IMPACT OF CREDIT ACCESS ON FARMERS' INVESTMENT BEHAVIOR IN VIETNAM

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Abstracts

Agricultural credit is regarded as a crucial factor in economic development. Despite the importance of agricultural credit to developing countries, little is known about how such credit impacts rural household, especially in Vietnam. This thesis conducts an empirical analysis of the impact of agricultural credit on farm outcomes and household investment by employing VARHS panel data. In order to do this, we make a comparison between ordinary least squares and fixed effects method to choose the best effective method to control for unobserved heterogeneity. Then, we run multiple regression and find consistent evidence that access to credit leads to a growth in farm production and profit and in household welfare. Furthermore, we also provide potential channels through which credit access affects agricultural profit by analyzing the impact of credit on household investment.

Key words: credit, fixed effects, rural households, Vietnam.

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Chapter 1

Introduction

1.1. Contextual background

Credit is essential in farming systems as it permits producers, farmers, etc. to lend money for their production needs. From an individual perspective, agriculture credit provides an essential resource for efficient farming in the presence of scarcity in developing countries (Guirkinger, 2008). From a social perspective, agriculture credit promotes rural areas' prosperity by raising agricultural output production. However, in developing countries where the economy still largely depends on agriculture, the proportion of total credit devoted to agriculture is relatively low compared to its contribution to GDP, and gaining access to agriculture credit remains difficult (Miller et al., 2018). According to World Bank Open Data, while agriculture in Vietnam makes up approximately 20% of total GDP, only 10% of total commercial credit is allocated to agriculture and these sectors. Furthermore, difficulty in accessing credit is reported as the highest percentage, which is 49%, among all of the barriers to improving agricultural production. The lack of access to credit is, as a result, one of the major reasons why poor rural households continue to live in poverty.

Although many empirical studies have looked into the role of agricultural credit in poverty reduction, income, and living standards improvement for farmers (Thanh et al., 2019; Khandker & Koolwal, 2015; Bui et al., 2018), the impact of credit on rural welfare still remains ambiguous, with inconsistent results among the series of previous studies. Under the same dataset, while Pitt and Khandker (1998) found that access to micro-credit enhances rural household welfare in Bangladesh, Roodman and Morduch (2013) showed that such an impact is modest. In Vietnam, only a few studies investigated the impact of credit on agricultural productivity and their results also showed mixed results. Duong and Nghiem (2022) and Cuong (2008) proposed that micro-credit programs help reduce poverty by encouraging productivity and contribute considerably to household consumption, however, several results showed the opposite results, with an insignificant effect found in the relationship between microfinance and household welfare (Phan et al., 2014; Nghiem et al., 2012).

Therefore, it is important and policy-relevant to revisit the role of credit in agricultural production to help policymakers acknowledge the importance of credit to rural households and thus encourage banking and financial services to offer credit to lenders. In order to deal with unobserved heterogeneity problems, we will employ the fixed effects method to capture time-invariant unobserved household characteristics, which are correlated with both access to credit and farm outcomes, and time-varying trends that affect the whole sample size.

1.2. Research objectives and research questions

The main objective of this paper is to analyze the impact of access to credit on farm outcomes, specifically farm production (which is measured by the total value of crops produced), farm sales and farm profit. Furthermore, we also analyze potential channels through which agricultural credit affects farm outcomes following the theoretical framework. In particular, we will evaluate the impact of access to credit on household investment in agricultural capital (e.g., equipment,

materials, etc.), on the total land area used for crop production, and on the labor force (working days, hiring costs).

The main research question and two sub-research questions will be explored in accordance with the problem statement and existing literature, as detailed below:

Research question:

- To what extent does credit access affect farmers' investment behavior in Vietnam?

Sub-research questions:

- What is the impact of credit on farm outcomes (farm production, farm sales and farm profit)?
- What are the underlying reasons behind the difference in farm outcomes with the availability of credit? In other words, what is the impact of credit on investment in (a) agricultural capital; (b) farm area for crop production, (c) labor's working days, and (d) labor's hiring costs?

1.3. Limitations of the study

In terms of the limitations, this study does account for other potential factors that might affect credit access such as supply-side shocks, as credit might also depend on the opening and closing of bank branches due to the unavailability of the data. Furthermore, crop types are not incorporated into this analysis besides traditional inputs and household characteristics due to VARHS characteristics. To be more specific, a household can apply for credit to grow different types of crop, and thus it is a challenging task to keep track of a household's crop cultivation associated with their credit history. Therefore, we could not distinguish the impact of credit access on different types of crops although several crop types are likely to require more credit than the others. For example, cash crops such as coffee, tea and tobacco often require a greater amount of initial investment or external credit compared to crow crops including rice, wheat or soybeans. Therefore, it is advisable that future research examine these problems to give more valuable insights into how credit influences crops' performance.

Despite its effectiveness compared to the classic OLS model, our main methodology, fixed effects, cannot capture unobserved, cross-household characteristics that change over time, in other words, time-varying heterogeneity. Moreover, time-varying and aggregate trends that only affect a part of the total sample could not also be investigated. Another problem that fixed effects estimators are exposed to is the risk of reverse causality (Vaisey & Miles, 2016). In other words, it might be challenging to determine whether the causal effect is actually derived from the impact of credit access on farm production or it is the improvement in crop yields that induces farmers to obtain more credit instead. Nevertheless, both unobserved heterogeneity and reverse causality are inevitable and commonly-faced challenges that confront other standard methods (OLS model, Poisson model, logit model, etc.). Therefore, it is still convincing to employ the fixed effects model due to its robustness to biases if all required assumptions hold.

1.4. The structure of the research paper

The paper is structured as follows. Following the Introduction, Chapter 2 reviews existing studies regarding the impact of access to credit on farm outcomes in both international and

Vietnam contexts, with an aim to summarize relevant theories, propose previous debates, and identify possible gaps that need to be addressed. Furthermore, we also discuss the possible mechanisms underlying the impact of credit on farm yields. Chapter 3 proposes the conceptual framework that positions our research problem and limits the scope of our data to specific variables in the main equation. Chapter 4 explains the effectiveness of our main methodology by comparing it with the pooled OLS, as well as presents assumptions we need to account for. Chapter 5 provides a description of the data set with descriptive analysis and interprets the regression results with robustness checks. Finally, chapter 6 summarizes the main findings according to the empirical results and gives recommendations for future research.

Chapter 2

Literature review

2.1. Impact of access to credit on farm outcomes and household well-being

2.1.1. Credit access and its impact in the developing countries

In the series of existing studies, credit has been proven to play a crucial role in the output and productivity of farm systems. Regarding the groundbreaking studies that strongly influence this research field, Feder et al. (1990) gave a convincing explanation that the presence of credit helps production levels come closer to the optimum levels as much as possible, hence, the output or profit also increases accordingly. Similarly, there are many other studies measuring the impact of credit on agricultural production and rural income, mainly because gaining access to credit is one of the significant factors in raising productivity in developing countries, which aligns with the suggestion by Feder et al. (1990). For example, Carter (1989) found that credit has a positive impact on peasant productivity in Nicaragua and that credit recipients are more likely to achieve higher technical efficiency compared to non-credit recipients. Likewise, Zeller et al. (1998) concluded that smallholder farmers who took part in agricultural credit programs in Malawi gained substantially higher crop production and crop income. When taking gender impact into account, Pitt and Khandker (1998) concluded that the micro-credit program in Bangladesh raises household consumption expenditure of both genders, with a more significant effect found among female participants. These early shreds of evidence paved the way for future research into the importance of credit in developing countries, followed by the emergence of controversial results, which makes this a more complex and multi-dimensional matter.

In recent years, various studies have indicated the significance of credit in reducing poverty by raising household production and income in developing countries, with both commonalities and differences in their findings. Nordjo and Adjasi (2019) employed the Propensity Score Matching (PSM) approach to differentiate the impact between credit and non-credit participants of smallholder farmers in Ghana and reached a conclusion that farmers with access to production credit achieve a higher productivity rate. Meanwhile, Elahi et al. (2018) divided credit into two different sources, formal and informal, with the former being more accessible, however, the latter is more desirable for farmers as they tend to seek loans from informal sources. Furthermore, under the same methodology (PSM), they found that credit availability does not necessarily increase a farm's productivity due to misapplication or improper usage. This evidence aligns with the finding by Jimi et al. (2019) in which higher production yields are associated with effective credit management strategies.

To provide a more valid comparison, we compare the two following studies that employed the same dataset. While Pitt and Khandker (1998) found that better access to micro-credit is associated with the improvement in rural household welfare in Bangladesh, such an impact is found to be modest in the paper by Roodman and Morduch (2013). These contradictory results could be to blame for the severe flaws in Roodman and Morduch's econometric methods (two-

stage least square regression) and their invalid interpretation (Pitt, 2014). Other controversial results were reported on the positive and negative effects of credit on farm productivity, which depend on how rural households utilize it as we mentioned above. This could also be another factor that produces inconsistent results as credit usage mostly depends on a household's management capability, which is considered an individual, unobserved factor or so-called unobserved heterogeneity. On the one hand, credit is associated with higher agricultural yields by lessening financial burdens and encouraging households to invest in farm infrastructure, modern inputs and technology once it is used properly (Jimi et al., 2019). On the other hand, misapplication or lack of knowledge about credit is one of the main reasons why such favorable outcomes are unlikely to happen, which results in little to no increase in farm efficiency (Taylor et al., 1986). In some worst-case scenarios, households may experience huge debt pressures and default; consequently, a decline in farm outcomes (Seng, 2018; Nguyen et al., 2019). Apart from being conducted in different countries, another possible explanation for these inconsistent results could be the inefficiency of PSM in capturing unobserved heterogeneity between the treated and control group although this approach is proper to deal with the problem of selection bias. However, the data set (VARHS) that we will employ in this paper is less likely to prone to the problem of selection or attrition bias (Brandt & Tarp, 2017). This explains why we opt for the fixed effects model instead of PSM.

2.1.2. Credit access and its impact in Vietnam

In the context of Vietnam**,** several studies have looked at the impact of credit on agricultural productivity and farm output; however, their findings also showed inconsistent results. While Lam et al. (2019) found that credit access has a significant positive impact on agricultural output efficiency as it improves both on-farm and off-farm income, Luan and Bauer (2016) and argued that only non-farm income is affected by credit in a positive way and better-off households rather than the poor are more likely to access formal credit. Similarly, there is no evidence found in the impact of microcredit on the adoption of improved rice varieties in Vietnam as the farmers are likely to use credit to invest in off-farm activities rather than crop cultivation (Nguyen & Pham, 2020). Duong and Nghiem (2022) and Cuong (2008) suggested that micro-credit programs help alleviate poverty by enhancing productivity and household well-being, which is measured by household consumption. Nevertheless, few studies showed the opposite results, with a minor impact found in the relationship between micro-credit and household welfare (Phan et al., 2014; Nghiem et al., 2012). Especially, by employing VARHS, Phan et al. (2022) reached the similar findings by Duong and Nghiem (2022) and Cuong (2008) by concluding that microcredit aids rural households in reducing vulnerability to poverty. Furthermore, they also found that the more affluent households are better at utilizing credit, which is in line with what is found in the paper by Luan and Bauer (2016). However, Phan et al. (2023) employed VARHS again to the later study and found that an increase in credit borrowing leads to a reduction in the investment in rural children's education. This contradicts their previous findings as the educational level is a key determinant for a long-term and sustainable reduction in poverty. We also observe that Propensity Score Matching (PSM) is also a prevalent approach employed in those previous studies that we have mentioned in the context of Vietnam. Under the same argument that mentioned above, we would argue that fixed effects model is a more appropriate method concerning the problem of unobserved heterogeneity as existing studies commonly fail to tackle this problem.

