The determinants and impact of agricultural credit on Vietnam agricultural performance

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Abstract

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The Vietnamese agricultural sector has experienced remarkable progress since the 1986 Renovation reform that transformed Vietnam from a nation on the brink of famine into one of the biggest agricultural exporters worldwide. Despite undeniable achievements over the past 30 years, the Vietnamese agricultural sector currently faces a number of issues because of the conditions of a transition economy and climate change. The agricultural sector mainly consists of small-scale producers who cannot take advantage of economies of scale and have lagged behind regional and other developing countries in labour, agricultural land, and water productivity. Therefore, transforming the agricultural sector into a large-scale, modern, technology-based sector is an important priority of Vietnam's farming community.

One most critical element that fosters the development and modernization of the agricultural sector and rural areas in developing countries such as Vietnam is agricultural credit. The Vietnamese government has tried to meet rural households' credit demand by issuing decrees on credit-related policies for agricultural and rural development. Vietnam's farm households, however, suffer from credit rationing. Failure to correctly recognize the credit demand and credit rationing of farmers might be a major reason for the ineffectiveness of credit programmes in Vietnam and other developing countries. Despite the acknowledged importance of credit in agricultural development, no empirical investigation has explored the relationship between credit and Vietnam's agricultural performance at the macro-level. In addition, no study simultaneously examines credit demand, credit rationing determinants, and credit rationing impact on farm performance in formal, semi-formal, and informal credit markets, leading to biased estimates.

In this study, we conduct both micro-level and macro-level analyses. For micro-level analysis that uses farm household survey data, we apply the direct elicitation method to classify the farm households' credit rationing conditions. Trivariate probit models are used to examine the relationships among formal, semi-formal, and informal credit markets, the determinants of credit demand and credit rationing of farm households. We use the multinomial endogenous treatment effects model to investigate the impact of credit rationing on farm performance. For macro-level analysis that uses secondary macro data, the credit-agricultural performance nexus is explored using the indicator saturation break tests, Kapetanios (2005) unit root test, Autoregressive distributed lag (ARDL) model, and Toda–Yamamoto (1995) approach to Granger causality.

The trivariate probit model's results reveal complementary relationships among two pairs of credit markets (formal versus informal and semi-formal versus informal). The joint significance of the correlations among credit demand and credit rationing in different credit markets is confirmed, which supports the use of the trivariate probit models when simultaneously investigating credit demand and credit rationing determinants in formal, semi-formal, and informal credit markets. In general, there are dissimilarities among the determinants of farm households' credit demands and credit rationing in different markets, reflecting Vietnam's segmented credit markets. The multinomial endogenous treatment effects model results confirm that credit rationing in any credit market has a severe, negative impact on agricultural outcomes for farm households. The ARDL model's results indicate that agricultural credit positively influences agricultural GDP in both the short and long run. The results also show the long-term positive, significant effects of labour and rainfall on agricultural GDP. The Toda–Yamamoto (1995) approach to the Granger causality test's result reveals a unidirectional causal relationship running from credit to agricultural GDP.

Keywords: Formal, Semi-formal, Informal credit, Farm performance, Agricultural GDP, Vietnam.

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Abbreviations

2SLS	Two-stage least squares
ADF	Augmented Dickey-Fuller test
AGDP	Agricultural gross domestic product
AGRIBANK	Vietnam Bank for Agriculture and Rural Development
AIC	Akaike information criterion
APF	Agricultural production function
ARDL	Autoregressive distributed lag
ATM	Automatic teller machine
BP	Bai-Perron
CDPF	Cobb-Douglas production function
CIC	Credit Information Centre
CSI	Cubic spline interpolation
DEM	Direct elicitation method
DFID	Department for International Development
ECM	Error correction model
ESR	Endogenous switching regression
FI	Financial institution
GDP	Gross domestic product
GHK	Geweke–Hajivassiliou–Keane
GMM	Generalised method of moments
GSO	General Statistics Office of Vietnam
HFIV	High-frequency indicator variable
IFC	International Finance Corporation
IIS	Impulse indicator saturation
IPWRA	Inverse probability weighted regression approach
IS	Indicator saturation
IV	Instrumental variable
KP	Kapetanios
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
L-C	Life-cycle

LR	Likelihood ratio
METE	Multinomial endogenous treatment effects
MFI	Licensed microfinance institution
MWALD	Modified Wald
NAGVA	National agricultural gross value-added
NGO	Non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PCF	People credit fund
P-I	Permanent income
PP	Phillips–Perron
PSM	Propensity score matching
R&D	Research and development
ROSCA	Rotating savings and credit association
RRD	Red River Delta
SA	Seasonal adjustment
SBV	State Bank of Vietnam
SD	Standard deviations
SIC	Schwartz information criterion
SIS	Step indicator saturation
SME	Small and medium enterprise
SRM	Switching regression model
TFP	Total factor productivity
TVPM	Trivariate probit model
T-Y	Toda–Yamamoto
UCB	Upper bound critical
VAR	Vector autoregression
VBSP	Vietnam Bank for Social Policies
VGCL	Vietnam General Confederation of Labour
VIF	Variance inflation factor
VLSS	Vietnam Living Standard Survey
VND	Vietnamese dong

WTO	World Trade Organization
WU	Women's Union

Chapter 1

Introduction

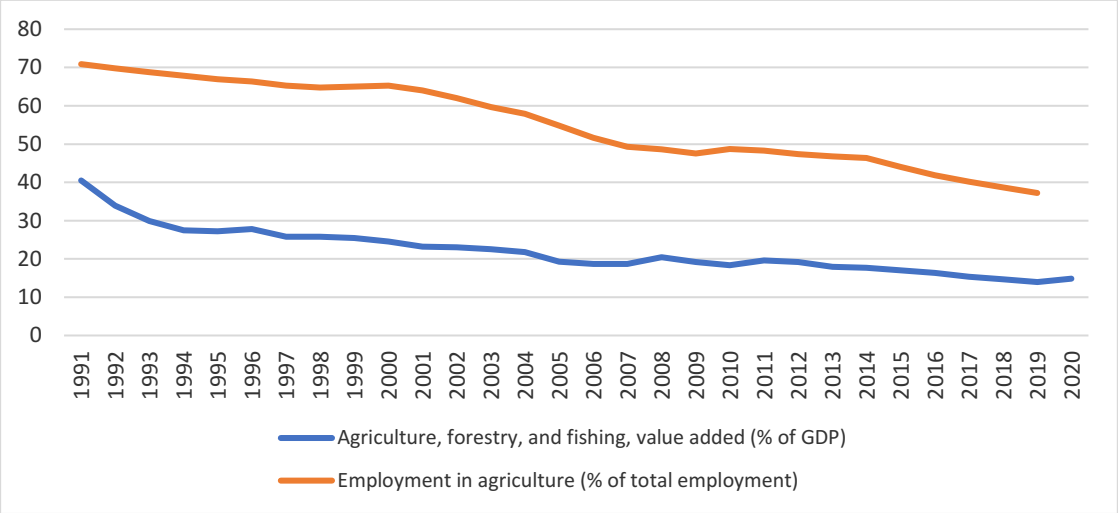
1.1. The characteristics of the Vietnam's agricultural sector

Since the "Doi moi" initiative (Vietnam's Renovation reform) in 1986, Vietnam's agricultural sector has seen remarkable progress. The sector's development has changed Vietnam from a nation on the brink of famine to one of the biggest agricultural exporters worldwide. Besides the important contribution to poverty reduction and economic growth, the agricultural sector also plays an essential part in ensuring the socioeconomic stability of Vietnam. For instance, agricultural employment (at least part-time jobs) and rural communities have served as a shock absorber for surplus labour during the late 2000s global financial crisis and recent fluctuations of the macro-economy (World Bank, 2016b).

The World Bank (2014) divides nations into five groups by the contribution of agricultural employment to the workforce and the share of the agricultural sector to national GDP: agriculture-based, pre-transition, transition, urbanizing, and developed nations. Based on the World Bank's (2014) classification, Vietnam is currently classed as a transition economy, with the agricultural sector contributing between 25% and 50% to the workforce and less than 25% to GDP. Figure 1.1 shows the contribution to employment and Vietnam's GDP of the agricultural sector has gradually decreased. This phenomenon is predictable and consistent with the transformation process that follows a pattern of a decrease in the number of employees directly working in farming along with a continuing decrease in the share of the agricultural sector's GDP compared with the other sectors of the economy (World Bank, 2014). Nevertheless, the agricultural sector still plays an essential and irreplaceable part in the social and economic improvement of Vietnam since the sector continues to provide employment to nearly half of Vietnam's workforce (Oxford Business Group, 2017; World Bank, 2019).

Although the achievements of the Vietnam's agricultural sector during the past 30 years are undisputed, the sector currently has the salient features of a transition economy along with some outstanding characteristics because of geographical and climate change problems. First, most of Vietnam's exported agricultural products are raw commodities that are commonly traded at low prices with low value-added gains (World Bank, 2016b). Second, the sector's growth has mostly come from intensive labour use and an increase in the use of fertilisers, water, cropping areas, and other resources such as agrochemicals, raising concerns for sustainable development and

environmental issues (OECD, 2015; World Bank, 2016b). Third, regarding labour, agricultural land, and water productivity, Vietnam lags behind regional and other developing countries (World Bank, 2016b). Fourth, the agricultural sector is currently experiencing increasing competition from other domestic sectors for important inputs such as labour, water, and land. Total agricultural land area doubled in the past 30 years, from 20% of Vietnam's total land in 1986 to approximately 40% in 2018 (World Bank, 2021c). However, most arable land has already been used and urbanisation and industrialisation have posed a threat to a considerable shrinkage of agricultural land. In addition, competition with other sectors for employees has raised agricultural labour costs that have an adverse impact on the ability of the sector to compete globally (World Bank, 2016b). Fifth, there are limited public investments supporting applications of new technology and innovation in agro-food production or advancing post-harvest processing of and logistics for agricultural products (World Bank, 2016b). Sixth, the agricultural sector mainly consists of small-scale producers who cannot take advantage of economies of scale. According to the OECD (2015), over nine million households operate in small land areas with an average of 0.8 hectares. Finally, Vietnam is recognised as one of 10 countries that are possibly most affected by climate change. The agricultural sector is threatened by climate variabilities such as floods, droughts, and saltwater intrusion, especially in Red River and Mekong Deltas (OECD, 2015).



Data source: World Bank (2021a) and World bank (2021b)

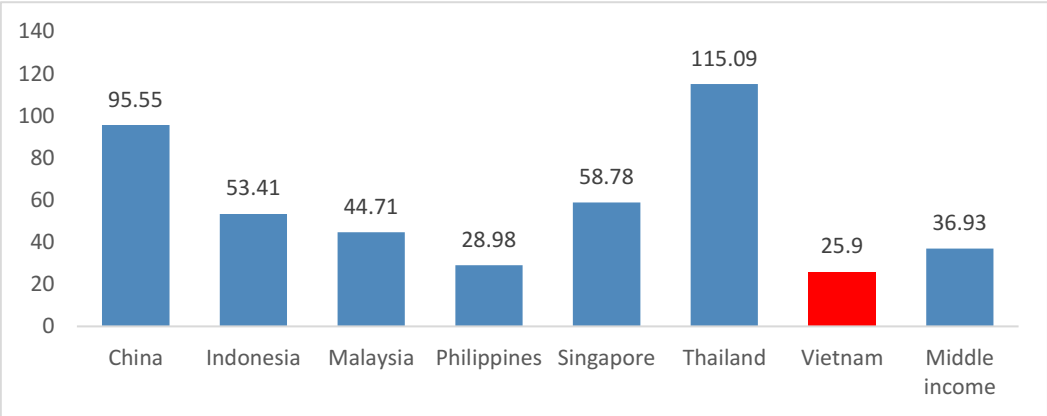
Figure 1.1. Vietnam's agricultural sector's contribution to GDP and the workforce

These above features cause significant difficulties to the development of Vietnam's agricultural sector. Thus, to achieve sustainable growth, Vietnam's agricultural sector needs to be modernised with strong investment in technology, increasing the size of farms to increase labour productivity, the value of agricultural products, and minimize the impact of climate change. Given the dominance of smallholder farmers with low capital bases, adequate credit access for smallholder farmers is a

critical factor for this modernisation process. In the next 4 sections, we present more detail about the financial system in Vietnam (where farm households can get agricultural loans), the significant role of agricultural credit, credit rationing in the agricultural sector, and the current situation of agricultural and rural credit in Vietnam.

1.2. An overview of Vietnam's financial system

After transforming from a mono-bank system into a two-tier banking system in 1988-1989, the Vietnam's banking system, including the formal financial system, has made significant, stable development in terms of products, services, and structure, approaching a more market-based financial system (Anwar & Nguyen, 2011). The Vietnam's financial system is relatively large compared with other middle-income peers (Hernandez, 2017; International Monetary Fund, 2017). The total assets of the Vietnam's financial system were worth over 320 percent of GDP in 2020 (Thanh, 2021). The Vietnam's banking system has played a dominant part in the formal financial system as the total assets of the banking sector comprised about 62.6 percent of financial sector assets in 2020 (Thanh, 2021).

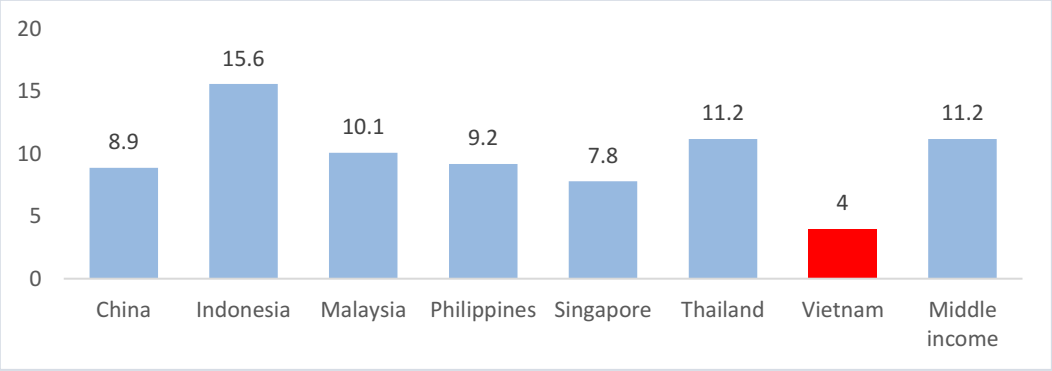


Data source: World Bank (2021e)

Figure 1.2. Number of ATMs per 100,000 adults in various countries in 2019

During the last 25 years, Vietnam has experienced rapid growth in bank credit, resulting in the credit-to-GDP ratio at the end of 2019 reaching 138 percent of GDP, which significantly exceeds other countries of similar development level (Thuy, 2019; World Bank, 2021d). However, indicators such as the number of ATMs or bank branches per 100,000 adults, which reflect the ability to access financial services, are relatively low compared with regional peers and middle-income countries (see Figures 1.2 and 1.3). In addition, Vietnam's bank branch networks are unevenly distributed, focusing mainly on urban areas. According to Luc et al. (2017), only 10 percent of rural communes in Vietnam

have financial institutions, making it more difficult for farmers and rural households to access formal finance.



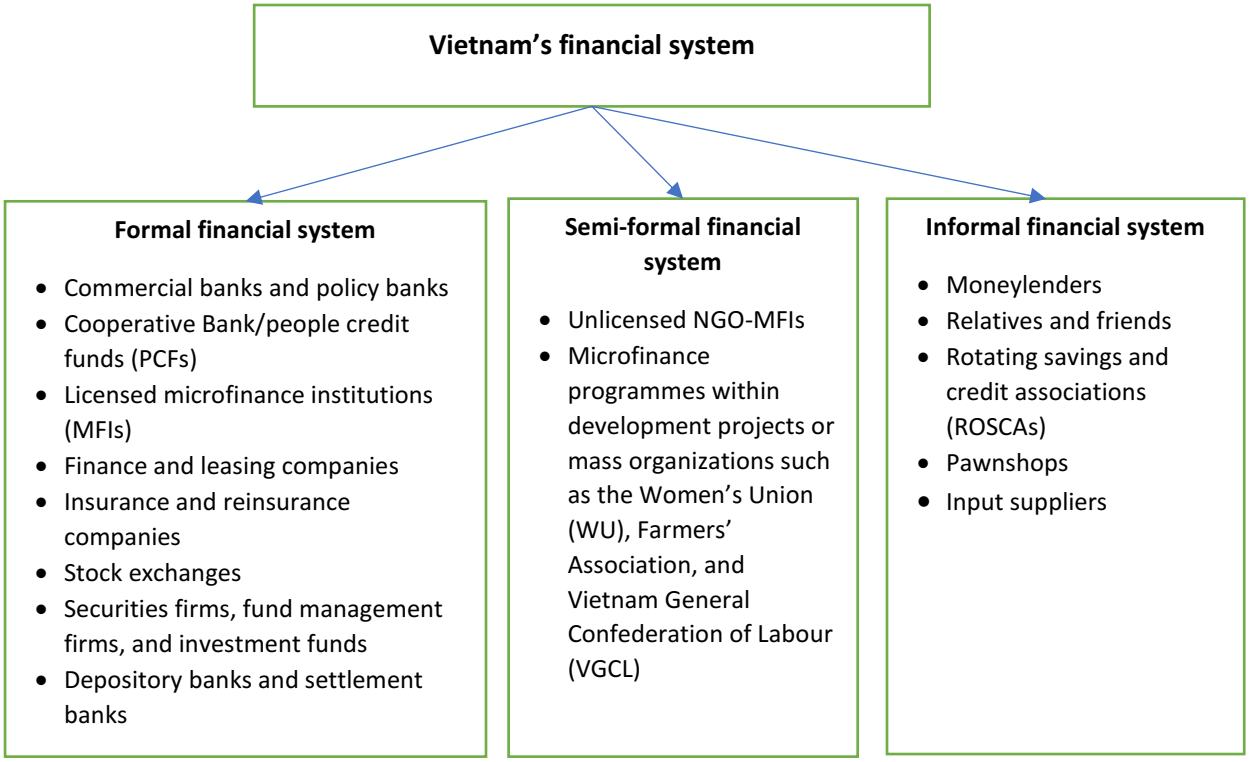
Data source: World Bank (2021f)

Figure 1.3. Number of commercial bank branches per 100,000 adults in various countries in 2019

The Vietnam's stock market has experienced significant development in scale since it was officially launched in 2000, significantly supporting the mobilisation and allocation of capital to accelerate industrialisation and modernisation of the country (Tu et al., 2017). There were only two enterprises with total capitalisation equivalent to just 0.28 percent of GDP in the initial stage of the stock market in 2000. In 2019, the number of listed firms had considerably increased to 745, and the total capitalization of the stock market reached 57.2 percent of GDP (World Bank, 2021g, 2021h). Despite this success, Vietnam's stock market still has some weaknesses. For example, derivatives products, an important component of stock markets, are still underdeveloped. According to Cuong and Toan (2016), derivatives such as commodity futures contracts, are used to manage the risk of price fluctuations for agricultural products in many countries. Generally, derivatives have a salutary effect on the agricultural sector's ability to access credit because derivatives mitigate the risk of lenders who provide loans to agricultural producers, enabling them to offer more credit at lower interest rates. Cuong and Toan (2016) also suggest that the development of agricultural derivatives is important for Vietnam presently and in future. Vietnam's derivatives market was officially launched in August 2017, but derivatives products are still limited, especially those related to agricultural outputs. Thus, derivatives, as a risk management tool, have not significantly benefited the agricultural sector in terms of reducing risk and obtaining more credit.

Vietnam's insurance sector has exhibited impressive, stable development with a 20.8 percent compounded annual growth rate of gross written premiums from 2007 to 2017 (World Bank, 2020a). However, the insurance market's size is still modest as the total insurance premiums (both life and non-life insurance) at the end of 2018 was 2.4 percent of GDP (World Bank, 2020a). For agricultural insurance, the overall market share is relatively small. The total premium revenue of agricultural

insurance is less than 1 percent of the total non-life insurance revenue (Hernandez, 2017). Only 3.1 percent of farmers who worked in agriculture have bought agricultural insurance (World Bank, 2019). According to Duc (2017), agricultural insurance plays an important role in supporting small-scale producers and farmers to be able to access appropriate financial services. Given the ineffective operation of the insurance in Vietnam's agricultural sector, agricultural production has not been well-protected against risks such as natural disasters or epidemics. Thus, farmers are exposed to further risk of failure. This implies that formal creditors are hesitant to serve this sector because of high default risk. Without credit access, risk-averse poor farm households are troubled by outdated technology, deal with an uneconomical allocation of resources, and are trapped in poverty.



Source: Adapted from Le (2003), Iwase (2011), IFC (2014), Khoi and Gan (2017), Luc et al. (2017)

Figure 1.4. The Vietnam financial system

Similar to other developing countries, formal, semi-formal, and informal financial sectors coexist within Vietnam's financial sector (Iwase, 2011; IFC, 2014; Khoi & Gan, 2017). Figure 1.4 provides an overview of the players in the three sectors of Vietnam's financial system. The semi-formal sector was launched in the late 1990s in the form of microfinance programmes. These programmes are operated by non-governmental organizations (NGOs) and international programmes collaborating with local organisations at the provincial level including mass organizations such as the Farmers' Association or Women's Union (WU). The semi-formal sector, which currently consists of over 300 microfinance programmes, mainly focuses on providing financial services to women and the poor

with small loans (IFC, 2014; Khoi & Gan, 2017). IFC (2014) reports that the formal sector, together with the semi-formal sector, provides microfinance services to an estimated 10 million low-income customers. The informal sector is composed of a wide variety of lenders, including moneylenders, ROSCAs (rotating savings and credit associations), input suppliers, pawnshops, and relatives and friends. According to IFC (2014), though there are no exact statistics about the size of the informal sector in Vietnam, it is believed that this sector is probably the largest credit provider for the low-income class. Although there is controversy surrounding the existence of informal creditors, it is undeniable that the informal sector has played an essential part in financial inclusion in Vietnam, especially the poor who have little access to formal creditors (Pham & Izumida, 2002; Barslund & Tarp, 2008; IFC, 2014; Khoi & Gan, 2017).

1.3. The role of credit in the agricultural sector

Agriculture contributes to the national economic development of all economies, especially developing countries. Compared with other sectors in developing economies, agriculture is the most crucial sector and, perhaps, irreplaceable in generating output and employment (Soubbotina & Sheram, 2000). Agricultural sector development, with regard to the Mellor hypothesis (i.e., the agricultural sector growth can lead to the non-agricultural sector growth), has six important impacts: (1) improves farm output and profitability, which increases farmers' welfare; (2) reduces food prices, supporting both poor rural and urban households; (3) decreases the agricultural labour need due to the agricultural productivity growth and hence provides more labour for domestic industrial sector expansion; (4) stimulates the domestic absorption of industrial goods; (5) strengthens the competitiveness of both the agricultural and industrial sectors; and (6) boosts exports with a positive effect on foreign exchange earnings (Johnston & Mellor, 1961; Gollin, 2010).

According to Mosher (1966) and Jugale (1991), there are five significant factors that accelerate agricultural development and modernization. These are: (1) education for farmers; (2) the availability of credit for production; (3) boosting farmers' action groups through cooperatives, social organizations, etc.; (4) improving and enlarging the land base for agricultural cultivation; and (5) a suitable plan and guide for agricultural development at the national level. Kohansal et al. (2008) and Moahid and Maharjan (2020) postulate that one of the most crucial elements that fosters the development of agricultural and rural areas in the developing world is agricultural credit. Not surprisingly, the agricultural sector relies on an efficient financial system. This provides adequate credit to support more developed agricultural segments to compete internationally and boost less developed segments to shift towards modern agricultural technologies (Zuberi, 1989; World Bank, 2014). Agricultural credit is undoubtedly a vital indirect factor, among others, to improve the

efficiency and productivity of farming practices. Based on credit assistance, farmers can buy key inputs from outside the farm and invest in modern agricultural machines. This enables farmers to deal with the backwardness and low level of access to resources. In addition, credit supports lengthy periods of production and alleviates the seasonal characteristics of the agricultural sector (Jugale, 1991; Chaudhuri & Cherical, 2012; World Bank, 2017). Specifically, agricultural credit not only plays an economic role but also has technological and social roles (Jugale, 1991). For the economic role, the use of agricultural credit improves crop yields and hence increases farmers' income and welfare, opens up employment opportunities for people who are unemployed not only in the agricultural industry but also in the manufacturing and service industries, and supports farmers to divert resources and change to other crop types because of climate change and global changes in the demand for agricultural products. In the social aspect, agricultural credit has an indirect but crucial role in ensuring food security, redressing poverty, gender and income inequality, and reducing environmental concerns (Jugale, 1991; Byerlee et al., 2009; Christiaensen et al., 2011, Divanbeigi & Saliola, 2017). For the technological role, farmers in developing countries, with the help of credit, can apply modern farm technologies (biological, chemical, and mechanical advances), which are capital intensive, to acquire a sustainable increase in agricultural outputs (Jugale, 1991; Kohansal et al., 2008; Collins et al., 2017).

1.4. Credit rationing in the agricultural sector

Credit is often used to finance working and fixed capital, but credit extension is believed to finance too little investment, leading to credit rationing in developing countries (Bencivenga & Smith, 1993). Generally, credit rationing could be interpreted as a situation in which one who demands credit does not receive enough quantity needed and faces credit constraints (Jansson et al., 2013). There are four types of credit rationing: price, quantity, risk, and transaction cost (Boucher et al., 2009). Price rationing occurs when the interest rate for a loan is too high (Ali et al., 2014). Quantity rationing happens when borrowers apply for loans and their applications are totally rejected or partially approved (Ali et al., 2014). Risk rationing and transaction cost rationing refer to individuals or enterprises who have access to credit but do not apply for loans for different reasons such as the fear of losing collateral, costly and time-consuming loan procedures (Guirkinger & Boucher, 2008; Ali & Deininger, 2014).

Although the fundamental role of credit in overall economic development is indisputable, those who need credit, especially farmers, often suffer, to a large extent, from credit constraint (Kochar, 1997; Rui & Xi, 2010; Yadav & Sharma, 2015; Linh et al., 2019). The development of agricultural and rural finance lags behind other segments of the financial system (World Bank, 2014). The distinctive

characteristics of rural and agricultural sectors, such as spatially dispersed production, seasonal, and weather-dependent features, and lower density of population, lead to higher risks and transaction costs for lenders. In addition, rural households often apply for small amounts of loans with inadequate collateral. Thus, formal credit institutions focus on urban areas to take advantage of lower operating costs and cover fixed transaction costs by larger loan size (World Bank, 2014).

Interestingly, agricultural credit markets in the developing world share a common characteristic of credit rationing and an equilibrium interest rate (Casillas & Mitchell, 2003). This can be explained by the imperfect feature of the rural credit market because of information asymmetry (Stiglitz & Weiss, 1981; Zeller, 1994; Boucher et al., 2009). Information asymmetry occurs in the credit market when the lender does not have access to information that the borrower has. This implies that the borrower commonly knows more about his or her repayment capacity than the lender. Information asymmetry triggers the issues of moral hazard and adverse selection in the credit market. Adverse selection is derived from the ineffectiveness of interest rates when performing the role of a screening device (Luci, 2004). Specifically, adverse selection occurs when lenders, because of information asymmetry, have to raise interest rates to offset the cost of gathering borrowers' information and unobserved risks, leading to riskier projects being selected (Collins et al., 2017).

A farm household with a relatively safe project with a low expected return will be excluded from the credit market with high interest rate by an expected negative profit. A rise in interest rate could trigger moral hazard problems as farmers change from a low-risk investment with a low probability of default to riskier investments that have higher expected returns but a higher probability of default (Hoff & Stiglitz, 1990; Okurut et al., 2005). However, in the presence of information asymmetry, when credit demand exceeds credit supply, creditors are reluctant to raise the interest rate from the prevailing level to the level equating credit demand and supply because of the fear of increasing loan defaults (Tran, 2014). Thus, creditors might offer interest rates under the market clearing level as the interest rate can act as an incentive mechanism and screening device (Stiglitz & Weiss, 1981). As a result, some farm households will drop out of the credit market at the prevailing interest rate. Information asymmetry also has two other applications in the credit market, signalling and incentive-compatible contracting (Neff, 1998). Signalling is a solution to deal with adverse selection issues. An example is signalling via collateral that helps lenders categorise farm households into safe and risky borrower groups (Bester, 1985; Neff, 1998). Farm households with less risky projects use collateral to achieve lower repayment obligations. Risky farm households, because of the fear of losing collateral, do not provide collateral and bear higher obligations of repayment (Neff, 1998). On the other hand, incentive-compatible contracting is an approach to avoid moral hazard issues (Bolton & Scharfstein, 1990). For instance, the lender provides the farm household with a long-term

credit contract that clearly states that the access to credit in the following period is subject to the project's performance in the present period. This kind of credit contract encourages farm households to truthfully report his or her profits to the lender (Bolton & Scharfstein, 1990; Neff, 1998).

In addition to asymmetric information, the awareness of risk related to farming activities and other structural problems, such as monopolistic competition in rural credit markets, contribute to agricultural credit rationing (Collins et al., 2017). Petrick (2005) and Das and Laha (2017) suggest that credit rationing is also caused by credit contract enforcement problems and the lack of an adequate legal framework for information disclosure.

Agricultural credit rationing has an adverse impact on farm production together with the development of the agricultural sector. Credit rationed farmers find it difficult to purchase inputs for agricultural production or to invest in farm-related projects (Reyes & Lensink, 2011; Collins et al., 2017). This leads to a lower level of inputs and an underinvestment state, resulting in a lower level of farm outputs, household income and welfare (Petrick, 2005). In addition, credit rationed farm households cannot separate consumption from production decisions and are incapable of smoothing their expenditure over time. This implies that credit rationed farmers have to divert their long-term funds from productive to non-productive activities, leading to a lack of funds to invest in long-term farm projects (Petrick, 2005; Yadav & Sharma, 2015). Regarding technology adoption, credit constraint adversely impacts famers' decisions to apply new technology, which ultimately slows modernisation in the agricultural sector (Collins et al., 2017). Regarding social impact, the poor farmers with low incomes and savings have difficulty in escaping the poverty vicious circle without the help of credit (Ejiogu, 2018).

1.5. Agricultural and rural credit in Vietnam

There are three markets providing credit to the rural and agricultural sector coexisting in Vietnam, including formal, semi-formal, and informal credit markets (Tra & Lensink, 2008; Khoi & Gan, 2017; Linh et al., 2020).

1.5.1. Formal credit sector

Formal credit providers in Vietnam are regulated and supervised by the State Bank of Vietnam (central bank), and their credit activities are pursuant to credit institution law. The formal credit sector comprises bank institutions (people credit funds (PCFs), cooperative bank, commercial banks, and policy banks) and non-bank institutions (finance and leasing companies, licensed MFIs) (Khoi & Gan, 2017; Truong et al., 2020). In the formal credit sector, Vietnam Bank for Agriculture and Rural

Development (AGRIBANK) and Vietnam Bank for Social Policies (VBSP) are the two biggest rural credit providers. According to World Bank (2021b), the agriculture, forestry, and fishery sector accounts for 14.85% of Vietnam's GDP in 2020. However, the total outstanding credit to this sector only accounts for 8.4% of the total outstanding credit to the whole economy in Vietnam at the end of 2020 (State Bank of Vietnam, 2021a). Khoi and Gan (2017) report that credit supply by the PCFs and commercial banks to the rural and agricultural sectors has experienced a recent increasing trend. Nevertheless, Vietnamese farm households find it difficult to access formal credit markets because of asymmetric information, high transaction costs, strict collateral requirements, underdevelopment of agricultural insurance, low presence of bank branches in rural areas, weak enforcement of credit contracts, etc. (Hoff & Stiglitz, 1990; Ghosh et al., 2000; IFC, 2014; Khoi & Gan, 2017). In rural areas of Vietnam, there were 1,836 communes having the presence of people credit funds and/or bank branches, accounting for 22.13% of the total rural communes in 2020 (General Statistics Office of Vietnam, 2021). In fact, the government has made considerable efforts to meet the credit demands of Vietnam's rural households through subsidised formal credit with lower interest rates and collateral requirements provided by VBSP, AGRIBANK, and PCFs. However, loans under the social policy programmes that aim to serve the poorest people with small loans, have been inadequate for agricultural investment (IFC, 2014). Furthermore, despite the government's efforts, a significant number of rural farm households remain credit rationed by formal lenders and hence depend on informal sources of credit (Pham & Izumida, 2002; Barslund & Tarp, 2008; Tran, 2014; Linh et al., 2020). According to the General Statistics Office of Vietnam (2021), about 56% of rural households that had credit demand for agricultural, forestry, and fishery production could not access loans in 2016. Although this rate had decreased significantly but was still quite high in 2020 (i.e., about 24% of rural households without access to formal credit).

1.5.2. Semi-formal credit sector

Semi-formal credit providers, including non-governmental organizations, unlicensed MFIs, and microfinance programs within mass organizations (e.g., Farmers' Union or Women's Union) or development projects (Truong et al., 2020), do not operate under the credit institution law. The semi-formal credit sector attempts to supply financial services to specific groups in the population that are excluded from formal financial services (Khoi & Gan, 2017). According to Le (2011), the semi-formal sector performs better in tailoring credit conditions to serve the poor than formal institutions. IFC (2014) and Khoi and Gan (2017) report that mass organisations such as Youth Union, Farmers' Union, War Veterans, and Women's Union play a crucial role in the semi-formal credit market. For example, the Women's Union manages many independent funds such as provincial social/charity funds that provide microcredit. In addition, the Women's Union also manages its own

funds mobilized from union members or funds in partnership with NGO microfinance schemes (IFC, 2014). The operations of MFIs have been gradually legalised (Tran, 2014). Unlike formal MFIs, semi-formal MFIs cannot mobilize voluntary savings and are limited to compulsory savings, leading to heavy dependence on external funding such as a donor-supported funds, provincial subsidies, and internal funding through investment by owners (Le, 2017). This significantly inhibits semi-formal MFIs from increasing available funds to grant microcredit and hence increase outreach. To stimulate the development of microfinance, the government has made a remarkable effort to formalise existing semi-formal MFIs. In particular, the Credit Institution Law 2010 recognizes MFIs as a component of the formal credit system. In addition, documents guiding the process of formalizing semi-formal MFIs or setting up new formal MFIs in Vietnam were established. However, formalization of semi-formal MFIs still faces difficulties (Le, 2011). As of June 2019, only four MFIs have been officially licensed in Vietnam (State Bank of Vietnam, 2021b).

1.5.3. Informal credit sector

The informal credit sector includes credit providers who are unlicensed and provide credit that is not regulated by the state but relies on social sanctions or personal relationships as the enforcement means. Informal credit sources include moneylenders, relatives and friends, rotating savings and credit associations, pawnshops, and input suppliers (Khoi & Gan, 2017; Linh et al., 2019; Dang et al., 2019). IFC (2014) reports that low-income people in Vietnam usually rely on informal credit sources. According to Lainez (2014), a third of credit transactions in Vietnam occurs in the informal credit market. One major actor in the informal credit sector is the *moneylender* who usually lives in the same area as the borrowers and provides loans in the form of cash or kind. Because of having advantages in getting information about borrowers, moneylenders often do not require collateral from borrowers but mutual trust (Pham & Lensink, 2007). However, they also face the problem of adverse selection. Thus, they tend to provide credit only to creditworthy clients. The loans from moneylenders often have more flexible repayment schedules but higher interest rates than formal lenders (Tran, 2014). Besides moneylenders, rural farm households also depend on informal credit that comes from *relatives and friends*. In having unexpected events or income shocks, rural farm households usually consider relatives and friends as the first credit source (Pham & Lensink, 2007). This type of credit often has a free or low interest rate with flexible repayment terms. However, borrowing from these informal credit actors significantly depends on a good network of wealthy relatives and friends. In addition, it is difficult for poor farmers to get loans from this source because of complicated social implications (Quach, 2005; Tran, 2014).

