUGGESTIONS

Limited access to agricultural credit is seen by many observers as one of the major impediments to agricultural technology adoption among smallholder farmers in developing countries. The literature and much of the policy discourse focused on supply-side factors—for example, farmers not having access to credit sources—and recommended addressing supply-side constraints to improve smallholders' access to credit through making

more credit available at more affordable rates and more accessible conditions. However, demand-side factors, such as borrowers' risk-averse behavior and financial illiteracy and high transaction costs can also play important roles in credit rationing for smallholder farmers.

This study investigates the agricultural credit constraint status of smallholders in Ethiopia and Tanzania: whether the credit constraints faced by smallholders are driven by supply-side factors or by demand-side factors or, alternatively, whether credit is not a binding factor for smallholders. Using survey data from Ethiopia and Tanzania, the study further examines the factors affecting smallholders' credit constraint status. Against the claims in much of the literature and policy discourse, we find that out of all credit-constrained households in the survey sample in Ethiopia and Tanzania, 45 percent and 77 percent, respectively, of the credit constraints emanate from demand-side factors such as risk-perceptions, high transaction costs, lack of access to information, limited knowledge about agricultural technologies, or a combination of these factors.

The descriptive analysis reveals that the rate of loan rejections in both countries is low. Of those who have applied for loans, 93 percent and 95 percent in Ethiopia and Tanzania, respectively, received the loan amount they requested. This high level of approval does not statistically differ between formal and informal sources of credit. Of the sampled households, 86 percent in Ethiopia and 54.7 percent in Tanzania report that they are not credit constrained. Demand-side constrained households make up 9.5 percent (in Ethiopia) and 42 percent (in Tanzania) of households; whereas 6.7 percent (Ethiopia) and 10.2 percent (Tanzania) of households are supply-side constrained—indicating that demand-side constraints are more widespread than supply-side constraints.

Risk aversion behavior (including the fear of default) is reported to be the most limiting demand-side constraint in Ethiopia (15 percent) and in Tanzania (69 percent). Purchase of livestock is the single most frequent reason for farmers to take a loan in Ethiopia, where it accounts for 45 percent of total loans. Purchase of agricultural equipment and inputs for crop production (such as land, tractors, fertilizer, seed, pesticide, and hired labor) account for 30 percent and 52 percent of the loans in Ethiopia and Tanzania, respectively. Interestingly, irrigation-related costs such as the purchase of motor pumps or tube-wells account for less than 1 percent of the loans in the two countries, despite the over-sampling of irrigating households for this survey. Results from the multinomial probit analysis suggest the existence of gendered credit constraints, with women being more likely to be credit constrained (from both the supply and/or demand sides) than men. Female respondents are more likely to be supply-side credit constrained (in Ethiopia) and more likely to be demand-side credit constrained (in Tanzania). Access to an MFI and membership in local associations are important factors for easing credit constraints in both countries.

Based on these findings, we suggest three policy implications. First, improving credit access via easing supply-side constraints alone may not necessarily boost agricultural credit use and technology adoption by smallholders

in Ethiopia and Tanzania; efforts to tackle demand-side constraints are also be necessary. Second, whereas the key demand-side constraint is farmers' risk behavior, the key supply-side constraint is related to lack of adequate collateral. Policies should focus on easing farmers' fear of risk: for example, through insurance coverage to mitigate key demand-side factors. On the supply-side, mechanisms for enhancing smallholders' capacity to possess bankable collateral should be introduced. Finally, gender-sensitive policies, such as easing collateral requirements for women loan applicants should be considered to address the larger constraints women face when attempting to access credit.

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