2.2. The underlying mechanisms of the impact of credit on farm outcomes

Whether or not access to credit exerts an influence on farm outcomes has always been a controversial topic and carefully examined by previous researchers. Nevertheless, we should also have a clear understanding of the determinants or channels through which farm output is affected by credit availability. According to Samson and Obademi (2018), Nigerian farmers achieve higher farm productivity as credit support accommodates them with desired farm inputs including land, labor and seeds, fertilizer, etc. Indeed, Martey et al. (2019) and Moahid et al. (2022) also shown that agricultural credit enables smallholder farmers in Africa and Bangladesh to purchase necessary agricultural inputs, thus enhancing output to the optimal level. This is in agreement with the findings by Ciaian et al. (2012) in which the increase in farm use of inputs and improved productivity of farmers in central and east Europe are attributed to the additional credit. However, the authors suggest that there is no evidence found in the effect of credit constraints on land. In contrast, Tabetando et al. (2023) put forward some arguments that rural households in Uganda and Kenya are more likely to involve in land investment such as land rental or land sales with the provision of credit to deal with weather shocks. This is supported by the previous study by Laha (2013), which reveals that access to credit pose a significant impact on ground lease decisions, leading to the improvement in technology and agricultural production. The previous studies on the relationship between credit and labor force also show inconsistent findings. On the one hand, access to credit positively influences the number of hired labors in agricultural production (Oseni et al., 2019; Porgo et al., 2017). On the other hand, increasing access to credit efficiently decreases child labor rates in poor regions (Gatti & Dehejia, 2002; Nguyen & Anh, 2018).

We can see that many previous studies have looked into the relationship between credit and farm outcomes in Vietnam, and among these studies, the results still remain controversial and ambiguous. Therefore, this research aims to contribute to current academic debates by providing more transparent results. According to Luan and Bauer (2016), formal credit would mainly benefit people with a high ability to pay debt and poor farmers are likely to be excluded from formal markets; consequently, they will seek informal credit or unofficial loans. Therefore, we would capture both the impact of formal and informal credit on farm efficiency, with a focus on agriculture credit (credit applied to agriculture-related activities). Furthermore, Phan et al. (2023) explained the reason why microcredit has a positive impact on household vulnerability is due to its impact on household income and consumption. This leads to our decision to choose the main outcomes as crop yields and farm profit, as they are closely related to the farm income and household consumption. Furthermore, existing studies commonly fail to capture unobserved household characteristics, which are correlated with access to credit, in evaluating the effect of credit on farm outcomes (Barslund & Tarp, 2008; Nguyen et al., 2019). This may lead to potential endogeneity problems and, therefore, biased and inconsistent results. Accordingly, this research will aim to overcome this limitation by employing fixed effects method to capture time-invariant unobserved household characteristics, which are correlated with both access to credit and farm outcomes, and time-varying trends that affect the whole sample size. Another novelty of our research is that by using VARHS, we could take a large sample of 12 rural provinces across Vietnam into account, whereas the previous studies mostly cover the sample of a single province or specific regions. In addition, while several studies only employed the VARHS data in only one year to perform their evaluation (Luan & Bauer, 2016; Nguyen & Pham, 2020), our study will be

conducted over a period of 10 years from 2008 and 2018, which contributes to the robustness and accuracy of our findings.

Chapter 3
Theoretical framework

In order to elaborate the mechanism through which credit access affects farm outputs, we develop a function derived from the standard Cobb-Douglas production function, which reflects the relationship between inputs, namely physical capital and labor, and the amount of output produced. The aim of this section is to consolidate the theories underlying our econometric equation to evaluate the impact of changes in the inputs on the crop production or profit. Furthermore, we will focus on the interlinked relationship between access to credit, farms' investment, and farms' outcomes to explain how credit access leads to changes in a farm's production.

Assuming that a farm produces output y using its endowment z (e.g. managerial ability and self-supplied capital, land, and labor) and a composite input $g(k, l, m, n)$ of capital k, land l, labor n, and other materials m that are acquired from the market. The farm production function is then given by,

$$y = z^{1-\gamma} [g(k, l, m, n)]^{\gamma} \tag{1}$$

where $\gamma \in (0, 1)$ is a factor-income-share parameter. Then, the production satisfies the condition,

$$\frac{\partial y}{\partial x} > 0 \quad \text{and} \quad \frac{\partial^2 y}{\partial x^2} < 0 \quad \text{for } x = k, l, m, n \tag{2}$$

Let c denote the unit cost of the composite input, p denote the price, and q denote the quantity or output. The profit function is as follows:

$$\pi = p.q - cg(k, l, m, n)$$

or

$$\pi = p\, z^{1-\gamma}[g(k, l, m, n)]^{\gamma} - cg(k, l, m, n) \tag{3}$$

where the former term represents revenue, calculated by price times output, and the latter term represents the cost of the composite input. It is also noted that $q \equiv y$.

The farm's problem now is to choose the amount of $g(.)$ to maximize its profit, given by,

$$\pi = max\, \{p\, z^{1-\gamma}[g(k, l, m, n)]^{\gamma} - cg(k, l, m, n)\} \tag{4}$$

$$\text{s.t. } cg(k, l, m, n) \leq \lambda yz$$

Finally, we assume that the farm can borrow to pay for production costs and repay its debt after selling its output. The farm uses its endowment as collateral to borrow money, with a borrowing constraint so that the farm cannot borrow more than a fraction λy of its endowment z. Therefore, the higher the value of λ, the higher the degree of access to credit.

The constraint satisfies the condition,

$$\frac{\partial x}{\partial \lambda} > 0 \quad \text{for } x = k, l, m, n \tag{5}$$

Equation (1) suggests that the more inputs a household utilizes, the higher productivity their farm yields. However, once there are excessive inputs, the production process may become inefficient (see equation 2). In particular, when a farm purchases more inputs but does not expand the capacity accordingly, the production level will not accelerate but remains constant. For example, a landowner will increase the crop value produced by hiring more laborers to plough the field. Nevertheless, if he hires laborers to an unnecessary number without expanding the farm area, he will achieve no more productivity gains as it already reached the maximum. From equations (4) and (5), it suggests that the more credit a household obtains, the more likely they are to purchase more inputs such as machines, fertilizers, seeds, etc., hence, the value of output produced and profit experiences an increase correspondingly. In other words, when there is little credit earned, the portion of inputs drifts away from the optimal production level, which may lead to a fall in production.

Chapter 4
Methodology

4.1. Ordinary Least Squares (OLS) model

We estimate the impacts of credit access on farm outcomes using the following OLS regression model

$$Y_{ht} = \alpha_0 + \alpha_1 CreditAccess_{ht} + X'_{ht}\,\Phi + \upsilon_{ht} \quad (6)$$

where outcome Y_{ht} represents the total value of crop produced, total value of crop sales and farm profit (all in log form).

We follow the existing literature (Kaila & Tarp, 2019) to leave the outcome in log form. In particular, logarithmic transformation of variables in a regression model is a common method to handle cases when there is a non-linear relationship between the independent and dependent variables. Applying the logarithm to one or more variables instead of the unlogged form makes our model become linear while still effectively preserving the non-linear relationship. Furthermore, logarithmically transforming variables is a useful technique for our data regarding the transformation of originally skewed dependent variables into normally distributed data (see Figure 1 – Figure 6 below).

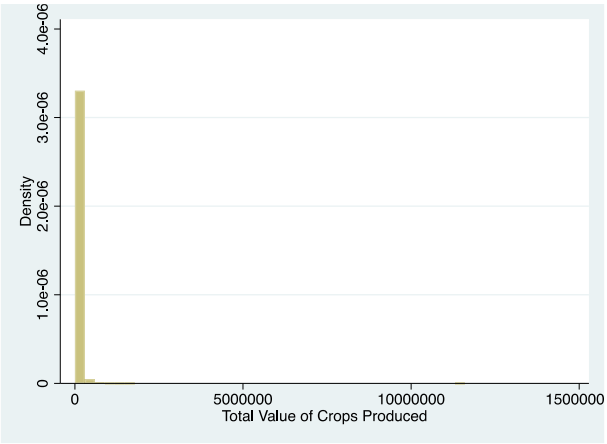

Figure 1. *Total value of crops produced*

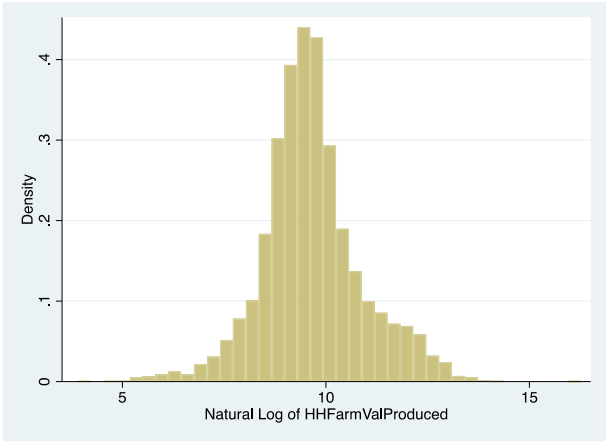

Figure 2. *Log-transformed total value of crops produced*

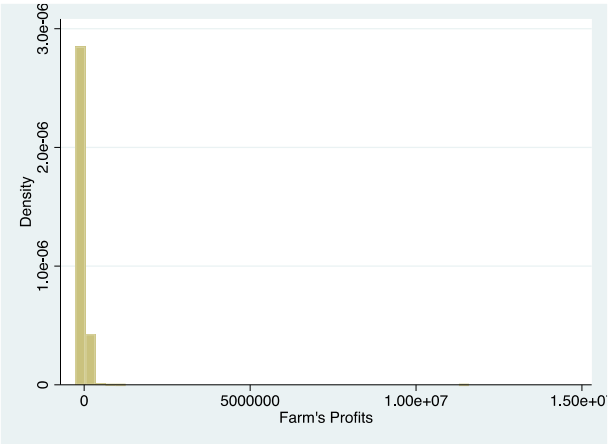

Figure 3. *Farm's profits*

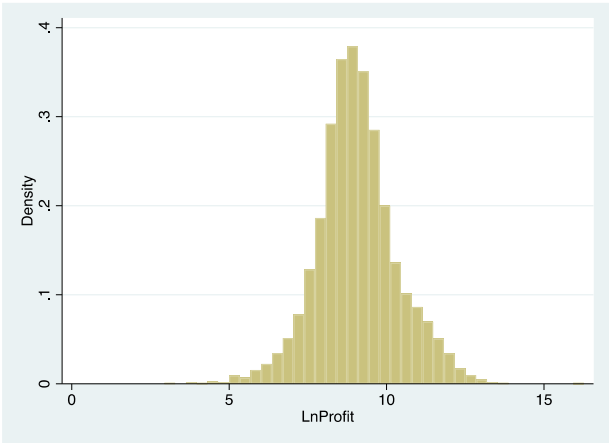

Figure 4. *Log-transformed farm's profits*

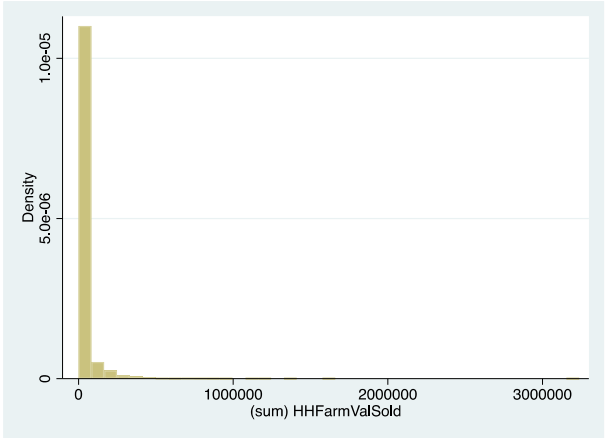

Figure 5. *Total value of crops sold*

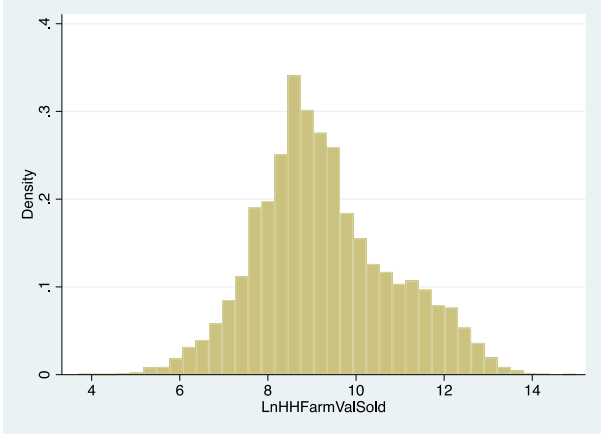

Figure 6. *Log-transformed total value of crops sold*

Source: Author's visualization using Stata

A notable concern on the use of the logarithm of profit is that this approach poses a problem, as it eliminates observations with zero or negative profits, which may skew the analysis. However,

according to Table 1, only 82 out of 9936 observations have a negative profit, accounting for approximately 0.83%. Furthermore, the household that earns negative profit are more likely to gain access to credit compared to its counterpart. Therefore, we argue that there is no need to employ other approaches such as quadratic functional form or inverse hyperbolic functions as the application of natural logarithm will not seriously affect the validity of the results.