ROSCAs (known as *Ho, Phuong,* or *Hui* in North, Middle, and South Vietnam, respectively) are another source of informal credit. ROSCA refers to groups of individuals who have acquaintanceship and have confidence in each other, contributing assets to formulate simultaneously the savings and lending process (Pham & Lensink, 2007; Tran, 2014). These informal credit mechanisms support farmers to access credit more easily in the case of urgent need. In addition, ROSCAs are useful for small-scale farmers because credit from ROSCAs bear a low interest rate, have highly flexible lending terms, and no collateral requirement (Hernandez, 2017). However, the participants bear all the risks if the ROSCA breaks down because of borrowers' inability to repay loans (Quach, 2005; Tran, 2014). Agricultural *input suppliers* also participate in the informal credit market, providing inputs such as seeds or fertilizers to farmers on credit and then collecting payment after harvest or another agreed time (Pham & Lensink, 2007). Input supplier credit supports farm producers, especially cash-poor smallholder farmers, with access to important inputs for production and hence decreases the level of agricultural underinvestment. However, credit from input suppliers has some disadvantages such as increased input prices and loss of discount opportunities. Other sources of informal credit include *pawnshops* as expensive informal credit lenders. Pawnshops (or pawnbrokers) are speedy, convenient sources of loans. However, the loans provided are usually small with short time periods. In addition, farmers need to pledge physical collateral such as gold and jewellery and the loan amounts are normally, substantially less than the value of the pledged assets.

1.6. The research problem statement

Transforming the agricultural sector into a large-scale, modern, technology-based sector is one important priority of the Vietnam's farming community. Besides effective policies supporting this transformation, more attention should be paid to improve access to finance for farmers to invest in infrastructure, human resources and technology, and, hence, acquire technical efficiency and sustainable growth. Given the small-scale farming system of Vietnam, adequate access to credit for smallholder farmers is a crucial factor for transformation.

However, rural credit markets in most developing nations, but particularly in Vietnam, are inefficient, leading to severe farm household credit rationing. The lack of sufficient farm loans has an adverse impact on farm production and hinders the country's agricultural development. The question is: What factors influence farmers' ability to fully meet credit demands and does credit have a significant impact on agricultural performance?

Despite the coexistence of three rural credit markets in Vietnam, the literature on the determinants of rural households' credit demands and credit rationing in Vietnam mainly concentrates on one or two credit markets, which might result in biased estimates of credit demand and credit rationing

determinants. Incorrect identification of determinants affecting the farm households' credit demand and credit rationing can reduce the effectiveness of supportive policies to promote access to credit for them. In addition, different studies' results on the determinants of credit demand, credit rationing, the credit rationing impacts on agricultural performance, and the linkages among different credit markets are inconsistent regarding credit sources, survey periods, and regions. To the best of our knowledge, no study has simultaneously investigated the linkages among the formal, semi-formal, and informal credit markets in Vietnam although this information is of importance for policymakers to enhance the overall performance of agricultural credit markets. In addition, no empirical investigation has explored the relationship between credit and Vietnam's agricultural performance at the macro-level. Thus, the issue of whether credit actually contributes to the development of Vietnam's agricultural sector is still debatable.

1.7. The research objectives

This study aims to fill the gaps in the literature, providing up-to-date and more comprehensive information about the determinants of agricultural credit demand and credit rationing, the linkages among formal, semi-formal, and informal agricultural credit markets, and the credit-agricultural performance nexus at both the micro- and macro-levels in Vietnam. The five research objectives are:

First, we explore the relationships among formal, semi-formal, and informal agricultural credit markets in Vietnam.

Second, we examine farm households' determinants of agricultural credit demand in the formal, semi-formal, and informal credit markets in Vietnam.

Third, we examine farm households' determinants of agricultural credit rationing in the formal, semi-formal, and informal credit markets in Vietnam.

Fourth, we analyse the credit rationing impact on agricultural performance at the micro-level (household level) in Vietnam.

Finally, we investigate the short- and long-term relationship between credit and agricultural performance at the macro-level in Vietnam.

1.8. The research questions

To address the five research objectives, this study seeks to answer the five research questions with the first four questions at the micro-level analysis and the last question at the macro-level analysis. The research questions are:

1. Are there any linkages among the formal, semi-formal and informal credit markets in Vietnam?
2. What determinants affect farm households' demand for agricultural credit in Vietnam?

3. What determinants affect the probability of a household being credit rationed in agricultural credit markets in Vietnam?

4. How does credit rationing affect farm performance at the micro-level in Vietnam?

5. Are there short-run and long-run relationships between the agricultural credit and the performance of the agricultural sector at the macro-level in Vietnam?

1.9. The contributions of the study

The study contributes both academic and practical implications in four ways. First, this is the first study to explore the linkages among the three agricultural credit markets in Vietnam (formal, semi-formal, and informal) to provide more inclusive results. Second, this study addresses the interdependence of farm households' credit demands and credit rationing in the different credit markets. This study is the first to simultaneously explore the determinants of credit demands and credit rationing in the formal, semi-formal, and informal credit markets in Vietnam. Third, this is the first study that attempts to evaluate both the short- and long-run impacts of credit on Vietnam's agricultural performance at the macro-level. Finally, the study's results can be used by farmers, credit institutions, and researchers to evaluate the performance of Vietnam's agricultural credit market. Recommendations to improve access to credit for the agricultural sector could be useful for policymakers in designing new policies and strategies aiming to enhance Vietnam's agricultural credit market's efficiency, which ultimately increases farm performance, ensures food security, and reduces rural poverty.

1.10. The data collection and research methods

Both primary data and secondary data are used in this study. Primary data are used for micro-level analysis while secondary data are used for macro-level analysis. Primary data are collected from smallholder farm households in the Red River Delta (RRD) region of Vietnam using a survey questionnaire. Secondary data are collected from different sources such as General Statistics Office of Vietnam (GSO), State Bank of Vietnam (SBV), and other official data sources.

Different research techniques are used in this study. The direct elicitation method (DEM) is applied to identify the credit rationing status of farm households. A trivariate probit model (TVPM) is used to investigate the determinants of agricultural credit demand, credit rationing, and the linkage among formal, semi-formal, and informal credit markets in Vietnam. A multinomial endogenous treatment effects (METE) model is used to evaluate the impact of credit rationing on agricultural performance The DEM, TVPM models, and METE models are used for the micro-level analysis. The autoregressive

distributed lag (ARDL) model is applied to analyse short- and long-run relationships between credit and agricultural performance at the macro-level.

1.11. The thesis structure

The remainder of the thesis is organised as follows. Chapter two discusses relevant literature on the definitions of credit rationing, approaches to measuring credit rationing, the determinants of credit demand and credit rationing, the relationships among different credit markets, and the impact of credit on agricultural performance both at the micro- and macro-levels. Chapter three explains the methodologies and data collection methods of the study. Chapter four describes the RRD smallholder farm household survey data. Chapter five discusses the study's empirical results, and Chapter six reports the significant findings, discusses the study's limitations, offers policy recommendations, and suggests directions for further research.

Chapter 2

Literature review

Chapter two provides an overview of credit rationing in the agricultural sector, the interrelationships among different credit markets, the determinants of credit demand and credit rationing, and the linkage between agricultural credit and agricultural performance. Sector 2.1 reviews the relationships among different credit markets. Section 2.2 discusses the determinants of credit demand. Section 2.3 defines credit rationing, the various methods to empirically measure it, and the determinants of credit rationing. Sector 2.4 summarises the literature on credit's effect on agricultural performance at the micro-level. Sector 2.5 discusses the credit-agricultural output nexus at the macro-level. Sector 2.6 summarises the chapter.

2.1. The relationships among the different credit markets

In many developing countries, including Vietnam, formal, semi-formal, and informal credit markets coexist although the lending rates of the three markets differ (Tra & Lensink, 2008; Linh et al., 2019; Truong et al., 2020). Different credit markets have dissimilar characteristics in terms of loan purpose, value of the loan, interest rate, collateral, and procedures. Germidis et al. (1991) argue that the formal credit sector has triple biases: (1) it gives priority to households with high income and large enterprises over low-income households and small enterprises; (2) it prefers non-agricultural credit to agricultural credit; and (3) it favours the public sector over the private sector. Lainez (2014) postulates that households applying for a loan from formal credit institutions have to provide collateral and administrative papers, experience cumbersome procedures, and wait a long time for loans to be approved. Nissanke and Aryeete (1998) depict informal lenders as generally localised and focussed on small, short-term loans with a higher interest rate than the formal sector. Informal lenders take wider forms of collateral and use simpler credit submission and disbursement processes. Whereas loans from formal creditors are predominantly used for investment and production (Mohieldin & Wright, 2000; Linh et al., 2019), informal credit is broadly applied for consumption purposes or farmers' need of working capital (Chipeta & Mkandawire, 1991; Nissanke & Aryeete, 1998). In many developing countries, semi-formal lenders play an important part in the credit market since they focus on providing subsidized loans for targeted borrowers such as the poor and women (Tra & Lensink, 2008). Like informal lenders, semi-formal lenders allow flexibility in collateral, which allows poor farmers to access credit (Ghate, 2000). Typically, loans from the semi-

formal sector are short-term, of small value with subsidized interest rates that are generally less than commercial interest rates (Kashuliza et al., 1998, Linh et al., 2019).

Given the co-existence of the different credit markets, a good number of researchers have paid attention to the reasons why this phenomenon arises and the linkages among the credit markets. The co-existence of different credit sectors indicates segmentation or fragmentation of the credit markets. Nissanke and Aryeete (1998) emphasise the differences between the two terms: "fragmentation" and "segmentation". Segmentation indicates multiple credit markets coexist and serve different clientele with dissimilar characteristics and credit needs. Von Pischke (1991) argues that segmentation, by its very nature, is not necessarily unwanted and may actually increase effectiveness through specialization to better serve different credit market niches. Nissanke and Aryeete (1998) believe the level of integration among the different credit segments is the decisive factor for the market's efficiency.

Fragmentation suggests the interaction both within and across different credit segments is inadequate. This leads to the positive impacts of specialisation being outweighed by the negative impacts of weak connections among the different credit segments. Fragmentation or a lack of integration is specified by limited access to credit or other financial services, insignificant funds flowing across credit segments, considerable differences in interest rates and risk-adjusted returns for similar financial products. In a fragmented credit market, there is a lack of substitutability among the different credit segments, leading to inefficiency in risk, size, and maturity transformation, and financial resources mobilization and allocation (Nissanke & Aryeete, 1998). Conversely, well-integrated credit markets generally allow direct funds to flow across different segments and there is the ability of substitution among different credit providers (i.e., there is overlapping clientele that can freely switch among them). Thus, the key difference between segmented and fragmented credit markets is that the segmented market with specialisation for different niches may increase the efficiency while the fragmented market with the lack of integration among different segments is undesirable.

The controversial issue why the credit market is fragmented or segmented has been extensively debated in the literature. According to Nissanke and Aryeete (1998), there are two main schools providing explanations for segmentation of the financial market, the "financial repression" and "structural and institutional" schools. The "financial repression" school gives a policy-based excuse for the underdevelopment, inefficiency, and segmentation of the financial market, emphasizing the excessive intervention and control of government as the main reason. Repressive policies such as interest rate ceilings or control over the allocation of credit are considered to scale down the formal

financial market's size and distorts market signals. Ceilings on savings and credit rates are likely to increase demand for and decrease the supply of credit. Formal credit institutions usually consider priority sectors such as small and medium enterprises (SMEs) or the agricultural sector as high-risk areas. When there is a lending rate ceiling, formal credit institutions cannot increase premiums to deal with high risk and high transaction costs. The disparity between credit demand and supply because of interest rate ceilings forces formal credit institutions to ration loans by mechanisms other than the interest rate, provoking the expansion of the informal credit market with unrestrained rates (Nissanke & Aryeete, 1998). Roe (1991) argues that when formal credit institutions are seriously impeded by distorted policies, the informal credit sector expands and thrives. Based on this school, integration of the financial market will be achieved through interest rate liberalisation and the elimination of government control. Nonetheless, Nissanke and Aryeete (1998) assert that the general evidence from African countries during the 1970s and 1980s and their empirical results do not support the idea that financial liberalisation can solely tackle market fragmentation. Particularly, the informal credit market thrives in spite of the considerable reduction in government controls.

The structural and institutional view attributes the existence and extent of financial market segmentation or fragmentation to the differences among the costs and characteristics of the dissimilar kinds of credit transactions, imperfect information, a weak formal financial system, and inadequate market-supporting infrastructure (such as a weak legal system for credit contract enforcement). Regarding the dissimilarities among different types of credit transaction, Nissanke and Aryeete (1998) argue that household credit demand tends to be relatively small, which requires low transaction costs for both the borrower and the lender to enable the transaction to take place. Formal credit institutions are reluctant to carry out this kind of credit transaction because the lending rate cannot cover all the costs, including transaction costs. In such a situation, the informal option is more suitable because it can reduce the risk and transaction costs. As a result, the credit market is segmented.

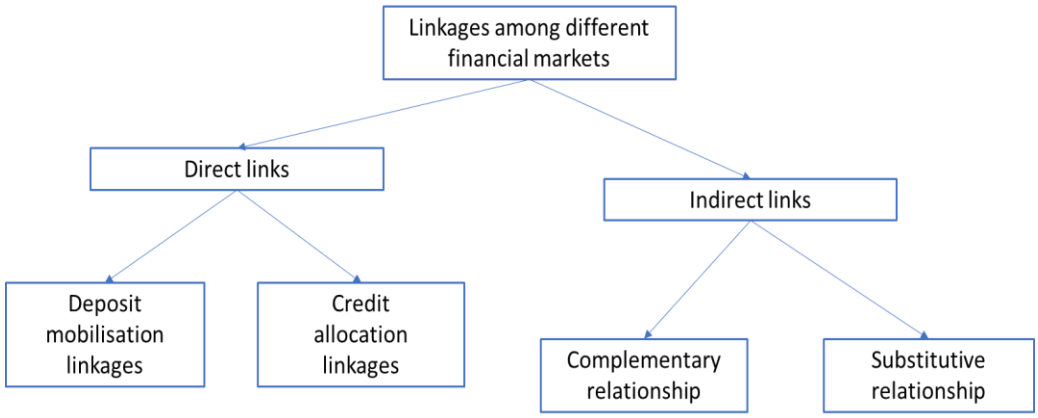
In addition, asymmetric information, which triggers adverse selection and moral hazard problems, can lead to credit rationing and a lack of substitutability among different credit segments and, ultimately, results in a fragmented credit market. The weakness of the formal banking sector in developing nations could be a source of fragmentation (Nissanke & Aryeete, 1998). The lack of interest, expertise, and advanced management skills in lending to small-scale borrowers and the agricultural sector constrains loans from commercial banks to agricultural firms and farm households. Likewise, a weak legal environment and inadequate infrastructure significantly influence the risk perception of the lenders and the costs related to credit contract enforcement. To secure a loan, formal lenders require collateral assets. This may exclude many would-be small-scale

borrowers who have good projects but no collateral. When the stringent requirements of collateral restrain small-scale borrowers from accessing formal credit, they are likely to turn to the informal sector where group responsibility or reputation may be used as collateral (Nagarajan et al., 1995; Nissanke & Aryeete, 1998).

The two main schools explaining financial market segmentation, as emphasized by Nissanke and Aryeete (1998), are not mutually exclusive but are complementary. Ghate (1988) argues that the informal credit sector includes two components: the "autonomous" and "reactive" components. The autonomous component refers to pawnbrokers, ROSCAs, and indigenous bankers that are historically earlier than the formal credit sector. This component evolved to adapt to the features of informal credit market niches. The reactive component arises in response to excessive and inefficient controls over the formal credit sector. Bell (1990) considers this component as a "residual" component that satisfies the "spill-over demand" of clients who are excluded by the formal credit market. Ghate (1988) suggests the expansion of the reactive component is not linear over time because it is influenced by the liberalisation and regulations of the formal credit market. In the same spirit, a "parallel" credit market and a "fragmented" credit market are distinguished by Roemer and Jones (1991). Government controls and regulations are the main reasons for the existence of a parallel credit market whereas the fragmented credit market came into existence in the absence of government controls and regulations. The authors also emphasize the coexistence of both fragmentation and parallelism in the credit markets of developing countries. Nissanke and Aryeete (1998) state that the financial repression school is related to parallelism whereas fragmentation in credit markets is better explained by the structural and institutional school.

Based on the literature, linkages among the different financial markets could be conceptually classified as indirect and direct links (Bell, 1990; Aryeetey, 1996; Nissanke & Aryeete, 1998). The direct links can be divided into the linkages in the allocation of credit and linkages in the mobilisation of deposits. For deposit mobilisation linkages, informal agents could play an important role between savers and formal financial institutions; informal agents can mobilise short-term micro-savings that commercial banks are unable to access because of high transaction costs. Informal agents transform the size, duration, and risk of these micro-savings and then deposit them in the banking system (Nissanke & Aryeete, 1998). This helps to decrease the cost of mobilising savings for commercial banks and encourages the savings habit for informal agents' clients. In addition, this direct link helps informal agents hold less idle capital (Nissanke & Aryeete, 1998). Besides informal agents, Nissanke and Aryeete (1998) emphasize the emergence of the semi-formal sector that can mobilise micro-savings and have a relatively strong relationship with commercial banks.

Direct linkage in the allocation of credit refers to the situation where informal agents borrow from formal institutions and then on-lend the funds. Bell (1990) indicates that informal lenders who are known to bank officials have less access to credit because commercial banks do not encourage on-lending. However, Aryeetey and Gockel (1991) argue that many informal lenders such as money lenders or traders, can borrow money from commercial banks as they generally undertake lending activities together with other businesses and bank officials do not know they will on-lend the money. Bell (1990) supports this kind of linkage because of the potential reduction in interest rate. Specifically, when moneylenders are granted low-cost credit by commercial banks, their cost of funds decreases which results in lower interest rates charged in on-lending activity. In principle, such linkages increase benefits for both lenders and borrowers. Nevertheless, Aryeetey (1992) and Nissanke and Aryeete (1998) claim that although being granted credit from formal institutions, informal lenders are unlikely to reduce their lending rates because of the monopoly they hold. Indirect links that work through the credit demand relationship could be a substitute (competition) or a complement in practice. Figure 2.1 summarises the different kinds of relationships among different financial markets.



Source: Adapted from Nissanke and Aryeete (1998)

Figure 2.1. The linkages among different the financial markets

If two credit markets are substitutes, the growth of one market leads to a reduction of the other. This competitive relationship implies that the loan products of the two markets are substitutable. When this type of relationship prevails, a repressive financial environment would lead to expansion of the informal credit sector, whereas financial liberalisation is expected to trigger the contraction of informal credit activities (Nissanke & Aryeete, 1998). If two credit sectors are complementary, both sectors could grow simultaneously. Aryeetey (1992), for example, explains that if the expansion of an investment project that was initially financed by formal credit institutions creates additional demand that can be satisfied only by informal lenders, the use of the two kinds of credit could be

considered complementary. In this case, the informal sector could be regarded as the supplier of residual credit for the formal sector. Ghate (1988) argues that each credit market serves a spectrum of clients. When the client spectrum of one credit market cannot be served by the other, the markets are considered to have a complementary linkage. Nissanke and Aryeete (1998) argue that the indirect relationships among different credit sectors based on the demand side could vary among different countries and change dynamically. Indirect relationships depend on policy and economic conditions. Nissanke and Aryeete (1998) and Diagne et al. (2000) highlight that it is important to identify the indirect relationships among different credit markets to launch policies that aim to boost the integration of the credit markets.

Given the relative importance of indirect links, the literature focuses mainly on substitution or the complementarity among the different credit markets. The results on this issue vary among different studies. Aryeetey (1992) concludes that there is no apparent substitutability between formal and informal credit in Ghana based on the interview results in 1990. The author suggests that when the formal credit sector contracted over a period of repressive policies, businesspeople or enterprises preferred reducing the scope of operations or halting the planned investments to borrowing from informal sources. In contrast, when the government attempted to increase the availability of formal rural credit by creating rural banks in Ghana, farmers' use of informal credit did not seem to decline at all. Nissanke and Aryeete (1998) provide evidence of low substitutability between formal and informal credit in countries in Sub-Saharan Africa in the early 1990s. They explain that dissimilarities in the interest rates, size, and maturities of loans in different credit markets mean a negligible number of informal loan contracts could be compared with those of the formal credit market. Similarly, Jia et al. (2010), using bivariate probit specification, find that informal credit is a weak substitute for formal credit in rural China. Mohieldin and Wright (2000) discover similar results in rural Egypt.

Bell et al. (1997), using the data from their survey canvassed in 1980-1981 in rural Punjab (India), observe credit demand in both the formal and informal sectors is fairly inelastic in relation to interest rates. If the government imposed repressive policies on the formal credit sector, which leads to an increase in the lending rate, the demand for formal credit was hardly affected, i.e., there was no spill-over demand effect. This implies a non-substitutable relationship between these credit markets. Based on a three-round survey conducted in Malawi from 1995 to 1996, Diagne (1999) illustrates that informal credit acts as an imperfect substitute for formal credit as borrowing from formal sources decreases but cannot entirely eliminate borrowing from informal sources. Muhammed (2013) uses bivariate probit specification and concludes informal credit can perfectly substitute for formal credit among rice farmers in Ghana's northern region, implying that the two

credit sources are mutually exclusive. In contrast, Awunyo-Vitor and Abankwah (2012) find that an increasing demand for formal loans by maize farmers in the Brong Ahafo and Ashanti areas (Ghana) does not lower their demand for informal loans. This result shows the informal and formal credit sectors have a complementary rather than a substitutable relationship.

In Vietnam, Saint-Macary and Zeller (2012) examined the relationship between the formal and informal credit sectors in Yen Chau (northern Vietnam's mountainous district). Based on a survey of 300 farm households between 2007 and 2008, the authors find that informal and formal credit are imperfect substitutes. The authors explain the differences between the two kinds of credit are the main reason for this phenomenon. In contrast, Thu et al. (2020), who surveyed 402 poor rural households in Thai Nguyen province, Vietnam, conclude that the informal credit market has a complementary relationship with the formal market and is an incentive to develop the formal credit market.

2.2. The determinants of credit demand

Based on the literature, the factors affecting farm households' credit demand can be classified into six groups: human capital, social capital, physical capital, credit history, geography, and other demographic profile-related factors. However, the results on the determinants of credit demand among different studies are inconsistent regarding credit sources, survey periods, and regions (Barslund & Tarp, 2008; Dang et al., 2019).

2.2.1. Human capital factors

Education of head is an indicator of human capital. Mpuga (2010) hypothesizes that education level and demand for credit have a positive relationship since the educated are more likely to be active in participating in business activities. Empirical results from Zeller (1994), Mpuga (2010) and Rizwan et al. (2019) show a significant, positive impact of the household head's education level on formal and informal credit demand. Barslund and Tarp (2008) and Lin et al. (2019) demonstrate the opposite for the informal credit market, i.e., the demand for informal credit is likely to decrease with increased years of formal education. One possible explanation is that a better-educated household head is likely to have better access to formal credit (Bendig et al., 2009).

Years involved in farming activities or *farming experience* is an indicator of human capital. Reyes (2011) argues that years of farming experience reflect farmers' management skills. The theoretical expectation of the effect of farming experience on credit demand is unclear. Farmers with more years in farming might have new ideas to improve productivity and need capital to realize these ideas, resulting in increased credit demand. Conversely, farm households with more farming

experience are likely to achieve greater efficiency, which generates more capacity for self-financing (Reyes, 2011). In addition, these farm households are more capable of predicting the demand for seasonal capital or input price fluctuation to prepare in advance, helping them reduce reliance on external finance, which leads to a decrease in credit demand. The literature shows mixed results on farming experience's influence on credit demand. Akpan et al. (2013), using a probit model to investigate the factors affecting credit demand among farm households in Akwa Ibom State (Nigeria), confirm that increased years involved in farming activities is likely to increase farmers' demand for credit. Girma and Abebaw (2015) and Chandio, Jiang, Rehman, et al. (2020) produce similar results. However, Atieno (1997) demonstrates farming experience significantly, negatively influences credit demand.

2.2.2. Social capital factors

Social status is considered a type of social capital of a farm household. According to the literature, there are different views and definitions of social capital. However, Portes (1998) asserts that there is a growing consensus that "social capital stands for the ability of actors to secure benefits by virtue of membership in social networks or other social structures". Social capital can be classified into bonding, linking, and bridging social capital (Woolcock & Sweetser, 2002). Bonding social capital or "strong social ties" indicates social networks among homogeneous groups with similar socio-economic features such as close groups of friends, family, and neighbours (Lin, 1982; Dinh et al., 2012). Bridging social capital or "weak social ties" describes social networks among individuals with socially heterogeneous characteristics. Linking social capital refers to connections with people holding positions of influence in private and public organizations such as banks, courts, or local government councils (Bandyopadhyay et al., 2006; Dinh et al., 2012).

One of the most outstanding advantages of social capital is that it enables individuals and groups to access information and valuable resources such as credit (Georg, 2009; Sanchez-Famoso et al., 2013). Social capital has an important role in fostering information and the exchange of ideas, facilitating the acquisition and transfer of soft information, decreasing information asymmetry to reduce transaction cost, and enhancing cooperation and the reputations of individuals or groups (DFID, 1999; Fafchamps & Minten 2002; Sanchez-Famoso et al., 2013). However, social capital has some negative impacts, including the exclusion of non-members of the social network, free-riding issues originating from excessive claims on fellow members' resources, downward levelling norms, and restraints on individual freedom (Portes, 1998). In addition, social capital may induce familiarity and homophily biases that bring about the loss of business cooperation opportunities outside social networks and the neglect of transaction shortcomings with network members.

Social status is considered an indicator of linking social capital. Li et al. (2020) assume that a household head who is a member of the government might raise the confidence of a household about obtaining credit, which positively affects the likelihood of applying for credit. Li et al.'s (2020) results show that households with the head as a member of the government are more likely to apply for a loan. However, Jia et al. (2010) and Cheng and Ahmed (2014) find social status or social entitlement insignificantly, negatively impacts the likelihood of applying for formal credit.

Social group participation could be a proxy for bridging social capital (Wallace & Pichler, 2007). Social group participation may encourage farmers to exchange ideas related to alternative sources of finance, and new investment projects and, hence, create an increased need for credit (Reyes, 2011; Akpan et al., 2013). Empirically, Akudugu (2012) examines the factors that influence farmers' demand for credit supplied by rural banks in Ghana. The author finds that participating in a farm-based group is likely to increase farmers' agricultural credit demands. Djoumessi et al. (2018) confirm that agricultural association participation significantly, positively affects credit demand and credit access by smallholder farmers in the southwest Cameroon.

2.2.3. Physical capital factors

Theoretically, Barslund and Tarp (2008) and Moahid and Maharjan (2020) consider *farmland* as productive capital; the larger the farm size the more likely farm households demand credit to purchase important agricultural inputs such as fertiliser or improved seeds. Empirically, Barslund and Tarp (2008) and Cheng and Ahmed (2014) find that households with more land area tend to apply for formal and semi-formal credit. Conversely, Jia et al. (2010) assert that farm size has a negative impact on formal credit demand whereas Barslund and Tarp (2008) and Cheng and Ahmed (2014) suggest farm size does not affect informal credit demand.

Assets (land area, house, durable assets) owned by households can be used as proxies for household wealth or physical capital (Mpuga, 2010; Tran et al., 2016). Theoretically, households with more assets are less likely to depend on credit (Tran et al., 2016). Empirically, the results of household assets' impacts on credit demand are mixed. Though Barslund and Tarp (2008) and Mpuga (2010) find a significant, positive relationship between household assets and formal credit demand, Cheng and Ahmed (2014) report the impact of house value on the possibility of a household applying for formal credit as unclear. For semi-formal and informal credit markets, Mpuga (2010) and Cheng and Ahmed (2014) show that a household is more likely to apply for credit with the increase of household assets' value. Duong and Thanh (2015) conclude that rural households with higher house value have a greater probability of participating in microcredit programs. Barslund and Tarp (2008) demonstrate more total assets decrease the possibility of demanding credit in the informal market.

2.2.4. Credit history factors

Previous studies have examined the effect of credit history variables, including *bad credit history* (Barslund & Tarp, 2008), *granted credit in the past years* (Jia et al., 2010), and *outstanding loans* (Das & Laha, 2017), on farm households' credit demands. Das and Laha (2017) assume rural households with outstanding formal loans typically do not apply for additional credit. Jia et al.'s (2010) study reveals that having formal credit in the past three years has an insignificant effect on rural Chinese households' willingness to borrow from formal credit sources. Barslund and Tarp (2008) conclude that a bad credit history significantly, positively affects rural households' demand for informal credit but does not influence the demand for formal credit. The authors explain that a bad credit history makes it difficult for rural households to secure formal loans. Thus, they turn to informal credit providers for their credit needs. Das and Laha (2017) show that having outstanding formal credit does not significantly affect a household's probability of applying for new formal credit.

2.2.5. Geographical factors

The impact of geographical factors on farm household's demand for credit has received considerable attention in previous studies. Geographical factors that may affect a farm household's credit demands are *distance to credit sources* and *regional differences***.** Theoretically, distance to market, main road, district centre, or credit sources is considered a hindrance to farm households in submitting credit applications or to be granted credit since the distance raises transaction costs and reduces the effective income from selling farm products, which implies lower repayment capacity (Winter-Nelson & Temu, 2005; Simtowe et al., 2008). Empirically, Chandio, Jiang, Rehman, et al. (2020) discover that a long distance to a financial institution or credit provider has a significant, negative influence on rural households' likelihood of applying for credit since the long distance increases transport costs for the loan. In contrast, Svotwa et al. (2020) conclude that the farm household – bank distance is not significantly related to credit demand. For regional differences, Barslund and Tarp (2008) used dummy variables to distinguish provincial differences in Vietnam and find regional differences significantly impact the households' credit demand.

2.2.6. Other demographic profile factors

Gender is one of the most common variables relating to the household head's characteristics in the literature. Simtowe et al. (2008) and Mpuga (2010) expect male-headed households will have more credit demand than female-headed households since males have greater chances of accessing production resources. Previous studies reveal males are more likely to have a high demand for formal loans (Zeller, 1994; Chaudhuri & Cherical, 2012). Mpuga (2010) concludes men exhibit a

higher level of credit demand from formal, semi-formal, and informal sources than women since men have a greater chance of accessing production resources. In contrast, Dang et al. (2019) reveal women are positively related to the adoption of both formal and informal credit in Lam Dong province, Vietnam. Chandio, Jiang, Rehman, et al. (2020) show the gender of the rural household head does not significantly affect a household's formal credit demand.

Cheng and Ahmed (2014) assume that the household head's *age* has a positive impact on credit demand since an older household head is expected to be involved in more economic activities hence has increased demand for credit. Cheng and Ahmed (2014) also expect that there is a decreasing marginal impact of the head age because the elderly in rural areas often have little formal education and have less productive investment projects, leading to low demand for credit. Other studies reveal mixed results of the impact of the household head's age on credit demand. Barslund and Tarp (2008), Chaudhuri and Cherical (2012), Cheng and Ahmed (2014), and Lin et al. (2019) find a significant, negative influence of the household head's age on the likelihood of applying for credit. According to Cheng and Ahmed (2014), the elderly in rural areas often have little formal education and have fewer productive investment projects, leading to low credit demand. Zeller (1994), Quach (2005), and Mpuga (2010) show the opposite. In addition, Mpuga (2010) and Cheng and Ahmed (2014) conclude that head age squared has the opposite impact on credit demand to head age, implying a nonlinear relationship between demand for credit and head age.

Family size is one of the most common household-related variables used to explain the rural household's demand for credit. Theoretically, family size is anticipated to increase the likelihood of submitting a loan application. Chaudhuri and Cherical (2012) and Tran et al. (2016) assume that larger households tend to have lower capital available for production because of higher expenditure for consumption hence depend on credit. Empirically, Nguyen (2007) and Chaudhuri and Cherical (2012) suggest that family size significantly raises the likelihood of households applying for formal credit, whereas Mpuga (2010) and Chandio, Jiang, Rehman, et al. (2020) report no significant impact of family size.

Farm households' capability of *livestock production* is expected to positively affect farmers' probability of borrowing and the loan amount (Pham & Izumida, 2002; Barslund & Tarp, 2008; Moahid & Maharjan, 2020). Moahid and Maharjan (2020) conclude that livestock has an insignificant impact on farm households' likelihood of participation in the formal and informal credit markets in rural Afghanistan. Similarly, Gockel (2009) finds that the proportion of livestock to rural households' overall production does not significantly affect a household's possibility of borrowing more credit in Ha Tinh province, Vietnam. In contrast, Barslund and Tarp (2008), using feed expenditure as proxy

for livestock holdings, reveal that livestock holdings have a significant, positive effect on rural households' credit demand in Vietnam. Pham and Izumida (2002) considered total livestock production as proxy of farmers' ability in livestock production. They assert that livestock has a significant, positive influence on households' probability of borrowing in the formal credit market. The authors explain that livestock production generates a relatively higher rate of return. Thus, rural farm households in Vietnam are more likely to borrow to invest in livestock production.

2.3. Measuring credit rationing and the determinants of credit rationing

2.3.1. Credit rationing definitions

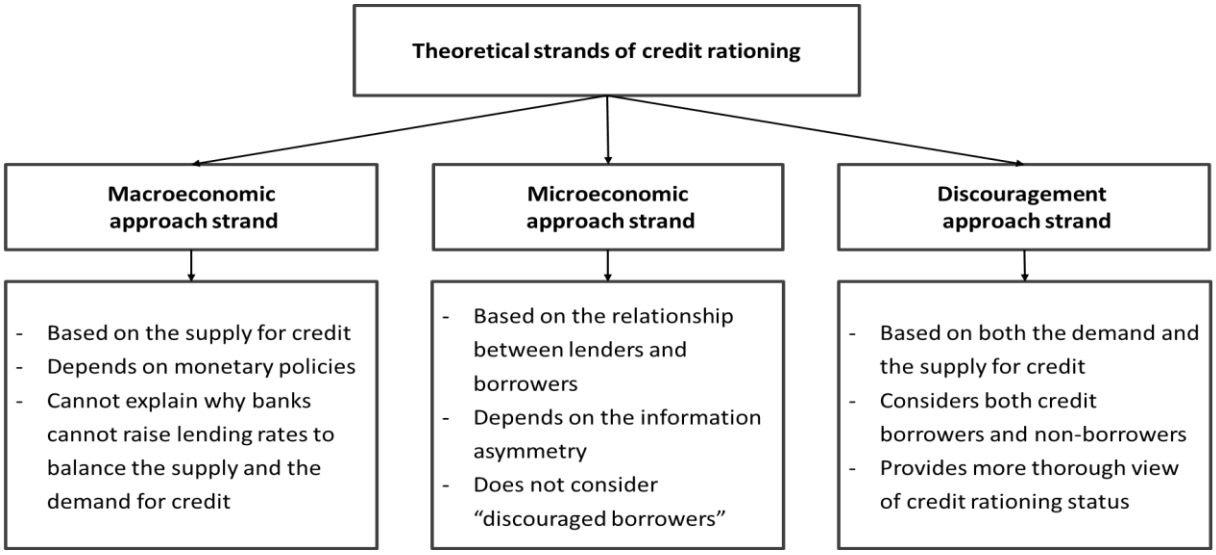
Credit rationing has been intensively debated among both theoretical and empirical researchers since World War II. According to Bellier et al. (2012), the theoretical literature on credit rationing can be categorized into three strands: (1) the macroeconomic approach; (2) the microeconomic approach; and (3) the discouragement approach.