Table 1. Summary statistics of credit access in 2 household groups

	N	Mean	SD	Min	Max
Household with negative profit	82	.146	.356	0	1
Household with positive profit	8,972	.085	.279	0	1
Total households	9,936	.078	.268	0	1

Source: Author's calculations using Stata

In equation (6), the subscripts h and t refer to household (farm) and survey year, respectively. The unit of production is household. Household outcome ≡ farm outcome. Our main explanatory variable, $CreditAccess$, is a dummy variable that takes the value of 1 if household h receives any loan for agricultural purposes in year t and 0 otherwise. X'_{ht} is a vector covariate including 2 groups. The first group includes household characteristics such as gender, age, age squared, ethnicity, and education of household head. The second group consists of household size, household composition (proportion of young children and elderly disaggregated by gender), and whether any household member is affiliated with the Communist Party. These household demographic characteristics are standard variables and are widely used in previous studies (Markussen & Tarp, 2014; Kaila & Tarp, 2019). These papers look at agriculture outcomes at the household level. ϕ is the coefficient of variables in the vector covariate X'_{ht} and υ_{ht} is the error term. The coefficient of interest α_1 which captures the effect of credit on farm outcomes hinges upon the variation in access to credit across households. Since unobserved heterogeneity across households is not accounted for, it is hard for α_1 to be interpreted as causal.

4.2. Fixed effects (FE) model

Fixed effects estimators are considered more effective for panel data that is divided into different categories such as industries, states, households, firms, etc. Especially in VARHS, there are potential factors that are correlated with both household access to credit and farm outcomes. For example, households that are more capable of farming can also be more likely to get access to agricultural credit. At the same time, there is also a probability that these more capable households will produce more output as well as make more profit. Hence, the increase in farm output and profit may be due to household capability rather than due to their access to agricultural credit. Another example is that households with better connections find it easier to gain access to credit and simultaneously they are more likely to produce more output and generate higher profit. In this case, we do not know if the change in the total value of crops produced and the change in profit is induced by the household's connections or by the access to agricultural loans. It is worth noting that these unobserved heterogeneities across households are inevitable since we cannot expect different households to have the same farming capabilities or the same degree of connections.

Failing to control for these factors (e.g. abilities, connections, etc.) could bias our estimated effects of credit access on farm outcomes (Barslund & Tarp, 2008; Nguyen et al., 2019). In other words, these confounding factors, if not controlled for, will prevent us from estimating the causal effects of credit access on farm outcomes. By including fixed effects (group dummies), we can control for these differences across households as FE estimation absorbs all the across-household variation into with-in household variation, which is necessary for reducing omitted variable bias. In equation (6), the estimation of α_1 hinges upon the variation in credit access across households, and unobserved heterogeneity across households are not accounted for; therefore, it is hard for α_1 to be interpreted as causal. Therefore, we proceed to estimate the household fixed effects model given by,

$$Y_{ht} = \beta_0 + \beta_1 CreditAccess_{ht} + X'_{ht}\,\Omega + \lambda_h + \delta_t + \epsilon_{ht} \quad (7)$$

The terms λ_h and δ_t respectively represent household fixed effects and year fixed effects. We also denote by ϵ_{ht} an idiosyncratic and time-varying error term. Household fixed effects λ_h captures the unobserved household heterogeneity which is jointly correlated with the access to credit and farm outcomes. The estimation of β_1 now depends on the within-household variation in credit access. Year fixed effects δ_t captures the influence of aggregate trends. For example, agricultural loans could become very accessible to all households in one year but not the other year. Even when we are making the within-household comparison, favorable weather in a particular year can raise farm production and profit for all households. These aggregate time-varying events affecting all households (such as policy change or favorable weather) can be controlled for by year-fixed effects (δ_t). The interpretation of β_1 is as follows. Holding other factors constant (ceteris paribus), gaining access to an agricultural loan raises the farm's total output value (profit) by $100 \times \beta_1$%. "Other factors" in (7) now include the (i) unobserved household-specific time-invariant characteristics as well as (ii) the aggregate time-varying events affecting all households which are not controlled for in equation (6). As a result, we expect the magnitude of β_1 to be smaller than the magnitude of α_1.

Similarly, we use the same approach to explain the underlying reasons behind the difference in farm outcomes with the provision of credit by accounting for the impact of credit access on other input variables. Y_{ht} in (7) now represents household investment in agricultural inputs, land area and labor force. Other variables are defined as above. The coefficient of interest is β_1.

It is noteworthy to mention that the FE approach does not address within-household confounding factors that are changing over time during the panel period, in other words, unobserved time-varying heterogeneity, and thus cannot eliminate all potential endogeneity problems. For example, we cannot account for farmers health conditions such as chronic diseases which affects both the farm activities and access to the credit market. Thus, we need to assume that these unobserved individual-specific factors are correlated with independent variables (credit access and household characteristics) and remain constant over time. Nevertheless, those problems are widespread and commonly faced by many previous studies, and we still believe that FE estimates are more robust to bias compared to other models such as OLS or random effects model regarding the scope and objective of this study.

Chapter 5
Data and empirical results

5.1. Data description

To measure the impacts of access to credit on farms, we employ the Vietnam Access to Resources on Household Survey (VARHS), conducted in even years from 2008 to 2018. The VARHS is a part of the UNU-WIDER's project on "Structural transformation and inclusive growth in Vietnam" and data were processed by and obtained from the Economic Research Information Center. The data was first collected in 2006 and the latest version being published is the 2018 dataset as there has been no onward survey until now after the outbreak of COVID-19 in 2019. Also, we removed the survey in 2006 because it has a lot of errors and is inconsistent with the latter years. VARHS is an unbalanced panel survey of rural households in twelve provinces of Vietnam including Dak Lak, Dak Nong, Dien Bien, Ha Tay (Ha Noi nowadays), Khanh Hoa, Lai Chau, Lam Dong, Lao Cai, Long An, Nghe An, Phu Tho, and Quang Nam. To establish the balanced panel data between 2008 and 2018, only households attending all survey years are included. The participants are therefore 1,656 households, which are interviewed every two years over a ten-year time period. Although being located in different places across Vietnam, these provinces are all relatively poor and depend heavily on agriculture as their major source of income. According to Figure 7, VARHS covers most regions of Vietnam, ranging from the North to the South, specifically major agricultural regions such as Red River Delta, Central Coast, Central Highlands, and Mekong River Delta (MRD), which constitutes a representative sample of the rural areas in Vietnam. It is also noted that before VARHS, there was no existing survey to provide background information about the rural characteristics, how credit was allocated to rural households, and how these households utilized or allocated such credit resources. This prevents policymakers and financial institutions from tackling the pressing issues regarding the rural credit markets.

Individuals in the households represented in this panel have all lived through and experienced a critical period in Vietnam's economic development while bearing their personal and household responsibilities. Furthermore, the VARHS has many ethnic and rural poor households that have been largely left out of traditional growth processes. This means that the data from VARHS can be used to identify policies for comprehensive growth that benefit all groups and minorities without leaving any groups behind. The advantages of having such panel data are significant. First, we can capture aggregate trends over time more precisely than using repeated cross-sectional data. Second, unobserved, time-invariant household features will be under control, and individual-level variations over time can be accounted for. Furthermore, VARHS panel data set also helps to overcome the problem of selection bias and endogeneity in assessing the impact of credit (Phan et al., 2023). Therefore, this panel dataset is a great fit for our main methodology, namely fixed effects, to overcome the problem of heterogeneity.

It is inevitable to have sample attrition bias with a household survey like VARHS due to several possible reasons such as household rejection to retake the interview or all household members' deaths. However, those reasons are reported to be less common for attrition rate than the problem of the migration of participants (Brandt and Tarp, 2017). The exclusion of such a group might bias the validity of our results. Due to VARHS's effective implementation and the

low number of migrants in rural areas in Vietnam, the attrition rate in VARHS is insignificant, with 7% reported from 2006 to 2014 (Brandt and Tarp, 2017).

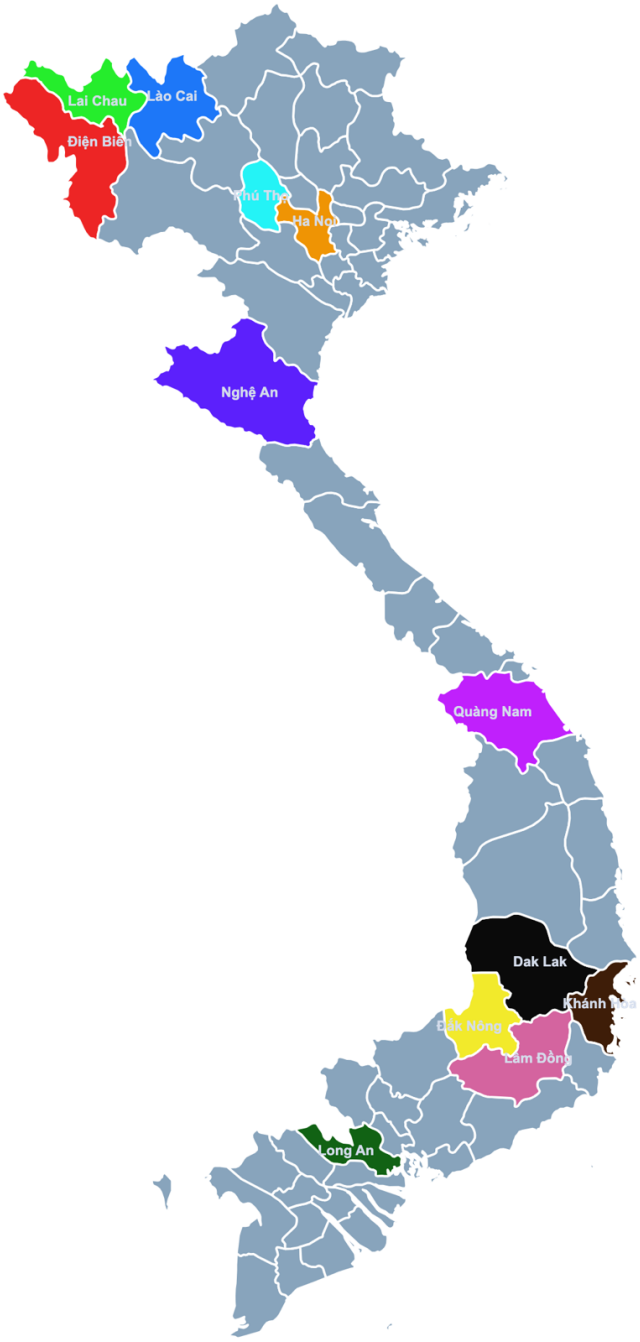

***Figure 7**. Location of the twelve provinces in VARHS*

Source: Proposed by the author

Table 2. Variable definitions and descriptive statistics

Variable	Definitions	N	Mean	SD	Min	Max
HHSize	Household size	9934	4.30	1.79	1	14
HHGender	Household head gender (1 if household head is male, 0 otherwise)	9934	1.22	0.41	1	2
HHAge	Age of household head	9934	54.79	12.85	18	99
HHAge2	Square of age of household head	9934	3166.50	1507.00	324	9801
HHElementary	Education of household head (1 if household head complete elementary school, 0 otherwise)	9934	0.77	0.42	0	1
HHEthnicity	Ethnicity of household head (1 if household head is Kinh, 0 otherwise)	9936	0.78	0.41	0	1
ComunistParty	1 if household member is associated with Communist Party, 0 otherwise	9934	0.09	0.29	0	1
HHFe0to6	% household female age 0-6	9934	0.02	0.07	0	.5
HHFe7to15	% household female age 7-15	9934	0.05	0.11	0	.667
HHFe60to999	% household female age 60+	9934	0.11	0.21	0	1
HHMa0to6	% household male age 0-6	9934	0.03	0.07	0	.667
HHMa7to15	% household male age 7-15	9934	0.06	0.12	0	.75
HHMa60to999	% household male age 60+	9934	0.07	0.16	0	1
CrdtAccess3	1 if household receives agricultural loan, 0 otherwise	9936	0.08	0.27	0	1
Profit	Farm's profit	9056	21475.06	129383.89	-270950	11594610
HHFarmValProduced	Total value of crops produced	9056	38352.47	144681.52	50	11600000
HHFarmValSold	Total value of crops sold	9056	27152.44	83504.36	0	3237379
HHAgrCapital	Household investments in agricultural capital, e.g. machine (000 VND)	9936	1741.64	17676.61	0	1280200
HHFarmAreaProduced	Farm area used for crop production	9056	30359.61	149618.69	0	2049798
HHFarmCostHiredLbrs	Cost of hiring labor to work in farms (000 VND)	9062	2282.78	7733.54	0	200000
HHAgrWorkDays	Number of days household working in the farm, monthly average	9936	17.39	15.97	0	206.583