The first strand is based on the supply for credit and postulates that because of the limitation of funds banks can attract, credit rationing always exists and the extent of rationing depends purely on real economic activity and supply conditions (Scott, 1957a, 1957b; Bellier et al., 2012). Traditional monetary theory considers the interest rate as the main stimulus for borrowing/lending or savings decisions. However, the macroeconomic approach claims that monetary policies, not the interest rate, are the decisive determinant of credit accessibility (Baltensperger & Devinney, 1985). More precisely, credit supply can be directly affected by changes in the money supply that are undoubtedly influenced by monetary policy. For instance, the implementation of restrictive monetary policies results in a considerable reduction in the money supply, even if the policies induce only a moderate increase in the interest rate. This suggests the available money that banks can lend to clients will be significantly constrained, resulting in credit rationing (Bellier et al., 2012). The macroeconomic approach does not pay attention to demand-side characteristics and hence cannot shed light on why banks are unable to increase lending rates to balance the credit demand and supply to realise better profits (Bellier et al., 2012).

Proponents of the second strand argue information asymmetry can provoke adverse selection and moral hazard, resulting in credit rationing (Stiglitz & Weiss, 1981; Williamson, 1987; Bellier et al., 2012). The complication of the relationships between the lenders and borrowers are considered in this strand. When asymmetric information exists, financial institutions (FIs) are not willing to raise the interest rate to equate to credit demand and supply, resulting in a "backward-bending credit supply curve" (Bellier et al., 2012; Tran, 2014). Specifically, a rise in the interest rate affects the profit

of commercial banks in two opposing ways. The positive effect is to increase the banks' net interest income. The negative effect is to increase risk in banks' portfolios caused by the moral hazard and adverse selection issues. The trade-off between the increase in lending rate and the cost of loan defaults results in credit rationing. In this situation, credit demand exceeds supply at the lending rate quoted by commercial banks. This implies that some borrowers are credit rationed, i.e., they accept to borrow at the quoted lending rate, but they cannot have access to credit or the full requested amount of credit (Bellier et al., 2012).

The third strand pays attention to both enterprises and households that apply for credit and non-borrowers that have a demand for but do not submit credit applications because of high transaction costs or fear of rejection (Kon & Storey, 2003; Boucher et al., 2009; Bellier et al., 2012). Levenson and Willard's (2000) study was the first to mention the term "discouraged borrowers" and, following this, Kon and Storey (2003) formalised the "discouraged borrowers" theory (Bellier et al., 2012). Kon and Storey (2003) suppose information asymmetry and positive application costs are the main reasons why borrowers are discouraged from applying for credit. Discouragement could be considered a mechanism of self-rationing because loan application decisions are made by the potential borrowers (Han et al., 2009). The discouragement approach investigates credit rationing from both credit supply and demand (i.e., external and internal credit rationing) hence provides a more thorough view of credit rationing. Figure 2.2 summarises the three theoretical strands that explain credit rationing.



Source: Adapted from Kon and Storey (2003), Bellier et al. (2012), and Freel et al. (2012)

Figure 2.2. The theoretical strands of credit rationing

Not surprisingly, the three strands of credit rationing in the literature have provided various definitions on credit rationing that either include or ignore the demand side of credit rationing.

Disregarding the demand side of credit rationing in empirical work may underestimate both the credit demand and the extent of credit rationing, especially in rural areas (Tran, 2014). Thus, we will follow the third strand and take both credit rationing's demand and supply side into consideration. According to Jia et al. (2010), a household is defined as credit rationed when a loan application is rejected (partially or fully) or when the household is discouraged from taking a loan**.** Credit rationing can be categorised into four groups: transaction cost rationing; price rationing; risk rationing; and quantity rationing (Boucher et al., 2009; Ali et al., 2014). Quantity credit rationing is classified as external credit rationing, which is the case where the lender does not provide the full amount of credit requested by the borrower (Tran, 2014). Internal credit rationing happens when farmers do not apply for loans for different reasons although they have credit demand (Dohcheva, 2009). Transaction cost and risk rationing are classified as internal rationing.

Quantity rationing refers to the situation where households' applications for loans are fully rejected (full quantity rationing) or are partially approved (partial quantity rationing). Households that do not apply for credit in spite of having a positive demand can be classified as fully quantity rationed if the reason for not applying is fear of rejection. Quantity rationing is associated with the credit supply side (Tran, 2014). Transaction cost rationing implies that households that have positive notional credit demand but do not submit a loan application because of a lack of knowledge on where or how to apply, a lack of local credit suppliers, or complications in the loan application and process (Ali & Deininger, 2014; Olomola & Gyimah-Brempong, 2014; Tran, 2014). Households are considered as risk rationed when they have credit demand and can access credit but do not submit any credit application because of a fear of being indebted or losing their collateral (Guirkinger & Boucher, 2008; Ali & Deininger, 2014; Tran, 2014). Both risk rationing and transaction cost rationing are related to the demand side of credit. Price rationing occurs when a high interest rate discourages households from applying for a loan (Guirkinger & Boucher, 2008). Price rationing can be classified as internal or external rationing. Internal price rationing happens when farm households are not willing to apply for credit with fair market interest rates. External price rationing could happen when the lender increases the interest rate (Olomola & Gyimah-Brempong, 2014).

2.3.2. Approaches to measuring credit rationing

The literature presents different methods to empirically measure credit rationing. These methods are categorized as direct or indirect methods (Bellier et al., 2012; Tran, 2014).

The indirect method attempts to investigate credit rationing by exploiting the theoretical difference in important variables between credit rationed and unrationed groups (Tran, 2014). Specifically, the violation of the assumptions of the permanent income (P-I) or the life-cycle (L-C) hypothesis can be

tested to detect credit rationing (Godquin & Sharma, 2005). The popular proposition of the P-I/L-C hypothesis that can be tested is that if credit rationing or credit constraint does not exist, a change in consumption will be related to a change in earnings (predicted or lagged changes) but not with shocks of transitory income (Diagne et al., 2000; Godquin & Sharma, 2005; Tran, 2014; Tran & Santarelli, 2014). However, the empirical conclusions based on the results of this method are ambiguous since violation of the assumptions of the P-I/L-C hypothesis is neither an adequate nor essential condition for being credit rationed (Musah, 2015). For example, households with prudent or precautionary behaviour may cut their consumption when an adverse income shock happens regardless of their credit rationing status (Tran et al., 2016; Mukasa et al., 2017).

The direct method (also known as the direct elicitation method) has been widely used in empirical analysis to measure credit rationing (e.g., Jia et al., 2010; Ali et al., 2014; Tran et al., 2016). The direct elicitation method (DEM) involves collecting information from household surveys to classify households into credit rationed or non-rationed credit groups (Bellier et al., 2012; Tran et al., 2016). Jappelli (1990) and Feder et al. (1990) were the pioneers to empirically apply DEM to directly measure credit rationing through interviews. One of the strongest points of DEM is that this method considers various kinds of credit rationing, such as transaction cost or risk rationing, that are expected to occur in rural credit markets (Boucher et al., 2009). Furthermore, DEM can explore not only the credit rationing status of each household but also the type of credit rationing to which the household belongs, delivering a more comprehensive measure of credit rationing than other methods (Tran, 2014). This method, nevertheless, is questioned on its validity because it is probable that the credit rationing status is exaggerated (Jia et al., 2010; Tran et al., 2016). However, the studies by Gilligan et al. (2005) and Boucher et al. (2009) confirm classifications of credit rationing based on DEM are reliable. Both Gilligan et al. (2005) and Boucher et al. (2009) highlight whether DEM can accurately distinguish between unconstrained and constrained households. Better design of the questionnaire, piloting, and using a large sample size are possible ways to reduce potential biases from DEM (Domeher et al., 2017). According to Petrick (2005), this method does not consider a household's repayment capacity and hence cannot distinguish between inefficient and efficient credit rationing. In addition, although DEM has improved the accuracy of detecting the existence of credit rationing compared with the indirect method, DEM cannot measure the extent of credit rationing (Diagne et al., 2000; Tran, 2014). Farm households are categorised into credit rationed or non-rationed groups but the data on the household's credit rationing level are not available when using DEM. Regardless of DEM's drawbacks, this direct method has been commonly used by researchers and remains the more practical method to evaluate credit rationing, especially in developing countries that are data-constrained (Tran & Santarelli, 2014; Domeher et al., 2017).

2.3.3. The determinants of credit rationing

Like credit demand determinants, previous studies have explored the determinants of farm household credit rationing and identified human capital, social capital, physical capital, credit history, geography, and other demographic profile-related factors as important in explaining farm household credit rationing. However, there are inconsistent results on credit rationing determinants among the different studies in terms of regions, study periods, and credit markets.

2.3.3.1. Human capital factors

The household head's *education level* is expected to decrease the possibility of being credit rationed since more educated farmers are believed to be more able to engage in better investment projects (Barslund & Tarp, 2008; Tran et al., 2016). Empirically, Jia et al. (2010), Cheng and Ahmed (2014), Tran et al. (2016), and Lin et al. (2019) find household heads with more education are less likely to be formal credit rationed. Freeman et al. (1998) report a similar relationship for both formal and informal credit. Ali et al. (2014) conclude that education has a significant impact on decreasing the incidence of being semi-formal credit rationed. However, Cheng and Ahmed (2014) find that household head's education level does not significant affect the household's probability of being credit rationed in the informal market.

Farming experience is expected to help farmers better cope with adverse changes affecting agricultural output, resulting in better farm performance, higher capacity for loan repayment and better creditworthiness. Lawal et al. (2009) and Ansah et al. (2016) confirm that years of farming experience have a significant, negative impact on the possibility of being credit rationed. Similarly, Chandio et al. (2017) conclude that the farming experience positively affects farmers' access to credit. Reyes (2011) concludes that though farming experience has a negative but insignificant effect on the likelihood of quantity rationing, farming experience is likely to increase the likelihood of being risk and transaction cost rationed. Reyes (2011) explains farmers having more years involved in farming activities may be associated with being older, which makes them feel it difficult handling loan applications and become more risk averse. Freeman et al. (1998) assert the relationship between farmers' credit rationing condition and number of years involved in farming practices does not exist in Kenya and Ethiopia.

2.3.3.2. Social capital factors

Social capital is hypothesized to increase a household's access to credit when physical collateral is ineffective in screening a household's creditworthiness (Tran et al., 2016). Jia et al. 's (2010) and Cheng and Ahmed's (2014) findings support the hypothesis that a household head with *social status,*

or holding any position in the community, increases the possibility of access to formal credit. Ali et al. (2014) assert that blood relatives or members of the farm household holding political office decreases credit rationing probability in the semi-formal credit market. Liu et al. (2020) reveal that holding party membership positively but insignificantly affects the credit availability from formal sources for farmers.

Involvement in *social activities and economic groups* enables farm households to build a reputation and a relationship with banks, thus reducing transaction costs in a loan application, which lowers the possibility of being credit rationed (Reyes, 2011). Winter-Nelson and Temu (2005) and Muayila and Tollens (2012) show that households with the head belonging to local associations have a lower probability of being credit constrained. Liu et al. (2020) show that participating in economic organizations is beneficial to farmers for obtaining informal loans.

Dinh et al. (2012) use four indicators, including *weak and strong ties to individuals with higher social position* (e.g., local authority) or *similar social position* (e.g., family or friends), to examine the impact of social capital on credit rationing in Vietnam. The authors reveal that the four indicators do not significantly affect farm households' likelihood of being credit rationed.

2.3.3.3. Physical capital factors

Households' physical capital (i.e., *land title, land area, house, durable assets*) is expected to improve household liquidity, increase repayment capacity and creditworthiness, and reduce a household's possibility of being credit constrained (Baiyegunhi et al., 2010; Tran et al., 2016, Sekyi et al., 2017). Foltz (2004) and Cheng and Ahmed (2014) show that the value of houses and durable assets has a negative relationship with the likelihood of being credit rationed in the informal credit market but only Foltz's (2004) study shows statistical significance. Nguyen (2007) and Barslund and Tarp (2008) conclude that land use rights (red book) and land area do not significantly affect banks' decisions to grant credit in Vietnam.

Theoretically, *farmland* can be used as collateral for a loan and it is expected to ease credit rationing. However, in some countries, such as China and Vietnam, farmland is not owned by farmers but by the government and cannot be used as collateral for a credit application (Jia et al., 2010; Tran et al., 2016). Thus, the expected influence of farmland size on credit rationing is unclear (Boucher et al., 2009; Tran, 2014). Empirically, Nguyen (2007) and Tran et al. (2016) show having more farmland eases farmers' formal credit rationing. Cheng and Ahmed (2014) have similar results for the semi-formal and informal credit markets. On the other hand, Simtowe et al. (2008) argue that more farmland might result in greater credit demand for input purchases, whereas the size of farmland does not affect creditors' lending decisions because of the limited rights of households over

cultivatable land areas. Therefore, farmland and formal credit rationing are positively, significantly associated (Simtowe et al., 2008; Jia et al., 2010; Lin et al., 2019).

2.3.3.4. Credit history factors

Previous studies have examined the impact of a household's credit history on credit rationing. Both theoretical hypotheses and empirical results confirm that a *bad credit history* or *having the previous loan rescheduled* are positively associated with the possibility of the household being credit rationed in the formal credit market (Petrick, 2004; Barslund & Tarp, 2008). Jia et al.'s (2010) study reveals that having formal or informal credit in the past three years has an insignificant effect on the rural Chinese households' possibility of being credit constrained. On the other hand, Cheng and Ahmed (2014) find that credit histories in the formal and semi-formal credit markets significantly influence the propensity to be credit rationed in the informal credit market.

2.3.3.5. Geographical factors

Distance to credit sources is considered a hindrance for farm households in submitting credit applications or being granted credit since the distance raises transaction costs (Simtowe et al., 2008). Boucher et al. (2009) and Tran et al. (2016) demonstrate that a longer distance or travel time to a credit source is likely to increase a household's credit rationing. For *regional differences*, Foltz's (2004) study concludes that households in regions with more production development are more likely to be credit constrained since the higher credit demand is not alleviated by an improved formal banking sector. Barslund and Tarp (2008) use dummy variables to distinguish provincial differences in Vietnam and find regional differences significantly influence a household's possibility of being credit rationed.

2.3.3.6. Other demographic profile factors

Theoretical expectations of the impact of *gender* on credit rationing are mixed. On one hand, males are more disadvantaged in obtaining subsidized credit than females (Tran et al., 2016). On the other hand, males are more able to self-finance (Simtowe et al., 2008). Thus, the effect of gender on credit rationing is theoretically unclear. Empirically, the effect of *gende*r on credit rationing differs among studies. Barslund and Tarp (2008) and Kuwornu et al. (2012) show that households with a male head are more likely to be credit rationed in the formal credit market. Freeman et al. (1998) draw a similar conclusion for both the informal and formal credit markets. Cheng and Ahmed (2014) and Tran et al. (2016) show a positive relationship between female household head and credit rationing. Ali et al. (2014), Das and Laha (2017), and Ojo and Baiyegunhi (2020) find a household head's gender does not significantly affect credit rationing.

The literature shows the effect of a household head's *age* on credit rationing is mixed. Nguyen (2007), Jia et al. (2010), and Tran et al. (2016) show that a household with an older head has a lower likelihood of being credit rationed. This could be because an older household head usually has accumulated enough capital and more likely does not have new agricultural investments (Tran et al., 2016). Conversely, Baiyegunhi et al. (2010), Cheng and Ahmed (2014), and Luan et al. (2016) report the opposite effect. This may be explained by the fact that younger household heads tend to be more active in participating in social organizations and in seeking information about credit sources to establish relationships with lenders (Baiyegunhi et al., 2010; Luan et al., 2016).

Theoretically, *family size* increases the likelihood of being credit rationed. Chaudhuri and Cherical (2012) and Tran et al. (2016) assume that, on the demand side, larger households tend to have lower capital available for production because of higher consumption expenditure hence depend on credit. However, on the supply side, the impact of family size is vague. On one hand, a household with a large family might use a significant portion of income from the project funded by loans for consumption rather than loan repayment. This might adversely affect the ability to repay the loan, making lenders reluctant to lend money to a large household. On the other hand, a large household provides cheap labour at the household level. If this cheap labour is used effectively, the household will generate more income and thus improve loan repayment ability. Nuryartono (2011) and Kuwornu et al. (2012) find *family size* has a significant positive influence on the possibility of formal credit rationing. Conversely, Lin et al. (2019) find that household size has a negative influence on the credit rationing of farming households. Freeman et al. (1998) find household size has an insignificant, positive effect on the likelihood of being credit rationed.

The literature suggests *livestock farmers* are less credit rationed than *crop farmers* (Mohamed & Temu, 2008; Awotide et al., 2015). Mohamed and Temu (2008) explain that raising livestock, especially cattle, could be an indicator of a household's relative wealth. In addition, livestock farming is relatively less risky than crop farming because of weather-related conditions (Salem et al., 2011).

2.4. The impact of credit on agricultural performance at the micro-level

The credit-agricultural outcome relationship at the micro-level (farm or household-level) has received significant attention in the literature. Studies mainly focus on formal and informal credit (e.g., Xi & Li, 2007; Duy, 2012; Luan et al., 2016). A limited number of studies (Girabi & Mwakaje, 2013; Mukasa et al., 2017) pay attention to the semi-formal credit market.

Given that the credit-agricultural output nexus is investigated at the micro-level, most studies use cross-sectional data from household or farm surveys. A small number of researchers use panel data

to investigate this issue (Ciaian et al., 2012; Mukasa et al., 2017). Different studies use various research techniques to explore credit's impact on agricultural performance. Most of the studies apply propensity score matching (PSM) and switching regression model (SRM) methods (e.g., Ciaian et al., 2012; Luan et al., 2016; Mukasa et al., 2017; Seck, 2019). Stochastic frontier analysis is used by a good number of researchers (e.g., Dolisca &Jolly, 2008; Duy, 2012; Akram et al., 2013). Previous studies also use the Cobb-Douglas production function (CDPF) estimated by OLS (ordinary least squares) to evaluate the influence of credit on agricultural output (Ekwere & Edem, 2014; Asim et al., 2015). Quantile regression has been used by several researchers (Xi & Li, 2007; Duy, 2012).

The explanatory variables used in any empirical model largely depend on the research method chosen. For instance, the independent variables in the SWR and PSM approaches depend on the probit or logit model to identify the factors influencing the credit access or credit rationing status of the farmers. Thus, the independent variables in these approaches are related to farm household characteristics, household head characteristics, assets, credit history, geographic factors, etc. Conversely, studies using CDPF usually use important agricultural inputs as explanatory variables. However, agricultural inputs such as fertiliser, pesticide, and seed are used only when evaluating the credit impact on a particular crop output such as wheat yield (Bashir et al., 2010; Asim et al., 2015), rice production (Duy, 2012), sunflower and maize productivity (Girabi & Mwakaje, 2013).

Given concern for endogeneity in the estimation technique to evaluate the impact of credit on agricultural outcome and bias caused by unobserved factors, instrumental variable (IV) has been used in previous studies (Xi & Li, 2007; Dong et al., 2012; Akudugu, 2016; Tran et al., 2016). An appropriate IV is very important because it has a significant effect on the accuracy and effectiveness of credit's effect estimation. However, the choice of IV differs significantly in different studies; Xi and Li (2007) use a farmer's debt ex-ante as the instrument of credit, whereas Tran et al. (2016) use the time a household spends on travelling to the nearest financial institution. Dong et al. (2012) use two dummy variables indicating whether a farm household had received a loan previously and the house value. In Akudugu's (2016) study, competitors' characteristics at the district and community level (such as the average household savings and the average quantity of credit borrowed) are used as IVs. Although different IVs are used, the instruments must satisfy the condition that they influence only the selection variables (e.g., access to credit or credit rationing status) but not the outcome variables (e.g., agricultural output).

Most of the previous studies have demonstrated that credit from all sources (formal, semi-formal and, informal) has a significantly positive effect on agricultural outcomes. Bashir et al. (2010) and Asim et al. (2015) apply CDPF and find that the use of formal credit in the agricultural sector

significantly contributes to agricultural productivity enhancement. Bashir et al.'s (2010) results indicate that a one percent increase in agricultural credit granted by formal institutions results in a 0.025 percent increase in wheat yield in Lahore (Pakistan). Similarly, Asim et al. (2015) confirm that the wheat and the cotton yields of farmers who get credit from commercial banks in Sahiwal (Pakistan) are 2.6 percent and 1.5 percent higher, respectively, than those of farmers who do not borrow. Duy (2012), using the Vietnam Living Standard Survey 2008 (VLSS) and the Stochastic Frontier Analysis approach, concludes that credit access is likely to enhance the production efficiency among rice farmers in the Mekong Delta (Vietnam). Duy (2012) also finds access to formal credit has a greater impact on the efficiency of Vietnam farmers' rice production than access to informal credit. Chiona et al. (2014) use the stochastic frontier analysis approach and assert that formal credit access positively affects maize production efficiency of Zambia's smallholder farmers.

Tran et al. (2016) apply the endogenous switching regression (ESR) model to estimate the effect of credit constraints on farm households' incomes in the north central coastal Vietnam. The authors conclude that formal credit constraint has a negative influence on farm household income. The authors confirm that in the group of farm households not constrained by credit, the income per capita between female- and male-headed and non-poor and poor families shows no difference. This implies that having adequate access to credit supports female-headed and the poor farm households in reducing the income gap with male and the non-poor counterparts, respectively. Tran et al. (2016) also show the useful role of informal loans as an appropriate supplement to formal loans in improving the income of farm households that are credit constrained in the formal credit market. Freeman et al. (1998) conducted cross-sectional surveys in the Kiambu district (Kenya) and the Debre and Libanos Selale districts (Ethiopia) on a sample of smallholder dairy farms, using the ESR model to investigate the influence of formal credit constraint on milk productivity. Their results show formal credit has a positive impact on milk productivity; however, the marginal impact of credit on productivity is higher on credit constrained milk producers than their credit non-constrained counterparts. If the credit used to buy crossbred milking cows increases by 1 percent, the milk productivity of credit non-constrained farm households and credit constrained counterparts in Ethiopia increases by 0.4 percent and 0.6 percent, respectively. Foltz (2004) provides evidence that credit constraint negatively affects farm profitability in rural Tunisia. The author argues that credit rationing negatively affects farm profits by lowering production outputs because of the sub-optimal allocation of various inputs such as land or labour. Seck (2019) investigated the impact of both "ex-ante" credit constraints (mostly price, risk, and transaction cost constraints) and "ex-post" credit constraints (quantity constraints) on smallholder farming productivity using the ESR model

and primary data from a smallholder farmer survey in the Senegal River Valley. Seck (2019) concludes that all types of credit constraint negatively affect farm performance.

Ciaian et al. (2012) hypothesize the effect of different levels of credit constraint may be non-linear. The authors divide farms in Central and Eastern Europe into eight groups based on the credit-output ratio. Adopting PSM, Ciaian et al. (2012) conclude access to formal credit has a positive relationship with farm output and farm productivity. In addition, the gain in farm productivity by a unit of additional credit is higher in the groups with a lower credit-output ratio, implying a decline in the marginal productivity per additional credit. Owuor and Shem (2012) focus on the influence of informal credit on smallholder farm performance in Kenya. Their results confirm that borrowing from informal sources significantly, positively affects farm output via purchased factors.

Xi and Li (2007) use IV quintile regression and assert both informal and formal loans significantly, positively contribute to Chinese farmers' outputs. Using both the OLS and two-stage least squares (2SLS) methods to capture the effect of credit on Chinese farmers' outputs, Xi and Li (2007) assert that the OLS method estimators underestimate the farm credit effect because of neglecting the endogeneity issue. The results from IV quintile regression indicate that the poorest and richest farm households are not significantly influenced by credit. Meanwhile, middle and low-income farm households are supported most by formal and informal credit. The authors explain the poorest farm households are usually affected by a lack of skills and essential capital that inhibits them from utilising loans to make production investments. Conversely, the richest farmers are typically not credit constrained; they can fund production investments from self-accumulation. Thus, credit has a negligible influence on these farm households. Duy (2012) divides his sample of rice farmers in the Mekong Delta (Vietnam) into four equal groups based on production scale and applies quantile regression to evaluate the effect of credit on rice production. The author finds that the rice outputs across all production scale groups are significantly, positively affected by both informal and formal credit access.

For semi-formal credit, Girabi and Mwakaje (2013) evaluate the effect of credit from MFIs on the productivity of farm households in Iramba (Tanzania). Their results confirm that the group of credit beneficiaries has higher agricultural productivity than the group of credit non-beneficiaries. Likewise, Mukasa et al. (2017) assert that if the credit constraint from all sources (formal, semi-formal, and informal) is removed, constrained farmers' output in Ethiopia would increase by 60%. In addition, the authors discover the effects of different kinds of credit constraint on agricultural output are not the same. The gain in farm productivity through the removal of credit constraints is smallest for quantity credit constrained farms and the biggest for price credit constrained ones.

Ibrahim and Bauer (2013) conducted a survey of rural farmers in 2009 in North Kordofan (Sudan) to investigate microcredit's impact on farm profits. Using the Heckman selection model, Ibrahim and Bauer (2013) find microcredit has no effect on farm production. The authors explain that microloan sizes might be too small to produce a significant effect on farm performance. Similarly, Khandker et al. (1998) report that formal credit has no influence on farm production in Bangladesh during the 1991-92 study period. Sjah et al. (2003) conclude the effect of credit from government schemes and private sources on farm production is unclear in Indonesia. Luan et al. (2016) use the PSM method and conclude access to informal credit and preferential credit does not impact total household farm income in Vietnam. Interestingly, the authors find commercial bank credit negatively affects total farm income of households although positively affects total household income. This is because loans from commercial banks were largely used to support non-farm activities.

2.5. The impact of credit on agricultural performance at the macro-level

Given the considerable role of agricultural production in the national economy and the importance of credit to agrarian growth in developing countries, an ample body of literature has investigated the credit–agricultural performance nexus at the macro-level. Empirical work on the impact of credit on agricultural outcomes at the macro-level mainly focus on formal credit sources. The reason could be the available data are largely from the formal credit sector (Sriram, 2007) and time-series data on credit from semi-formal and informal sources do not exist or lack information (Das et al., 2009; Misra et al., 2016). This data limitation for informal and semi-formal credit sources can be resolved by conducting a survey at field level. A field-level survey helps to reveal information about different sources of credit that farm households and agricultural enterprises actually use. However, generalized conclusions about the relationship between credit and agricultural performance can barely be drawn based on a field-level survey (Misra et al., 2016).

Theoretically, agricultural credit is a vital indirect factor, among others, to boost the output of the agricultural sector (Sriram, 2007; Das et al., 2009; Yadav & Sharma, 2015). Agricultural credit contributes to agricultural production growth in two ways: (i) it reduces liquidity and investment limitations in agriculture; and (ii) it enables a consumption-smoothing effect of credit (Das et al., 2009; Misra et al., 2016). On the other hand, empirically investigating the credit-agricultural output relationship is not easy. Besides the limitation on semi-formal and informal credit data, there are three key explanations that clarify this issue. First, the credit–agricultural output nexus is affected by factors such as agro-ecological factors, holding sizes, and cropping pattern. Second, estimation of this relationship can be exposed to endogeneity bias arising from co-determinants of credit and agricultural output. Third, in addition to affecting agricultural output through increased use of

inputs, credit stimulates consumption smoothing and also increases the probability of taking on greater risk. This implies that better credit provision encourages risk-averse farm households and enterprises to invest in new agricultural projects that ultimately affect the outputs of the agricultural sector. The latter two impacts are often difficult to capture (Misra et al., 2016).

Conventionally, the agricultural production function (APF) demonstrates the relationship among important inputs (e.g., fertiliser, pesticides, labour, land, capital, water) and physical amounts of agricultural outputs (Iqbal et al., 2003; Ahmad, 2011). Empirically, given that agriculture is a multi-product industry, Iqbal et al. (2003) postulate that agricultural gross domestic product (AGDP) is used as a dependent variable when examining the influence of different inputs on agricultural output at the macro-level. The issue whether agricultural credit is encompassed in the agricultural production function as one explanatory variable has been critically discussed (e.g., Iqbal et al., 2003; Ahmad, 2011; Chisasa & Makina, 2013).

Iqbal et al. (2003) argue that using credit as an explanatory variable in the APF generally encounters criticism because that credit does not have a direct influence on agricultural output but an indirect impact through supporting farm households to obtain various inputs. However, Carter (1989) argues that credit has a crucial influence on agricultural performance via three channels: (i) credit may be used to purchase modern technological packages that support farmers to enhance technical efficiency and hence lead a shift towards a better input-output relationship, (ii) credit helps the agricultural sector allocate resources more efficiently by easing financial constraints on buying essential inputs, and (iii) credit can promote more intensive use of fixed inputs such as family labour, agricultural land, and farming skills that finally increase agricultural productivity. Based on Carter's (1989) argument, Ahmad (2011) and Chisasa and Makina (2013) posit that agricultural credit should be directly used as an explanatory variable. Other important inputs such as improved seeds, pesticides, and fertiliser, are dropped because they may be purchased using credit.

According to Yadav and Sharma (2015), the effect of credit on agricultural output can be divided into two main groups: (1) agricultural output is positively, significantly influenced by agricultural credit (e.g., Chisasa & Makina, 2013, 2015; Shahbaz et al., 2013; Chandio, Jiang, Rauf, et al., 2020); and (2) the relationship between credit and agricultural output cannot be established directly (e.g., Hussain, 2012; Adeola & Ikpesu, 2016; Lawrence & Ikechukwu, 2016).

Previous studies use different approaches to explore the credit-agricultural output nexus, including the CDPF estimated by OLS, Granger causality, co-integration and a mixed approach. Iqbal et al. (2003) use CDPF estimated by OLS to discover the impact of institutional credit on AGDP in Pakistan from 1971 to 2002 and conclude that institutional credit significantly, positively influences

agricultural output. Using the same approach, Saleem and Jan (2011), Chisasa and Makina (2013), and Rimal (2014) achieve similar results; whereas Hussain's (2012) study shows that credit disbursement had an insignificant, positive effect on agricultural production. Hussain (2012) believes that the insignificance of agricultural credit possibly indicates inefficiencies in the use of credit in the agricultural sector. However, there are some concerns about the accuracy of the OLS results. Particularly, the OLS regression analysis is based on the assumption that no correlation exists between all independent variables and the error term. This assumption implies that there is no endogeneity issue (Abdallah et al., 2015). Nevertheless, like evaluation at the micro-level, there is a possible endogeneity issue when evaluating the credit effect on agricultural output at the macro-level. Thus, Misra et al. (2016) assert that using the OLS to estimate the CDPF gives biased, inconsistent results in the presence of endogeneity. In addition, Ahmad (2011) emphasizes that non-stationary issues in time-series data could happen, leading to the problem of spurious regression, which raises concern about the reliability of the significance of the agricultural credit variable.

The issue whether agricultural credit leads agricultural performance or vice versa at the macro-level has attracted considerable attention in the literature. The empirical results show that the causality direction diverges markedly among countries. Using the Granger causality test, Shahbaz et al. (2013) conclude bi-directional causality exists between financial development (proxied by real credit disbursed to farmers by financial institutions) and agricultural growth in Pakistan from 1971 to 2011. The result is consistent with Yazdi and Khanalizadeh's (2014) finding. Chisasa and Makina (2015) report uni-directional causality from bank loans on the agricultural sector’s production in South Africa from 1970 to 2011 and no reverse causality. Likewise, Khan et al.'s (2017) results confirm the presence of uni-directional causality running from institutional credit for agriculture to AGDP in India from 1980 to 2011. Conversely, Ogbuabor and Nwosu (2017) find no causality running from credit from deposit money banks to the agricultural sector and agricultural productivity over the period 1981-2014 in Nigeria. Nnamocha and Eke (2015) reveal a similar result for bank credit and agricultural output from 1970 to 2013 in Nigeria. Anetor et al. (2016) conclude there are bi-directional causalities between commercial loans to agriculture and Nigeria’s agricultural production. However, there is no causality between the agricultural sector’s production and the agricultural credit guarantee scheme fund (ACGSF – a scheme operated by the Nigeria Central Bank to enhance access to agricultural credit).

Using the ARDL bounds test method, Ahmad (2011) reveals a cointegration relationship among credit, agricultural output, labour, cropped area, and water from 1974 to 2008 in Pakistan. The results in Shahbaz et al. (2013), Chisasa and Makina (2015), Khan et al. (2017), and Ahmad et al. (2018) support cointegration between agricultural production and agricultural credit. Conversely,

Oyakhilomen et al.'s (2012) and Adeola and Ikpesu's (2016) studies show no cointegrating relationship between agricultural output and credit during the period 1981-2011 and 1981-2013, respectively, in Nigeria. Oyakhilomen et al. (2012) believe that the limited number of farmers who were granted credit, the small value of the loans, and loan diversion from agricultural production purposes to other purposes are the reasons for the non-existence of this relationship.

Recent scholars pay attention to the short- and long-run relationships between credit and agricultural performance. Using the ARDL bounds test approach and annual data over the period 1981-2014 in Nigeria, Olaniyi (2017) asserts that in both the short and long run, agricultural credit significantly, positively affects agricultural performance. Similarly, Chandio, Jiang, Rauf, et al. (2020) find that in both the short and long term, agricultural credit exhibits a significant, positive relationship with agricultural performance in Pakistan from 1983 to 2016. Other studies find a significant, positive influence exists only in the long run (Chisasa & Makina, 2015; Nnamocha & Eke, 2015; Ogbuabor & Nwosu, 2017; Florence & Nathan, 2020). Conversely, Badeeb and Lean (2017) use the ARDL bounds test approach and report credit to the private sector has a significant, negative influence on agricultural value added in Yemen from 1980 to 2012. The explanation for this negative relationship could be agricultural shocks such as flooding and drought, which negatively influence the repayment capacity of agricultural borrowers.

Nnamocha and Eke (2015) conclude that bank credit does not affect the agricultural output of Nigeria in the short run. Similarly, the studies by Ogbuabor and Nwosu (2017) in Nigeria, Badeeb and Lean (2017) in Yemen, Tekilu et al. (2018) in Ethiopia, and Florence and Nathan (2020) in Uganda find credit's influence on agricultural production is marginal in the short run. Tekilu et al. (2018) postulate that the underdevelopment of FIs and the inefficiency of Ethiopia's financial sector hinder the efficient allocation of credit to agricultural production activities in the short run. Contrary to Olaniyi (2017), the finding in Chisasa and Makina (2015) shows that, in the short run, agricultural credit in previous periods significantly, negatively affects agricultural output. The reasons for this negative relationship could be a mismatch between agricultural production and repayment cycles, higher interest rates farmers have to bear, or the uncertain nature of agricultural output because of input and output price fluctuation, climate change, etc. (Chisasa & Makina, 2015).

Misra et al. (2016) suggest that other explanatory variables, which are likely to influence agricultural performance such as public investment, should be included in econometric models together with agricultural credit. Mwabutwa (2017) argues that public investment in agriculture is considered a crucial factor in boosting agricultural growth. Mogues et al. (2012) believe that public investment is necessary for sustainable economic and agricultural growth because public investment contributes

to reduction of the inequality of welfare and income distributions in society and the mitigation of market failures. Increased credit supply to agriculture from formal sources may not be a contributing factor to the agricultural growth without the support of public investment in irrigation, extension, and research (Sriram, 2007; Misra et al., 2016). However, empirical studies give mixed results for the public investment-agricultural performance relationship. Nadeem et al. (2013) use the total factor productivity (TFP) decomposition method and Granger causality test to examine the public investment-agricultural productivity nexus in Pakistan. Their results confirm public investment in agricultural research, rural roads, and irrigation significantly, positively influence agricultural productivity in Punjab, Pakistan. In addition, Nadeem et al. (2013) find a uni-directional causality running from agricultural research to agricultural performance over the period 1970-2005.

Misra et al. (2016) use the generalised method of moments (GMM) to evaluate the impact of various explanatory variables (including agricultural credit and public investment in infrastructure, irrigation, and electricity) on agricultural productivity in India. They show the intensity of agricultural credit positively, significantly influences agricultural productivity. Though public investment in irrigation systems has a significant, positive impact on productivity, public investment in electricity and roads do not significantly affect productivity. However, Misra et al. (2016) note that their conclusion about the effect of public investment on agricultural productivity needs to be taken with caution because of the time-series data constraint at the macro-level.

Mogues et al. (2012) conclude that public agricultural investments (in irrigation, agricultural research and development (R&D), and extension) play an important part in the growth of agricultural production. In addition, Mogues et al. (2012) confirm public investment in the non-agricultural sector (in education, health, electrification) contribute to agricultural performance. De and Dkhar (2018) apply the ARDL bounds test approach to explore the relationship between agricultural production and public expenditure for different purposes (including agriculture, education, and rural development) in Meghalaya (India) from 1984 to 2014. Their results confirm long-run relationships among agricultural output, public expenditure on rural development, agriculture and allied activities, transport, communications, medical and public health, and education. Though public investment in transport and education has a significant, positive impact, public investment in health care does not significantly influence agricultural performance in the long run.

Interestingly, De and Dkhar (2018) find that public expenditure on agricultural and allied activities has a significant, negative impact on agricultural output. The authors explain this type of public expenditure includes some components (such as expenditure on wildlife) that do not directly affect the growth in agricultural production. Abula and Ben's (2016) results show that public expenditure

on the agricultural sector significantly, negatively affect agricultural output whereas credit granted by commercial banks to the agricultural sector has a positive but insignificant effect on Nigeria's agricultural output over the period 1981-2014. Abula and Ben (2016) explain that government funds allocated to the agricultural sector have not been judiciously or actually disbursed because of corruption. Yeboah (2016) uses the Johansen test and OLS to examine the impact of public investment on agricultural performance in Ghana from 1961 to 2013. The author's empirical result reveals the presence of a significant, positive influence of public investment on agricultural performance and a long-run relationships among public investment, gross fixed capital formation, and agricultural productivity.

In addition to investment variables, previous studies have paid attention to weather-related or climate change-related variables when evaluating the performance of the agricultural sector. Das (2005) postulates that agricultural growth continues to rely heavily on weather conditions despite recent technology developments that have helped boost the agricultural production in many nations. The influence of climate change on the agricultural sector varies among different countries. For example, Mendelsohn (2008) concludes the agricultural sectors of developing countries in tropical and subtropical regions are more sensitive to climate change than those in temperate regions. Because of the impact of weather or climate change, including weather or climate change variables such as temperature and rainfall (as control variables), in econometric models to evaluate the effect of credit on agricultural performance may help improve the accuracy of these models. Empirically, Chisasa and Makina's (2015) results show that agricultural credit, rainfall, capital formation, and AGDP are cointegrated in South Africa over the period 1970-2011. Rainfall significantly, negatively affects agricultural output; a one percent increase in the volume of the rainfall results in a 0.3 percent decrease in the AGDP. Ogbuabor and Nwosu's (2017) study uses two variables (annual rainfall and annual temperature) to capture the influence of climate change on the agricultural sector in Nigeria from 1981 to 2014. Their results report the existence of a stable long-run relationship among rainfall, temperature, agricultural credit, agricultural land, agricultural labour, and agricultural productivity (proxied by agricultural value added per labourer). Though the influence of rainfall is statistically insignificant, temperature significantly, positively contributes to Nigeria's agricultural production (Ogbuabor & Nwosu, 2017).

Agricultural labour is also one of the most crucial and effectual elements in agricultural production (Rufai et al., 2018). Agricultural labour availability affects the performance of the agricultural sector as it determines planting, well-timed crops, and harvest processing (Oluyole et al., 2013). Using the OLS method, Udah and Nwanchulwu (2015) confirm that agricultural labour significantly, positively affects the agricultural output of Nigeria during the period 1960-2010. Similarly, Shahbaz et al.

(2013), using the ARDL approach, conclude that the agricultural labour force is positively related to Pakistan's agricultural performance from 1971 to 2011.

2.6. Chapter summary

This chapter summarises previous studies on the factors influencing farm households' credit demand, credit rationing, the relationships among different credit markets, and the credit-agricultural output nexus. Various theoretical strands (macroeconomic, microeconomic, and discouragement) of credit rationing are discussed. However, the discouragement strand, which considers both supply and demand for credit, provides a more exhaustive view of credit rationing.

To measure credit rationing, empirical methods are divided into indirect and direct methods. The indirect method is based on violations of the assumptions of the permanent income or the life-cycle hypothesis. However, this method provides ambiguous empirical conclusions. The direct method, involving gathering information from household surveys to detect credit rationing, has been broadly used in empirical research, especially in developing nations that are data constrained.

Based on the literature, characteristics that affect the farm households' credit demand and credit rationing are categorized into six groups: human capital, social capital, physical capital, credit history, geographical, and other demographic profile-related factors. Previous studies commonly use binary dependent variables to indicate the credit demand and credit rationing status. Thus, probit and logit models are mainly used to investigate factors influencing credit demand and credit rationing. The empirical results of earlier research confirm the impacts of different groups on credit demand and credit rationing vary among different credit markets and different regions.

The co-existence of different credit markets has received attention from a number of researchers who focus on the reasons triggering this phenomenon. The literature presents two main schools of thought: the "financial repression" school (giving a policy-based excuse for the segmentation of the financial market) and the "structural and institutional" school (based on imperfect information, weak formal financial system, and inadequate market-supporting infrastructure). The relationships among different credit markets can be divided into direct links (links in the credit allocation and/or deposit mobilisation) and indirect links (links in credit demand that could be substitutes or complements). Prior empirical research largely focuses on substitution or complementarity among different credit markets; the results on indirect links vary among different researchers.

Previous studies focus on the effect of credit on agricultural performance both at the micro- and macro-levels. Though studies at the micro-level use cross-sectional data collected from household or farm surveys, studies at the macro-level mainly use time-series data and focus on formal credit

because of limitation of the data for informal and semi-formal credit sources. The empirical results on credit's effect on agricultural performance can be divided into two main groups: (1) positive impact of credit on agricultural performance; and (2) no direct impact of credit on agricultural performance.

A considerable amount of research has investigated factors hindering farmers from getting the full requested credit amount and the credit effect on agricultural performance in Vietnam. However, no comprehensive study simultaneously examines credit demand and credit rationing, and the linkages among formal, semi-formal, and informal credit markets. Furthermore, there is no empirical research exploring the credit-agricultural performance nexus at the macro-level in Vietnam. This study aims to bridge these gaps, analysing the factors that affect the farm households' credit demand and credit rationing, the linkages among the three credit markets, and the relationship between credit and agricultural performance at the macro- and micro-levels.

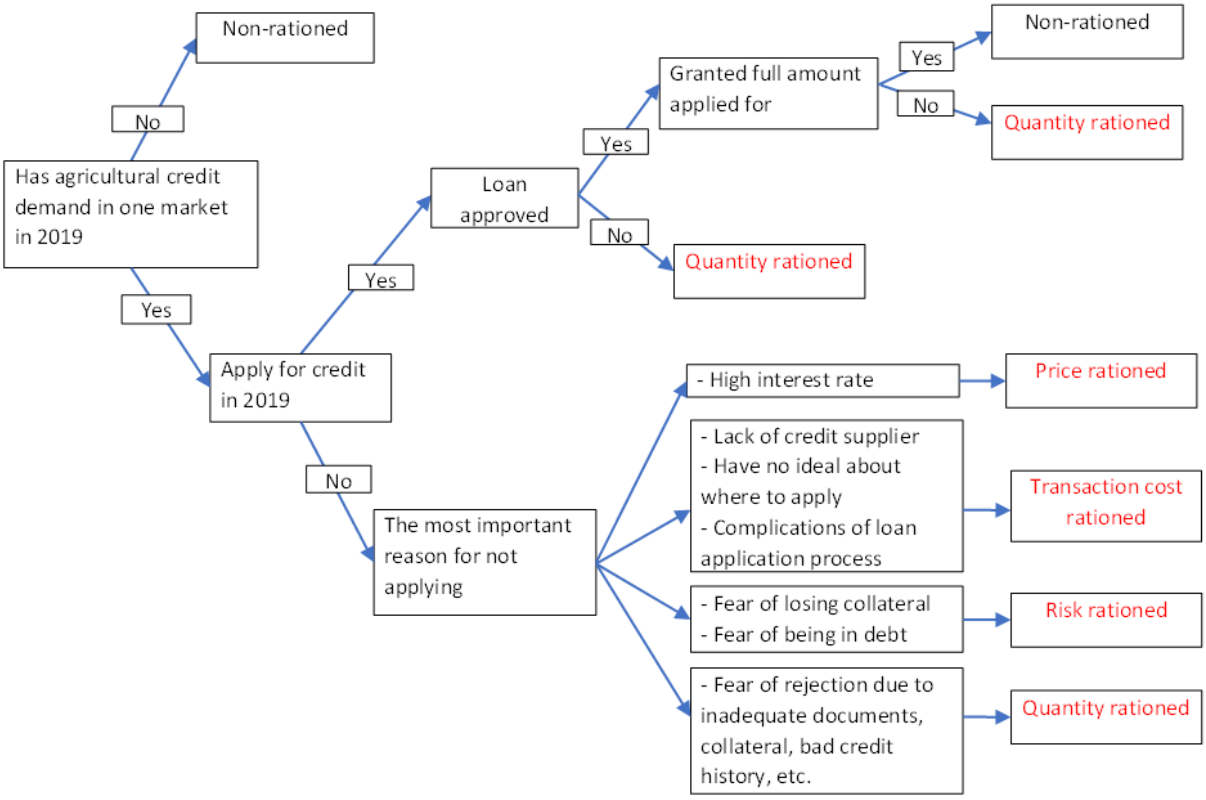
Chapter 3

Research methodology and data

This chapter discusses the data and methodologies used in the study. Sections 3.1, 3.2, and 3.3 present the methodologies used for the micro-level analysis and Section 3.4 presents the methodologies used for the macro-level analysis. Section 3.1 describes the "direct elicitation method" to empirically measure credit rationing. Section 3.2 presents the "trivariate probit models" used to investigate credit demand and credit rationing determinants and the interrelationships among the different credit markets. Section 3.3 focuses on the "multinomial endogenous treatment effects model" to evaluate the influence of credit rationing on agricultural performance at the household level. Section 3.4 discusses the steps to implement the "autoregressive distributed lag model" to investigate the short- and long-run relationships between agricultural performance and agricultural credit at the macro-level. Section 3.5 presents the sources of primary and secondary data, survey questionnaire design, sampling process, and sample size. Section 3.6 summarises the chapter.

3.1. The DEM to measure credit rationing

The direct elicitation method (DEM) was used in this study to identify credit rationing using a structured questionnaire because the empirical findings based on the indirect method are ambiguous. Each farm household was asked the same set of questions for each credit market (formal, semi-formal, and informal markets). A farm household was asked whether the household had credit demand for agricultural activities in 2019. If the answer was "No", the household was categorized into the non-rationed group. If the answer was "Yes", the respondent was asked whether the household applied for credit in 2019. If the answer was "No", the respondent was asked for the reasons. If the most important reason was the high interest rate, the household was classified into the price rationed group. If the answer was one of the three reasons: lack of credit supplier, no idea about where to apply, or complications of loan application and process, the household was classified into the transaction cost rationed group. If the household had not applied for a loan because of the fear of being in debt or losing its collateral, the household was classified into the risk rationed group. If the fear of rejection (e.g., fear of rejection because of inadequate documents, collateral, or bad credit history) was the reason for not applying, the household was classified into the quantity rationed group.



Source: Adapted from Boucher et al. (2009) and Ali et al. (2014)

Figure 3.1. The direct elicitation method (DEM) for identifying credit rationed households

For the second question, if the answer was "Yes", the respondent would be asked whether the loan was approved. If the loan were rejected or partly approved, the household was classified as quantity rationed. If the household had received the full amount of loan requested, the household was classified into the non-rationed group. Figure 3.1 shows the DEM process.

3.2. The trivariate probit model to answer research questions one, two, and three

3.2.1. Conceptual framework

Farm households' propensity to have agricultural credit demand and the propensity to be credit rationed are unobserved, but they depend on certain factors such as the household's demographic profile, physical capital, and geographical factors. According to the literature, a conceptual framework of the potential determinants affecting farm households' agricultural credit demand/credit rationing is illustrated in Figure 3.2.

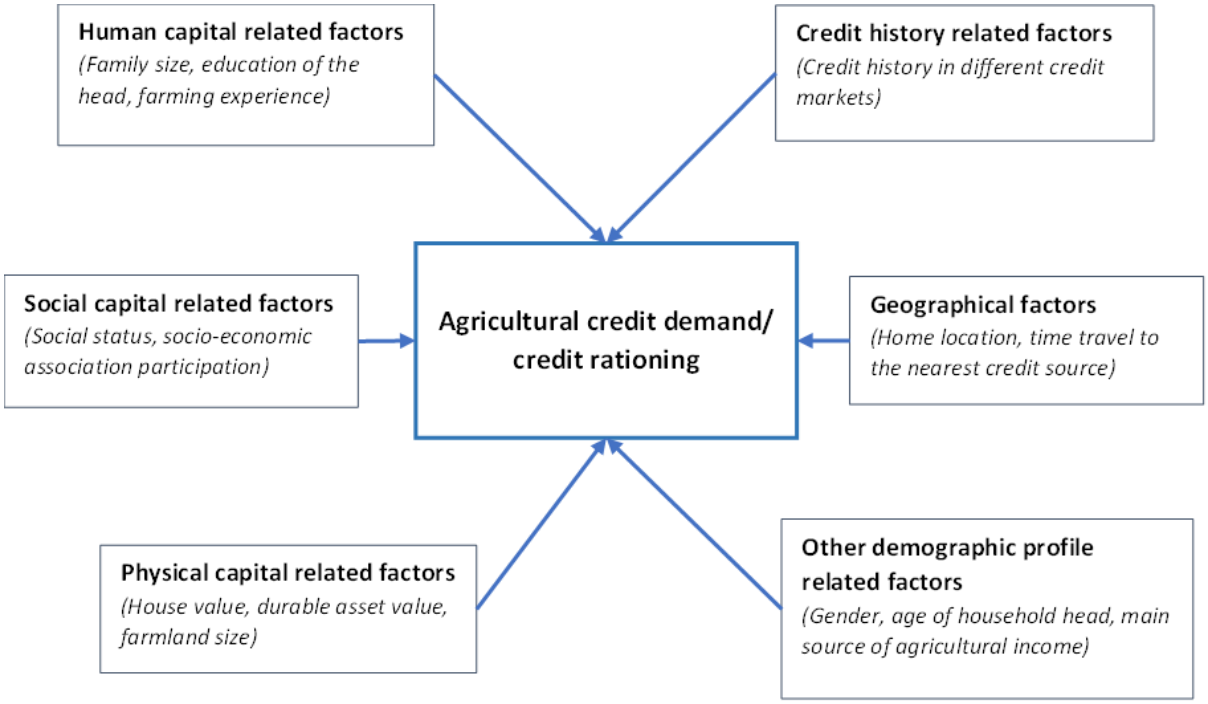


Figure 3.2. Factors affecting farm household's agricultural credit demand and credit rationing

3.2.2. The trivariate probit model to investigate credit demand determinants and interrelationships among different credit markets

Apart from observable factors, there are unobserved factors that could simultaneously influence farm households' credit demands in different credit markets. For example, farm households may have dissimilar judgements on the "pros and cons" of one credit market over the other options because of their understanding of the loan products or the requirements of the different credit markets. Thus, the decision to have a credit demand in each credit market may not be independently based on farm households' judgements. This could lead to a correlation of farm households' propensity of having credit demand in different credit markets. The correlation between credit demand in different credit markets implies either a substitutable (negative correlation) or complementary relationship (positive correlation). Failure to capture unobserved factors and the nexus among agricultural credit demands in different credit markets will lead to bias and inefficient estimates. Therefore, we use the trivariate probit model (TVPM) to explore the determinants of farm households' credit demands. TVPM allows the determinants of credit demand in three different credit markets to be investigated jointly. In addition, TVPM can deal with the interdependence (pairwise correlations) between credit demand in any pair of different credit markets (Triguero et al., 2013). The coefficients of these pairwise correlations can be used to test the complementary/substitution relationships among the three credit markets. The specifications of the TVPM can be expressed as:

$$DC_{ki}^{*} = \theta_k{}'Z_{ki} + \varepsilon_{ki},\ k \in \{1,2,3\} \quad (3.1)$$

DC_{ki}=1 if $DC_{ki}^{*} \geq 0$ and 0 otherwise (3.2)

Where: *k* =1, 2, 3 to denote formal, semi-formal, and informal credit markets, respectively; DC_{ki}^{*} is a latent variable capturing the unobserved propensity of farm household *i* to have a credit demand in credit market *k*; DC_{ki} is a binary variable indicating farm household *i's* observed credit demand in credit market *k* (1 if farm household demands credit in credit market *k* and 0 otherwise); Z_{ki} is a vector of explanatory variables (see Table 3.1); θ_k is the corresponding parameter vector; and ε_{ki} is error term capturing the influence of unobserved factors on farm households' credit demands. ε_{ki} *(for k* =1, 2, 3) jointly follows a trivariate normal distribution (Ramful & Zhao, 2008):

$$(\varepsilon_{1i}, \varepsilon_{2i}, \varepsilon_{3i})' \sim TVN\left(0, \begin{bmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{bmatrix}\right) \quad (3.3)$$

The off-diagonal elements, ρ_{lm} (for *l,m* = 1,2,3; $l \neq m$, and $\rho_{lm} = \rho_{ml}$), indicate the correlation coefficient of ε_l and ε_m. ρ_{lm} captures unobserved correlations among the error terms of different credit demand latent equations.

The trivariate joint probabilities can be expressed as (Blind & Müller, 2019):

$$\text{Prob}\,(DC_1 = dc_{1i}, DC_2 = dc_{2i}, DC_3 = dc_{3i} \mid Z_1, Z_2, Z_3) =$$

$$\Phi_3\,(q_{1i}\theta_1{}'Z_{1i}, q_{2i}\theta_2{}'Z_{2i}, q_{3i}\theta_3{}'Z_{3i}; q_{1i}q_{2i}\rho_{12}, q_{1i}q_{3i}\rho_{13}, q_{2i}q_{3i}\rho_{23}) \quad (3.4)$$

Where: dc_{ki}=1 if farm household *i* has a credit demand in credit market *k* and 0 otherwise (k=1, 2, 3); q_{ki}= $2dc_{ki} - 1$; $\Phi_3\,(.)$ denotes the standard trivariate normal distribution's cumulative distribution function.

The model's log-likelihood function (Blind & Müller, 2019) is expressed as:

$$\log L = \sum_{1}^{N} log\Phi_3\,(q_{1i}\theta_1{}'Z_{1i}, q_{2i}\theta_2{}'Z_{2i}, q_{3i}\theta_3{}'Z_{3i}; R) \quad (3.5)$$

Where: N is the number of observations; and the covariance matrix R of errors has the off-diagonal elements R_{lm}= $q_{li}q_{mi}\rho_{lm}$ ((for *l,m* = 1,2,3; and $l \neq m$).

Following Cappellari and Jenkins (2003), the Geweke–Hajivassiliou–Keane (GHK) simulator is used to estimate the trivariate probit model. Train (2009) argues that the GHK simulator is the most reliable approach to simulate normal probabilities and yields unbiased results with any given random draw number. Cappellari and Jenkins (2003) suggest that the GHK simulator produces consistent estimates when the number of draws equals or is higher than the square root of the observed number. With a

sample size of 648, this study set the number of draws to 50, which is well above the square root of the number of observations.

The trivariate probit model's variables are defined in Table 3.1.

Table 3.1. Definitions of the model's variables

Variables		Explanations
Dependent variables		
Credit demand	DC_1	1 if household has formal credit demand, 0 otherwise
	DC_2	1 if household has semi-formal credit demand, 0 otherwise
	DC_3	1 if household has informal credit demand, 0 otherwise
Explanatory variables		
Human capital	*Hedu*	1 if the head has high school or higher education, 0 otherwise
	Farmexpe	Years of the head's farming experience
Social capital	*Socstatus*	1 if the head holds any position in the community, 0 otherwise
	Socecogroup	Number of socio-economic associations the head has joined
Credit history	*Badhisfor*	1 if the household could not repay loans or had formal loans restructured in past 3 years, 0 otherwise
	Badhissemi	1 if the household could not repay loans or had semi-formal loans restructured in past 3 years, 0 otherwise
	Badhisinfor	1 if the household could not repay loans or had informal loans restructured in past 3 years, 0 otherwise
Physical capital	*Houseval*	1 if house value > 300 million VND, 0 otherwise
	Durableval	1 if durable property value > 50 million VND, 0 otherwise
	Farmlandsize	Farmland size (m^2)
Geography-related factors	*Fortime*	Length of time to the closest formal credit provider (minutes)
	Semitime	Length of time to the closest semi-formal credit provider (minutes)
	HAN	1 if farm located in Ha Noi, 0 otherwise
	HAID	1 if farm located in Hai Duong, 0 otherwise
Demographic profile	*Familysize*	Number of people in household
	Mainagrincome	1 if primary farm production is livestock, 0 otherwise
	Hgender	1 if the head is man, 0 otherwise
	Hage	1 if the head is more than 45 years old, 0 otherwise

Correlation coefficient ρ_{lm} indicates the relationship between credit market *l* and credit market *m.* Research objective 1 (explore the relationships among formal, semi-formal, and informal agricultural credit markets) is answered by testing the statistical significance of the correlation coefficient ρ_{lm}. Particularly, Credit markets *m* and *l* are correlated if the correlation coefficient ρ_{lm} significantly differs from zero. If the correlation coefficient ρ_{lm} is significantly positive, we can conclude that credit markets *m* and *l* are complements. If the correlation coefficient ρ_{lm} is significantly negative, we can conclude that credit markets *m* and *l* are substitutes (Rodríguez-Entrena & Arriaza, 2013).

3.2.3. The trivariate probit model to investigate credit rationing determinants

A farm household might be credit rationed in one or more credit markets simultaneously. Credit rationing in different credit markets may not be independent because of unobserved factors (such as the entrepreneurial capacity of the farm household) that could affect a household's likelihood of being simultaneously credit rationed in different credit markets. The trivariate probit (TVPM) model was chosen to explore the determinants affecting farm households' credit rationing for two reasons. First, the TVPM model can simultaneously investigate credit rationing in three different credit markets. Second, the model can deal with the possible interdependence of credit rationing in different credit markets (Asfaw et al., 2016). The econometric specification of the TVPM model investigating credit rationing determinants is similar to that investigating credit demand determinants (see subsection 3.2.2). The set of explanatory variables of the TVPM model investigating credit rationing determinants is the same as that of the TVPM model investigating credit demand determinants (see Table 3.1). Definitions of the dependent variables are given in Table 3.2.

Table 3.2. Definitions of the model's dependent variables

	Variable	Explanation
Dependent variable		
Credit ration	CR_1	1 if household is credit rationed in the formal market, 0 otherwise
	CR_2	1 if household is credit rationed in the semi-formal market, 0 otherwise
	CR_3	1 if household is credit rationed in the informal market, 0 otherwise

3.3. Multinomial endogenous treatment effects model to answer research question four

Because of the limited number (20) of households being credit rationed in two or three markets simultaneously (3, 10, 4, and 3 households were credit rationed in both formal and semi-formal, both formal and informal, both semi-formal and informal, and all three credit markets, respectively), the objective of investigating the impact of credit rationing in two or three markets simultaneously on farm performance are left for future study. This study is restricted to only the impact of being credit rationed in each credit market. This led to a decrease of 20 observations, leaving 628 observations that include farm households being non-rationed or rationed in individual credit markets (formal, semi-formal, or informal).

Evaluating the impact of credit rationing on farm performance may encounter the issues of endogeneity and sample selection bias (Dong et al., 2012). For example, farm households may self-ration and the propensity of being credit rationed is likely to be determined by unobserved factors

(such as farm household management and entrepreneurial capacity) that may be correlated with farm households' agricultural performance. Thus, we apply the multinomial endogenous treatment effects (METE) model to examine the impact of credit rationing on agricultural performance because of its ability to deal with endogeneity and selection bias problems (Khonje et al., 2018).

Estimation with the METE model is divided into two stages. In the first stage, farm households are classified into one of four mutually exclusive categories *j* of credit rationing status. The *j*-th treatment category with *j* = 0,1,2,3 represents farm households that are non-rationed, rationed in the formal market only, rationed in the semi-formal market only, and rationed in the informal market only, respectively. Following Deb and Trivedi (2006a, 2006b), let R_{ij}^{*}indicate the likelihood of farm household *i* being credit rationed in only the *j*-th credit market:

$$R_{ij}^{*} = \ v_i'\beta_j + \sum_{k=1}^{J} \delta_{jk} lv_{ik} + \ \boldsymbol{\varepsilon_{ij}} \qquad (3.6)$$

Where: v_i denotes a vector of explanatory variables (the set of explanatory variables in this stage is the same as the set of explanatory variables used in the TVPM model investigating credit demand determinants; see Table 3.1 for the list and definitions of the explanatory variables) associated with parameter vector β; $\boldsymbol{\varepsilon_{ij}}$ are i.i.d (i.e., independently and identically distributed) error terms; lv_{ik} denotes the latent variable capturing the unobserved determinants common to credit rationing of farm household *i* and farm performance. Without losing generality, let *j* = 0 denote the credit non-rationed group (i.e., the control group) with R_{i0}^{*} = 0. Credit rationing is observed in the form of a binary variable b_i with b_i = ($b_{i1}, b_{i2}, \ldots, b_{iJ}$). Similarly, let $lv_i = (lv_{i1}, lv_{i2}, \ldots, lv_{iJ})$. The probability of a farm household being credit rationed can be expressed as:

$$\Pr(b_i \,|v_i, lv_i) = g\left(v_i'\beta_1 + \sum_{k=1}^{J} \delta_{1k} lv_{ik} + \ v_i'\beta_2 + \sum_{k=1}^{J} \delta_{2k} lv_{ik} + \ldots + v_i'\beta_j + \sum_{k=1}^{J} \delta_{Jk} lv_{Jk} \right) \qquad (3.7)$$

Where: g indicates a multinomial probability distribution (Manda et al., 2016); and g is assumed to follow a mixed multinomial structure (Deb & Trivedi, 2006b) in equation (3.8):

$$\Pr(b_i \,|v_i, lv_i) = \frac{\exp(v_i'\beta_j + \delta_j lv_{ij})}{1 + \ \sum_{k=1}^{J} \exp\,(\, v_i'\beta_k + \delta_k lv_{ik})} \qquad (3.8)$$

The second stage of the METE model examines the impact of credit rationing on farm performance. The expected farm performance equation is:

$$E\ (y_i|b_i, z_i, lv_i) = z_i'\alpha + \sum_{j=1}^{J} \Upsilon_j b_{ij} + \sum_{j=1}^{J} \lambda_j lv_{ij} \quad (3.9)$$

Where: y_i is the farm performance of household *i*, proxied by the natural logarithm of the household's net farm revenue per labour unit; $z_i\ is$ a vector of exogenous factors with associated parameter vector α; parameter Υ_j captures the impact of credit rationing on farm performance relative to credit non-rationed farm households; and latent factors lv_{ij} are incorporated into equation (3.9) to indicate that farm performance is impacted by unobserved factors that also influence the credit rationing of the households. Parameter λ_j (factor-loading) indicates the correlation between farm performance and credit rationing through unobserved factors. When λ_j is negative (positive), the unobserved factors that decrease the probability of being credit rationed in *j*-th credit market also increase (decrease) farm performance. The outcome variable is continuous and follows a normal (Gaussian) distribution function. The maximum simulated likelihood approach is applied to estimate the model (Manda et al., 2016). Research objective 4 (analysing the credit rationing impact on agricultural performance at the micro-level) can be answered by testing the statistical significance of parameter Υ_j. Based on the literature, we choose net farm revenue as the proxy for farm performance. Net farm revenue reflects the farm households' agricultural production and the possibility of commercializing agricultural products as net farm revenue takes into account only products sold in the market (not including defective and returned products). In addition, a number of farm households in Vietnam specialize in both different crops and livestock thus farm revenue is more suitable than farm yield (suitable for one type of crop or livestock).

Definitions of the dependent variables used in the METE model are given in Table 3.3.

Table 3.3. Definitions of the METE model's dependent variables

Variable		Explanation
Dependent variable		
Credit ration	*R₁*	1 if household is credit rationed in only formal market, 0 otherwise
	R₂	1 if household is credit rationed in only semi-formal market, 0 otherwise
	R₃	1 if household is credit rationed in only informal market, 0 otherwise
Farm performance	*Farmrev*	Net farm revenue per agricultural labour unit per month (thousand VND)

Although the METE model can be identified when $v_i = z_i$, Deb and Trivedi (2006a) suggest the use of instrumental variables (or exclusion restrictions) for a more robust estimate of the METE model's parameters. Instrumental variables (IVs) that affect a farm household's credit rationing and do not directly affect farm performance are included in the credit rationing (treatment) equations but not in the farm performance (outcome) equations. We use three IVs (time to travel to the nearest

formal credit source (Fortime); time to travel to the nearest semi-formal credit source (Semitime); and house value (Houseval)) to estimate the METE model. These three IVs are unlikely to directly influence farm performance except through credit rationing. Following Di Falco et al. (2011) and Manda et al. (2016), a simple falsification test is conducted to confirm the validity of the IVs. Whether the IVs significantly affect a farm household's credit rationing is checked by using the results of the first stage of the METE model. In this study, the OLS estimate with dependent variable ln(Farmrev) and the same set of explanatory variables with the METE model is used to check whether the IVs directly affect farm performance (Di Falco et al., 2011).

3.4. Autoregressive distributed lag (ARDL) model to answer research question five

Based on the literature, Figure 3.3 presents the conceptual framework illustrating agricultural credit and other factors (public investment, labour, and weather-related factor) that may affect Vietnam's agricultural performance.

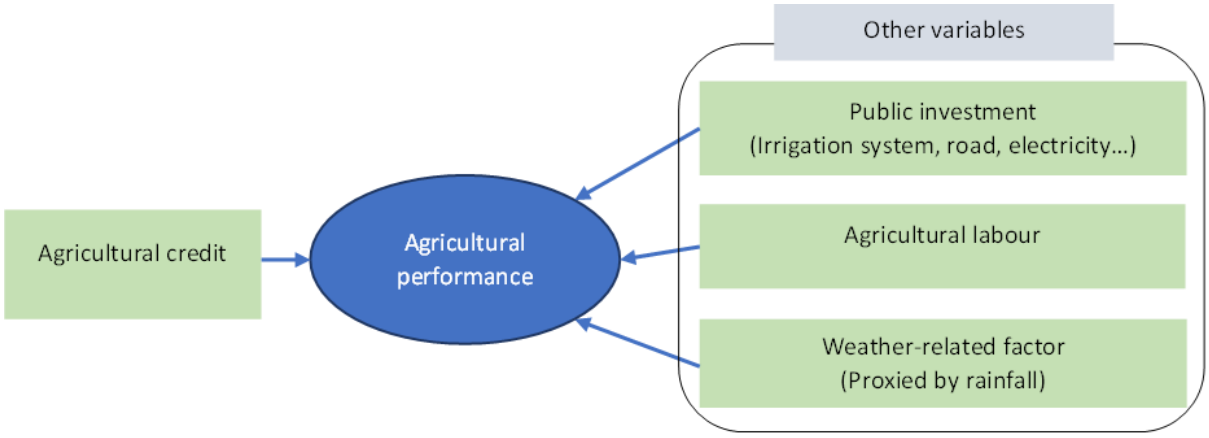


Figure 3.3. Agricultural credit and other factors influencing agricultural performance

Following the studies by Nnamocha and Eke (2015), Chisasa and Makina (2015), and Ogbuabor and Nwosu (2017), the empirical model in reduced form is:

$$AGDP = f(BUDINV, ACRED, LABOR, RAIN) \quad (3.10)$$

Where: AGDP is agricultural gross domestic product (a proxy for agricultural performance), ACRED is agricultural credit, LABOR is agricultural labour, BUDINV is public investment, and RAIN is rainfall.

To investigate model (3.10), we apply the ARDL bounds test method to evaluate the short- and long-run impacts of credit on Vietnam's agricultural performance. There are five main reasons for choosing ARDL. First, ARDL can be used when the variables are all integrated of order one (I(1)) or a mix of integrated of order zero (I(0)) and one (I(1)) or all I(0) (Pesaran & Pesaran, 1997; Badeeb &

Lean, 2017). Second, ARDL is suitable for a small sample size (Badeeb & Lean, 2017; Makuyana & Odhiambo, 2019). Third, the approach can investigate both short- and long-term impacts simultaneously (Olaniyi, 2017). Fourth, ARDL allows the variables in the model to be endogenous (Pesaran et al., 2001). Fifth, the use of suitable lags and the contemporaneous estimation of short- and long-term components in the ARDL model eliminate the issues of both endogeneity and serial correlation (Pesaran & Shin, 1999). Table 3.4 provides detailed descriptions, measurements, and a priori signs of variables for the ARDL model.