Source: Author's calculations using Stata

Table 2 reports variable definitions and descriptive statistics. The main explanatory variable (CrdAccess3) is a dummy variable that takes the value of 1 if the household receives any loan for agricultural purposes and 0 otherwise. Other variables used in our econometric model to estimate the output include household characteristics (gender, age, age squared, ethnicity, and education of household head), household size, household composition (proportion of young children and elderly disaggregated by gender), and whether any household member is associated with the Communist Party. According the statistical data, there are approximately four members in a household. 22% of the household heads are female. The average age of the household head is approximately 54 years old. For the age variable, we add a squared term to capture possible non-linear effects. In terms of the education level, almost 77% of the household heads complete elementary school, which shows that the majority of the participants is literate. 78% of the sample size belongs to the Kinh ethnic group, however, only 9% are affiliated with Communist Party. As reported in the household composition statistics, household members that belong to working age account for the majority of the household size. Noteworthily, only 8% of the total sample size are able to gain access to agricultural credit. The dependent variables in the regression model are farms' profit (Profit), total value of crops produced (HHFarmValProduced), total value of crops sold (HHFarmValSold), farms' investment in agricultural capital (HHAgrCapital), farm area used for crop production (HHFarmAreaProduced), cost of hiring laborers to work in farms (HHFarmCost_HiredLbrs), and number of days household working in the farm (HHAgrWorkDays).

Regarding farm's profit (Profit), this variable is calculated by taking revenue minus all costs, including input cost and intermediate costs as follows:

$$Profit = Total\ revenue - Total\ cost \tag{8}$$

$$Total\ cost = Input\ cost + Intermediate\ cost\ 1 + Intermediate\ cost\ 2 + Intermediate\ cost\ 3 \tag{9}$$

where
$Input\ cost$: farm's cost of hired labors, capita rental, maintainance and cattle rental
$Intermediate\ cost\ 1$: farm's cost of seeds and saplings, fertilizers and herbicide
$Intermediate\ cost\ 2$: farm's cost of farm tools, irrigation, energy
$Intermediate\ cost\ 3$: farm's other costs

It is also noted that the total value of crops produced and the farm's profit modules are defined consistently through the six even years of VARHS. For example, items and types of activities generating the total value of crops produced and farm revenue are the same across the six rounds.

5.2. Empirical results

5.2.1. OLS regression

The production function, as specified in equation (1), has independent variables such as land, labor, capital, and materials, which establishes the relationship between inputs and output. Therefore, we initially proceed to run the regression for production function with dependent variable being output and independent variables comprising all inputs to warrant further investigation.

Table 3. Impact of farm inputs on farm outputs with OLS model

VARIABLES	(1) LnHHFarmValProduced	(2) LnHHFarmValSold	(3) LnProfit
LnHHAgrCapital	0.0262***	0.0322***	0.0285***
	(0.00264)	(0.00476)	(0.00345)
LnHHFarmAreaProduced	0.290***	0.359***	0.314***
	(0.0174)	(0.0260)	(0.0200)
LnHHAgrWorkDays	0.195***	0.107***	0.228***
	(0.0138)	(0.0221)	(0.0172)
LnHHFarmCost_HiredLbrs	0.500***	0.659***	0.437***
	(0.0106)	(0.0167)	(0.0130)
HHSize	0.0290***	0.0112	0.0383***
	(0.00677)	(0.0118)	(0.00881)
HHGender	-0.0626**	-0.0419	-0.0672**
	(0.0247)	(0.0451)	(0.0327)
HHAge	-0.00398	0.00186	-0.00105
	(0.00486)	(0.00945)	(0.00631)
HHAge2	2.22e-05	-3.96e-05	-1.65e-05
	(4.15e-05)	(8.30e-05)	(5.42e-05)
HHElementary	-0.0277	-0.0750*	-0.0393
	(0.0224)	(0.0419)	(0.0288)
HHEthnicity	0.147***	0.306***	0.0398
	(0.0232)	(0.0459)	(0.0302)
ComunistParty	0.0528*	0.000174	0.0334
	(0.0298)	(0.0594)	(0.0402)
HHFe0to6	-0.378***	-0.300	-0.440***
	(0.126)	(0.254)	(0.162)
HHFe7to15	-0.135*	0.0279	-0.0937
	(0.0778)	(0.147)	(0.101)
HHFe60to999	-0.129**	-0.150	-0.0683
	(0.0605)	(0.111)	(0.0818)
HHMa0to6	-0.337***	-0.680***	-0.409**
	(0.122)	(0.232)	(0.171)
HHMa7to15	-0.0547	0.106	-0.0531
	(0.0785)	(0.138)	(0.101)
HHMa60to999	0.00399	0.0172	-0.000551
	(0.0769)	(0.151)	(0.104)
Constant	3.255***	0.902***	2.727***
	(0.176)	(0.319)	(0.223)

Observations	5,282	4,151	5,226
R-squared	0.746	0.607	0.620

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

Source: Author's calculations using Stata

According to table 3, an increase in agricultural capital will lead to 2.62% growth in crop yields, 3.22% rise in crop sales and 2.85% increase in profit. For the investment in land area, the figures witness a more dramatic increase. In particular, a unit increase in farm size will boost the crop production by 29%, total value of crop sales by 36% and profit by 31%. Similarly, by extending the number of working days on the farm, farmers experience an increase from roughly 10% to 20% in those farm outcomes. The biggest increase is reported in the spending on the cost of hiring labor coefficients. With one more unit of hiring labor cost, there will be a 50% increase in farm production, 66% increase in farm sales and 44% in farm profit. These statistics all support the theoretical framework that extra investment in the farm inputs will guarantee higher yields in farm outputs.

Table 4. Impact of credit access on farm outputs with OLS model

VARIABLES	(1) LnHHFarmValProduced	(2) LnHHFarmValSold	(3) LnProfit
CrdtAccess3	1.307***	1.522***	1.243***
	(0.0460)	(0.0588)	(0.0464)
HHSize	0.116***	0.103***	0.125***
	(0.00911)	(0.0131)	(0.00937)
HHGender	-0.247***	-0.171***	-0.258***
	(0.0375)	(0.0565)	(0.0386)
HHAge	0.0214***	0.0272**	0.0153**
	(0.00703)	(0.0108)	(0.00698)
HHAge2	-0.000221***	-0.000276***	-0.000182***
	(6.16e-05)	(9.48e-05)	(6.08e-05)
HHElementary	-0.0623**	0.00449	-0.0980***
	(0.0308)	(0.0474)	(0.0310)
HHEthnicity	-0.0547*	0.140***	-0.206***
	(0.0293)	(0.0469)	(0.0305)
ComunistParty	0.0970**	0.292***	0.0892*
	(0.0491)	(0.0765)	(0.0498)
HHFe0to6	-1.319***	-1.155***	-1.400***
	(0.173)	(0.284)	(0.179)
HHFe7to15	-0.702***	-0.448**	-0.668***
	(0.117)	(0.181)	(0.122)
HHFe60to999	-0.809***	-0.622***	-0.737***
	(0.0860)	(0.126)	(0.0861)
HHMa0to6	-1.026***	-1.569***	-0.970***
	(0.167)	(0.265)	(0.173)
HHMa7to15	-0.658***	-0.559***	-0.664***
	(0.108)	(0.161)	(0.111)
HHMa60to999	-0.158	-0.0491	-0.0856
	(0.120)	(0.176)	(0.123)
Constant	9.162***	8.274***	8.875***

	(0.205)	(0.313)	(0.204)
Observations	9,054	6,362	8,970
R-squared	0.177	0.140	0.174

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

Source: Author's calculations using Stata

As reported in Table 4, having access to agricultural credit leads to a 130.7% growth in the total value of crops produced, a 152.2% rise in the total value of crops sold, and a 124.3% increase in farm profit. To further explain these significant growths, we refer to Table 5 below considering the impact of credit on different investment decisions. In particular, farmers are more likely to purchase agricultural capital by 196.6% and expand the farm area used for crop production by 111.1%. Likewise, farmers also spend more days working and more expenses to hire laborers to work on farms, with an increase of 40.6% and 97.3%, respectively.

Table 5. Impact of credit access on farm investments with OLS model

VARIABLES	(1) LnHHAgrCapital	(2) LnHHFarmAreaProduced	(3) LnHHAgrWorkDays	(4) LnHHFarmCost_HiredLbrs
CrdtAccess3	1.966***	1.111***	0.406***	0.973***
	(0.138)	(0.0477)	(0.0270)	(0.0608)
HHSize	0.211***	0.120***	0.0993***	0.0749***
	(0.0241)	(0.00990)	(0.00663)	(0.0136)
HHGender	-0.758***	-0.152***	-0.237***	-0.0955*
	(0.0845)	(0.0434)	(0.0272)	(0.0521)
HHAge	-0.0136	0.0116	0.0181***	0.00762
	(0.0176)	(0.00830)	(0.00561)	(0.0108)
HHAge2	3.01e-05	-0.000147**	-0.000198***	-7.95e-05
	(0.000145)	(7.47e-05)	(4.93e-05)	(9.34e-05)
HHElementary	-0.206**	-0.156***	-0.0445**	-0.0488
	(0.0829)	(0.0366)	(0.0227)	(0.0465)
HHEthnicity	-0.0347	-0.446***	-0.366***	0.0743
	(0.0917)	(0.0350)	(0.0212)	(0.0461)
ComunistParty	-0.0505	0.0402	-0.0623*	0.246***
	(0.112)	(0.0563)	(0.0341)	(0.0674)
HHFe0to6	-2.165***	-1.535***	-0.968***	-1.036***
	(0.472)	(0.189)	(0.142)	(0.257)
HHFe7to15	0.209	-0.612***	-0.288***	-0.693***
	(0.334)	(0.131)	(0.0906)	(0.177)
HHFe60to999	-0.415***	-0.865***	-0.515***	-0.539***
	(0.152)	(0.107)	(0.0629)	(0.123)
HHMa0to6	-0.862*	-0.997***	-0.476***	-0.761***
	(0.487)	(0.181)	(0.125)	(0.253)
HHMa7to15	-0.539*	-0.441***	-0.252***	-0.593***
	(0.298)	(0.127)	(0.0794)	(0.165)
HHMa60to999	-1.013***	-0.171	-0.0508	-0.0670
	(0.211)	(0.147)	(0.0914)	(0.164)
Constant	3.176***	8.711***	2.470***	6.885***
	(0.524)	(0.238)	(0.162)	(0.314)
Observations	9,934	9,034	9,157	5,324
R-squared	0.078	0.161	0.167	0.082

Source: Author's calculations using Stata

5.2.2. Fixed effects regression

As mentioned before, FE models account for unobserved individual-specific characteristics that are constant over time. By including individual fixed effects, the model effectively controls for these time-invariant heterogeneities. Furthermore, after conducting two approaches, we observe that the R-squared value of FE is much greater compared to OLS in our regression (see Appendix 1 - 6), which implies that the FE model is more effective in its explanatory power and more compatible with this data compared to other available models (Keharom et al., 2016; Nepal & Thapa, 2009). First, we regress farm inputs (capital, labor, land) on farm outputs (farm production, farm sales and farm profit) to justify the main results. Then, we present the results of the impacts of credit access on farm outcomes after accounting for time-invariant individual-specific factors. Moreover, to further explain the possible channels through which credit access exerts an influence on farm outcomes, we carry out the regression where farm inputs are response variables and credit is the main explanatory variable.