Table 3.4. Descriptions, measurements and a priori signs of the ARDL model's variables

Variable	Description	Measurement	A priori sign	Authors
AGDP	Agricultural gross domestic product	Total gross domestic product from the agricultural sector (billion VND, at constant prices of 2010)		
ACRED	Agricultural and rural credit (proxy for agricultural credit)	Agricultural and rural credit provided by formal credit institutions (do not include credit from VBSP (Vietnam Bank for Social Policies) and VDB (Vietnam Development Bank); billion VND, at constant prices of 2010)	+	Olaniyi, 2017; Ogbuabor and Nwosu, 2017; Chandio, Jiang, Rauf, et al., 2020; etc.
LABOR	Labour in agriculture, forestry, and fisheries sectors (proxy for agricultural labour)	Total labour in agriculture, forestry, and fisheries sectors (thousand people)	+	Shahbaz et al., 2013; Udah and Nwanchulwu, 2015.
BUDINV	Total State budget capital investment (proxy for public investment)	Public capital investment in all sectors including the agricultural sector (billion VND, at constant prices of 2010)	-/+	Mogues et al., 2012; Nadeem et al., 2013; Abula and Ben, 2016; De and Dkhar, 2018; etc.
RAIN	Rainfall	Total rainfall (mm)	-/+	Mendelsohn, 2008; Chisasa and Makina, 2015; Ogbuabor and Nwosu, 2017.
$STRUCDUM_h$	Structure change dummy variables	Dummy variables indicate the breakpoints of AGDP		

The ARDL framework can handle variables integrated of order zero and/or one; however, this framework cannot deal with variables integrated of order two. Thus, all ARDL model variables should be tested to ensure that no variable has an order of integration greater than 1 (i.e., I(1)). In addition, the issue of spurious regression arises when the variables in time series models are non-stationary. Thus, we use different unit root tests to test for stationary of the data. Enders (2015) argues that if there is suspicion concerning time series data's structural breaks, unit root tests should be applied with caution. A structural break is defined as "a sudden jump or fall in an economic time series which occurs due to the change in regime, policy direction, and external shocks, among others"

(Shrestha & Bhatta, 2018, p. 75). Structural breaks are considered as "changes in the parameters during the process of generating data" (Hendry & Nielsen, 2007). The break can happen at the level or the slope of time series data. Sun et al. (2017) argue that fundamental variables' long-term relationships are affected by structural breaks. Conventional unit root tests such as "Augmented Dickey-Fuller test" (ADF test); "Phillips–Perron test" (PP test), or "Kwiatkowski-Phillips-Schmidt-Shin test" (KPSS test) do not deal with structural changes of data. Perron (1989) insists that ignoring structural breaks results in a bias that decreases the ability to reject a false null hypothesis of unit root (i.e., the result of the unit root test confirms that a time series variable has a unit root; however, the variable is stationary in reality). In addition, failure to deal with structural breaks may lead to the incompleteness of model specifications, leading to biased estimates and resultant inferences (Sun et al., 2017). Thus, before estimating the ARDL model, we perform structural changes and multiple breakpoints unit root tests for all variables. Figure 3.4 summarizes the steps to estimate the credit-agricultural performance nexus using the ARDL model; subsections 3.4.1 to 3.4.7 present the steps in more detail.

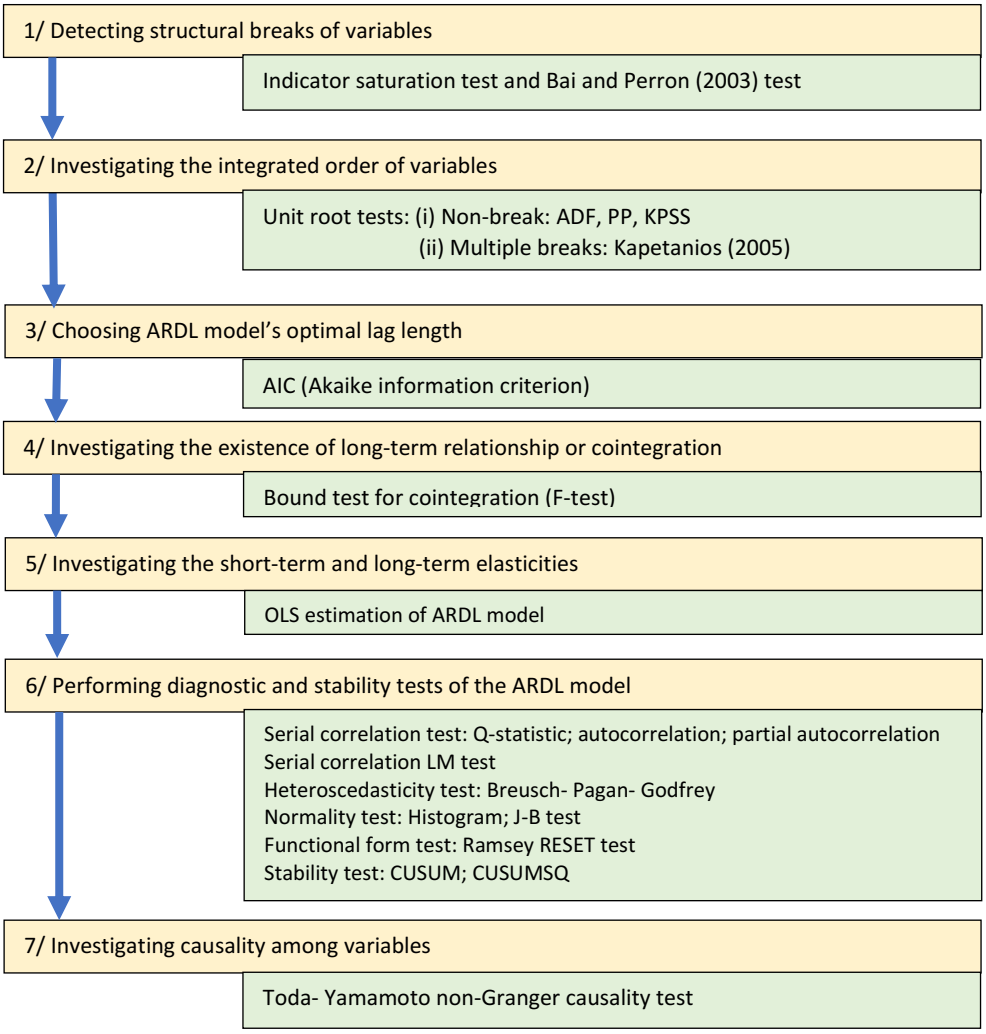


Figure 3.4. Steps to implement the ARDL model

3.4.1. Indicator saturation methodology to identify structural breaks

We use a newly developed methodology called indicator saturation (IS) to investigate breaks in all the variables used in the ARDL model. The step indicator saturation (SIS) and impulse indicator saturation (IIS) are applied to detect the structural breaks endogenously. IS techniques follow a general to specific approach that can identify breaks at any point in time of the data, with unidentified extent and length, unknown number of breaks, and unknown times when the breaks occur (Doornik et al., 2013; Mariscal & Powell, 2014; Marczak & Proietti, 2016). The choice of this methodology is because of three advantages of the IS technique. First, Santos (2008) argues that the IS method has a high ability to detect time series data breaks in the variance and/or the mean. Secondly, using pulse and step dummies (which are used in IS techniques) is considered as the most flexible and simplest approach to model structural breaks (Marczak & Proietti, 2016). Third, IS techniques do not require trimming percentage (trimming factor) so that they are more appropriate for the small sample size of this study (49 quarterly observations).

Doornik et al. (2013) show that the SIS technique produces better results than the IIS technique in most simulation cases, but there are some circumstances (such as a sole impulse locating in the middle of simulated time series data) in which the IIS technique performs better. In addition, the SIS technique focuses on the detection of permanent shifts or level shifts in a time series variable, whereas the IIS technique can be used to identify additive outliers (single period shifts) or sudden changes in the variable mean (Pretis et al., 2018; Zuzana, 2018). Therefore, Mariscal and Powell (2014) suggest using both the IIS and SIS to achieve better results when detecting breaks.

IS techniques are based on adding impulse/step dummies (indicators) for all observations in econometric models (Mariscal & Powell, 2014; Raggad, 2018). In this study, the empirical models include only constant and impulse (or step) dummies for each observation. Models using IIS and SIS techniques are as follow (respectively):

$$IIS: \qquad y_t = \mu + \sum_{k=1}^{K} \delta_k I_{k,t} + \varepsilon_t , \qquad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) , \qquad t = 1,2, \dots K \qquad (3.11)$$

$$SIS: \qquad y_t = \mu + \sum_{k=2}^{K} \beta_k S_{k,t} + \varepsilon_t , \qquad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) , \qquad t = 1,2, \dots K \qquad (3.12)$$

Where: y_t indicates time series to be tested; μ indicates constant; *K* indicates the number of total observations; $I_{k,t}$ indicates impulse dummy (1 for time index *t = k* and 0 otherwise); $S_{k,t}$ indicates step dummy (1 for time indexes *t ≥ k* and 0 for *t < k*); δ_k and β_k indicate unknown parameters; and ε_t indicates the random error term.

Theoretically, the potential number of indicators (or dummies) of the IIS/SIS techniques to detect breaks of y_t can be as large as K. However, adding all these indicators into a model is impractical (Raggad, 2018). Hence, the dummies are divided into blocks, and the IIS/SIS techniques follow the split-half method (Marczak & Proietti, 2016). Only the first half of impulse/step dummies (first block) is incorporated into the model in the first stage. The model is regressed and only the dummies with statistical significance at the predetermined α level are retained (Marczak & Proietti, 2016). In the second stage, the second half of the dummies (second block) substitutes for the first block and the process to select statistically significant indicators is repeated (Marczak & Proietti, 2016). In the final stage, all insignificant indicators of the two blocks are eliminated and only the significant indicators of the two blocks are jointly added to the terminal model (Marczak & Proietti, 2016; Raggad, 2018). The terminal model is re-estimated in a recursive fashion to re-select only significant indicators that represent breaks of the model (Mariscal & Powell, 2014; Castle et al., 2015; Panday, 2015).

3.4.2. Checking variables' order of integration using different unit root tests

The number of breaks in different variables may vary from 0 to m (m≥ 1) breaks. Based on the number of breaks that are detected in the first step, various unit root tests are used to examine the variables' stationary characteristics. To estimate the variables' order of integration, first, we use three conventional unit root tests, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Phillips–Perron (PP), and Augmented Dickey-Fuller (ADF) tests. Next, we apply the KP test, a multiple structural breaks unit root test introduced by Kapetanios (2005).

3.4.2.1. Unit root test for no structural break

Different conventional unit tests that do not consider structural breaks, namely the KPSS test, PP test, and ADF test are used.

The ADF test

The ADF test is an extension of the Dickey-Fuller unit root test as the ADF test incorporates the lagged differences of time series to control for residual autocorrelation (Mariscal & Powell, 2014). The ADF test consists of no constant, constant, and both trend and constant in testing the model (Mariscal & Powell, 2014). The most general form of ADF test is specified as follows:

$$\Delta y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{K} \delta_i \Delta y_{t-i} + \varepsilon_t , \qquad (3.13)$$

Where: y_t indicates the time series to be tested; μ indicates constant; β, α, δ_i indicate coefficients to be estimated; K indicates lag length; Δ indicates first difference operator; and ε_t indicates white noise.

The null hypothesis of the presence of unit root ($\alpha = 0$) is tested against the alternative hypothesis of stationary ($\alpha < 0$) using the t-statistics of $\hat{\alpha}$.

The PP test

The PP test has a different way to handle the heteroskedasticity and autocorrelation issues from the ADF test. The PP test is considered a non-parametric test that permits the heterogeneous distribution and weak dependence of the error terms (Mariscal & Powell, 2014). To deal with these issues, the PP test applies a correction factor to the t-statistic calculation without using lagged differences of the dependent variable to test the model (Mariscal & Powell, 2014; Shrestha & Bhatta, 2018). The most general form of PP test is as:

$$\Delta y_t = \mu + \beta t + \alpha y_{t-1} + u_t \,, \qquad (3.14)$$

Where: y_t indicates time series to be tested; μ indicates constant; β, α indicate the coefficients to be estimated; u_t indicates the disturbance term with zero mean (u_t is not required to be homogeneous or serially uncorrelated (Enders, 2015)).

The procedure to test the hypothesis of the PP test is similar to that of the ADF test except for the use of modified test statistics (Enders, 2015; Asteriou & Hall, 2016; Shrestha & Bhatta, 2018).

The KPSS test

KPSS test differs from the PP and ADF tests in the way the alternative and null hypotheses are specified. Whereas the KPSS test has the null hypothesis of stationary time series, the PP and ADF tests have the null hypothesis of non-stationary time series (Kočenda & Černý, 2015). This helps the KPSS test to better distinguish between the near unit root and real unit root time series than the ADF and PP test (Kočenda & Černý, 2015). The most general form of the KPSS test model is:

$$y_t = \varphi t + w_t + e_t \,, \qquad w_t = w_{t-1} + u_t \qquad (3.15)$$

Where: y_t indicates the time series to be tested; φt indicates deterministic trend component; w_t indicates a random walk; e_t indicates stationary error term; and $u_t \sim \mathrm{I.I.D}\,(0, \sigma_u^2)$.

Equation (3.15) tests for trend stationary. The term φt is left out if level stationary is tested (Kočenda & Černý, 2015). The null hypothesis of stationary ($\sigma_u^2 = 0$) is tested against the alternative hypothesis of non-stationary ($\sigma_u^2 \neq 0$) (Shin & Schmidt, 1992; Kočenda & Černý, 2015). The KPSS test reports critical values based on one-side LM statistics (Kočenda & Černý, 2015; Shrestha & Bhatta, 2018).

3.4.2.2. Kapetanios (2005) unit root test (KP test) with more than two breaks

The KP test is suitable for multiple structural breaks in univariate time series. The breaks are unknown and endogenously detected. One of the outstanding features of the KP test is that the number of breaks can be more than two. Kapetanios (2005) emphasizes that, in the KP test, the unspecified number of structural breakpoints may be equal to or less than the maximum number of structural breakpoints (M) allowed. The model of the KP test is:

$$y_t = \aleph y_{t-1} + \alpha + \beta t + \sum_{i=1}^{m} \theta_i DU_{i,t} + \sum_{i=1}^{m} \lambda_i DT_{i,t} + \sum_{i=1}^{K} \delta_i \Delta y_{t-i} + \varepsilon_t \,, \qquad (3.16)$$

Where: y_t indicates the time series to be tested; K indicates the lag length; m indicates the number of breaks; Δ indicates the first difference operator; $\alpha, \beta, \theta, \lambda, \delta, \aleph$ are parameters to be estimated; ε_t indicates white noise; $T_{\mathrm{B},i}$ *+1* indicates true (*i-th*) breakpoint; $DU_{i,t}$ indicates the intercept-break dummy variable where $DU_{i,t}$ = 1 ($t > T_{\mathrm{B},i}$); and $DT_{i,t}$ indicates the trend-break dummy variables where $DT_{i,t}$ = 1 ($t > T_{\mathrm{B},i}$)($t - T_{\mathrm{B},i}$).

We apply the most general form of the KP test that allows breaks in both intercept and trend. A grid search procedure following Bai and Perron's (1998) study was implemented to detect the location(s) of structural breaks (Kapetanios, 2005). The null hypothesis of a unit root ($\aleph$ =1) is tested against the alternative hypothesis of stationary ($\aleph$ < 1) using the t-statistic of $\hat{\aleph}$. The appropriate number of structural breaks produces the smallest t-statistic ($\tau_{\min}$), and $\tau_{\min}$ is adopted as the final test statistic (Kapetanios, 2005).

3.4.3. Choosing the ARDL model's optimal lag length

Choosing the ARDL model's lag length is important because the suitable lag length plays a significant role in tackling many problems such as endogeneity, serial correlation, and heteroskedasticity (Pesaran & Shin, 1999; Nkoro & Uko, 2016). If too many lagged variables are added, the power of the ARDL model is reduced. The autocorrelation issue of the error term occurs if an insufficient lag length is chosen, leading to biased results and inferences (Ghouse et al., 2018). To decide the ARDL model's optimal lag length, the Schwartz information criterion (SIC) and the Akaike information criterion (AIC) are the most common criteria used in the literature (Raggad, 2018). Whereas SIC selects the lowest number of lag lengths that create the most parsimonious model, AIC provides the maximum number of lags for the ARDL model (Wahid & Jalil, 2010). We use the lag length from the AIC. The ARDL model with the lag length selected by the AIC is not too parsimonious so that it is more prudent to avoid the error term's autocorrelation issues. The AIC is given as:

$$The\ AIC\ criterion = \frac{2K}{T} + \ln\left(\frac{SSE}{T}\right) \qquad (3.17)$$

Where: SSE indicates the sum of squared errors; K indicates the number of estimated coefficients in the model; and T indicates the number of observations.

$(p+1)^k$ number of ARDL models are estimated to choose the suitable number of lags for each variable, where p is the maximum lag length, and k is the number of variables (Wahid & Jalil, 2010). The ARDL model optimal lag length is the one that minimises the AIC criterion (Demise et al., 2017; Hill et al., 2018).

3.4.4. Investigating the long-term relationships among the variables

In this study, the ARDL model is a single-equation model with AGDP as the dependent variable. Thus, we add dummy variables ($\mathrm{STRUCDUM}_h$) indicating structural breaks of the AGDP variable (detected by using the indicator saturation approach in the first step) into the ARDL model. All variables are transformed into the form of the natural logarithm to achieve reliable, consistent results (Shahbaz et al., 2013). The ARDL-UECM (i.e., unrestricted error correct model) model that investigates whether a long-term relationship among AGDP, ACRED and other variables exists is:

$$\Delta LnAGDP_t = \delta_0 + \delta_1 LnAGDP_{t-1} + \delta_2 LnACRED_{t-1} + \delta_3 LnLABOR_{t-1} + \delta_4 LnBUDINV_{t-1} + \delta_5 LnRAIN_{t-1} + \sum_{i=1}^{p} \delta_{6i} \Delta LnAGDP_{t-i} + \sum_{i=0}^{q} \delta_{7i} \Delta LnACRED_{t-i} + \sum_{i=0}^{r} \delta_{8i} \Delta LnLABOR_{t-i} + \sum_{i=0}^{s} \delta_{9i} \Delta LnBUDINV_{t-i} + \sum_{i=0}^{w} \delta_{10i} \Delta LnRAIN_{t-i} + \sum_{h=1}^{m} \delta_{11h} \mathrm{STRUCDUM}_h + \varepsilon_t \qquad (3.18)$$

Where: δ_0 indicates the drift component; Ln is a natural logarithm; Δ is the first difference operator; ε_t is the white noise; δ_i (i =1,...,11) indicates coefficients estimated; p, r, q, s, and w indicate the optimal number of lags for lnAGDP, lnLABOR, lnACRED, lnBUDINV, lnRAIN, respectively (the number of lags is decided by the AIC criterion in the third step); m indicates the number of breaks of the lnAGDP variable; $\mathrm{STRUCDUM}_h$ (h =1,…,m) indicates the structural breaks of AGDP (1 for time indexes $t \geq T_h$ and 0 for $t < T_h$ with T_h denotes the *h-th* breakpoint).

The ARDL model is estimated using the OLS method. The long-term relationship between credit and agricultural performance at the macro-level (part of research objective 5) is tested by using the ARDL bounds test or F-test. Particularly, the joint F-statistic (ARDL bounds test or F-test) is used to test the null hypothesis of no cointegration (long-term relationship among variables). The null hypothesis is equal to H_0: δ_i=0; ∀ *i=1, 2, …, 5*. The comparison is between the calculated value of F-statistic and the two sets of critical values given by Narayan (2005) for a small sample size. The null hypothesis is rejected, and a steady state equilibrium exists among the variables if the F-statistic is larger than the upper bound critical (UCB) value. The null hypothesis cannot be rejected if the calculated F-statistic is smaller than the lower bound critical value. It is inconclusive for the existence of cointegration if

the calculated F-statistic falls between the upper and lower bounds' critical values (Badeeb & Lean, 2017).

3.4.5. Investigating short-term and long-term elasticities

An error correction mechanism exists based on "the Granger representation theorem" if lnAGDP, lnACRED, and other variables in the ARDL model are cointegrated (Engle & Granger, 1987). The error correction mechanism implies a "disequilibrium adjustment process" that prevents the variables from moving too far from the long-term equilibrium (Roca, 2018). The Error Correction Model (ECM), which is derived from the ARDL model, is estimated when the null hypothesis of no cointegration in the fourth step is rejected. The ECM illustrates how variables "behave in the short run consistent with a long-run cointegrating relationship" (Verbeek, 2012, p. 347). The ECM is given as follows:

$$\Delta LnAGDP_t = \delta_0 + \sum_{i=1}^{p} \delta_{6i} \Delta LnAGDP_{t-i} + \sum_{i=0}^{q} \delta_{7i} \Delta LnACRED_{t-i} + \sum_{i=0}^{r} \delta_{8i} \Delta LnLABOR_{t-i} + \sum_{i=0}^{s} \delta_{9i} \Delta LnBUDINV_{t-i} + \sum_{i=0}^{w} \delta_{10i} \Delta LnRAIN_{t-i} + \lambda ECM_{t-1} + \sum_{h=1}^{m} \delta_{11h} \mathrm{STRUCDUM}_h + \varepsilon_t \quad (3.19)$$

Where: *ECM* indicates Error Correction term, and λ indicates the coefficient of *ECM*.

ECM_{t-1} illustrates the "error" occurring in the previous period, i.e., the deviation of AGDP_{t-1} from its long-term value. The parameter λ shows the speed of adjustment that is needed to return to the long-term equilibrium after a short-run shock. For example, if λ equals -0.5, the deviation of AGDP during the previous period from the equilibrium level can be adjusted by 50% in the current period. If cointegration exists, λ must be significantly negative.

3.4.6. Performing the ARDL model diagnostic and stability tests

Diagnostic and stability tests are applied to the selected ARDL model to examine the appropriateness and robustness of the model. The diagnostic tests include tests for serial correlation ("Breusch-Godfrey serial correlation LM test", "Correlogram"), normality tests ("Histogram", "Jarque-Bera test"), a test for heteroscedasticity ("Breusch-Pagan-Godfrey test"), and a test for misspecification of the functional form ("Ramsey RESET test").

The parameters of the ARDL model are tested for stability using the "CUSUM" and "CUSUMsq" tests developed by Brown et al. (1975). Parameter stability tests are important to detect model misspecification, structural change, and potential biases (Raj, 1995; Shahbaz et al., 2013; Meo et al., 2018).

3.4.7. Investigating causality among the variables

If there is a long-term relationship (or cointegration) among the variables in the ARDL model, then the "Toda–Yamamoto (1995) approach to Granger causality" (T-Y test) is applied to investigate the causality directions. Granger causality is considered a statistical concept and can be expressed as: "A variable X is said to Granger-cause a variable Y if past and present values of X contain information that helps predict future values of Y better than using information contained in past and present value of Y alone" (Pesaran, 2015, p. 514).

There are two main reasons why we use the T-Y test in our study. First, the T-Y test can be applied for a set of variables with mixed integrated orders, and the T-Y test is suitable regardless of whether the variables are cointegrated or not (Zapata & Rambaldi, 1997; Wolde-Rufael, 2004; Salahuddin & Gow, 2019). Second, the T-Y test, besides detecting the Granger-causality among variables, can be a robust check for the result of the ARDL bounds test in the fourth step. If the null hypothesis of no cointegration in the ARDL bounds test is rejected, then there exists at least one direction of Granger-causality (Granger, 1988; Masih & Masih, 1997; Fan et al., 2019).

In the T-Y test, an augmented VAR model is used to investigate the direction and causality among the variables in the model. Four main steps are implemented to perform the T-Y test. First, all variables are tested for the order of integration to determine the maximum order of integration (d_{max}) (Elian & Suliman, 2015; Fritsche & Pierdzioch, 2017; Ozturk, 2017). Second, an original VAR model is set up in the levels of all variables, and the optimal lag length (h) for this VAR model is determined using the information criteria such as AIC (Marwan et al., 2013; Elian & Suliman, 2015; Ozturk, 2017). Third, the VAR (h) model is augmented by adding in d_{max} additional lags of all variables to form an augmented VAR (h + d_{max}) (Amiri & Ventelou, 2012; Bruns & Gross, 2013; Ozturk, 2017). The augmented VAR is given by:

$$y_t = \Upsilon_0 + \sum_{i=1}^{h+d_{max}} \omega_i y_{t-i} + u_t \qquad (3.20)$$

Where: *h* indicates the optimal number of lags; and d_{max} indicates the maximum order of integration.

$$y_t = \begin{bmatrix} LnAGDP_t \\ LnBUDINV_t \\ LnACRED_t \\ LnLABOR_t \\ LnRAIN_t \end{bmatrix}_{5X1} ; \; y_{t-i} = \begin{bmatrix} LnAGDP_{t-i} \\ LnBUDINV_{t-i} \\ LnACRED_{t-i} \\ LnLABOR_{t-i} \\ LnRAIN_{t-i} \end{bmatrix}_{5X1} ; \qquad \Upsilon_0 = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \end{bmatrix}_{5X1} ;$$

$$\omega_t = \begin{bmatrix} \text{К}_{11,i} & \text{К}_{12,i} & \text{К}_{13,i} & \text{К}_{14,i} & \text{К}_{15,i} \\ \text{К}_{21,i} & \text{К}_{22,i} & \text{К}_{23,i} & \text{К}_{24,i} & \text{К}_{25,i} \\ \text{К}_{31,i} & \text{К}_{32,i} & \text{К}_{33,i} & \text{К}_{34,i} & \text{К}_{35,i} \\ \text{К}_{41,i} & \text{К}_{42,i} & \text{К}_{43,i} & \text{К}_{44,i} & \text{К}_{45,i} \\ \text{К}_{51,i} & \text{К}_{52,i} & \text{К}_{53,i} & \text{К}_{54,i} & \text{К}_{55,i} \end{bmatrix}_{5X5} \quad ; \quad u_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}_{5X1}$$

Finally, Granger-causality among the variables is examined by adopting the modified Wald (MWALD) test developed by Toda and Yamamoto (1995) (Wolde-Rufael, 2004; Amiri & Ventelou, 2012). For example, the null hypothesis that LnACRED does not Granger-cause LnAGDP is equal to H_0: К_{3i}=0, ∀ i=1, 2, …, h. The MWALD test statistics have asymptotical chi-square (χ^2) distribution and h degree of freedom (Adriana, 2014; Rana & Sharma, 2019).

3.5. Data and sample size

3.5.1. Secondary data for the macro-level analysis

Secondary data (for the macro-level analysis) are used for the ARDL model and are from different sources. Based on the availability of the data on agricultural credit and rainfall, we obtain data from 2004:Q4 to 2016:Q4. Data on AGDP, agricultural credit (proxied by agricultural and rural credit provided by formal credit institutions which do not include credit provided by Vietnam Bank for Social Policies and Vietnam Development Bank), and public investment (proxied by total State budget capital investments) are collected from Bloomberg, State Bank of Vietnam (SBV), and the General Statistics Office of Vietnam (GSO), respectively. Data on agricultural labour (proxied by labour in the agriculture, forestry, and fisheries sectors) are from GSO. Data on rainfall are from the Climate Change Knowledge Portal (World Bank, 2020b). Data on agricultural GDP, agricultural credit, and public investment are measured at constant prices of 2010 in billion Vietnam Dong (VND). Agricultural labour is measured in thousands of persons. Rainfall is reported in millimetres (mm).

Though quarterly data on other variables are available for the whole study period, only semi-annual data on agricultural labour are reported from 2005 to 2009. To use the quarterly data for the entire study period, the semi-annual data of agricultural labour for the pre-2010 period are transformed into quarterly data using the interpolation method. In the literature, interpolation methods can be classified into two main categories: (1) data interpolation without additional high-frequency indicator variable (HFIV) such as cubic spline interpolation (CSI) method, and (2) data interpolation using additional indicator variables such as the Denton (1970) or Chow-lin (1971) methods (Chamberlin, 2010; Sax & Steiner, 2013; Wójcik, 2016). In this study, we use the CSI method to interpolate the agricultural labour series for three reasons. First, the CSI method is a popular for

interpolating time series from low-frequency to high-frequency without additional related HFIV (Rashid & Jehan, 2013; Stuart, 2018). This is suitable for our study because it is difficult to choose an appropriate HFIV for an agricultural labour series because of limited macro-data at a quarterly frequency of developing countries like Vietnam. Second, the CSI method is chosen for its simplicity and reasonable empirical performance (Ajao et al., 2012; Carrizosa et al., 2013). Third, this method is relatively simple by using EViews 10 software.

The data on rainfall and agricultural-related variables may contain seasonal patterns. Maximiliano (2015) and Enders (2015) insist that one typical characteristic of agricultural time series data is seasonality, resulting from the weather-dependent features of the agricultural sector. To better recognise the underlying relationships among agricultural GDP and other variables, all variables that have seasonal patterns are seasonally adjusted using the X-13 filter implemented by the X-13-ARIMA-SEAT program. The X-13-ARIMA-SEAT program was developed by the U.S. Census Bureau and has become one of the most common SA (seasonal adjustment) programs (Guidotti et al., 2016). In fact, the SEATS and X-13 filter (and its predecessor the X-11 filter) are standard techniques for SA that are used by official statistics (Lee, 2018). We use the X-13 filter for three main reasons. First, an automatic process to detect outliers is incorporated into the X-13 filter, which helps the X-13 filter to be robust to outliers and eliminates distortions of the seasonally adjusted procedure (Hyndman & Athanasopoulos, 2018; Lee, 2018). Second, seasonally adjusted series from the X-13 filter are less volatile and less influenced by the problems of parameter uncertainty than the series de-seasonalised by the SEATS filter (Lee, 2018). Third, seasonal and trend changes are automatically processed by the X-13 filter (Hyndman & Athanasopoulos, 2018), making the SA procedure easy and simple.

3.5.2. Primary data for the micro-level analysis

3.5.2.1. Questionnaire design

A smallholder farm household survey was conducted from April to July 2020 in the Red River Delta (RRD) using a structured survey questionnaire. The survey questionnaire was constructed to collect micro-level data regarding agricultural credit demand, credit rationing status, characteristics, farm performance of surveyed households, and the characteristics of agricultural credit in different credit markets. The survey questionnaire consisted of five sections. Section 1 focused on agricultural credit demand, borrowing activity, credit rationing status, and types of credit rationing of farm households. In addition, Section 1 aimed to recognize loan characteristics in formal, semi-formal, and informal credit markets. Section 2 was specialized for non-borrowers in 2019 to discover their future credit demand. Section 3 focused on the farm households' credit history and relationships with credit

providers. Section 4 aimed to gather information on geographical factors such as time to travel to the nearest credit source. The last section was designed to obtain information regarding the surveyed households' demographics, socio-economic activity, and farm performance (see Appendix B).

To achieve consistency, accuracy, and completeness, the survey questionnaire was pre-tested by surveying a small number of farm households in Ha Noi, Ha Nam, and Hai Duong provinces (10 households in each province). Through the pre-test process, the quality of the survey questionnaire was improved. The questions were then easier for farm households to understand and answer, creating more reliable survey results when conducting the actual survey.

3.5.2.2. Sample size for primary data (micro-level data)

Sample size is determined by the conventional formula of Cochran (1977):

$$n_o = \frac{z^2 pq}{e^2} \qquad (3.21)$$

Where: z is the value of the selected confidence level; n_o is the sample size; e is the acceptable margin of error for the proportion being estimated; p is the estimated proportion of an attribute that is presented in the population; and q is 1-p. We assume p = 0.5 and hence q = 0.5; ± 5% precision and 95% confidence levels are chosen (that maximises the number of observations). Thus, z is equal to 1.96. The sample size is:

$$n_o = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} \quad = 385 \text{ households}$$

However, to receive enough usable responses with sufficient, reasonable answers, 750 farm households were asked to complete the survey.

3.5.2.3. Micro-level data collection

A structured survey questionnaire was used to obtain primary data from agricultural households in Vietnam. We surveyed Vietnamese smallholder farm households whose main income was from crops and livestock production because 70% of the gross output of Vietnam's agricultural sector is from crops and livestock, and most Vietnamese agricultural producers are smallholder households (World Bank, 2019). The survey was conducted from April to July 2020 in the Red River Delta (RRD). There are four main reasons for choosing the RRD. First, the region is the third-largest contributor to the national agricultural gross value-added (NAGVA), accounting for 14% of NAGVA (World Bank,

2016b). Second, land fragmentation and small agricultural landholdings issues have been reported to be severe in the RRD and northern mountainous regions, hindering modernization of the agricultural sector and may limit farm households' access to credit (World Bank, 2019). Small agricultural parcels held by farm households are also considered an explanation for the low labour productivity for rice in the RRD (World Bank, 2016b). Third, the contribution of the agricultural sector to the economic development in the RRD has been declining steadily because of industrialization and urbanization (World Bank, 2016b). This phenomenon shows the clear direction of agricultural transformation. Fourth, the region is vulnerable to climate change (e.g., sea-level rise, frequency and intensity of storms, and changes in rainfall) (World Bank, 2016b; McElwee et al., 2017).

We use a multi-stage disproportionate stratified random sampling process for the survey. First, the relevant provinces in the RRD were categorized into three groups according to income (high, middle, and low). Next, Ha Noi, Hai Duong, and Ha Nam provinces were randomly chosen to represent the high, middle, and low income groups, respectively. In each province, two random rural districts were selected (Phuc Tho and Ba Vi districts in Ha Noi; Binh Luc and Thanh Liem districts in Ha Nam; and Kinh Mon and Binh Giang districts in Hai Duong). Finally, a random commune that had crops and livestock production was identified in each of the six districts. Overall, 750 farm households specialising in livestock and/or crops took part in the survey (125 farm households in each commune), resulting in 648 valid questionnaires (86.4%) for empirical analysis.

3.6. Chapter summary

Chapter Three presents the methods to empirically measure credit rationing, analyse the determinants of credit demand and credit rationing, the nexus among different credit markets, and the impact of credit on agricultural performance at both the macro- and micro-levels in Vietnam. Chapter Three also discusses the primary data, survey questionnaire design, and sample size.

The DEM method is chosen to empirically measure credit rationing because of its advantages over the indirect method. The DEM method classifies farm households into different groups based on their credit rationing status, such as non-rationed, price rationed, quantity rationed. Trivariate probit models are used to investigate the determinants that affect farm households' credit demand and credit rationing status, and the substitute/complement relationships among formal, semi-formal, and informal credit markets. Because of the advantages of the METE model, such as the ability to handle endogeneity and sample selection bias problems, it is used to evaluate the influence of credit rationing on farm households' net farm revenue.

The ARDL model is chosen to investigate the short- and long-run relationships between agricultural credit and the performance of the agricultural sector at the macro-level in Vietnam. The issues of structural break are tested with indicator saturation methodology before implementing unit root tests and the ARDL model since ignoring structural breaks leads to biases in the results of unit root tests and ARDL model. Next, the T-Y test is performed to detect causality among the variables in the ARDL model.

Secondary data are from different sources such as GSO, SBV, the Climate Change Knowledge Portal (World Bank), and other official data sources. Primary data are from agricultural households in Vietnam based on a survey questionnaire that focuses on smallholder farmers who specialize in crops and livestock in the Red River Delta of Vietnam. A multi-staged disproportionate stratified random sampling technique is used to choose the study sample; the sample size is determined based on the conventional formula of Cochran (1977).

Chapter 4

Description of the RRD smallholder farm household survey data

The chapter describes the RRD smallholder farm household survey data (micro-level data). Section 4.1 discusses the credit demand and credit rationing conditions of the surveyed households. Section 4.2 presents the characteristics of farm households in terms of credit demand and credit rationing conditions, human capital, social capital, physical capital, credit history, geographical factors, and demographic profile. The characteristics of agricultural credit in all three credit markets are discussed in Section 4.3. Section 4.4 summarizes the chapter.

4.1. Credit demand and the credit rationing status of respondents

Table 4.1 summarizes the credit demands of the surveyed 648 farm households in formal, semi-formal, and informal credit markets. Credit demand in one market does not exclude demand for credit in another market. The results show 52.93% of the farm households had a credit demand (in one, two or all three markets). There were 283, 101, and 94 households having demand in the formal, semi-formal, and informal credit markets, respectively. The results show that formal credit was the most common credit source for RRD farm households. Among the farm households that have a credit demand, 67.35% of them had a demand in only one credit market; only 6.71% of the households had a demand in all three credit markets. Among the farm households with a demand in two credit markets, there were 59 households (66.29%) with a demand in the formal and informal markets. This reflects the stronger connection between that pair of credit markets (formal versus informal) compared with the other pairs of credit markets (such as semi-formal versus informal).

Table 4.1. Farm households' credit demands in different credit markets

DC_1	DC_2	DC_3	Number of observations	Percentage (of the total sample)	Percentage (of farm households having credit demand)
-	-	-	305	47.07%	
Yes	-	-	174	26.85%	50.73%
-	Yes	-	48	7.41%	13.99%
-	-	Yes	9	1.39%	2.62%
Yes	Yes	-	27	4.17%	7.87%
Yes	-	Yes	59	9.10%	17.20%
-	Yes	Yes	3	0.46%	0.87%
Yes	Yes	Yes	23	3.55%	6.71%

***Note**: DC_1, DC_2, DC_3 indicate households demanding credit in the formal, semi-formal, and informal markets, respectively.*

Table 4.2 reports the credit rationing condition of the surveyed respondents. The results show 22.38% of the surveyed households (42.27% of the surveyed households with credit demand) were credit rationed in at least one of the three credit markets. The proportions of households being credit rationed in only the formal, semi-formal, and informal markets were 8.95%, 5.4%, and 4.94%, respectively. The proportions of households being credit rationed in two or three credit markets were relatively low (less than 3.1% of the total surveyed respondents). This implies that different credit markets used different criteria to ration farm households' loan applications. Therefore, households facing credit rationing in one market might not face rationing in another market.

Table 4.2. Farm households' credit rationing status in different credit markets

CR_1	CR_2	CR_3	Number of observations	Percentage (of the total sample)	Percentage (of total credit rationed farm households)
-	-	-	503	77.62%	
Yes	-	-	58	8.95%	40.00%
-	Yes	-	35	5.40%	24.14%
-	-	Yes	32	4.94%	22.07%
Yes	Yes	-	3	0.46%	2.07%
Yes	-	Yes	10	1.54%	6.90%
-	Yes	Yes	4	0.62%	2.76%
Yes	Yes	Yes	3	0.46%	2.07%

***Note**: CR_1, CR_2, CR_3 indicate households being credit rationed in the formal, semi-formal, and informal markets, respectively.*

Table 4.3 provides detail on the different credit rationed categories that farm households face. The results show that quantity rationed households were the most popular, accounting for 89.2%, 82.22%, and 75.51% of the credit rationed households in the formal, semi-formal, and informal markets, respectively. The proportions of the price rationed households were very low in all three markets (0%, 0%, and 2.4% in the formal, semi-formal, and informal markets, respectively). The results imply loan interest rates might not be the main obstacle in farm households' access to credit.

Table 4.3. Types of credit rationing and the distribution among them

	Formal credit market		Semi-formal credit market		Informal credit market	
	N	%	N	%	N	%
Price rationed	0	0%	0	0%	1	2.04%
Risk rationed	4	5.40%	3	6.67%	9	18.37%
Quantity rationed	66	89.20%	37	82.22%	37	75.51%
Transaction cost rationed	4	5.40%	5	11.11%	2	4.08%
Total	74	100%	45	100%	49	100%

Table 4.4 reports the reasons for farm households being credit rationed regarding the different credit markets and different types of credit rationed households (e.g., discouraged credit rationed households, rejected applicants, and non-rejected applicants but not receiving full credit amount applied for). Discouraged credit rationed households are those that have credit demand but do not submit credit applications because of the high transaction costs, fear of rejection, or any other reason (Kon & Storey, 2003; Moahid & Maharjan, 2020).

Table 4.4. The reasons for credit rationing

Description	Having formal credit demand (283)		Having semi-formal credit demand (101)		Having informal credit demand (94)	
	Non-borrowers	Borrowers	Non-borrowers	Borrowers	Non-borrowers	Borrowers
Number of respondent households	16	267	14	87	16	78
Number of credit rationed households	16	58	14	31	16	33
Reasons for being credit rationed						
Discouraged credit rationed households and reasons	***16***		***14***		***16***	
- Complications of the loan application process	4		0		0	
- Fear of being in debt/ losing collateral	4		3		9	
- Fear of rejection because of inadequate documents/collateral/bad credit history	8		6		4	
- Have no idea about where to apply	0		5		2	
- High interest rate	0		0		1	
Rejected applicants and reasons		***5***		***7***		***9***
- Not enough collateral		3		0		2
- Bad credit history		1		0		3
- Uncertain income		1		4		4
- No support from credit officers		0		1		0
- Inadequate documents		0		2		0
Non- rejected applicants but not receiving full amount and reasons		***53***		***24***		***24***
- Not enough collateral		27		2		7
- Bad credit history		3		0		4
- Uncertain income		7		3		7
- Agricultural projects not good enough		7		1		6
- No support from credit officers		3		2		0
- Inadequate documents		6		4		0
- Limited loan amount for individual borrower		0		12		0

The proportions of discouraged credit rationed households to credit rationed borrowers in the semi-formal market and informal markets (45.16% and 48.48%, respectively) were higher than for the formal credit market (27.59%). Though the discouraged households' main reason for being credit rationed in the formal and semi-formal credit markets was the fear of rejection (such as because of bad credit history, inadequate documents, or collateral), the main reason in the informal credit market was the fear of being in debt or losing collateral. The results reflect that the application

processes and requirements of the formal and semi-formal credit markets might be stricter than for the informal credit market (Tra & Lensink, 2008). If farm households in rural Vietnam are unable to make their loan payments on the due date, formal credit providers would rather restructure the farm households' debts than foreclose their collateral because of poor quality and low liquidity (Tran, 2014).

Based on borrowers' responses, non-rejected but credit rationed farm households account for the majority of the credit rationed households in the formal, semi-formal, and informal markets (91.38%, 77.42%, and 72.73%, respectively). The main cause of credit rationing in the formal credit market was a lack of collateral, reflecting that collateral was one of the most important components in the rationing process of formal credit providers. The reasons for credit rationing in the informal credit market varied, but included uncertain income, agricultural projects not good enough, bad credit history, and not enough collateral. Interestingly, the main reason for credit rationing in the semi-formal credit market was the loan limit amount set by the semi-formal credit providers for each farm household. Some semi-formal providers set 80 million VND (approximately 3,562 USD)[1] as the maximum loan amount that can be granted to an individual borrower. This result implies that the loan amount provided by semi-formal lenders is relatively small and might not be enough for agricultural production purposes.

Table 4.5 provides information on the agricultural credit demand of non-borrowers (including households that did not have agricultural credit demand (305 households) and households with credit demand but did not borrow from any credit source in 2019 (19 households)) in the future. The results show 42.98% of non-borrowers in 2019 expect to have future agricultural credit demand, and the vast majority (93.2%) of those with credit demand intend to borrow. Not surprisingly, the formal credit source is the most sought after credit source by non-borrowers. State-owned and commercial banks are the most preferred options regarding the formal credit market, whereas mass organisations (such as Women's Union or Farmers' Association) and relatives/friends are the most selected options regarding the semi-formal and informal credit markets, respectively.

[1] 1 USD = 23109 VND as of July 1st, 2020

Table 4.5. The agricultural credit demand of non-borrowers in the future

Non- borrowers (N=324)	Yes		No	
	N	%	N	%
Have credit demand in the future	147	42.98	177	51.75
Intend to borrow in the future	137	40.06	187	54.68
Credit sources to be borrowed from				
Formal credit	115	33.63		
- State-owned banks/ commercial banks	102	29.83		
- Licensed microfinance institutions	13	3.80		
- Cooperative bank/ people credit funds	18	5.26		
Semi-formal credit	49	14.33		
- Non-government organizations	5	1.46		
- Women's Union/ Farmers' Association/ Vietnam General Confederation of Labour	35	10.23		
- Unlicensed microfinance institutions	15	4.39		
- Others	0	0.00		
Informal credit	24	7.02		
- Money lenders	1	0.29		
- Relatives and friends	11	3.22		
- Pawn shops	0	0.00		
- ROSCAs	4	1.17		
- Input suppliers	4	1.17		
- Middlemen (fruit collectors)	4	1.17		
- Others	0	0.00		

4.2. Respondents' characteristics

4.2.1. Human capital factors

Table 4.6 shows that 42.43% of farm household heads completed secondary school or lower. The proportions of the household heads in each education level category (primary school or lower, secondary school, high school, and higher level of education) of the formal credit demand group were quite similar to that of the overall study sample. However, the proportions of the household heads with secondary school level or lower in the semi-formal and informal credit demand groups (58.41% and 51%, respectively) were higher than those of the formal credit demand group and the overall study sample (42.05% and 42.43%, respectively). For the credit rationed group, Table 4.7 shows that the proportions of household heads with secondary school level or lower in the formal, semi-formal, and informal credit demand groups (75.67%, 77.78%, and 55.1%, respectively) were much higher than that of the overall study sample (42.43%). The proportions of household heads with an education level higher than high school in the formal and semi-formal credit rationed groups (6.76% and 0%, respectively) were very low, but the proportion for the informal credit rationed group was much higher (22.45%) (see Table 4.7). These results imply that the education level of the household head had a strong relationship with a farm household's credit rationing status in the

formal and semi-formal credit markets. Specifically, farm household heads with high school or higher might experience a lower probability of being credit rationed in the formal and semi-formal markets.

Table 4.6. Human capital characteristics of farm households by credit demand group

Factors	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Education level								
Primary school or lower	47	16.61	26	25.74	20	21.28	119	18.36
Secondary school	72	25.44	33	32.67	27	28.72	156	24.07
High school	113	39.93	36	35.64	28	29.79	243	37.50
Higher level of education	51	18.02	6	5.94	19	20.21	130	20.06
Total	283	100	101	100	94	100	648	100
Farming experience (years)								
Less than 5	4	1.41	10	9.90	5	5.32	25	3.86
5 to <10	67	23.68	31	30.69	30	31.92	127	19.60
10 to < 15	86	30.39	20	19.80	33	35.11	182	28.09
15 to <20	46	16.25	21	20.79	9	9.57	119	18.36
20 and above	80	28.27	19	18.81	17	18.09	195	30.09
Total	283	100	101	100	94	100	648	100
Mean farming years	14.91		12.34		12.37		15.23	

Table 4.7. Human capital characteristics of farm households by credit rationed group

Factor	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Education level								
Primary school or lower	24	32.43	12	26.67	13	26.53	119	18.36
Secondary school	32	43.24	23	51.11	14	28.57	156	24.07
High school	13	17.57	10	22.22	11	22.45	243	37.50
Higher level of education	5	6.76	0	0.00	11	22.45	130	20.06
Total	74	100	45	100	49	100	648	100
Farming experience (years)								
Less than 5	2	2.70	9	20.00	3	6.12	25	3.86
5 to <10	37	50.00	24	53.33	20	40.82	127	19.60
10 to < 15	24	32.43	7	15.56	18	36.74	182	28.09
15 to <20	6	8.11	3	6.67	5	10.20	119	18.36
20 and above	5	6.76	2	4.44	3	6.12	195	30.09
Total	74	100	45	100	49	100	648	100
Mean farming years	9.73		8.00		9.61		15.23	

Tables 4.6 and 4.7 show that the average household head's farming experience (in years) of the formal, semi-formal, and informal credit demand groups (14.91, 12.34, and 12.37, respectively) as well as those of the formal, semi-formal, and informal credit rationed groups (9.73, 8, and 9.61, respectively) were lower than the total sample (15.23). The majority of farm households being credit

rationed in the formal, semi-formal, and informal credit markets (85.13%, 88.89%, and 83.67%, respectively) were those with household heads having less than 15 years of farming experience. Household heads with 20 years or more of farming experience accounted for 30.1% of the study sample but accounted for a small proportion of the formal, semi-formal, and informal credit rationed groups (6.76%, 4.44%, and 6.12%, respectively). The results indicate that the farming experience of the household head exhibits a negative correlation with the probability of being credit rationed.

4.2.2. Social capital factors

Table 4.8 reveals that over half of farm households in the formal, semi-formal, informal credit demand groups (69.97%, 67.33%, and 61.7%, respectively) joined one to three socio-economic associations (such as Women's Union or Farmers' Association) and the proportion of households joining four or more socio-economic associations was very low (1.77%, 0%, and 0%, respectively). The average number of socio-economic associations in which farm households participated in the semi-formal and informal credit demand groups (0.99 and 0.95, respectively) were much lower than the total sample (1.21).

Table 4.8. Social capital characteristics of farm households by credit demand groups

Factor	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Number of socio-economic associations farm household joined								
0	80	28.27	33	32.67	36	38.30	187	28.86
1-3	198	69.97	68	67.33	58	61.70	449	69.29
4 or more	5	1.77	0	0.000	0	0.00	12	1.85
Total	283	100	101	100	94	100	648	100
Mean	1.19		0.99		0.95		1.21	
Social status								
Yes	37	13.07	8	7.92	5	5.32	67	10.34
No	246	86.93	93	92.08	89	94.68	581	89.66
Total	283	100	101	100	94	100	648	100

Table 4.9 shows the proportions of farm households of the formal, semi-formal, and informal credit rationed groups that did not participate in any socio-economic association (35.14%, 57.78%, and 46.94%, respectively) are higher than the total sample (28.86%); however, the differences from the total sample were more evident in the semi-formal and informal credit rationed groups. The average number of socio-economic associations that the semi-formal and informal credit rationed households joined (0.64 and 0.78, respectively) were much lower than the total sample (1.21)

whereas that of the formal credit rationed households (1.04) showed a marginal difference. The results indicate socio-economic association participation has a strong relation to households' credit rationing status in the semi-formal and informal credit markets compared with the formal credit market.

Table 4.9. Social capital characteristics of farm households by credit rationed groups

Factor	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Number of socio-economic associations farm household joined								
0	26	35.14	26	57.78	23	46.94	187	28.86
1-3	48	64.86	19	42.22	26	53.06	449	69.29
4 or more	0	0.00	0	0.00	0	0.00	12	1.85
Total	74	100	45	100	49	100	648	100
Mean	1.04		0.64		0.78		1.21	
Social status								
Yes	1	1.35	1	2.22	1	2.04	67	10.34
No	73	98.65	44	97.78	48	97.96	581	89.66
Total	74	100	45	100	49	100	648	100

Table 4.8 shows that the vast majority (89.66%) of the farm household heads did not hold a government position at village level or higher. The proportion of the household heads with the social status of the formal credit demand group (13.07%) was higher than the total sample (10.34%). In contrast, the proportions of the household head with social status of the semi-formal and informal credit demand groups (7.92% and 5.32%, respectively) were lower than the total sample. The proportion of household heads with social status of the formal, semi-formal, and informal credit rationed groups (1.35%, 2.22%, and 2.04%, respectively) were much lower than the formal, semi-formal, and informal credit demand groups (13.07%, 792%, and 5.32%, respectively) (see Tables 4.8 and 4.9). This result implies that the social status of the household head negatively affects the farm households' credit rationing status.

4.2.3. Physical capital factors

Table 4.10 shows that 56.17% of the farm households had a farm size from 0.1 to 1 ha. The average households' farmland size of the formal credit demand group (0.51 ha) was higher than the overall study sample (0.41 ha), while the average households' farmland sizes of the semi-formal and informal credit groups (0.36 ha and 0.38 ha, respectively) were lower than the overall study sample. Regarding credit rationed groups, the majority of the households in the formal, semi-formal, and informal credit markets (81.07%, 82%, and 69.83%, respectively) had farmland sizes less than 0.5 ha (see Table 4.11). The average households' farmland size of the formal, semi-formal, and informal

credit rationed groups (0.35 ha, 0.28 ha, and 0.34 ha) were lower than the overall study sample (0.41 ha).

Table 4.10. The physical capital characteristics of farm households by credit demand group

Factor	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Farmland size (ha)								
0.1 ha or less	65	22.97	31	30.69	32	34.04	189	29.17
0.1 to < 0.5	119	42.05	48	47.53	37	39.36	283	43.67
0.5 to < 1	43	15.19	13	12.87	17	18.09	81	12.50
1 and above	56	19.79	9	8.91	8	8.51	95	14.66
Total	283	100	101	100	94	100	648	100
Mean	0.51		0.36		0.38		0.41	
House value (million VND)								
Less than 100	15	5.30	9	8.91	7	7.45	29	4.48
100 to < 300	68	24.03	35	34.65	32	34.04	129	19.91
300 to < 500	89	31.45	26	25.74	28	29.79	174	26.85
500 to < 700	32	11.31	11	10.89	4	4.26	71	10.96
700 and above	79	27.91	20	19.81	23	24.47	245	37.81
Total	283	100	101	100	94	100	648	100
Durable assets' value (million VND)								
Less than 10	1	0.35	5	4.95	1	1.06	10	1.54
10 to < 30	64	22.61	29	28.71	33	35.11	128	19.75
30 to < 50	94	33.22	35	34.65	30	31.91	196	30.25
50 to < 70	79	27.92	18	17.82	17	18.09	180	27.78
70 and above	45	15.90	14	13.86	13	13.83	134	20.68
Total	283	100	101	100	94	100	648	100

The proportions of households with house value less than 300 million VND in the formal, semi-formal, and informal credit demand groups (29.31%, 43.65%, and 41.49%, respectively) were higher than the total sample (24.38%) (see Table 4.10). Similarly, the proportions of households with house value less than 300 million VND in the formal, semi-formal, and informal credit rationed groups (48.65%, 55.55%, and 51.02%, respectively) were much higher than the total sample (see Table 4.11). The proportions of households with house value 500 million VND or higher in each credit rationed group (25.67%, 24.44%, and 12.24% in the formal, semi-formal, and informal credit rationed groups, respectively) were lower than each credit demand group (39.23%, 30.69%, and 28.73% in the formal, semi-formal, and informal credit demand groups, respectively). However, all these proportions were higher than the proportion of households with house value 500 million VND of the total sample (48.77%). These results imply that house value is negatively correlated with both household credit demand and credit rationing.

The results show 77.78% of the surveyed farm households had durable assets value ranging from 10 to 70 million VND (see Table 4.10). Similar to house value, the proportions of households having a relatively low value of durable assets (less than 50 million VND) in each credit demand and credit

rationed group (56.18%, 68.32%, 68.1%, 68.92%, 77.78%, and 81.63% in the formal credit demand, semi-formal credit demand, informal credit demand, formal credit rationed, semi-formal credit rationed, and informal credit rationed groups, respectively) were higher than the overall study sample (51.54%) (see Tables 4.10 and 4.11). The results indicate households with less durable assets' value might have a higher probability of both having credit demand and being credit rationed.

Table 4.11. The physical capital characteristics of farm households by credit rationed group

Factor	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Farm size (ha)								
0.1 ha or less	27	36.49	14	31.11	20	40.82	189	29.17
0.1 to < 0.5	33	44.59	22	48.89	14	28.57	283	43.67
0.5 to < 1	6	8.11	8	17.78	13	26.53	81	12.50
1 and above	8	10.81	1	2.22	2	4.08	95	14.66
Total	74	100	45	100	49	100	648	100
Mean	0.35		0.28		0.34		0.41	
House value (million VND)								
Less than 100	9	12.16	1	2.22	4	8.16	29	4.48
100 to < 300	27	36.49	24	53.33	21	42.86	129	19.91
300 to < 500	19	25.68	9	20.00	18	36.73	174	26.85
500 to < 700	6	8.11	4	8.89	4	8.16	71	10.96
700 and above	13	17.57	7	15.56	2	4.08	245	37.81
Total	74	100	45	100	49	100	648	100
Durable assets' value (million VND)								
Less than 10	1	1.35	4	8.89	0	0.000	10	1.54
10 to < 30	22	29.73	17	37.78	21	42.86	128	19.75
30 to < 50	28	37.84	14	31.11	19	38.78	196	30.25
50 to < 70	18	24.32	7	15.56	5	10.20	180	27.78
70 and above	5	6.76	3	6.67	4	8.16	134	20.68
Total	74	100	45	100	49	100	648	100

4.2.4. Other demographic profile

Table 4.12 shows that male household heads account for 70.22% of the surveyed households. This finding is similar to Tran et al.'s (2016) study in the north central coastal Vietnam. Males are usually the household heads and are responsible for significant decisions since they generate more income (Tran et al., 2016). The proportions of male household head in the formal credit demand and informal credit demand groups (74.91% and 72.34%, respectively) were higher than the total sample (70.22%), but lower in the semi-formal credit demand group (60.39%) (see Table 4.12). This implies that semi-formal credit might be more suitable for women. The proportion of the male household heads in each credit rationed group (77.03%, 60%, and 73.47% in the formal, semi-formal, and informal credit rationed groups, respectively) was marginally different from the credit demand group in the same credit market (74.91%, 60.39%, and 72.34% in the formal, semi-formal, and

informal credit demand groups) (see Tables 4.12 and 4.13). This implies the household head's gender does not have a strong connection with a farm household's credit rationing status.

Table 4.12. The demographic profile of farm households by credit demand groups

Factor	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Gender								
Male	212	74.91	61	60.40	68	72.34	455	70.22
Female	71	25.09	40	39.60	26	27.66	193	29.78
Total	283	100	101	100	94	100	648	100
Age group								
35 and under	42	14.84	10	9.90	18	19.15	119	18.36
36 to 45	128	45.23	49	48.52	35	37.23	276	42.59
46 to 55	80	28.27	37	36.63	28	29.79	177	27.31
More than 55	33	11.66	5	4.95	13	13.83	76	11.73
Total	283	100	101	100	94	100	648	100
Number of family members								
1-2	7	2.47	3	2.97	1	1.06	17	2.62
3-4	125	44.17	49	48.51	45	47.87	310	47.84
5-6	133	47.00	44	43.56	45	47.87	274	42.28
7 and above	18	6.36	5	4.95	3	3.19	47	7.25
Total	283	100	101	100	94	100	648	100
Mean	4.72		4.62		4.66		4.69	
Main agricultural production								
Livestock	133	47.00	48	47.52	36	38.30	307	47.38
Crop	150	53.00	53	52.48	58	61.70	341	52.62
Total	283	100	101	100	94	100	648	100

The age of the surveyed household heads was divided into four categories; 60.95% fell into the category of 45 years old or under (see Table 4.12). The proportions of household head in each age category of the formal credit demand and informal credit demand groups were quite similar to the total sample. The proportions of household head in the 35 years old or under and over 55 years old categories of the semi-formal credit demand group (9.9% and 4.95%, respectively) were much lower than the total sample (18.36% and 11.73%, respectively). Table 4.13 indicates that over half of household heads in the formal, semi-formal, and informal credit rationed groups (64.87%, 75.56%, and 57.14%, respectively) fell into the category of 45 years old or under.

Most surveyed households (90.12%) had three to six members (see Table 4.12). The average family size of the formal credit demand group (4.72) was slightly higher than the total sample (4.69); the average family sizes of the semi-formal and informal credit demand groups (4.62 and 4.66, respectively) were lower. Table 4.13 shows that households in the formal and informal credit

rationed groups had larger average families (4.97 and 4.88, respectively) whereas households in the semi-formal group had a smaller than average families (4.56) than the total sample (4.69).

Table 4.13. The demographic profile of farm households by credit rationed group

Factor	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Gender								
Male	57	77.03	27	60.00	36	73.47	455	70.22
Female	17	22.97	18	40.00	13	26.53	193	29.78
Total	74	100	45	100	49	100	648	100
Age group								
35 and under	13	17.57	6	13.33	12	24.49	119	18.36
36 to 45	35	47.30	28	62.22	16	32.65	276	42.59
46 to 55	19	25.68	10	22.22	16	32.65	177	27.31
More than 55	7	9.46	1	2.22	5	10.20	76	11.73
Total	74	100	45	100	49	100	648	100
Number of family members								
1-2	0	0.000	1	2.22	0	0.00	17	2.62
3-4	27	36.49	23	51.11	21	42.86	310	47.84
5-6	39	52.70	19	42.22	26	53.06	274	42.28
7 and above	8	10.81	2	4.44	2	4.08	47	7.25
Total	74	100	45	100	49	100	648	100
Mean	4.97		4.56		4.88		4.69	
Main agricultural production								
Livestock	33	44.60	19	42.22	19	38.78	307	47.38
Crop	41	55.40	26	57.78	30	61.22	341	52.62
Total	74	100	45	100	49	100	648	100

Table 4.12 shows 52.62% of the surveyed households focused on cropping. The proportions of crop farm households in each credit demand and credit rationed group were over 50% (see Tables 4.12 and 4.13). Table 4.12 shows that though the proportions of livestock farm households in the formal and informal credit demand groups (47% and 47.53%) were slightly different from the total sample (47.38%), the proportion in the informal credit demand group (38.3%) was much lower. The proportion of crop farm households in the informal credit demand group (617%) was similar to the informal credit rationed group (61.22%), but the proportions of crop farm households in the formal and semi-formal credit demand groups (53% and 52.48%, respectively) were lower than their counterparts in the formal and semi-formal credit rationed groups (55.41% and 57.78%, respectively) (see Tables 4.12 and 4.13).

4.2.5. Credit history of respondents

Table 4.14 shows that only small proportions of the surveyed households had a bad credit history in the formal, semi-formal, and informal credit markets (8.03%, 3.1%, and 1.7%, respectively). Tables

4.14 and 4.15 reveal that the proportions of farm households having bad formal credit history of the formal credit demand and formal credit rationed groups (12.72% and 31.08%, respectively) were higher than the overall study sample (8.03%). Similar results are confirmed for the semi-formal and informal credit markets (sees Table 4.14 and 4.15). This implies bad credit history in one credit market can have positive correlations with the probability of having credit demand or being credit rationed in the same credit market.

Table 4.14. The credit history of farm households by credit demand group

Factor	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Bad formal credit history								
Yes	36	12.72	10	9.90	18	19.15	52	8.03
No	247	87.28	91	90.10	76	80.85	596	91.97
Total	283	100	101	100	94	100	648	100
Bad semi-formal credit history								
Yes	11	3.89	11	10.89	5	5.32	20	3.09
No	272	96.11	90	89.11	89	94.68	628	96.91
Total	283	100	101	100	94	100	648	100
Bad informal credit history								
Yes	5	1.77	2	1.98	7	7.45	11	1.70
No	278	98.23	99	98.02	87	92.55	637	98.30
Total	283	100	101	100	94	100	648	100

Table 4.15. The credit history of farm households by credit rationed groups

Factor	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Bad formal credit history								
Yes	23	31.08	8	17.78	13	26.53	52	8.03
No	51	68.92	37	82.22	36	73.47	596	91.97
Total	74	100	45	100	49	100	648	100
Bad semi-formal credit history								
Yes	3	4.05	10	22.22	1	2.04	20	3.09
No	71	95.95	35	77.78	48	97.96	628	96.91
Total	74	100	45	100	49	100	648	100
Bad informal credit history								
Yes	3	4.05	2	4.44	6	12.25	11	1.70
No	71	95.95	43	95.56	43	87.75	637	98.30
Total	74	100	45	100	49	100	648	100

4.2.6. Geographical factors

Table 4.16 shows that over three-quarters of farm households (76.08%) needed less than 30 minutes to travel to the nearest formal credit source. Similarly, 83.49% of farm households needed less than

30 minutes to travel to the nearest semi-formal credit source. The average times for households to travel to the nearest formal or semi-formal credit sources were 20.06 and 17.41 minutes, respectively. The average time to travel to the nearest formal source of the formal, semi-formal, and informal credit demand groups (20.74, 20.89, and 27.66 minutes, respectively) were higher than for the total sample (20.06 minutes). Similarly, households in the formal, semi-formal, and informal credit rationed groups spent an average of 18.78, 18.9, and 21.78 minutes, respectively, travelling to the nearest semi-formal credit source, which are all higher than the total sample average (17.41 minutes).

The average travel time of the formal credit rationed household (29.62 minutes) to the nearest formal credit source was higher than for all households (20.06 minutes) (see Table 4.17). A similar result is found regarding the semi-formal credit rationed households. They travel an average of 24.82 minutes to the nearest semi-formal credit source, which was well above total households (17.41 minutes) (see Table 4.17). The findings imply that the travel time to the nearest credit market source has a positive correlation with the household's probability of being credit rationed in that market.

Table 4.16. The geographical characteristics of farm households by credit demand group

Factor	Having formal credit demand		Having semi-formal credit demand		Having informal credit demand		All households	
	N	%	N	%	N	%	N	%
Time to nearest formal credit source (minutes)								
Less than 15	79	27.92	31	30.69	26	27.66	191	29.48
15 to < 30	135	47.70	43	42.57	45	47.87	302	46.60
30 and above	69	24.38	27	26.74	23	24.47	155	23.92
Total	283	100	101	100	94	100	648	100
Mean	20.74		20.89		21.28		20.06	
Time to nearest semi-formal credit source (minutes)								
Less than 15	91	32.15	40	39.61	24	25.53	249	38.43
15 to < 30	133	47.00	41	40.59	37	39.36	292	45.06
30 and above	59	20.85	20	19.80	33	35.11	107	16.51
Total	283	100	101	100	94	100	648	100
Mean	18.78		18.90		21.78		17.41	
Province								
Ha Noi	90	31.80	27	26.73	29	30.85	211	32.56
Hai Duong	77	27.21	25	24.75	34	36.17	215	33.18
Ha Nam	116	40.99	49	48.52	31	32.98	222	34.26
Total	283	100	101	100	94	100	648	100

Table 4.16 shows the proportions of survey households in different provinces (Ha Noi, Hai Duong, and Ha Nam) were only slightly different (32.56%, 33.18%, and 34.26%, respectively). The proportions of households of the formal and semi-formal credit demand groups in Ha Nam province (40.99% and 48.52%, respectively) were higher than for the total sample (34.26%). Likewise, the

proportion of households of the informal credit demand group (36.17%) in Hai Duong province was higher than the for the total sample (33.18%) (see Table 4.16). Table 4.17 shows only 27.03% and 20% of surveyed households of the formal and semi-formal credit rationed groups lived in Ha Noi province; the proportions of households living in Ha Nam province were much higher in these two groups (40.54% and 46.67%, respectively). These results imply that there might be regional differences in terms of farm households' credit demand and credit rationing status.

Table 4.17. The geographical characteristics of farm households by credit rationed group

Factors	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Time to nearest formal credit source (minutes)								
Less than 15	11	14.86	9	20.00	13	26.53	191	29.48
15 to < 30	20	27.03	18	40.00	23	46.94	302	46.60
30 and above	43	58.11	18	40.00	13	26.53	155	23.92
Total	74	100	45	100	49	100	648	100
Mean	29.62		25.04		21.43		20.06	
Time to nearest semi-formal credit source (minutes)								
Less than 15	14	18.92	10	22.22	15	30.61	249	38.43
15 to < 30	35	47.30	18	40.000	19	38.77	292	45.06
30 and above	25	33.78	17	37.78	15	30.62	107	16.51
Total	74	100	45	100	49	100	648	100
Mean	22.34		24.82		19.80		17.41	
Provinces								
Ha Noi	20	27.03	9	20.00	17	34.69	211	32.56
Hai Duong	24	32.43	15	33.33	15	30.61	215	33.18
Ha Nam	30	40.54	21	46.67	17	34.70	222	34.26
Total	74	100	45	100	49	100	648	100

4.2.7. Farm performance and income of rural households

Regarding the surveyed households' average farm income, Table 4.18 shows that the average farm income per month of all surveyed households (7.08 million VND)[2] was much higher than the households in the formal, semi-formal, and informal credit rationed groups (5.21, 4.17, and 4.93 million VND, respectively). The proportions of households in the two highest average farm income categories (i.e., having 6 million VND or more per month) of the formal, semi-formal, and informal credit rationed groups (27.03%, 24.44%, and 22.45%, respectively) were much lower than for the total sample (55.09%). Table 4.18 shows similar results regarding the average net farm revenue and the agricultural output value of the surveyed farm households. The average net farm revenue per agricultural labour unit per month of all surveyed households was 4.52 million VND, much higher than the households in the formal, semi-formal, and informal credit rationed groups (3.01, 2.78, and 2.78 million VND, respectively). The proportions of households in the two lowest average net farm

[2] 1 USD = 23109 VND as of July 1st, 2020

revenue per agricultural labour unit categories (i.e., having 4 million VND or less per month) of the formal, semi-formal, and informal credit rationed groups (85.14%, 82.22%, and 77.55%, respectively) were much higher than for the total sample (49.69%). These findings imply a negative relationship between farm households' credit rationing status and farm performance.

Table 4.18. The income, value of farm output, and net farm revenue of the surveyed farm households

Criteria	Formal credit rationed		Semi-formal credit rationed		Informal credit rationed		All households	
	N	%	N	%	N	%	N	%
Farm income per month (million VND)								
Less than 2	1	1.35	4	8.89	0	0.00	10	1.54
2 to < 4	21	28.38	23	51.11	19	38.78	103	15.90
4 to < 6	32	43.24	7	15.56	19	38.78	178	27.47
6 to < 8	11	14.86	8	17.78	6	12.24	131	20.22
8 and above	9	12.16	3	6.67	5	10.20	226	34.88
Total	74	100	45	100	49	100	648	100
Mean	5.21		4.17		4.94		7.08	
Non-farm income per month (million VND)								
Less than 2	20	27.03	13	28.89	11	22.45	151	23.30
2 to < 4	22	29.73	13	28.89	8	16.33	161	24.85
4 to < 6	18	24.32	12	26.67	18	36.76	150	23.15
6 to < 8	3	4.05	3	6.67	3	6.12	46	7.10
8 and above	11	14.87	4	8.89	9	18.37	140	21.60
Total	74	100	45	100	49	100	648	100
Mean	3.82		3.47		4.51		4.99	
Agricultural output value per month (million VND)								
Less than 3	2	2.70	2	4.44	0	0.00	11	1.70
3 to < 6	29	39.19	25	55.56	33	67.35	130	20.06
6 to < 9	23	31.08	12	26.67	6	12.24	160	24.69
9 to < 12	9	12.16	3	6.67	4	8.16	113	17.44
12 and above	11	14.87	3	6.67	6	12.25	234	36.11
Total	74	100	45	100	49	100	648	100
Mean	7.52		6.09		7.49		10.95	
Net farm revenue per month (million VND)								
Less than 3	2	2.70	2	4.44	0	0.00	11	1.70
3 to < 6	32	43.24	28	62.22	33	67.35	148	22.84
6 to < 9	24	32.43	10	22.22	7	14.29	188	29.01
9 to < 12	8	10.81	5	11.11	5	10.20	139	21.45
12 and above	8	10.81	0	0.000	4	8.16	162	25.00
Total	74	100	45	100	49	100	648	100
Mean	6.94		5.63		6.66		9.85	
Net farm revenue per agricultural labour unit per month (million VND)								
Less than 2	13	17.57	19	42.22	12	24.49	53	8.18
2 to < 4	50	67.57	18	40.00	26	53.06	269	41.51
4 to < 6	6	8.11	6	13.33	11	22.45	191	29.48
6 to < 8	5	6.76	0	0.00	0	0.00	89	13.73
8 and above	0	0.00	2	4.44	0	0.00	46	7.10
Total	74	100	45	100	49	100	648	100
Mean	3.01		2.78		2.78		4.52	

Like farm income, there was a considerable difference in the non-farm income of all surveyed households and the households in each credit rationed group. The average non-farm income per month of all surveyed households was 4.99 million VND, which was slightly higher than households in the informal credit rationed group (4.51 million VND) but much higher than that of households in the formal and semi-formal credit rationed groups (3.82 and 3.47 million VND, respectively).