Table 6. Impact of farm inputs on farm outputs with Fixed effects model

VARIABLES	(1) LnHHFarmValProduced	(2) LnHHFarmValSold	(3) LnProfit
LnHHAgrCapital	0.00102	-0.00106	-0.000733
	(0.00292)	(0.00545)	(0.00412)
LnHHFarmAreaProduced	0.146***	0.122***	0.169***
	(0.0144)	(0.0219)	(0.0189)
LnHHAgrWorkDays	0.177***	0.136***	0.204***
	(0.0157)	(0.0258)	(0.0211)
LnHHFarmCost_HiredLbrs	0.250***	0.251***	0.187***
	(0.0115)	(0.0192)	(0.0155)
HHSize	0.0424***	0.0101	0.0444***
	(0.0101)	(0.0171)	(0.0137)
HHGender	-0.0119	-0.153	0.0479
	(0.0528)	(0.0971)	(0.0767)
HHAge	0.00864	0.00526	0.0178
	(0.00916)	(0.0185)	(0.0125)
HHAge2	-7.71e-05	-4.45e-05	-0.000158
	(7.99e-05)	(0.000168)	(0.000111)
HHElementary	-0.0177	0.0310	-0.00784
	(0.0338)	(0.0637)	(0.0458)
HHEthnicity	-0.0479	-0.0198	0.0508
	(0.0881)	(0.188)	(0.163)
ComunistParty	0.0122	-0.0195	-0.00791
	(0.0441)	(0.0794)	(0.0623)
HHFe0to6	-0.393***	-0.162	-0.360*
	(0.142)	(0.290)	(0.203)
HHFe7to15	-0.0945	-0.0177	0.0470
	(0.106)	(0.199)	(0.166)
HHFe60to999	-0.223**	-0.166	-0.191
	(0.0918)	(0.177)	(0.123)
HHMa0to6	-0.303*	-0.301	-0.341
	(0.166)	(0.285)	(0.228)
HHMa7to15	-0.104	-0.0238	-0.109
	(0.103)	(0.178)	(0.149)

HHMa60to999	-0.0166	-0.0795	-0.0598
	(0.119)	(0.218)	(0.168)
Constant	6.151***	6.313***	5.238***
	(0.320)	(0.633)	(0.437)
Observations	5,117	3,891	5,053
R-squared	0.886	0.836	0.799

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

Source: Author's calculations using Stata

According to table 6, there is no evidence found in the impact of agricultural capital on farm outcomes. In terms of the land investment, a unit increase in farm size will accelerate the crop production by 14.6%, total value of crop sales by 12.2% and profit by approximately 17%. Likewise, by extending the number of working days on the farm, farmers witness a growth of 17.7% in crop production, 13.6% in crop sales and 20% in farm profit. The most significant increase is reported in the hiring labor expenditure figures. In particular, with one more unit of hiring labor cost spent, there will be a 25% rise in farm production and farm sales, and 18.7% increase in farm profit. These statistics appear to validate the equation (1) from the theoretical framework that greater investment in the farm inputs will lead to an increase in farm yields.

Table 7. Impact of credit access on farm outputs with Fixed effects model

VARIABLES	(1) LnHHFarmValProduced	(2) LnHHFarmValSold	(3) LnProfit
CrdtAccess3	0.129***	0.177***	0.115***
	(0.0315)	(0.0419)	(0.0367)
HHSize	0.0730***	0.0375***	0.0788***
	(0.00860)	(0.0137)	(0.0102)
HHGender	-0.0719	-0.0422	-0.00754
	(0.0518)	(0.0797)	(0.0594)
HHAge	0.0344***	0.0337**	0.0297***
	(0.00983)	(0.0153)	(0.0103)
HHAge2	-0.000286***	-0.000284**	-0.000246***
	(8.21e-05)	(0.000136)	(8.91e-05)
HHElementary	0.00906	0.0651	0.0120
	(0.0306)	(0.0505)	(0.0359)
HHEthnicity	-0.0793	-0.0157	-0.0944
	(0.0630)	(0.160)	(0.0895)
ComunistParty	0.0856**	0.0559	0.0836
	(0.0423)	(0.0717)	(0.0509)
HHFe0to6	-0.319**	-0.143	-0.506***
	(0.138)	(0.235)	(0.161)
HHFe7to15	-0.147	0.00444	-0.110
	(0.0984)	(0.165)	(0.119)
HHFe60to999	-0.331***	-0.266*	-0.332***
	(0.0887)	(0.147)	(0.104)
HHMa0to6	-0.391***	-0.594***	-0.540***
	(0.139)	(0.224)	(0.160)
HHMa7to15	-0.207**	-0.0518	-0.307***
	(0.0927)	(0.156)	(0.110)
HHMa60to999	0.0224	-0.0911	0.0398

	(0.120)	(0.190)	(0.139)
Constant	8.549***	8.232***	7.998***
	(0.303)	(0.471)	(0.314)
Observations	9,030	6,201	8,944
R-squared	0.773	0.765	0.701

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

Source: Author's calculations using Stata

As evident in Table 7, having access to agricultural credit leads to a 12.9% rise in the total value of crops produced, a 17.7% rise in the total value of crops sold and an 11.5% increase in farm profit. Moreover, the other explanatory variables also exert an impact on crop yields, crop sales and profit. Household size is associated with an increase in those farm outcomes, which shows that a household with more members increases labor force participation rate as well as the productivity rate. The age of the household head is found to be positively associated with farm outcomes as when the head of a household gets one year older, farm outcomes increase by 3%, implying that the older the household head becomes, the more efficient they are in farming activities. Besides, a household achieves higher crop yields once its member is affiliated with Communist Party, with 8.6% increase reported. Based on the household composition coefficients, a household in which children and elderly whose gender is female will significantly decrease crop outcomes by roughly 30%, which is as expected. Similarly, the male population at the age of under 15 poses a negative impact on those farm outcomes.

Moving to Table 8, we can see that farmers are able to achieve higher production levels with the presence of credit through a 22.3% increase in the investment in agricultural capital and a 14.7% growth in the farm area used for crop production. Nevertheless, unlike the significant coefficients found in the investment in the labor force in OLS, there is no evidence that gaining access to credit will increase the cost of hiring laborers and the number of working days on the farm. The possible explanation for these statistically insignificant coefficients could be attributed to the ambiguous impact of credit on the labor force. In particular, credit programs enable farmers to either increase the labor hiring costs and working days to yield higher returns or cut down on those factors as they attain greater technical efficiency through the investment in advanced farming practices.

Table 8. Impact of credit access on farm investments with Fixed effects model

VARIABLES	(1) LnHHAgrCapital	(2) LnHHFarmAreaProduced	(3) LnHHAgrWorkDays	(4) LnHHFarmCost_HiredLbrs
CrdtAccess3	0.223*	0.147***	-0.0236	0.0767
	(0.140)	(0.0420)	(0.0302)	(0.0550)
HHSize	0.114***	0.0726***	0.0650***	0.0237
	(0.0322)	(0.0106)	(0.00865)	(0.0168)
HHGender	-0.751***	0.00888	-0.0675	-0.0187
	(0.182)	(0.0634)	(0.0500)	(0.0891)
HHAge	0.0364	0.0343***	0.0384***	0.0188
	(0.0281)	(0.0109)	(0.00858)	(0.0175)
HHAge2	-0.000280	-0.000304***	-0.000309***	-0.000179
	(0.000239)	(9.52e-05)	(7.77e-05)	(0.000148)
HHElementary	-0.0162	0.0509	-0.0203	-0.0402
	(0.115)	(0.0427)	(0.0298)	(0.0617)
HHEthnicity	-0.195	-0.210**	-0.0583	-0.0319
	(0.316)	(0.0915)	(0.0954)	(0.186)
ComunistParty	0.0904	0.0609	0.0895**	0.0890
	(0.151)	(0.0524)	(0.0422)	(0.0816)
HHFe0to6	-0.378	-0.575***	-0.296**	0.0750
	(0.502)	(0.176)	(0.144)	(0.283)
HHFe7to15	0.192	-0.0770	-0.0820	-0.0486
	(0.373)	(0.130)	(0.0973)	(0.190)
HHFe60to999	0.250	-0.332***	-0.200**	-0.183
	(0.232)	(0.113)	(0.0883)	(0.157)
HHMa0to6	0.476	-0.301*	-0.412***	-4.37e-05
	(0.498)	(0.166)	(0.133)	(0.260)
HHMa7to15	0.0791	-0.197*	-0.297***	-0.231
	(0.349)	(0.118)	(0.0882)	(0.180)
HHMa60to999	-0.448	-0.0789	-0.0699	-0.365*
	(0.305)	(0.150)	(0.119)	(0.208)
Constant	1.703*	7.584***	1.370***	6.819***
	(0.912)	(0.329)	(0.258)	(0.557)
Observations	9,934	9,008	9,139	5,161
R-squared	0.477	0.653	0.593	0.694

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

Although purchasing more agricultural capital does not necessarily increase farm outputs based on Table 6, credit borrowings enhance farm outcomes by allowing farmers to invest in agricultural capital according to Table 7 and Table 8. One of the plausible reasons for this could be that farmers could not afford to invest in the capital for agricultural purposes such as modern machines without credit, and that with the provision of credit, they are now able to borrow money to invest in these inputs, which helps to increase the outputs accordingly.

It is also noted that the FE coefficients are much smaller in comparison with the OLS coefficients. This implies that OLS regression might overestimate the impact of credit access on farm outcomes as it does not effectively eliminate unobserved time-invariant heterogeneity or individual-specific factors such as farming capability, household connections, etc. In other words, failing to capture those factors may magnify the coefficients as OLS results are the aggregate impact of both access to credit and these aforementioned household-specific characteristics. Therefore, our results suggest that FE coefficients are more valid and robust to bias.

Now, we carry out robustness check for the main results presented above by regressing both access to credit and farm inputs on farm outcomes. As evident from Table 9, the coefficients appear to validate the previous results regarding the impact of credit access and the farm inputs on the total value of crops produced, total value of crop sales, and crop profit. It is also reasonable when all coefficients diminish in degree as the inclusion of both credit access and farm inputs might absorb the actual impact of each other.

Table 9. Robustness check for the mechanisms

VARIABLES	(1) LnHHFarmValProduced	(2) LnHHFarmValSold	(3) LnProfit
CrdtAccess3	0.0908***	0.142***	0.0779**
	(0.0287)	(0.0435)	(0.0392)
LnHHAgrCapital	0.000971	-0.00119	-0.000772
	(0.00291)	(0.00541)	(0.00411)
LnHHFarmAreaProduced	0.145***	0.120***	0.167***
	(0.0144)	(0.0218)	(0.0189)
LnHHAgrWorkDays	0.178***	0.137***	0.205***
	(0.0157)	(0.0258)	(0.0211)
LnHHFarmCost_HiredLbrs	0.249***	0.251***	0.186***
	(0.0115)	(0.0192)	(0.0155)
HHSize	0.0426***	0.0106	0.0446***
	(0.0101)	(0.0171)	(0.0137)
HHGender	-0.00660	-0.146	0.0522
	(0.0526)	(0.0969)	(0.0768)
HHAge	0.00846	0.00484	0.0177
	(0.00916)	(0.0184)	(0.0126)
HHAge2	-7.65e-05	-4.27e-05	-0.000158
	(7.99e-05)	(0.000168)	(0.000111)
HHElementary	-0.0157	0.0348	-0.00623
	(0.0337)	(0.0634)	(0.0458)
HHEthnicity	-0.0564	-0.0356	0.0435
	(0.0884)	(0.188)	(0.163)
ComunistParty	0.0134	-0.0195	-0.00685
	(0.0443)	(0.0797)	(0.0624)
HHFe0to6	-0.420***	-0.224	-0.384*
	(0.142)	(0.291)	(0.203)

HHFe7to15	-0.106	-0.0460	0.0369
	(0.106)	(0.198)	(0.165)
HHFe60to999	-0.221**	-0.165	-0.191
	(0.0908)	(0.176)	(0.123)
HHMa0to6	-0.324*	-0.346	-0.358
	(0.166)	(0.286)	(0.228)
HHMa7to15	-0.118	-0.0522	-0.121
	(0.103)	(0.178)	(0.149)
HHMa60to999	-0.0201	-0.0853	-0.0620
	(0.119)	(0.218)	(0.168)
Constant	6.165***	6.339***	5.250***
	(0.321)	(0.632)	(0.438)
Observations	5,117	3,891	5,053
R-squared	0.887	0.837	0.800

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

Source: Author's calculations using Stata

5.2.3. Robustness check at different fixed effects levels

Now, we proceed to run robustness tests for the FE coefficients with Province, District and Village fixed effects. According to Table 10 – 12, it is evident that credit access has a significantly positive impact on all farm outcomes including farm production (total value of crops produced), farm sales (total value of crops sold) and farm profit. This validates the results captured by using Household fixed effects in Table 7.