4.3. The characteristics of agricultural loans

The characteristics of agricultural loans in the formal, semi-formal, and informal credit markets are summarized in Table 4.19. The mean value of credit demand in the formal credit market (136.21 million VND) was the highest among the three credit markets, followed by the informal credit market (57.55 million VND) and the semi-formal credit market (47.72 million VND). The results show 71.02% of the formal credit demand values ranged from 50 to less than 200 million VND, whereas 87.13% of the formal credit demand values were less than 100 million VND. The informal credit demand values varied considerably.

Table 4.19. The characteristics of agricultural loans in the formal, semi-formal, and informal credit markets

Loan characteristic	Formal loans		Semi-formal loans		Informal loans	
	N	%	N	%	N	%
Agricultural credit demand (in million VND)	***283***	***100***	***101***	***100***	***94***	***100***
Less than 25	0	0.00	27	26.73	29	30.85
25 to < 50	5	1.77	18	17.82	9	9.57
50 to < 100	66	23.32	43	42.57	34	36.17
100 to < 200	135	47.70	13	12.87	18	19.15
200 to < 300	53	18.73	0	0.00	3	3.19
300 and above	24	8.48	0	0.00	1	1.06
Mean	136.21		47.72		57.55	
Loan amount value applied (in million VND)	***267***	***100***	***87***	***100***	***78***	***100***
Less than 25	0	0.00	24	27.59	22	28.21
25 to < 50	5	1.87	17	19.54	8	10.26
50 to < 100	61	22.85	33	37.93	27	34.62
100 to < 200	129	48.31	13	14.94	17	21.79
200 to < 300	52	19.48	0	0.00	3	3.85
300 and above	20	7.49	0	0.00	1	1.28
Mean	135.57		47.70		51.28	
Loan value granted (in million VND)	***267***	***100***	***87***	***100***	***78***	***100***
0	6	2.25	6	6.90	8	10.26
0 to < 25	1	0.37	28	32.18	24	30.77
25 to < 50	9	3.37	16	18.39	9	11.54
50 to < 100	76	28.46	33	37.93	22	28.21
100 to < 200	110	41.20	4	4.60	12	15.38
200 to < 300	48	17.98	0	0.00	2	2.56
300 and above	17	6.37	0	0.00	1	1.28
Mean	125.22		36.67		47.31	
Collateral requirement	***267***	***100***	***87***	***100***	***78***	***100***
No collateral	2	0.75	62	71.26	21	26.92

Loan characteristic	Formal loans		Semi-formal loans		Informal loans	
	N	%	N	%	N	%
Property (land or building)/house	246	92.13	11	12.64	11	14.10
Machinery/equipment	25	9.36	4	4.60	8	10.26
Saving books	13	4.87	1	1.15	3	3.85
Personal properties/durable assets	8	3.00	4	4.60	31	39.74
Durable assets (e.g., home appliances, TV)	5	1.87	0	0.00	22	28.21
Other	11	4.12	1	1.15	4	5.13
Interest rate (%/month)						
Highest interest rate	1.1%		0.75%		2.5%	
Lowest interest rate	0.42%		0.2%		0%	
Loan duration	***261***	***100***	***81***	***100***	***70***	***100***
Short term (less than 1 year)	126	48.28	30	37.04	55	78.57
Medium term (1 to less than 5 years)	103	39.46	48	59.26	13	18.57
Long term (5 years and above)	32	12.26	3	3.70	2	2.86
Loan payment schedule	***261***	***100***	***81***	***100***	***70***	***100***
Weekly	0	0.00	0	0.00	1	1.43
Monthly	144	55.17	63	77.78	35	50.00
Quarterly	104	39.85	10	12.35	4	5.71
Semi-annual	10	3.83	4	4.94	11	15.71
Annually	3	1.15	4	4.94	14	20.00
Other	0	0.00	0	0.00	5	7.14
Loan processing time	***267***	***100***	***87***	***100***	***78***	***100***
Within one day	2	0.75	1	1.15	38	48.72
Less than 1 week	76	28.46	14	16.09	16	20.51
1-4 weeks	180	67.42	68	78.16	17	21.79
1 month or longer	9	3.37	4	4.60	7	8.97
Difficulties when borrowing	***267***	***100***	***87***	***100***	***78***	***100***
No difficulty	31	11.61	45	51.72	20	25.64
Complicated loan process	148	55.43	5	5.75	0	0.00
High administration fee	44	16.48	6	6.90	2	2.56
Unfriendly credit officers	13	4.87	2	2.30	18	23.08
Extra money requested for approval	3	1.12	3	3.45	7	8.97
High value of collateral	74	27.72	3	3.45	2	2.56
Inconsistent credit rules, regulations	5	1.87	5	5.75	28	35.90
Other difficulties	1	0.37	21	24.14	2	2.56

The proportions of fully rejected loans in the formal and semi-formal credit markets (2.25% and 6.9%, respectively) were much lower than those in the informal credit market (10.26%). The mean loan amount granted in the formal, semi-formal, and informal credit markets (125.22, 36.67, and 47.31 million VND, respectively) were much lower than the mean credit demands in these credit markets. This result reflects the negative impact of credit providers' rationing process on satisfying farm households' credit demand.

Nearly all formal loans (99.25%) required collateral; houses, land, or buildings were the main type of collateral (92.13%). Semi-formal credit providers did not pay much attention to collateral since 71.26% of semi-formal loans did not require collateral. Only 26.92% of the informal loans did not require collateral. Informal credit providers appeared to accept a wide range of collateral such as houses, equipment, durables assets, or personal property.

The semi-formal loan interest rate range (from 0.2% to 0.75% per month) was lower than the formal loan interest rate one (from 0.42% to 1.1% per month). The interest rate of informal loans varied considerably from 0% to 2.5% per month. For the loan duration, 48.28% of the formal loans and 78.57% of informal loans were short-term loans, whereas 59.26% of semi-formal loans were medium-term loans. The results show that 12.26% of formal loans were long-term loans followed by 3.7% in the semi-formal and 2.86% in the informal credit groups. For the loan payment schedule, most of the formal and semi-formal loans (95.02% and 90.13%, respectively) had a monthly or quarterly payment schedule. In contrast, informal lenders provided a more flexible payment schedule. For the loan processing time, nearly half (48.72%) of informal loans took one day to be processed, whereas over two thirds (67.42%) of the formal loans and over three quarters (78.16%) of the semi-formal loans took one to four weeks.

When applying for loans, 88.39% of formal credit borrowers and 74.36% of informal credit borrowers found applying difficult. The main difficulties for formal borrowers were the complicated loan process (55.43%) and the high value of the collateral (27.72%). The main difficulties for the informal borrowers were unfriendly credit officers (23.08%) and inconsistent credit rules and regulations (35.9%). Interestingly, 51.72% of the semi-formal borrowers found no difficulty in borrowing. Among the difficulties when borrowing from the semi-formal credit sources, the loan limit amount granted by semi-formal lenders for an individual borrower was the most common difficulty (24.14%).

4.4. Chapter summary

The chapter describes the study's RRD farm household survey data. The descriptive statistics show the characteristics of credit demand, credit rationing status, farm households' profiles, and agricultural loans in the different credit markets.

The survey data show 52.93% of farm households had credit demand with formal credit being the most demanded credit source. There was a strong correlation between the formal and informal credit markets compared with other two pairs of credit markets. The descriptive statistics show 22.38% of surveyed households were credit rationed in at least one credit market. Quantity credit rationed households were the most common; the proportion of price credit rationed households in all three markets was very low. Discouraged households' main reason for being credit rationed in the formal and semi-formal credit markets was fear of rejection. The main reasons in the informal credit market were the fear of losing collateral or being in debt. Among the borrowers, credit rationed households in the formal market were mainly because of a lack of collateral, whereas the main

reason for the semi-formal credit market was the limited loan amount set by the semi-formal lenders.

The results show 42.43% of all farm household heads had secondary school or lower and the average farming experience was 15.23 years. The average number of socio-economic associations that farm households joined is 1.21. The majority of the farm household heads did not hold a government position at the village level or higher. The surveyed farm households had relatively small land area for agricultural production (0.41 ha on average). Most surveyed farm households had durable assets ranging in value from 10 to 70 million VND and a house valued at less than 500 million VND. Furthermore, 70.22% of the surveyed household heads were male and 60.95% of the heads were 45 years old or under. Most households had three to six members; 52.62% of farm households were engaged in cropping.

Only a small percentage of the surveyed households had bad credit history in each of the credit markets. However, bad credit history in one credit market is positively correlated to the likelihood of having credit demand in the same credit market. Similarly, bad credit history has a positive correlation with farm households' probability of being credit rationed. The average travel times to the nearest formal or semi-formal credit source were 20.06 and 17.41 minutes, respectively. The proportions of households in different provinces differ slightly; there are regional differences in terms of farm households' credit demand and credit rationing status. In farm performance, the average farm income, net farm revenue, and agricultural output value of the households in each credit rationed group were lower than the total sample reflecting the negative relationship between farm performance and credit rationing status.

On average, the credit demand value, loan amount applied for, and loan value granted in the formal credit market is much higher than in the informal and semi-formal markets. Formal loans required collateral with real estate as the main type of collateral; semi-formal lenders did not seem too concerned with collateral. The interest rate range of informal loans fluctuated widely compared with the formal and semi-formal loans. Most loans in the three credit markets were short- and medium-term; the proportion of short-term loans in the informal credit market was the highest. The loan processing time of the informal credit market was generally shorter than for the formal and semi-formal credit markets. Most formal and informal borrowers found it difficult to borrow, whereas a large proportion of the semi-formal borrowers reported no difficulty in borrowing. There were differences in terms of difficulties when borrowing in each credit market. The main difficulties in the formal credit market were the complicated loan process and the high value of collateral; informal credit borrowers mainly faced inconsistent credit rules and unfriendly credit officers. The main

difficulty in the semi-formal credit market is the limited loan amount that could be granted to an individual borrower.

Chapter 5

Empirical results and discussion

Chapter 5 reports and discusses the empirical findings of the trivariate probit, and multinomial endogenous treatment effects model for the micro-level analysis (Sections 5.1 and 5.2), and the ARDL model for the macro-level analysis (Section 5.3). Section 5.1 analyses the results of the trivariate probit model that investigates the determinants of credit demands in and interrelationships among formal, semi-formal, and informal credit markets. Section 5.2 discusses the determinants of credit rationing from the trivariate probit model's results and the impacts of credit rationing on farm performance at the micro-level from the multinomial endogenous treatment effects model's results. Section 5.3 presents the impact of agricultural credit on agricultural GDP from the ARDL model's results. Section 5.4 summarizes the chapter.

5.1. The determinants of credit demand and interrelationships among different credit markets

This section discusses the results of the TVPM to answer research question 1 (linkages among different credit markets) and research question 2 (determinants affecting farm households' credit demand). Sub-section 5.1.1 shows the descriptive statistics for the TVPM. Sub-section 5.1.2 discusses the relationships among the formal, semi-formal, and informal credit markets. Sub-section 5.1.3 provides the empirical results of the determinants of credit demand.

5.1.1. The descriptive statistics for trivariate probit model

Tables 5.1 and 5.2 report the statistics of the model's variables for the whole sample and each credit demand group (the definitions of variables used in this model are presented in Section 3.2).

Table 5.1. The descriptive statistics of the trivariate probit model's dependent variables

Variable	Mean	SD
DC_1	0.44	0.50
DC_2	0.16	0.36
DC_3	0.15	0.35

Table 5.1 shows the proportions of surveyed households that have credit demands in the formal, semi-formal, and informal markets are 43.7%, 15.6%, and 14.5%, respectively. Table 5.2 shows that for human capital factors, the farming experience of household heads in the three credit demand groups is lower than for the whole sample, suggesting an adverse effect of farming experience on

credit demand. The education levels and social capital factors (social status and socio-economic association participation) of surveyed households vary among the different credit demand groups. For the physical capital factors, households with a credit demand tend to have a smaller house and durable property value than the whole sample. Regarding credit history, the mean value of bad credit history in all three credit demand groups is greater than in the full sample. Thus, households with a poor credit history are inclined to have higher credit demand. Table 5.2 also shows that the longer it takes to get to formal and semi-formal credit sources, the higher the level of credit demand by the household.

Table 5.2. The descriptive statistics of the model's explanatory variables

	Variable	All respondents (N=648)	Formal credit demand (N = 283)	Semi-formal credit demand (N = 101)	Informal credit demand (N = 94)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Human capital	*Hedu*	0.58 (0.49)	0.58 (0.49)	0.42 (0.5)	0.5 (0.5)
	Farmexpe	15.23 (8.7)	14.9 (8.49)	12.34 (6.98)	12.37 (7.65)
Social capital	*Socstatus*	0.1 (0.3)	0.13 (0.34)	0.08 (0.27)	0.05 (0.23)
	Socecogroup	1.21 (1.05)	1.19 (1.01)	0.99 (0.84)	0.95 (0.88)
Physical capital	*Farmlandsize*	4050.21 (4658.89)	5124.52 (5542.76)	3638.48 (4585.18)	3776.18 (4582.6)
	Houseval	0.76 (0.43)	0.71 (0.46)	0.56 (0.5)	0.59 (0.5)
	Durableval	0.48 (0.5)	0.44 (0.5)	0.32 (0.47)	0.32 (0.47)
Credit history	*Badhisfor*	0.08 (0.27)	0.13 (0.33)	0.1 (0.3)	0.19 (0.4)
	Badhissemi	0.03 (0.17)	0.04 (0.19)	0.11 (0.31)	0.05 (0.23)
	Badhisinfor	0.02 (0.13)	0.02 (0.13)	0.02 (0.14)	0.07 (0.26)
Geographical	*Fortime*	20.06 (11.22)	20.73 (11.55)	20.89 (10.15)	21.28 (11.9)
	Semitime	17.41 (10.45)	18.78 (10.79)	18.9 (12.02)	21.78 (12.91)
	HAN	0.33 (0.47)	0.32 (0.47)	0.27 (0.44)	0.31 (0.46)
	HAID	0.33 (0.47)	0.27 (0.45)	0.25 (0.43)	0.36 (0.48)
	Ha Nam (base group)	0.34 (0.47)	0.41 (0.49)	0.49 (0.5)	0.33 (0.47)
Other demographic profile features	*Familysize*	4.69 (1.3)	4.72 (1.19)	4.62 (1.09)	4.66 (1.18)
	Hgender	0.7 (0.46)	0.75 (0.43)	0.6 (0.49)	0.72 (0.45)
	Hage	0.39 (0.49)	0.4 (0.49)	0.42 (0.5)	0.44 (0.5)
	Mainagrincome	0.47 (0.5)	0.47 (0.5)	0.48 (0.5)	0.38 (0.49)

For other households' demographic profiles, the formal and informal credit-demand households have a higher percentage of men than the whole sample, whereas households with semi-formal credit demand have women heads more than the whole sample. These statistics indicate the different roles of men and women in demanding different types of credit. The average age of household heads with credit demand in all three credit markets is higher than for the whole sample, implying a positive relationship between the heads' age and households' credit demands. Households' main farm production varies among the different credit demand groups.

5.1.2. The different credit market relationships

Table 5.3 shows the pairwise correlation coefficients between households' different credit demands. The pairwise correlation coefficient ρ_{lm} is tested for statistical significance with the null hypothesis of no relationship between credit market *m* credit market and *l* (Ho: $\rho_{lm} = 0$). The coefficient ρ_{13} is positive and statistically significant at 1%, confirming the complementary relationship between the formal and informal markets. The result is consistent with the conclusions of Awunyo-Vitor and Abankwah (2012) and Thu et al. (2020) that the informal credit market has a complementary nexus with the formal credit market. Similarly, the positive, significant correlation between households' probability of demanding semi-formal and informal credit indicates informal credit and semi-formal credit are complementary. However, the value of ρ_{23} (0.212) is much lower than ρ_{13} (0.7), indicating that the relationship between informal and semi-formal credit is weaker than that between formal and informal credit. The coefficient ρ_{12} is positive (with a small value) and not statistically significant, implying that the complementary relationship between formal and semi-formal credit is unclear. This might be because of the differences in the target client groups of each credit market, small value of semi-formal loans, and the limited outreach of semi-formal providers (Tran, 2014).

Table 5.3. The pairwise correlation coefficients between the households' different credit demands

Pairwise correlation	Coefficient
ρ_{12}	0.078 (0.084)
ρ_{13}	0.7*** (0.057)
ρ_{23}	0.212** (0.092)

***Notes**: ** p < 0.05; *** p < 0.01; standard errors are in parentheses.*

5.1.3. The determinants of agricultural credit demand results

Table 5.4 displays the marginal effects of the explanatory variables on farm households' credit demands. According to Triguero et al. (2014), the coefficients of TVPM indicate the impact of the explanatory variables on the latent variable (i.e., the household's propensity to have a credit demand), whereas the marginal effects report the impact of the explanatory variables on the possibility of a positive outcome (i.e., household has a credit demand in one market). Thus, the marginal effects are presented in Table 5.4 rather than coefficients of TVPM to better measure the explanatory variables' influence on households' probability of having a credit demand.

The variance inflation factor (VIF) test is conducted to test for multicollinearity problems in the TVPM. A VIF value (mean VIF or each explanatory variable's VIF) greater than 10 is taken as a signal

of multicollinearity problems (Chun and Mun, 2012). The results (see Table 5.5) show that the mean VIF (1.2) and each explanatory variable's VIF are less than 10, confirming that the TVPM does not suffer from multicollinearity.

Table 5.4 presents the result of the Wald test for the joint significance of the TVPM. The Wald test is used to test the null hypothesis Ho: all coefficients of the TVPM's explanatory variables are equal to zero. If the null hypothesis of the Wald test is not rejected, it indicates the explanatory variables in the TVPM are not significant. The result shows that the Wald test ($\chi^2(54) = 185.56$) is significant at 1%, rejecting the null hypothesis and suggesting the overall significance of TVPM. The independence test for households' credit demand in different credit markets (Ho: $\rho_{12} = \rho_{13} = \rho_{23} = 0$) is significant at 1%, confirming the joint significance of the error correlations. This result suggests that using TVPM is more suitable than univariate probit models.

Table 5.4. Trivariate probit model results (marginal effects) – the determinants of credit demand

		Formal credit demand (DC_1)	Semi-formal credit demand (DC_2)	Informal credit demand (DC_3)
Human capital	*Hedu*	0.062 (0.041)	-0.049 (0.03)	0.016 (0.03)
	Farmexpe	-0.001 (0.003)	-0.006*** (0.002)	-0.004** (0.002)
Social capital	*Socstatus*	0.072 (0.062)	0.018 (0.048)	-0.048 (0.05)
	Socecogroup	-0.02 (0.019)	-0.02 (0.015)	-0.021 (0.014)
Physical capital	*Farmlandsize*	0.00002*** (0.000004)	-0.0000002 (0.000003)	0.000003 (0.000003)
	Houseval	-0.089* (0.045)	-0.087*** (0.03)	-0.067** (0.03)
	Durableval	-0.062 (0.039)	-0.062** (0.029)	-0.05* (0.028)
Credit history	*Badhisfor*	0.281*** (0.071)	-0.06 (0.053)	0.065 (0.045)
	Badhissemi	0.031 (0.108)	0.197*** (0.062)	0.029 (0.068)
	Badhisinfor	-0.107 (0.147)	-0.029 (0.096)	0.215** (0.087)
Geographical	*Fortime*	-0.001 (0.002)	-0.002 (0.001)	-0.002 (0.001)
	Semitime	0.005** (0.002)	0.001 (0.001)	0.005*** (0.001)
	HAN	-0.06 (0.047)	-0.039 (0.034)	0.008 (0.033)
	HAID	-0.139*** (0.046)	-0.062* (0.034)	0.004 (0.032)
Other demographic profile features	*Familysize*	0.004 (0.015)	0.007 (0.011)	-0.004 (0.011)
	Hgender	0.088** (0.041)	-0.056* (0.028)	0.009 (0.029)
	Hage	0.04 (0.044)	0.054* (0.031)	0.071** (0.03)
	Mainagrincome	0.004 (0.039)	0.021 (0.028)	-0.039 (0.027)
Log likelihood			-838.0183	
Wald χ^2 (54)			185.56***	
Test of $\rho_{12} = \rho_{13} = \rho_{23} = 0$ ($\chi^2(3)$)			86.7557***	
Number of obs.			648	

***Notes**: * p < 0.1; ** p < 0.05; *** p < 0.01; standard errors are in parentheses.*

For human capital, the farming experience of the household head has a negative influence on the semi-formal and informal credit demand of farm households. Holding other variables constant, farm

households with one more year of farming activity are 0.6% and 0.4% less likely to demand semi-formal and informal credit, respectively. This supports Atieno's (1997) study which shows a significant, negative relationship between credit demand and farming experience among Kenya's farm households. This result can be explained by experienced farmers' greater ability to predict the demand for seasonal capital or input price variation, which enables them to reduce their reliance on external finance and decrease credit demand (Reyes, 2011).

Table 5.5. The VIF test results

Variable	VIF
Farmexpe	1.49
HAN	1.48
HAID	1.44
Hage	1.39
Fortime	1.3
Hedu	1.25
Semitime	1.22
Socecogroup	1.16
Houseval	1.15
Durableval	1.13
Badhisfor	1.13
Familysize	1.12
Mainagrincome	1.1
Farmlandsize	1.1
Socstatus	1.08
Badhisinfor	1.06
Badhissemi	1.05
Hgender	1.03
Mean VIF	1.2

For social capital factors, the coefficients of social status for the formal and semi-formal credit markets are positive, reflecting that farm households with the head holding a position at the commune level or higher are more likely to have formal and semi-formal credit demands. The results support Jia et al.'s (2010) and Li et al.'s (2020) studies that show a positive association between formal credit demand and social status (or social entitlement). The coefficient of social status for the informal credit market is negative which indicates farm households with social status prefer formal and semi-formal credit to informal credit, reflecting segmentation of the credit markets. However, social status has little relationship with credit demand since the coefficients of social status are statistically insignificant for all three credit markets. Similarly, the coefficients of socio-economic association participation for all three markets are statistically insignificant which reflects socio-economic association participation does not have a strong connection with farm households' credit

demands. The possible explanation might be that participating in socio-economic associations does not provide effective information about new credit opportunities (Okten & Osili, 2004).

For physical capital factors, farm size positively affects a farm household's probability of having a formal credit demand. Holding other variables constant, a farm household with over 1000 m^2 of farmland is 2% more likely to have a formal credit demand. This might be explained by the fact that credit from formal providers is primarily used for production (Linh et al., 2019). This supports Barslund and Tarp's (2008) and Cheng and Ahmed's (2014) conclusions that farm size has a positive influence on formal credit demand. Household assets (value of house and durable property), in general, are negatively related to a farm household's credit demand for all three credit markets, implying that farm households with fewer assets are more likely to rely on credit for agricultural purposes. This is consistent with Barslund and Tarp's (2008) result for informal credit demand but contrary to the results in Barslund and Tarp (2008) and Mpuga (2010) for formal credit demand, and Cheng and Ahmed (2014) for semi-formal and informal credit demand. A possible explanation is that households with fewer assets might face economic pressures that lead to a higher demand for credit to invest in new agricultural projects to achieve a higher income and accumulate more assets.

For credit history-related factors, having a bad credit history significantly, positively affects farm households' probability of credit demand in all three credit markets. Households with a bad credit history in all three credit markets are 28.1%, 19.7%, and 21.5% more likely to have formal, semi-formal, and informal credit demand, respectively. A bad credit history indicates that a farm household has difficulty in repaying its loans. Thus, the household might have credit demand for new agricultural projects with expectation of gaining more income from new projects to repay bad loans.

Geographically, farm households in Hai Duong province are 13.9% and 6.2% less likely to demand formal and semi-formal credit, respectively, than those in Ha Nam province (base group). This result indicates that there are regional differences regarding farm households' credit demands. The result is consistent with Barslund and Tarp (2008) who show a significant influence of region on rural households' credit demands. Interestingly, travelling time to the nearest semi-formal credit source significantly, positively affects households' probability of demand for formal and informal credit. Time to travel to the closest semi-formal credit source might indicate the availability of semi-formal credit and the transport costs (especially when farmers need to travel multiple times to complete the loan applications). Holding other variables constant, one minute increase in travelling time to the nearest semi-formal credit source increases a household's likelihood of having a demand for formal and informal credit by 0.5%. This implies that if the cost of borrowing from the semi-formal credit market increases, farm households may consider more formal or informal credit.

For households' other demographic profile features, the head's gender has different effects on the household's credit demand in the different credit markets. Table 5.4 shows that male-headed households are 8.8% more likely to have formal credit demand than female-headed households. This result supports the findings of Zeller (1994) and Chaudhuri and Cherical (2012). Conversely, male-headed households are 5.6% less likely to have semi-formal credit demand than female-headed households. The possible explanation is that the semi-formal credit sector attempts to supply financial services to specific groups of the population that are excluded from formal financial services, such as the poor and women (Tra & Lensink, 2008; Khoi & Gan, 2017). According to Le (2011), semi-formal credit providers better serve the poor and women than their formal counterparts. The household head's age positively affects the household's probability of having semi-formal and informal credit demands. Households whose head is over 45 years are 5.4% and 7.1% more likely to have semi-formal and informal credit demand, respectively. This supports Lin et al.'s (2019) conclusion that the head's age has a positive effect on informal credit demand. Middle-aged and elderly people in rural areas might have little formal education and have more difficulty in applying through the formal lenders' complicated loan process than younger people. Thus, older farmers might prefer semi-formal and informal credit to formal credit, suggesting segmentation of the credit markets.

5.2. The determinants of credit rationing and impacts of credit rationing on farm performance

Section 5.2 discusses the results of TVPM to answer research question 3 (determinants affecting farm households' credit demand) and the results of the METE model to answer research question 4 (credit rationing impact on farm performance). Sub-section 5.2.1 presents the descriptive statistics for the TVPM and METE models. Sub-section 5.2.2 discusses the empirical results on the determinants of credit rationing. Sub-section 5.2.3 presents the estimation results for the impacts of credit rationing on farm performance.

5.2.1. The descriptive statistics for the trivariate probit and METE models

Tables 5.6 and 5.7 present the statistics for the trivariate probit and METE regression models. Table 5.6 shows the proportions of surveyed households that are credit rationed in the formal, semi-formal, and informal markets are 11.4%, 6.9%, and 7.6%, respectively. In the METE model, the average net farm revenue is approximately 4.5 million VND per labour unit per month. The proportions of surveyed households that are credit rationed in the formal market only, semi-formal market only, and informal market only are 9.2%, 5.6%, and 5.1%, respectively.

Table 5.7 gives the explanatory variables' means and standard deviations (SD) of the whole sample and the different credit rationed categories (of trivariate probit model). The mean values of human capital, social capital, physical capital factors, and livestock production (the main farming activity), in the whole sample are higher than for each credit rationed category. This might imply a role for these capitals and livestock production activity in diminishing a household's likelihood of being credit rationed in all three markets. Conversely, the mean values of a bad credit history and distance to credit sources in each credit rationed category are higher than the mean of the whole sample, implying a possible impact of bad credit history and long distance on credit rationing. Similarly, a bigger family and a higher proportion of male-headed households in the formal and informal credit rationed categories than in the whole sample suggests a positive influence of male household head and big family on households' credit rationing.

Table 5.8 reports the explanatory variables' means and standard deviations (SD) for the METE model. Like the trivariate probit model, human capital, social capital, physical capital factors, and livestock production might have a negative influence on a household's probability of being credit rationed in individual credit markets.

Table 5.6. The descriptive statistics of the trivariate probit and METE regression models' dependent variables

Variable	Mean	SD
Trivariate probit model		
CR_1	0.11	0.32
CR_2	0.07	0.25
CR_3	0.08	0.26
METE model		
R_1	0.09	0.29
R_2	0.06	0.23
R_3	0.05	0.22
Farmrev	4524.54	2624.65

Table 5.7. The descriptive statistics of the explanatory variables of the trivariate probit model

	Variable	All respondents (N=648)	Formal credit rationed (N = 74)	Semi-formal credit rationed (N = 45)	Informal credit rationed (N = 49)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Human capital	*Hedu*	0.58 (0.49)	0.24 (0.43)	0.22 (0.42)	0.45 (0.50)
	Farmexpe	15.23 (8.70)	9.73 (4.62)	8.00 (4.87)	9.61 (4.64)
Social capital	*Socstatus*	0.10(0.30)	0.01 (0.12)	0.02 (0.15)	0.02 (0.14)
	Socecogroup	1.21 (1.05)	1.04 (0.93)	0.64 (0.86)	0.78 (0.82)

Physical capital	*Farmlandsize*	4050.21 (4658.89)	3536.16 (4863.35)	2802.4 (2403.99)	3390.63 (3790.08)
	Houseval	0.76 (0.43)	0.51 (0.50)	0.44 (0.50)	0.49 (0.51)
	Durableval	0.48 (0.50)	0.31 (0.47)	0.22 (0.42)	0.18 (0.39)
Credit history	*Badhisfor*	0.08 (0.27)	0.31 (0.47)	0.18 (0.39)	0.27 (0.45)
	Badhissemi	0.03 (0.11)	0.04 (0.20)	0.22 (0.42)	0.02 (0.14)
	Badhisinfor	0.02 (0.13)	0.04 (0.20)	0.04 (0.21)	0.12 (0.32)
Geographical	*Fortime*	20.06 (11.22)	29.62 (14.27)	25.04 (10.93)	21.43 (11.65)
	Semitime	17.41 (10.45)	22.34 (11.26)	24.82 (13.91)	19.80 (11.97)
	HAN	0.33 (0.47)	0.27(0.45)	0.20 (0.40)	0.35 (0.48)
	HAID	0.33 (0.47)	0.32 (0.47)	0.33 (0.48)	0.31 (0.47)
	Ha Nam (base group)	0.34 (0.47)	0.41 (0.49)	0.47 (0.50)	0.35 (0.48)
Other demographic profile features	*Familysize*	4.69 (1.30)	4.97 (1.15)	4.56 (1.01)	4.88 (1.11)
	Hgender	0.70 (0.46)	0.77 (0.42)	0.60 (0.50)	0.73 (0.45)
	Hage	0.39 (0.49)	0.35 (0.48)	0.24 (0.43)	0.43 (0.50)
	Mainagrincome	0.47 (0.50)	0.45 (0.50)	0.42 (0.50)	0.388 (0.49)

Table 5.8. The descriptive statistics of the explanatory variables of the METE model

	Variable	Sample (N = 628)	Formal credit rationed only (N = 58)	Semi-formal credit rationed only (N = 35)	Informal credit rationed only (N = 32)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Human capital	*Hedu*	0.59 (0.49)	0.28 (0.45)	0.26 (0.44)	0.58 (0.50)
	Farmexpe	15.44 (8.72)	10.19 (5.03)	7.80 (4.50)	9.97 (4.61)
Social capital	*Socstatus*	0.11 (0.31)	0.02 (0.13)	0.03 (0.17)	0.03 (0.18)
	Sococogroup	1.21 (1.06)	1.07 (0.93)	0.46 (0.78)	0.72 (0.85)
Physical capital	*Farmlandsize*	4082.44 (4650.62)	3704.72 (4777.56)	3041.74 (2335.78)	3389.56 (2797.00)
	Houseval	0.77 (0.42)	0.59 (0.50)	0.46 (0.51)	0.53 (0.51)
	Durableval	0.49 (0.50)	0.36 (0.48)	0.23 (0.43)	0.16 (0.37)
Credit history	*Badhisfor*	0.07 (0.25)	0.24 (0.43)	0.11 (0.32)	0.19 (0.4)
	Badhissemi	0.03 (0.17)	0.02 (0.13)	0.23 (0.43)	0.00 (0.00)
	Badhisinfor	0.01 (0.12)	0.02 (0.13)	0.06 (0.24)	0.13 (0.34)
Geographical	*Fortime*	19.73 (10.98)	28.4 (14.50)	23.89 (9.19)	20.66 (8.33)
	Semitime	17.10 (10.20)	20.52 (9.94)	23.4 (13.47)	17.94 (10.07)
	HAN	0.33 (0.47)	0.29 (0.46)	0.23 (0.43)	0.41 (0.5)
	HAID	0.33 (0.47)	0.31 (0.47)	0.29 (0.46)	0.31 (0.47)
	Ha Nam (base group)	0.34 (0.47)	0.40 (0.49)	0.49 (0.51)	0.28 (0.46)
Other demographic profile features	*Familysize*	4.71 (1.32)	5.16 (1.20)	4.63 (1.11)	5.16 (1.22)
	Hgender	0.70 (0.46)	0.78 (0.42)	0.60 (0.50)	0.75 (0.44)
	Hage	0.40 (0.49)	0.38 (0.49)	0.29 (0.46)	0.53 (0.51)
	Mainagrincome	0.48 (0.50)	0.45 (0.50)	0.46 (0.51)	0.41 (0.50)

5.2.2. The determinants of credit rationing

Table 5.9 presents the trivariate probit model's results (marginal effects). The variance inflation factor (VIF) test result (mean VIF = 1.2) confirms no multicollinearity in the model (see Table 5.5). The Wald test for the joint significance of the trivariate probit model ($\chi^2(54) = 238.39$) is significant at 1%, which indicates the overall significance of the model. The test of independence among the different equations (Ho: $\rho_{12} = \rho_{13} = \rho_{23} = 0$) confirms that the null hypothesis of independence of the error terms is rejected at the 5% significance level. Thus, the trivariate probit model is suitable for simultaneously estimating credit rationing in the three markets.