Table 10. Robustness test for the impact of credit access on the total value of crops produced

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.619***	0.385***	0.275***
	(0.0563)	(0.0527)	(0.0463)
HHSize	0.107***	0.107***	0.116***
	(0.0128)	(0.0115)	(0.0100)
HHGender	-0.272***	-0.177***	-0.161***
	(0.0556)	(0.0517)	(0.0454)
HHAge	0.0225**	0.0273***	0.0216**
	(0.0104)	(0.00956)	(0.00916)
HHAge2	-0.000231**	-0.000265***	-0.000204**
	(9.22e-05)	(8.52e-05)	(8.17e-05)
HHElementary	0.00397	-0.00298	0.00510
	(0.0419)	(0.0384)	(0.0353)
HHEthnicity	0.0928	0.0108	-0.128
	(0.0634)	(0.0886)	(0.116)
ComunistParty	0.0474	0.0515	0.0591
	(0.0629)	(0.0571)	(0.0533)
HHFe0to6	-1.022***	-0.854***	-0.884***
	(0.196)	(0.176)	(0.160)
HHFe7to15	-0.668***	-0.599***	-0.577***
	(0.143)	(0.128)	(0.116)
HHFe60to999	-0.660***	-0.692***	-0.702***

	(0.108)	(0.102)	(0.0970)
HHMa0to6	-0.708***	-0.795***	-0.819***
	(0.181)	(0.170)	(0.153)
HHMa7to15	-0.585***	-0.573***	-0.560***
	(0.125)	(0.119)	(0.106)
HHMa60to999	-0.176	-0.0515	-0.0688
	(0.153)	(0.148)	(0.138)
Constant	9.060***	8.872***	9.048***
	(0.305)	(0.283)	(0.275)
Observations	9,054	9,054	9,052
R-squared	0.390	0.477	0.567

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

Source: Author's calculations using Stata

Table 11. Robustness test for the impact of credit access on the total value of crops sold

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.556***	0.347***	0.261***
	(0.0555)	(0.0515)	(0.0464)
HHSize	0.0927***	0.0830***	0.0801***
	(0.0147)	(0.0132)	(0.0120)
HHGender	-0.224***	-0.166***	-0.158***
	(0.0677)	(0.0622)	(0.0568)
HHAge	0.0217*	0.0246**	0.0220**
	(0.0123)	(0.0117)	(0.0110)
HHAge2	-0.000225**	-0.000249**	-0.000211**
	(0.000109)	(0.000104)	(9.54e-05)
HHElementary	0.105**	0.0715	0.0727
	(0.0516)	(0.0481)	(0.0459)
HHEthnicity	0.195**	0.152	-0.0297
	(0.0786)	(0.109)	(0.162)
ComunistParty	0.125	0.0955	0.103
	(0.0812)	(0.0737)	(0.0693)
HHFe0to6	-0.802***	-0.629***	-0.519**
	(0.257)	(0.229)	(0.225)
HHFe7to15	-0.487***	-0.464***	-0.476***
	(0.178)	(0.165)	(0.152)
HHFe60to999	-0.354***	-0.375***	-0.428***
	(0.125)	(0.120)	(0.116)
HHMa0to6	-0.960***	-0.992***	-1.003***
	(0.251)	(0.230)	(0.220)
HHMa7to15	-0.479***	-0.411***	-0.419***
	(0.153)	(0.143)	(0.143)
HHMa60to999	-0.134	-0.00296	-0.0676
	(0.185)	(0.177)	(0.162)
Constant	8.481***	8.437***	8.628***
	(0.358)	(0.346)	(0.342)
Observations	6,362	6,361	6,353
R-squared	0.500	0.562	0.624

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

Table 12. Robustness test for the impact of credit access on farm profit

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.571***	0.358***	0.262***
	(0.0566)	(0.0533)	(0.0474)
HHSize	0.110***	0.110***	0.116***
	(0.0128)	(0.0115)	(0.0104)
HHGender	-0.269***	-0.188***	-0.183***
	(0.0553)	(0.0510)	(0.0460)
HHAge	0.0204**	0.0236**	0.0200**
	(0.00994)	(0.00939)	(0.00889)
HHAge2	-0.000209**	-0.000229***	-0.000186**
	(8.80e-05)	(8.32e-05)	(7.89e-05)
HHElementary	0.00913	0.00887	0.0136
	(0.0408)	(0.0387)	(0.0356)
HHEthnicity	0.0682	-0.0159	-0.139
	(0.0639)	(0.0908)	(0.117)
ComunistParty	0.0313	0.0309	0.0473
	(0.0628)	(0.0579)	(0.0550)
HHFe0to6	-1.084***	-0.966***	-0.965***
	(0.202)	(0.186)	(0.172)
HHFe7to15	-0.649***	-0.602***	-0.559***
	(0.146)	(0.132)	(0.124)
HHFe60to999	-0.600***	-0.630***	-0.619***
	(0.108)	(0.103)	(0.0990)
HHMa0to6	-0.659***	-0.776***	-0.795***
	(0.187)	(0.180)	(0.166)
HHMa7to15	-0.618***	-0.598***	-0.575***
	(0.127)	(0.124)	(0.113)
HHMa60to999	-0.126	-0.0242	-0.0552
	(0.150)	(0.146)	(0.139)
Constant	8.502***	8.366***	8.499***
	(0.295)	(0.281)	(0.268)
Observations	8,970	8,970	8,967
R-squared	0.352	0.427	0.507

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

Source: Author's calculations using Stata

Likewise, the impact of credit on farm inputs, land area and labor force under these regional levels also remains consistent with our main findings at the household-fixed effects level as evident in Table 13 - 16. It is noteworthy that all impacts of credit become smaller when we conduct fixed effects at the greater scale or aggregation levels (i.e., village, district and province level). The possible explanation for this could be due to the overestimation in the impact of credit on farm outcomes variables. In particular, as the variation in individual heterogeneity (farming capabilities, connections, etc.) only cancel each other out at household level, these unobserved factors might get absorbed in the coefficients of credit access at more aggregate levels. In other words, the increase in farm outcomes can be due to household abilities or social connections instead of the pure impact from credit. This is relatively similar to the exaggeration in the impact of access to credit when OLS is applied. These results once again imply the effectiveness of household fixed

effects estimation in addressing the problem of omitted variable bias (OVB) or unobserved heterogeneity.

Table 13. Robustness test for the impact of credit access on farm investment in agricultural capital

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.899***	0.574***	0.430***
	(0.147)	(0.142)	(0.135)
HHSize	0.163***	0.159***	0.174***
	(0.0285)	(0.0271)	(0.0259)
HHGender	-0.708***	-0.590***	-0.531***
	(0.109)	(0.105)	(0.102)
HHAge	0.0199	0.0242	0.0176
	(0.0208)	(0.0197)	(0.0195)
HHAge2	-0.000167	-0.000204	-0.000163
	(0.000169)	(0.000161)	(0.000163)
HHElementary	0.0552	0.0931	0.0306
	(0.0966)	(0.0940)	(0.0880)
HHEthnicity	0.317**	-0.0123	0.305
	(0.145)	(0.216)	(0.269)
ComunistParty	-0.111	-0.108	0.0291
	(0.128)	(0.122)	(0.120)
HHFe0to6	-1.204**	-0.870*	-0.904**
	(0.481)	(0.470)	(0.455)
HHFe7to15	-0.152	-0.107	-0.270
	(0.382)	(0.350)	(0.327)
HHFe60to999	-0.446**	-0.496***	-0.522***
	(0.178)	(0.175)	(0.179)
HHMa0to6	-0.448	-0.386	-0.403
	(0.516)	(0.496)	(0.476)
HHMa7to15	-0.812***	-0.754**	-0.453
	(0.314)	(0.297)	(0.296)
HHMa60to999	-1.077***	-0.874***	-0.811***
	(0.246)	(0.242)	(0.245)
Constant	1.736***	1.722***	1.604**
	(0.638)	(0.618)	(0.624)
Observations	9,934	9,934	9,934
R-squared	0.231	0.284	0.340

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

Source: Author's calculations using Stata

Table 14. Robustness test for the impact of credit access on farm area used for crop production

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.573***	0.408***	0.321***
	(0.0590)	(0.0543)	(0.0512)

HHSize	0.106***	0.113***	0.119***
	(0.0136)	(0.0125)	(0.0117)
HHGender	-0.168***	-0.0440	-0.0393
	(0.0626)	(0.0573)	(0.0513)
HHAge	0.0269**	0.0291***	0.0182*
	(0.0116)	(0.0105)	(0.0106)
HHAge2	-0.000276***	-0.000287***	-0.000187**
	(0.000105)	(9.44e-05)	(9.43e-05)
HHElementary	-0.0189	0.0359	0.0548
	(0.0480)	(0.0450)	(0.0409)
HHEthnicity	-0.388***	-0.262***	-0.345***
	(0.0706)	(0.0915)	(0.122)
ComunistParty	-0.00320	-0.00143	-0.00446
	(0.0729)	(0.0669)	(0.0607)
HHFe0to6	-1.175***	-1.117***	-1.129***
	(0.216)	(0.200)	(0.190)
HHFe7to15	-0.583***	-0.473***	-0.545***
	(0.159)	(0.142)	(0.134)
HHFe60to999	-0.712***	-0.746***	-0.765***
	(0.140)	(0.131)	(0.126)
HHMa0to6	-0.638***	-0.755***	-0.786***
	(0.203)	(0.191)	(0.181)
HHMa7to15	-0.377***	-0.400***	-0.488***
	(0.144)	(0.139)	(0.130)
HHMa60to999	-0.143	-0.0212	0.0419
	(0.183)	(0.177)	(0.169)
Constant	8.220***	7.823***	8.136***
	(0.340)	(0.314)	(0.321)
Observations	9,034	9,034	9,032
R-squared	0.267	0.353	0.436

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

Source: Author's calculations using Stata

Table 15. Robustness test for the impact of credit access on the number of working days

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.205***	0.155***	0.0898***
	(0.0353)	(0.0328)	(0.0315)
HHSize	0.0931***	0.0976***	0.103***
	(0.00860)	(0.00794)	(0.00768)
HHGender	-0.199***	-0.145***	-0.150***
	(0.0376)	(0.0366)	(0.0337)
HHAge	0.0311***	0.0304***	0.0257***
	(0.00765)	(0.00703)	(0.00730)
HHAge2	-0.000279***	-0.000267***	-0.000227***
	(6.86e-05)	(6.29e-05)	(6.61e-05)
HHElementary	-0.0160	-0.00993	-0.0232
	(0.0277)	(0.0277)	(0.0266)
HHEthnicity	-0.209***	-0.183***	-0.154**
	(0.0358)	(0.0510)	(0.0646)
ComunistParty	-0.0519	-0.0356	0.000644
	(0.0422)	(0.0414)	(0.0421)

HHFe0to6	-0.829***	-0.759***	-0.779***
	(0.161)	(0.150)	(0.145)
HHFe7to15	-0.427***	-0.403***	-0.436***
	(0.108)	(0.0970)	(0.0895)
HHFe60to999	-0.544***	-0.567***	-0.548***
	(0.0815)	(0.0824)	(0.0823)
HHMa0to6	-0.529***	-0.636***	-0.614***
	(0.139)	(0.131)	(0.128)
HHMa7to15	-0.387***	-0.412***	-0.399***
	(0.0917)	(0.0880)	(0.0854)
HHMa60to999	-0.0969	-0.0851	-0.0693
	(0.111)	(0.111)	(0.110)
Constant	1.888***	1.787***	1.890***
	(0.220)	(0.206)	(0.212)
Observations	9,157	9,157	9,156
R-squared	0.267	0.331	0.406

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

Source: Author's calculations using Stata

Table 16. Robustness test for the impact of credit access on the cost of hiring labors

VARIABLES	(1) Province FE	(2) District FE	(3) Village FE
CrdtAccess3	0.267***	0.137**	0.0825
	(0.0595)	(0.0578)	(0.0548)
HHSize	0.0681***	0.0634***	0.0631***
	(0.0147)	(0.0131)	(0.0132)
HHGender	-0.0809	-0.0603	-0.0826
	(0.0550)	(0.0521)	(0.0506)
HHAge	-0.00123	-0.000173	-0.00238
	(0.0117)	(0.0116)	(0.0120)
HHAge2	-1.43e-05	-1.80e-05	2.22e-05
	(0.000101)	(0.000101)	(0.000102)
HHElementary	0.0429	0.0112	-0.00339
	(0.0481)	(0.0445)	(0.0465)
HHEthnicity	0.200***	0.0894	0.0258
	(0.0718)	(0.0934)	(0.130)
ComunistParty	0.141**	0.105*	0.0957*
	(0.0663)	(0.0609)	(0.0571)
HHFe0to6	-0.697***	-0.640***	-0.527**
	(0.229)	(0.218)	(0.230)
HHFe7to15	-0.644***	-0.579***	-0.598***
	(0.171)	(0.153)	(0.148)
HHFe60to999	-0.258**	-0.291***	-0.321***
	(0.112)	(0.110)	(0.113)
HHMa0to6	-0.398*	-0.442*	-0.421*
	(0.239)	(0.228)	(0.227)
HHMa7to15	-0.485***	-0.445***	-0.456***
	(0.155)	(0.145)	(0.143)
HHMa60to999	-0.0595	0.0472	-0.0208
	(0.164)	(0.153)	(0.155)
Constant	7.038***	7.110***	7.210***
	(0.345)	(0.338)	(0.369)

Observations	5,324	5,322	5,313
R-squared	0.424	0.483	0.543

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

Source: Author's calculations using Stata

Chapter 6
Discussion and conclusions

In this paper, we explore the impact of credit access on farm outcomes and it is evident that credit access has a significantly positive impact on farm production, farm sales and farm profit. Furthermore, we also suggest that credit can improve those farm outputs by encouraging farmers to purchase new farm inputs such as equipment, materials, etc., and to expand the farm area to cultivate crops. This is consistent with the findings by Arouri et al. (2015) in which they found that households in Vietnam are able to recover from extreme weather conditions because credit borrowings enable them to proceed with their production activities by satisfying their urgent needs for agricultural inputs such as fertilizers, laborers, etc. in the midst of the catastrophe. Our findings are also in agreement with previous studies by Tabetando et al. (2023) and Laha (2013) with respect to the increase in farm size due to credit provision, giving rise to the improved farm efficiency. Apart from the increase in farm production, credit is also reported to exert a positive impact in farm profit following to our main results, which is in line with the findings by Dang (2020) concerning the growth in peanut profit as a result of credit borrowings in Vietnam. At a more macro-level analysis, our findings could also imply that better access to credit is not only associated with the increase in agricultural production but also an improvement in household income and welfare, or a raise in living standards of the poor households in Vietnam, which is shown in the studies by Bui et al. (2019) and Thanh Tu et al. (2015). Nevertheless, policymakers should be aware that short-term credit does not ensure a permanent growth in farm productivity for its borrowers (Phan et al., 2023). In lieu of that, investment in education or improved farm activities should be incorporated simultaneously to warrant a sustainable growth in agricultural practices.

This study covers a large-scale sample size of different provinces in Vietnam and our main approach, fixed effects, successfully captures unobserved heterogeneity problems, which contributes to the existing studies as they commonly fail to capture unobserved household characteristics in evaluating the effect of credit on farm outcomes. However, there are some limitations that we cannot account for in this study. First, we do not yet examine other potential factors that might affect credit access from the supply side including the open or close date of the bank system or the lender; or evaluate the impact of credit access on each individual type of crops varying from high-input to low-input categories. Second, although FE is considered an effective approach to dealing with unobserved heterogeneity, it cannot eliminate all potential time-varying factors that might affect credit access and farm outcomes. Third, VARHS is a comprehensive and high-quality panel data set that covers various aspects of Vietnam's rural household; however, it is not updated with recent years and the latest year available is 2018. This prevents in-depth analysis of the impact of credit availability on rural households during and after the COVID-19 pandemic. Therefore, there is a need for further research on the relationship between credit access and farm outcomes that helps to tackle these aforementioned challenges to provide more valuable insights for policymakers. Furthermore, it is advisable that government and financial institutions implement micro-credit programs, particularly in underserved rural areas with limited access to formal credit, or reduce regulatory barriers that impede credit accessibility for small-scale farmers. Due to this action, the government can take one step closer to the goal of eradicating the poverty in Vietnam's rural areas.

Appendices

Appendix 1

Impact of Credit Access on Total Value of Crops Produced with OLS

LnHHFarmValProduced	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CrdtAccess3	1.307	.046	28.40	0	1.217	1.397	***
HHSize	.116	.009	12.69	0	.098	.133	***
HHGender	-.247	.037	-6.60	0	-.321	-.174	***
HHAge	.021	.007	3.05	.002	.008	.035	***
HHAge2	0	0	-3.60	0	0	0	***
HHElementary	-.062	.031	-2.02	.043	-.123	-.002	**
HHEthnicity	-.055	.029	-1.87	.062	-.112	.003	*
ComunistParty	.097	.049	1.98	.048	.001	.193	**
HHFe0to6	-1.319	.173	-7.64	0	-1.657	-.98	***
HHFe7to15	-.702	.117	-6.01	0	-.93	-.473	***
HHFe60to999	-.809	.086	-9.41	0	-.978	-.641	***
HHMa0to6	-1.026	.167	-6.14	0	-1.354	-.698	***
HHMa7to15	-.658	.108	-6.09	0	-.87	-.446	***
HHMa60to999	-.158	.12	-1.31	.191	-.394	.078	
Constant	9.162	.205	44.77	0	8.761	9.563	***

Mean dependent var	9.655	SD dependent var	1.240
R-squared	0.177	Number of obs	9054
F-test	129.656	Prob > F	0.000
Akaike crit. (AIC)	27846.985	Bayesian crit. (BIC)	27953.650

*** p<.01, ** p<.05, * p<.1

Source: Author's calculations using Stata

Appendix 2

Impact of Credit Access on Total Value of Crops Sold with OLS

LnHHFarmValSold	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CrdtAccess3	1.522	.059	25.87	0	1.406	1.637	***
HHSize	.103	.013	7.82	0	.077	.129	***
HHGender	-.171	.056	-3.03	.002	-.282	-.061	***
HHAge	.027	.011	2.51	.012	.006	.048	**
HHAge2	0	0	-2.91	.004	0	0	***
HHElementary	.004	.047	0.09	.924	-.088	.097	
HHEthnicity	.14	.047	2.98	.003	.048	.231	***
ComunistParty	.292	.077	3.81	0	.142	.442	***
HHFe0to6	-1.155	.284	-4.07	0	-1.711	-.599	***
HHFe7to15	-.448	.181	-2.48	.013	-.802	-.094	**
HHFe60to999	-.622	.126	-4.95	0	-.868	-.375	***
HHMa0to6	-1.569	.265	-5.91	0	-2.089	-1.048	***
HHMa7to15	-.559	.161	-3.48	.001	-.874	-.244	***
HHMa60to999	-.049	.176	-0.28	.781	-.395	.297	
Constant	8.274	.313	26.42	0	7.66	8.888	***

Mean dependent var	9.271	SD dependent var	1.554
R-squared	0.140	Number of obs	6362
F-test	77.492	Prob > F	0.000
Akaike crit. (AIC)	22738.278	Bayesian crit. (BIC)	22839.650

*** p<.01, ** p<.05, * p<.1

Source: Author's calculations using Stata

Appendix 3

Impact of Credit Access on Farm Profit with OLS

LnProfit	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CrdtAccess3	1.243	.046	26.76	0	1.152	1.334	***
HHSize	.125	.009	13.34	0	.107	.143	***
HHGender	-.258	.039	-6.70	0	-.334	-.183	***
HHAge	.015	.007	2.20	.028	.002	.029	**
HHAge2	0	0	-3.00	.003	0	0	***
HHElementary	-.098	.031	-3.16	.002	-.159	-.037	***
HHEthnicity	-.206	.03	-6.77	0	-.266	-.146	***
ComunistParty	.089	.05	1.79	.073	-.008	.187	*
HHFe0to6	-1.4	.179	-7.83	0	-1.751	-1.05	***
HHFe7to15	-.668	.122	-5.48	0	-.908	-.429	***
HHFe60to999	-.737	.086	-8.56	0	-.906	-.568	***
HHMa0to6	-.97	.173	-5.62	0	-1.308	-.632	***
HHMa7to15	-.664	.111	-5.97	0	-.882	-.446	***
HHMa60to999	-.086	.123	-0.70	.486	-.327	.155	
Constant	8.875	.204	43.46	0	8.475	9.275	***

Mean dependent var	9.052	SD dependent var	1.277
R-squared	0.174	Number of obs	8970
F-test	135.862	Prob > F	0.000
Akaike crit. (AIC)	28145.093	Bayesian crit. (BIC)	28251.618

*** p<.01, ** p<.05, * p<.1*

Source: Author's calculations using Stata

Appendix 4

Impact of Credit Access on Total Value of Crops Produced with FE

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs = 9,030
F(14, 7379) = 11.41
Prob > F = 0.0000
R-squared = 0.7733
Adj R-squared = 0.7226
Within R-sq. = 0.0242
Root MSE = 0.6514

LnHHFarmVal~d	Coefficient	Robust std. err.	t	P>t	[95% conf.	interval]
CrdtAccess3	0.129	0.031	4.110	0.000	0.067	0.191
HHSize	0.073	0.009	8.490	0.000	0.056	0.090
HHGender	-0.072	0.052	-1.390	0.166	-0.174	0.030
HHAge	0.034	0.010	3.500	0.000	0.015	0.054
HHAge2	-0.000	0.000	-3.480	0.001	-0.000	-0.000
HHElementary	0.009	0.031	0.300	0.767	-0.051	0.069
HHEthnicity	-0.079	0.063	-1.260	0.208	-0.203	0.044
ComunistParty	0.086	0.042	2.020	0.043	0.003	0.168
HHFe0to6	-0.319	0.138	-2.310	0.021	-0.589	-0.048
HHFe7to15	-0.147	0.098	-1.490	0.136	-0.339	0.046
HHFe60to999	-0.331	0.089	-3.730	0.000	-0.505	-0.157
HHMa0to6	-0.391	0.139	-2.820	0.005	-0.663	-0.120
HHMa7to15	-0.207	0.093	-2.230	0.026	-0.389	-0.025
HHMa60to999	0.022	0.120	0.190	0.852	-0.213	0.258

_cons	8.549	0.303	28.250	0.000	7.956	9.143

Source: Author's calculations using Stata

Appendix 5

Impact of Credit Access on Total Value of Crops Sold with FE

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs = 6,201
F(14, 4774) = 3.40
Prob > F = 0.0000
R-squared = 0.7652
Adj R-squared = 0.6951
Within R-sq. = 0.0102
Root MSE = 0.8528

LnHHFarmVa~ld	Coefficient	Robust std. err.	t	P>t	[95% conf.	interval]
CrdtAccess3	0.177	0.042	4.220	0.000	0.095	0.259
HHSize	0.038	0.014	2.740	0.006	0.011	0.064
HHGender	-0.042	0.080	-0.530	0.597	-0.198	0.114
HHAge	0.034	0.015	2.190	0.028	0.004	0.064
HHAge2	-0.000	0.000	-2.090	0.037	-0.001	-0.000
HHElementary	0.065	0.051	1.290	0.197	-0.034	0.164
HHEthnicity	-0.016	0.160	-0.100	0.922	-0.329	0.298
ComunistParty	0.056	0.072	0.780	0.436	-0.085	0.197
HHFe0to6	-0.143	0.235	-0.610	0.543	-0.603	0.317
HHFe7to15	0.004	0.165	0.030	0.978	-0.319	0.328
HHFe60to999	-0.266	0.147	-1.810	0.070	-0.554	0.022
HHMa0to6	-0.594	0.224	-2.650	0.008	-1.034	-0.155
HHMa7to15	-0.052	0.156	-0.330	0.740	-0.358	0.254
HHMa60to999	-0.091	0.190	-0.480	0.631	-0.463	0.281
_cons	8.232	0.471	17.460	0.000	7.308	9.156

Source: Author's calculations using Stata

Appendix 6

Impact of Credit Access on Farm Profit with FE

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs = 8,944
F(14, 7295) = 8.43
Prob > F = 0.0000
R-squared = 0.7015
Adj R-squared = 0.6340
Within R-sq. = 0.0174
Root MSE = 0.7710

LnProfit	Coefficient	Robust std. err.	t	P>t	[95% conf.	interval]
CrdtAccess3	0.115	0.037	3.140	0.002	0.043	0.187
HHSize	0.079	0.010	7.730	0.000	0.059	0.099
HHGender	-0.008	0.059	-0.130	0.899	-0.124	0.109
HHAge	0.030	0.010	2.870	0.004	0.009	0.050
HHAge2	-0.000	0.000	-2.760	0.006	-0.000	-0.000

HHElementary	0.012	0.036	0.330	0.739	-0.058	0.082
HHEthnicity	-0.094	0.089	-1.060	0.291	-0.270	0.081
ComunistParty	0.084	0.051	1.640	0.101	-0.016	0.183
HHFe0to6	-0.506	0.161	-3.140	0.002	-0.822	-0.190
HHFe7to15	-0.110	0.119	-0.930	0.354	-0.344	0.123
HHFe60to999	-0.332	0.104	-3.180	0.002	-0.537	-0.127
HHMa0to6	-0.540	0.160	-3.370	0.001	-0.855	-0.226
HHMa7to15	-0.307	0.110	-2.800	0.005	-0.522	-0.092
HHMa60to999	0.040	0.139	0.290	0.775	-0.233	0.312
_cons	7.998	0.314	25.480	0.000	7.383	8.614

Source: Author's calculations using Stata

References

Guirkinger, C. (2008) 'Understanding the coexistence of formal and informal credit markets in Piura, Peru', *World Development*, 36(8), pp. 1436–1452. doi:10.1016/j.worlddev.2007.07.002.

Miller, C., Ono, T. and Petruljeskov, M. (2018) *Agricultural Investment Funds for development* [Preprint]. doi:10.18356/e366fc04-en.

Thanh, P.T., Saito, K. and Duong, P.B. (2019) 'Impact of microcredit on rural household welfare and economic growth in Vietnam', *Journal of Policy Modeling*, 41(1), pp. 120–139. doi:10.1016/j.jpolmod.2019.02.007.

Khandker, S.R. and Koolwal, G.B. (2015) 'How has microcredit supported agriculture? evidence using panel data from Bangladesh', *Agricultural Economics*, 47(2), pp. 157–168. doi:10.1111/agec.12185.

Bui, T. *et al.* (2018) 'Improving the technical efficiency of Sengcu Rice producers through better financial management and sustainable farming practices in mountainous areas of Vietnam', *Sustainability*, 10(7), p. 2279. doi:10.3390/su10072279.

Pitt, M.M. and Khandker, S.R. (1998) 'The impact of group-based credit programs on poor households in Bangladesh: Does the gender of participants matter?', *Journal of Political Economy*, 106(5), pp. 958–996. doi:10.1086/250037.

Roodman, D. and Morduch, J. (2013) 'The impact of microcredit on the poor in Bangladesh: Revisiting the evidence', *SSRN Electronic Journal* [Preprint]. doi:10.2139/ssrn.2231535.

Duong, H.A. and Nghiem, H.S. (2022) 'The impact of microfinance on Poverty Reduction in Vietnam: A Dynamic panel-data analysis', *Poverty & Public Policy*, 14(4), pp. 405–422. doi:10.1002/pop4.354.

Cuong, N.V. (2008) 'Is a governmental micro-credit program for the poor really pro-poor? evidence from Vietnam', *The Developing Economies*, 46(2), pp. 151–187. doi:10.1111/j.1746-1049.2008.00061.x.

Phan, D.K. *et al.* (2014) 'The impact of microcredit on rural households in the Mekong River Delta of Vietnam', *Journal of the Asia Pacific Economy*, 19(4), pp. 558–578. doi:10.1080/13547860.2014.920591.

Nghiem, S., Coelli, T. and Rao, P. (2012) 'Assessing the welfare effects of microfinance in Vietnam: Empirical results from a quasi-experimental survey', *Journal of Development Studies*, 48(5), pp. 619–632. doi:10.1080/00220388.2011.638051.

Vaisey, S. and Miles, A. (2016) 'What you can—and can't—do with three-wave panel data', *Sociological Methods & Research*, 46(1), pp. 44–67. doi:10.1177/0049124114547769.

Feder, G. *et al.* (1990) 'The relationship between credit and productivity in Chinese agriculture: A microeconomic model of disequilibrium', *American Journal of Agricultural Economics*, 72(5), pp. 1151–1157. doi:10.2307/1242524.

Zeller, M. (1998) 'Market access by smallholder farmers in Malawi: Implications for technology adoption, agricultural productivity and crop income', *Agricultural Economics*, 19(1–2), pp. 219–229. doi:10.1016/s0169-5150(98)00027-9.

Nordjo, R.E. and Adjasi, C.K.D. (2019) 'The impact of credit on productivity of smallholder farmers in Ghana', *Agricultural Finance Review*, 80(1), pp. 91–109. doi:10.1108/afr-10-2018-0096.

Brandt, K. and Tarp, F. (2017) 'Characteristics of the VARHS data and other data sources', *Growth, Structural Transformation, and Rural Change in Viet Nam*, pp. 26–48. doi:10.1093/acprof:oso/9780198796961.003.0002.

Elahi, E. *et al.* (2018) 'Agricultural Advisory and financial services; farm level access, outreach and impact in a mixed cropping district of Punjab, Pakistan', *Land Use Policy*, 71, pp. 249–260. doi:10.1016/j.landusepol.2017.12.006.

Jimi, N. *et al.* (2019) 'The effects of access to credit on productivity: Separating technological changes from changes in technical efficiency', *SSRN Electronic Journal* [Preprint]. doi:10.2139/ssrn.3435389.

Nguyen, T.-T., Nguyen, T.T. and Grote, U. (2019) 'Credit and ethnic consumption inequality in the Central Highlands of Vietnam', *Social Indicators Research*, 148(1), pp. 143–172. doi:10.1007/s11205-019-02202-z.

Pitt, M.M. (2014) 'Re-re-reply to "the impact of microcredit on the poor in Bangladesh: Revisiting the evidence"', *SSRN Electronic Journal* [Preprint]. doi:10.2139/ssrn.2392537.

Seng, K. (2017) 'Rethinking the effects of microcredit on household welfare in Cambodia', *The Journal of Development Studies*, 54(9), pp. 1496–1512. doi:10.1080/00220388.2017.1299139.

Taylor, T.G., Drummond, H.E. and Gomes, A.T. (1986) 'Agricultural credit programs and production efficiency: An analysis of traditional farming in southeastern Minas Gerais, Brazil', *American Journal of Agricultural Economics*, 68(1), pp. 110–119. doi:10.2307/1241655.

Lam, B.T. *et al.* (2019) 'Impacts of credit access on agricultural production and rural household's welfares in northern mountains of Vietnam', *Asian Social Science*, 15(7), p. 119. doi:10.5539/ass.v15n7p119.

Nguyen, H. D. and Pham, T. T. (2020) 'Microcredit and adoption of the improved rice varieties in rural Vietnam', 12(3), pp. 89–101.

Phan, C.T., Vo, T.T. and Vo, D.T. (2022) 'Can microcredit reduce vulnerability to poverty? evidence from rural Vietnam', *Review of Development Economics*, 27(1), pp. 608–629. doi:10.1111/rode.12951.

Phan, C.T. *et al.* (2023) 'Does productive microcredit improve rural children's education? evidence from rural Vietnam', *Journal of Asian Economics*, 84, p. 101555. doi:10.1016/j.asieco.2022.101555.

Luan, D.X. and Bauer, S. (2016) 'Does credit access affect household income homogeneously across different groups of credit recipients? evidence from rural Vietnam', *Journal of Rural Studies*, 47, pp. 186–203. doi:10.1016/j.jrurstud.2016.08.001.

Samson, A. and Obademi, O. (2018) 'The determinants and impact of access to agricultural credit on productivity by farmers in Nigeria; evidence from Oyo State, Nigeria.', *Advances in Social Sciences Research Journal*, 5(3). doi:10.14738/assrj.53.3588.

Martey, E. *et al.* (2019) 'The impact of credit on the technical efficiency of maize-producing households in northern Ghana', *Agricultural Finance Review*, 79(3), pp. 304–322. doi:10.1108/afr-05-2018-0041.

Moahid, M. *et al.* (2022) 'Does access to agricultural credit help disaster-affected farming households to invest more on agricultural input?', *Agricultural Finance Review*, 83(1), pp. 96–106. doi:10.1108/afr-12-2021-0168.

Ciaian, P., Falkowski, J. and Kancs, D. (2012) 'Productivity and credit constraints: A firm-level propensity score evidence for agricultural farms in central and East European countries', *Acta Oeconomica*, 62(4), pp. 459–487. doi:10.1556/aoecon.62.2012.4.3.

Tabetando, R. *et al.* (2023) 'Land market responses to weather shocks: Evidence from rural Uganda and Kenya', *European Review of Agricultural Economics*, 50(3), pp. 954–977. doi:10.1093/erae/jbad005.

Laha, A. (2013) 'Technical efficiency in agricultural production and access to credit in West Bengal, India: stochastic frontier approach', *International Journal of Food and Agricultural Economics*, 1, pp. 53-64. https://doi.org/10.22004/AG.ECON.160094.

Oseni, I., Babalola, A., and Adesoye, B. (2019) 'Agricultural credit policy as a panacea for sustainable food production in Nigeria: Evidence from Ogun State', *SPOUDAI Journal of Economics and Business*, 69, pp. 18-29.

Porgo, M. *et al.* (2017) 'Credit constraints and labour allocation decisions in rural Burkina Faso', *Agricultural Finance Review*, 77(2), pp. 257–274. doi:10.1108/afr-05-2016-0047.

Nguyen, V.D. and Anh, M.N. (2018) 'Does governmental microcrediting benefit child labour in the poorest regions? new evidence from a transitional economy', *Economics & Sociology*, 11(3), pp. 333–344. doi:10.14254/2071-789x.2018/11-3/20.

Gatti, R. and Dehejia, R.H. (2002) 'Child labor: The role of income variability and access to credit in a cross-section', *Policy Research Working Papers* [Preprint]. doi:10.1596/1813-9450-2767.

Barslund, M. and Tarp, F. (2008) 'Formal and informal rural credit in four provinces of Vietnam', *The Journal of Development Studies*, 44(4), pp. 485–503. doi:10.1080/00220380801980798.

Kaila, H. and Tarp, F. (2019) 'Can the internet improve agricultural production? evidence from Viet Nam', *Agricultural Economics*, 50(6), pp. 675–691. doi:10.1111/agec.12517.

Markussen, T. and Tarp, F. (2014) 'Political connections and land-related investment in rural Vietnam', *Journal of Development Economics*, 110, pp. 291–302. doi:10.1016/j.jdeveco.2014.01.011.

Keharom, S., Mahachai, R., and Chanthai, S. (2016) 'The optimization study of α-amylase activity based on central composite design-response surface methodology by dinitrosalicylic acid method', *International Food Research Journal*, 23, pp. 10-17.

Nepal, R. and Thapa, G.B. (2009) 'Determinants of agricultural commercialization and mechanization in the hinterland of a city in Nepal', *Applied Geography*, 29(3), pp. 377–389. doi:10.1016/j.apgeog.2008.12.002.

Arouri, M., Nguyen, C. and Youssef, A.B. (2015) 'Natural disasters, household welfare, and resilience: Evidence from rural Vietnam', *World Development*, 70, pp. 59–77. doi:10.1016/j.worlddev.2014.12.017.

Dang, N.H. (2020) 'Determinants of profit efficiency among peanut farming households in Tra Vinh Province, Vietnam', *HCMCOUJS - Economics and Business Administration*, 7(2). doi:10.46223/hcmcoujs.econ.en.7.2.182.2017.

Thanh Tu, T.T., Viet, N.Q. and Loi, H.H. (2015) 'Determinant of access to rural credit and its effect on living standard: Case study about poor households in northwest, Vietnam', *International Journal of Financial Research*, 6(2). doi:10.5430/ijfr.v6n2p218.