Table 5.9. Trivariate probit model results (marginal effects) – the determinants of credit rationing

		Formal credit rationed (CR_1)	Semi-formal credit rationed (CR_2)	Informal credit rationed (CR_3)
Human capital	*Hedu*	-0.069*** (0.025)	-0.066*** (0.021)	0.017 (0.022)
	Farmexpe	-0.007*** (0.002)	-0.008*** (0.002)	-0.006*** (0.002)
Social capital	*Socstatus*	-0.149** (0.072)	-0.024 (0.045)	-0.049 (0.050)
	Socecogroup	0.008 (0.011)	-0.023** (0.011)	-0.018* (0.011)
Physical capital	*Farmlandsize*	-0.000001 (0.000003)	-0.000001 (0.000002)	0.0000002 (0.000002)
	Houseval	-0.04* (0.024)	-0.052*** (0.018)	-0.051** (0.02)
	Durableval	-0.006 (0.024)	-0.017 (0.02)	-0.062*** (0.022)
Credit history	*Badhisfor*	0.122*** (0.03)	-0.028 (0.028)	0.055** (0.028)
	Badhissemi	-0.01 (0.065)	0.14*** (0.033)	-0.067 (0.06)
	Badhisinfor	-0.04 (0.068)	-0.022 (0.046)	0.132*** (0.047)
Geographical	*Fortime*	0.003*** (0.001)	-0.0005 (0.001)	-0.001 (0.001)
	Semitime	0.0005 (0.001)	0.002*** (0.001)	0.001 (0.001)
	HAN	0.014 (0.028)	0.002 (0.023)	0.009 (0.023)
	HAID	0.011 (0.027)	0.008 (0.021)	-0.012 (0.023)
Other demographic profile features	*Familysize*	0.017* (0.009)	0.002 (0.007)	0.015* (0.008)
	Hgender	0.049* (0.025)	-0.017 (0.018)	-0.001 (0.021)
	Hage	-0.015 (0.025)	-0.013 (0.020)	0.027 (0.021)
	Mainagrincome	0.019 (0.023)	0.008 (0.018)	-0.013 (0.020)
Log likelihood			-387.93696	
Wald $\chi^2(54)$			238.39***	
Test of $\rho_{12} = \rho_{13} = \rho_{23} = 0$ ($\chi^2(3)$)			9.7550**	
ρ_{12}			-0.484** (0.1424)	
ρ_{13}			0.329 (0.1380)	
ρ_{23}			0.084 (0.1308)	
Number of obs.			648	

***Notes**: * p < 0.1; ** p < 0.05; *** p < 0.01; standard errors are in parentheses.*

For the association between the human capital factors and credit rationing, farm household heads with higher education levels are less likely to be credit rationed in the formal and semi-formal credit

markets. These results are consistent with the findings of Ali et al. (2014) and Tran et al. (2016). However, the education level of the head does not significantly affect the household's probability of informal credit rationing. This might be because informal credit providers are less likely to rely on education level to ration their loans (Cheng & Ahmed, 2014). Farming experience is a critical factor in reducing the probability of being credit rationed in all three credit markets. Credit providers might expect that farmers with more farming experience can better cope with the shocks that affect farm outcomes. Thus, experienced farm households have a greater likelihood of being granted credit. This supports the studies by Lawal et al. (2009) and Ansah et al. (2016) that show a positive impact of farming experience on easing credit rationing.

For social capital factors, social status is negatively related to a household's probability of being formal credit rationed. This result is consistent with Jia et al. (2010) and Cheng and Ahmed (2014) who conclude households with members as officials or holding social titles at village level are less likely to be formal credit rationed. Markussen and Tarp (2014) state that almost all formal credit providers operating in Vietnam's rural areas are state controlled and commune authorities are commonly employed by important state banks to screen households' credit applications. This implies local officials play a significant role in credit allocation by state-run credit providers (Markussen & Tarp, 2014). Thus, a farm household with the head holding any position at the commune level or higher has a lower probability of formal credit rationing. Participating in socio-economic associations has a negative effect on a household's credit rationing in the semi-formal and informal credit markets. The more household heads participate in socio-economic associations, the less likely they will be credit rationed by semi-formal and informal credit providers. This result implies that Vietnam's semi-formal credit providers collaborate closely with provincial socio-economic organizations, such as the Youth Union, Farmers' Union, Women's Union (IFC, 2014; Khoi & Gan, 2017). Participating in these groups helps farm households enhance their relationships and information sharing with semi-formal credit providers, thus improving their access to semi-formal credit. Socio-economic association participation also broadens farm households' networks that might include potential informal credit providers (such as friends or agricultural input suppliers) and so increase the likelihood of receiving an informal loan.

For physical capital factors, house value has a significant, negative influence on farm households' likelihood of being credit rationed in all three credit markets. According to Baiyegunhi et al. (2010) and Tran et al. (2016), household assets such as houses can be used as collateral for agricultural loans and are indicators of relative wealth. High house value enhances creditworthiness, ensures loan recovery in case of default, and thus eases households' credit rationing. Additionally, Vietnam's

formal credit providers mainly use conventional lending methods that heavily rely on collateral such as houses (or real estate) as the preferred collateral (Le & Nguyen, 2018; Luan & Kingsbury, 2019). Durable assets have a significant, negative impact on households' likelihood of being credit rationed only in the informal credit market. A possible explanation is that informal credit providers accept a wider range of collateral, including durable assets (Charles & Mori, 2016; Bethuel, 2018).

A bad credit history for a farm household has a significant, positive impact on a household's credit rationing condition. Farm households with restructured loans or not having made loan repayments in part or in full in the past three years in one credit market are more likely to be credit rationed. A bad credit history signals households' relatively poor credit reputation (Petrick, 2004) and raises concern about a household's business and production capacity. Thus, credit providers might be unwilling to lend to households with a bad credit history. Interestingly, having a bad credit history in the formal credit market also increases a household's probability of being rationed by informal credit providers. The explanation might be that the information about a household's credit history in the formal credit market in the last three years is kept in the National Credit Information Centre of Vietnam (CIC) and is not available to the semi-formal credit market. Informal lenders can use their own information-gathering methods or ask the borrowers to use the services of CIC to provide their credit history. Therefore, information about households' bad credit history in the formal credit market could be used to ration loans by informal lenders.

For geographical factors, time to travel to the nearest credit source in the formal and semi-formal credit markets significantly, positively influences a households' likelihood of credit rationing. The result implies that time to travel to the nearest credit source is an obstacle for farm households in applying for credit, especially when they need to travel multiple times to complete a loan application. This supports Tran et al. (2016) who reveal that rural households with a shorter travel time to the nearest bank are less likely to be formal credit rationed.

Among the other demographic profile factors, family size and the likelihood of being credit rationed in the formal and informal markets are positively linked. The explanation could be that lenders might be reluctant to grant a large family credit because large families have more consumption expenditure and might use part of the loan for consumption rather than production (Kuwornu et al., 2012). A male household head significantly, positively affects a household's likelihood of being credit rationed in the formal credit market. This finding is consistent with the conclusions of Zeller (1994), Barslund and Tarp (2008), and Chaudhuri and Cherical (2012) that male household heads have a lower likelihood of formal loan approval. The possible explanation is that male-headed households often apply for larger loans in the formal credit market than female-headed households (the male

average is 147.2 million VND compared with 100.2 million VND average for female-headed households). Formal lenders might anticipate higher default risk with a larger loan; thus, they credit ration male-headed households more often (Zeller, 1994).

In general, the empirical results show that credit rationing determinants vary in Vietnam's different credit markets. Each credit market provider uses a particular set of criteria to grant credit to targeted clientele, implying segmentation of agricultural credit markets in the RRD region.

5.2.3. The impact of credit rationing on farm performance

The results from the METE model (see Table 5.10) show that being credit rationed in each credit market significantly, negatively affects farm performance under both exogenous and endogenous assumptions of credit rationing with farm performance. This is consistent with Dong et al. (2012), Ali et al. (2014), and Mukasa et al. (2017), who show credit rationing significantly decreases farm production.

Table 5.10. The results of the METE model for credit rationing's impact on farm performance (ln(Farmrev))

	Exogenous assumption	**Endogenous assumption**
Credit rationing status		
Rationed in formal market only (R_1)	-0.219*** (0.0636)	-0.285*** (0.0750)
Rationed in semiformal market only (R_2)	-0.349*** (0.0816)	-0.499*** (0.0829)
Rationed in informal market only (R_3)	-0.372*** (0.0830)	-0.485*** (0.0976)
Factor-loading parameters		
$\lambda(R_1)$		0.098* (0.0555)
$\lambda(R_2)$		0.254*** (0.0576)
$\lambda(R_3)$		0.144** (0.0606)

***Notes**: The base category is a farm household being credit non-rationed in all three markets. A total of 50 simulations were used. Sample size is 628 households. *p < 0.1; **p < 0.05; ***p < 0.01; standard errors are in parentheses.*

The negative impact of credit rationing in each credit market under the exogenous assumption is lower than that under the endogenous assumption. Credit rationing in the formal, semi-formal, and informal credit markets is positively correlated with farm performance through unobserved factors when factor-loading parameters λ for R_1, R_2, and R_3 are positively significant. This supports the use of the endogenous model to investigate the impact of credit rationing on farm performance.

An explanation for the model's result under the endogenous assumption may be unobserved factors such as management and entrepreneurial ability, that allow farm households to manage a larger farm production scale that leads to an increase in credit demand to expand farm production.

However, like other developing countries, semi-formal lenders in Vietnam typically provide relatively small loans that might be insufficient for smallholder farm households with better management and entrepreneurial abilities. For the formal and informal credit markets, higher loan amounts demanded by smallholder farm households require more collateral since formal and informal lenders depend on other screening factors, such as collateral, to ration borrowers. If smallholder farm households demand more credit than the maximum value of their collateral, formal and informal lenders may not provide an adequate amount for these households regardless of how good their agricultural projects are.

Based on the endogenous assumption, the results show credit rationing in the formal, semi-formal, and informal credit markets reduces farm performance by 28.5%, 49.9%, and 48.5%, respectively. Therefore, besides formal credit and semi-formal credit, informal credit plays an important role in enhancing the agricultural production of smallholder farm households in the RRD region.

The simple falsification test results (see Appendix A - Tables A.1 and Table A.2) indicate that the IVs significantly impact farm households' credit rationing status but do not significantly affect households' agricultural performance. Thus, time to travel to the nearest formal credit source (Fortime), time to travel to the nearest semi-formal credit source (Semitime), and house value (Houseval)) can be used as valid IVs.

To check the robustness of the METE model's results, we use two other proxies of farm performance (agricultural income per labour unit (Agrincome) and total value of agricultural output per labour unit (Agiout)) and an inverse probability weighted regression approach (IPWRA) to examine credit rationing's impact on farm performance. Total value of agricultural output per labour unit per month measures the total production capacity of farm households (including all products sold and not sold). Meanwhile, agricultural income per labour unit per month reflects the profitability of farm household's agricultural activities. Table 5.11 shows that credit rationing in the three credit markets significantly lowers farm performance, affirming the importance of credit to farm production.

Table 5.11. The results of robustness tests for the impact of credit rationing on farm performance

	METE model with endogenous assumption			IPWRA model	
Treatment\outcome	ln(Agincome)	ln(Agiout)	ln(Farmrev)	ln(Agincome)	ln(Agiout)
R_1	-0.112* (0.0868)	-0.295*** (0.0841)	-0.27*** (0.0611)	-0.294*** (0.0689)	-0.252*** (0.0686)
R_2	-0.492*** (0.0849)	-0.509*** (0.0927)	-0.269*** (0.0860)	-0.306*** (0.0911)	-0.221** (0.1015)
R_3	-0.287** (0.1338)	-0.480*** (0.1116)	-0.426*** (0.0829)	-0.479*** (0.0680)	-0.431*** (0.0980)

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01; standard errors are in parentheses*

5.3. The impact of agricultural credit on the agricultural GDP

This section discusses the macro-level analysis. It includes the results of the indicator saturation break tests, unit root tests, ARDL model, and T-Y test to answer the research question 5 (short-run and long-run relationships between the agricultural credit and agricultural performance at the macro-level). Sub-section 5.3.1 presents the descriptive statistics for the ARDL model. Sub-section 5.3.2 illustrates the results of the indicator saturation break tests. Sub-section 5.3.3 provides the empirical results of the ARDL variables' order of integration. Sub-section 5.3.4 presents the main results of the ARDL model, including the credit – agricultural performance nexus in both the short and long term. Sub-section 5.3.5 analyses the causality among the ARDL model's variables based on the results of T-Y tests.

5.3.1. The descriptive statistics of the ARDL model

The descriptive statistics and correlation matrix of the variables of equation (3.18) are reported in Table 5.12. Based on the Jarque-Bera statistics, all variables exhibit skewness and kurtosis that conform to a normal distribution at the 5% significance level. The correlation matrix indicates that public investment, agricultural credit, and rainfall are positively correlated with AGDP. There is a significant, negative correlation between agricultural labour and agricultural credit and a significant, positive correlation exists between public investment and agricultural credit. All the pairwise correlation coefficients of the explanatory variables are below 0.8, indicating that multicollinearity is not an issue (Gujarati & Porter, 2009).

Table 5.12. The descriptive statistics and correlation matrix

	LnAGDP	LnBUDINV	LnACRED	LnLABOR	LnRAIN
Mean	11.18923	10.44025	12.77403	10.08412	5.910766
Standard deviation	0.208897	0.211724	0.352678	0.033564	0.230903
Skewness	-0.324752	-0.392451	0.002409	-0.757104	-0.229636
Kurtosis	1.803210	2.504390	1.839640	2.887242	4.042084
Jarque-Bera	3.785583	1.759303	2.749018	4.707149	2.647778
Probability	0.150651	0.414927	0.252964	0.095029	0.266098
Correlation matrix					
LnAGDP	1.000000				
LnBUDINV	0.658624***	1.000000			
LnACRED	0.856472***	0.718761***	1.000000		
LnLABOR	-0.038483	-0.199521	-0.263589*	1.000000	
LnRAIN	0.282111**	0.225366	0.172321	-0.077316	1.000000

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01.*

5.3.2. Indicator saturation break test results

The IS break tests are applied to detect structural breaks in AGDP and other variables for two purposes: (1) to identify breaks in AGDP to incorporate suitable break dummy variables into the ARDL model; and (2) to choose the appropriate results of the unit root tests. Predefined models of IS tests are used with a 1% significance level. The IS test results applied to AGDP are shown in Figure 5.1.

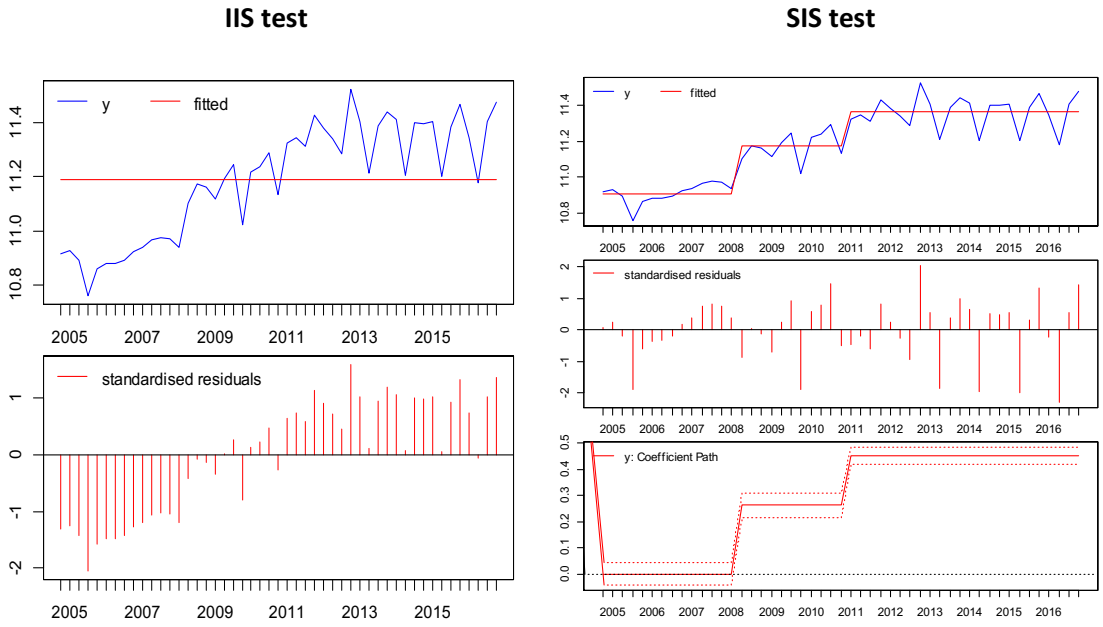


Figure 5.1. The indicator saturation test results for LnAGDP

The IIS test does not detect any break date but the SIS test confirms AGDP has two break dates: 2008:Q2 and 2011:Q1. The Bai-Perron (BP) 2003 test for structural breaks is also applied to AGDP to check the robustness of the IS test results. The BP (2003) test shows the same break dates as by the SIS test. Two break dates reflect the real changes in Vietnam's agricultural sector. Regarding the first break, Vietnam joined the WTO in 2007, which produced significant impacts on the agricultural sector to export and integrate into the international market (World Bank, 2016b). However, the influence of WTO entry has been evident only since 2008:Q2 because of the stringent requirements of exported agricultural products that Vietnamese farmers and enterprises had to meet (Ngoc & Ngan, 2014). For the second break, deeper integration into the regional and global economy and strong support of the Vietnamese government for the development of the agricultural sector since 2010, has created a new wave of large domestic enterprise investments in the agricultural sector (OECD, 2015; Diem & Thuy, 2019). This new wave of investment could have played a substantial role in stimulating agricultural production in Vietnam since 2011:Q1. With their rationality, two dummy

variables $STRUCDUM_1$ and $STRUCDUM_2$ are used to capture the impact of the two structural breaks 2008:Q2 and 2011:Q1, respectively.

The IS and BP (2003) test results for all variables at the level and the first difference (1st df.) are presented in Table 5.13. Though the results of the IS and BP (2003) tests are quite similar for all variables at the level, the results of the IS test are different from the BP (2003) test for variables at the first difference. The results of the IS test are preferable in this study because of its advantages (such as no trimming percentage). Thus, all the level and first difference of all variables (except for the first difference of AGDP) are found to have structural breaks, ranging from 2 to 4 breakpoints.

Table 5.13. Multiple breakpoint test results

Variable	Test	IIS	SIS	BP (2003)
LnAGDP	Level	None	2008:Q2, 2011:Q1	2008:Q2, 2011:Q1
	1st df.	None	None	None
LnBUDINV	Level	None	2007:Q1, 2009:Q2	2007:Q1, 2009:Q2
	1st df.	2010:Q1, 2011:Q1, 2011:Q2	2010:Q1, 2010:Q2	None
LnACRED	Level	None	2007:Q2, 2010:Q4, 2014:Q4	2007:Q1, 2010:Q3, 2012:Q4, 2015:Q1
	1st df.	2011:Q1, 2012:Q2	2008:Q1, 2008:Q4	None
LnLABOR	Level	None	2011:Q3, 2015:Q1, 2015:Q3	2011:Q3, 2015:Q1
	1st df.	2011:Q3	2011:Q3, 2011:Q4	None
LnRAIN	Level	2004:Q4, 2013:Q1, 2014:Q1	2005:Q2, 2011:Q1, 2014:Q1, 2014:Q2	None
	1st df.	2013:Q2, 2014:Q1	2014:Q1, 2014:Q2	None

Notes: *Impulse indicator saturation (IIS) and Step indicator saturation (SIS) tests are applied to detect the structural breaks of the ARDL model's variables at the level and the first difference. The Bai-Perron (BP) 2003 test for structural breaks is used for the robustness check of the IIS and SIS test results. See Section 3.4.1 (Indicator saturation methodology to identify structural breaks) for details on the methodologies.*

5.3.3. Unit root test results

Table 5.14 shows the results of ADF, PP, and KPSS tests that confirm all variables are stationary at the first difference, i.e., no variable has an order of integration more than I(1). Though all conventional tests confirm that LnRAIN is stationary at the level, the stationary properties of other variables at the level are inconclusive. For example, ADF and KPSS tests reveal LnAGDP is non-stationary, whereas the PP test indicates LnAGDP is trend stationary at the level. Differences among the results of KPSS, PP, and ADF tests may be because of the heterogeneous influences of structural breaks on the effectiveness of different conventional unit root tests.

Table 5.15 shows the results of the KP test. We prefer the results of the KP test to the conventional unit root tests because of the KP test's ability to deal with structural breaks. Based on the KP test results, LnAGDP, LnBUDINV, and LnRAIN are stationary at the level whereas LnLABOR and LnACRED are stationary at the first difference. Both types of unit root test indicate that no variable has the order of integration greater than I(1). Thus, the ARDL technique is suitable for this study's data set.

Table 5.14. Conventional unit root test results

Variables	Test	ADF's t-stat		PP's t-stat		KPSS's LM-stat	
		Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
LnAGDP	Level	-1.78 (3)	-0.15 (3)	-1.84 (2)	-4.42***(2)	0.82***(5)	0.22**(4)
	1st df.	-10.45***(2)	-10.92***(2)	-15.02***(15)	-14.78***(15)	0.13 (13)	0.118 (10)
LnBUDINV	Level	-2.27 (1)	-3.23* (1)	-3.89***(4)	-5.96***(4)	0.74** (5)	0.17** (4)
	1st df.	-5.44***(5)	-5.60***(5)	-14.54*** (1)	-14.39*** (1)	0.07 (2)	0.05 (2)
LnACRED	Level	0.21 (0)	-2.81 (0)	0.45 (6)	-3.08 (2)	0.93***(5)	0.04 (3)
	1st df.	-5.94***(0)	-5.88***(0)	-5.83***(6)	-5.75***(6)	0.10 (6)	0.07 (6)
LnLABOR	Level	-1.84 (0)	-2.01 (0)	-2.01 (7)	-2.06 (8)	0.20 (5)	0.15** (5)
	1st df.	-6.85***(0)	-6.92***(0)	-8.36***(4)	-10.51***(25)	0.19 (10)	0.12 (8)
LnRAIN	Level	-6.89***(0)	-6.83***(0)	-6.89***(3)	-6.83***(3)	0.20 (3)	0.11 (3)

***Notes**: Optimal lag lengths are inside brackets. *p < 0.1; **p < 0.05; ***p < 0.01.*

Table 5.15. Kapetanios (2005) unit root test results

Variables	Test	Test statistic	Breaks
LnAGDP	Level	-9.862***	2008:Q2, 2011:Q3, 2014:Q1
LnBUDINV	Level	-10.728***	2006:Q4, 2009:Q1, 2011:Q4, 2014:Q3
LnACRED	Level	-4.950	2007:Q4, 2011:Q1, 2013:Q3
	1st df.	-9.034***	2007:Q4, 2011:Q1, 2014:Q1
LnLABOR	Level	-7.018	2006:Q4, 2009:Q2, 2011:Q3, 2013:Q4
	1st df.	-8.236***	2007:Q1, 2010:Q2, 2014:Q3
LnRAIN	Level	-9.125***	2007:Q1, 2010:Q1, 2013:Q4

***Notes**: KP test is applied with structural breaks in both intercept and trend. *p < 0.1; **p < 0.05; ***p < 0.01.*

5.3.4. ARDL model results

5.3.4.1. Optimal lag lengths for ARDL model

Following Pesaran and Pesaran's (1997) suggestion, four was chosen as the maximum lag length for the ARDL model based on quarterly data. The AIC criterion is used to select the ARDL model's optimal lag length. The ARDL model with the lag length selected by the AIC is not too parsimonious so that it is more prudent to avoid the error term's autocorrelation issues. The ARDL specification

(4,0,4,0,0) is chosen to perform the cointegration analysis (see Figure 5.2). The optimal lag lengths for LnAGDP, LnBUDINV, LnACRED, LnLABOR, and LnRAIN are: p=4, q=0, r=4, s=0, and w=0, respectively.

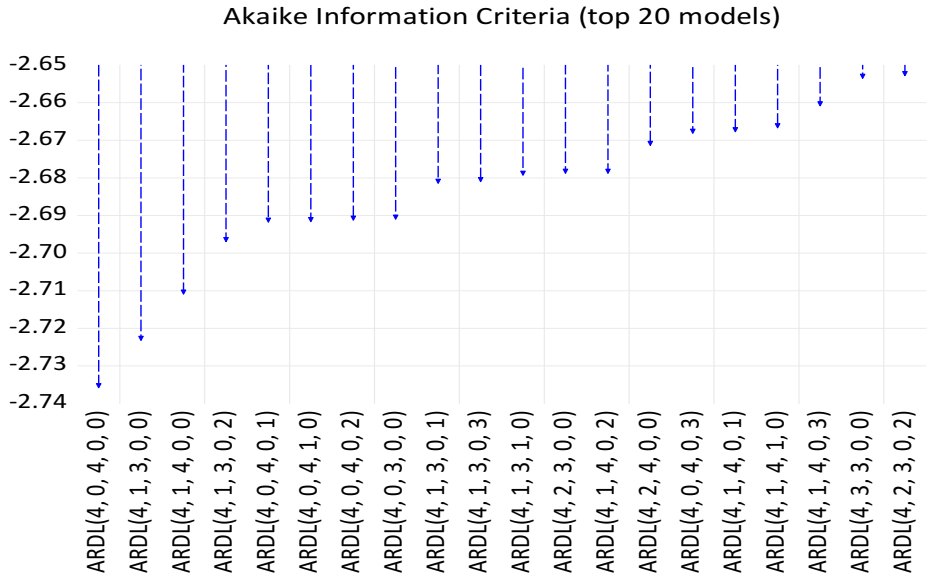


Figure 5.2. Optimal lag lengths selected by Akaike information criteria

5.3.4.2. Cointegration test results

The ARDL bounds test result for equation (3.18) is presented in Table 5.16. The joint F-statistic is used to test the null hypothesis of no cointegration (long-term relationship among variables). The null hypothesis is equal to Ho: δ_i=0; ∀ i=1, 2, …, 5 (the parameters from equation (3.18)). The computed F-statistic is 5.880, which is larger than the UCB value at the 5% significance level. Thus, the null hypothesis of no cointegration is rejected, i.e., a long-term relationship exists among agricultural credit, agricultural labour, rainfall, public investment, and agricultural performance in Vietnam.

Table 5.16. ARDL bounds test result

Estimated model	Maximum lag length	F-stat	Significant level	Critical value	
				Lower bound	Upper bound
LnAGDP= *f* (LnBUDINV, LnACRED, LnLABOR, LnRAIN)	4	5.880**	10%	2.638	3.772
			5%	3.178	4.45
with break dates: 2008:Q2, 2011:Q1			1%	4.394	5.914

***Notes**: **p < 0.05. Critical values for the ARDL model (Case III - unrestricted intercept and no trend) are obtained from Narayan (2005).*

5.3.4.3. Long-run and short-run relationship analysis

With the existence of a cointegration relationship, we examine the short- and long-run dynamics among the variables using the error correction model. Table 5.17 shows the estimated short- and long-run results. The long-run results confirm that agricultural credit boosts AGDP. Particularly, a one percent growth in agricultural credit increases AGDP by 0.19 percent. This finding supports Chisasa and Makina (2015) and Ogbuabor and Nwosu (2017), whose studies reveal the critical role of credit on the agricultural sector's performance in the long run.

Table 5.17. Short-run and long-run relationship analysis

Variable	Coefficient	t-Stat
Long-run results		
LnBUDINV	-0.023	-0.301
LnACRED	0.192**	2.141
LnLABOR	1.010***	2.945
LnRAIN	0.114**	2.259
Constant	-2.011***	-5.594
Short-run results		
ΔLnAGDP (-1)	-0.224	-1.465
ΔLnAGDP (-2)	-0.469***	-3.963
ΔLnAGDP (-3)	-0.547***	-5.461
ΔLnACRED	0.688**	2.543
ΔLnACRED (-1)	0.2414	0.770
ΔLnACRED (-2)	-0.815***	-2.817
ΔLnACRED (-3)	0.498*	1.895
$STRUCDUM_1$	0.220***	5.427
$STRUCDUM_2$	0.070**	2.388
ECM (-1)	-0.964***	-5.772

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01.*

Not surprisingly, the labour factor has a positive, significant association with agricultural performance in the long run since Vietnam's agricultural sector is still labour-intensive (World Bank, 2016b). The result shows that a one percent increase in labour results in an increase of 1.01 percent in AGDP. This conclusion is in accord with the findings of Ahmad (2011) and Shahbaz et al. (2013) in Pakistan.

An interesting conclusion from the results is that public investment has a negative, insignificant effect on AGDP. This finding could be explained by inefficiency, unaffordability, and too thin spread of public investment projects in Vietnam (Mishra, 2011; Huong, 2017).

Rainfall significantly, positively influences AGDP; a one percent increase in rainfall results in a 0.11 percent increase in AGDP. This finding reveals the performance of Vietnam's agricultural sector depends on weather-related factors such as rainfall.

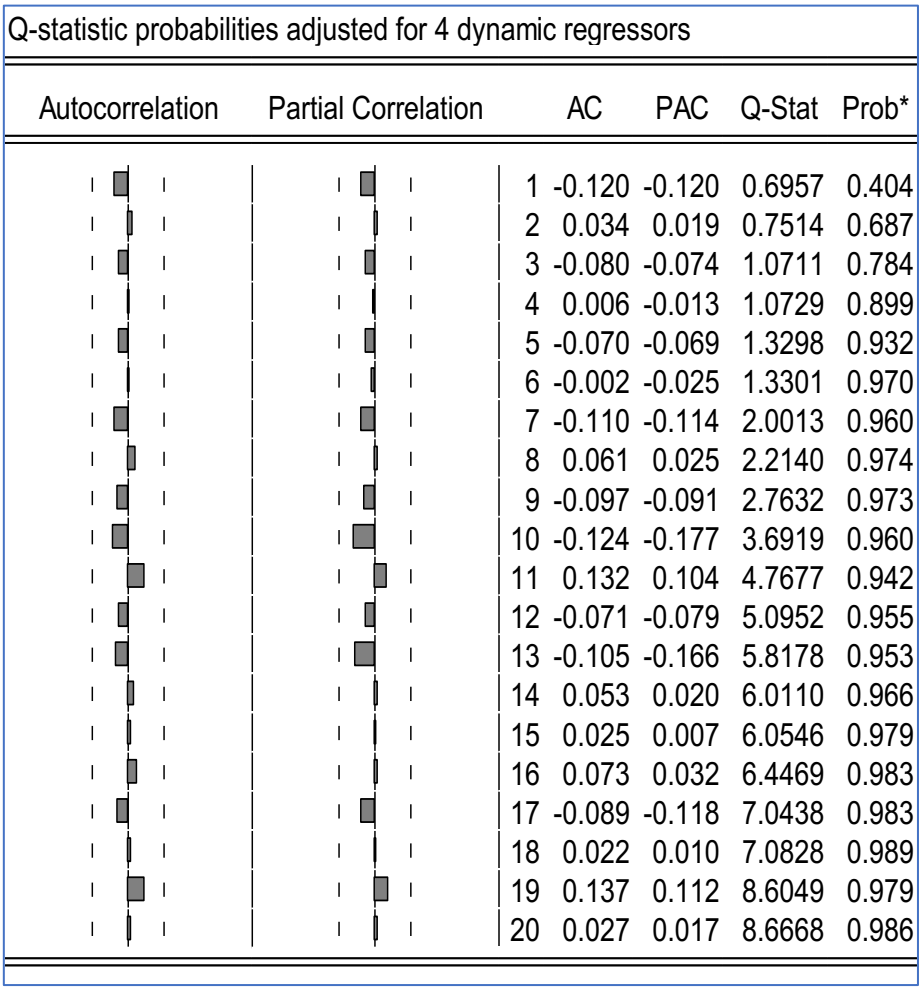
In the short run, we show that the coefficients of the current, first, and third lag of agricultural credit are positive but only the current and third lag of agricultural credit significantly affect AGDP. The second lag of agricultural credit has a significant, negative influence on AGDP, which may be because of the characteristics of agricultural credit granted by formal credit providers in Vietnam. Specifically, the lending periods of formal loans are not as flexible as informal loans that can be adjusted to match the agricultural production cycle (United States Agency for International Development, 2013). Formal loans for agriculture are often provided with a fixed lending period, such as 6 months or 12 months (Huy, 2016). Thus, agricultural loans with inappropriate lending periods may have adverse impacts on AGDP. However, the cumulative effect of credit on AGDP is positive in the short run, which reaffirms the importance of credit for agricultural performance. This result is similar to the findings of Chandio, Jiang, Rauf, et al. (2020) for Pakistan's agricultural sector.

The coefficient of *ECM(-1)* (lagged error correction term) is negative and statistically significant at the 1% level. This result supports the existence of a stable long-run relationships among AGDP, agricultural credit and other variables in the ARDL model. The coefficient of *ECM(-1)* is 0.964, indicating the rapid adjustment to the long-run equilibrium after a short-run shock. Specifically, 96.4 percent of the deviations from the long-run equilibrium are adjusted per quarter.

5.3.4.4. Diagnostics and stability test results

The diagnostics test results (see Figures 5.3, 5.4, and Table 5.18) confirm that the ARDL model does not suffer from autocorrelation, normality, heteroskedasticity, or functional form specification issues. Figure 5.3 shows the autocorrelation, partial correlation, and Q-statistic test results. With the Correlogram of the first 20 lags of residuals from equation (3.18) (see Figure 5.3), the spikes of the autocorrelation and partial correlation values are well within the dotted lines, suggesting that the model is unlikely to suffer from autocorrelation issue. The values of the autocorrelation coefficients of AC (autocorrelation) and partial autocorrelation (PAC) for the first 20 lags of residuals are close to zero, indicating that autocorrelation is unlikely to happen with the residuals of equation (3.18). The Q-statistic is used as another test for the autocorrelation with the null hypothesis of no serial correlation in the residuals. All corresponding P-values of the Q-statistics (see Figure 5.3) are bigger than 0.05. In other words, we cannot reject the null hypothesis of Q-statistic test at the 5% level of significance. In addition, Breusch-Godfrey Serial -Correlation LM test is performed to test the serial autocorrelation issue for the ARDL model with the null hypothesis of no serial correlation in the

residuals. The Breusch-Godfrey Serial -Correlation LM test result (see Table 5.18) show that the P-value of the F-statistic is 0.86, which much higher than 0.05. Therefore, we cannot reject the null hypothesis of no serial correlation.



Q-statistic probabilities adjusted for 4 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.120	-0.120	0.6957	0.404
		2	0.034	0.019	0.7514	0.687
		3	-0.080	-0.074	1.0711	0.784
		4	0.006	-0.013	1.0729	0.899
		5	-0.070	-0.069	1.3298	0.932
		6	-0.002	-0.025	1.3301	0.970
		7	-0.110	-0.114	2.0013	0.960
		8	0.061	0.025	2.2140	0.974
		9	-0.097	-0.091	2.7632	0.973
		10	-0.124	-0.177	3.6919	0.960
		11	0.132	0.104	4.7677	0.942
		12	-0.071	-0.079	5.0952	0.955
		13	-0.105	-0.166	5.8178	0.953
		14	0.053	0.020	6.0110	0.966
		15	0.025	0.007	6.0546	0.979
		16	0.073	0.032	6.4469	0.983
		17	-0.089	-0.118	7.0438	0.983
		18	0.022	0.010	7.0828	0.989
		19	0.137	0.112	8.6049	0.979
		20	0.027	0.017	8.6668	0.986

Figure 5.3. The Q-statistic, autocorrelation, and partial autocorrelation tests of the sample

The Jarque-Bera test is implemented to check the normality of equation (3.18) residuals. The null hypothesis of the Jarque-Bera test is the residuals are normally distributed. The Jarque-Bera is 1.58 with a p-value of 0.45 (see Figure 5.4), which shows that the Jarque-Bera statistic is not significant at the 5% level. Thus, we cannot reject the null hypothesis that the residuals are normally distributed. This implies no issue of normality with the residuals in the ARDL model.

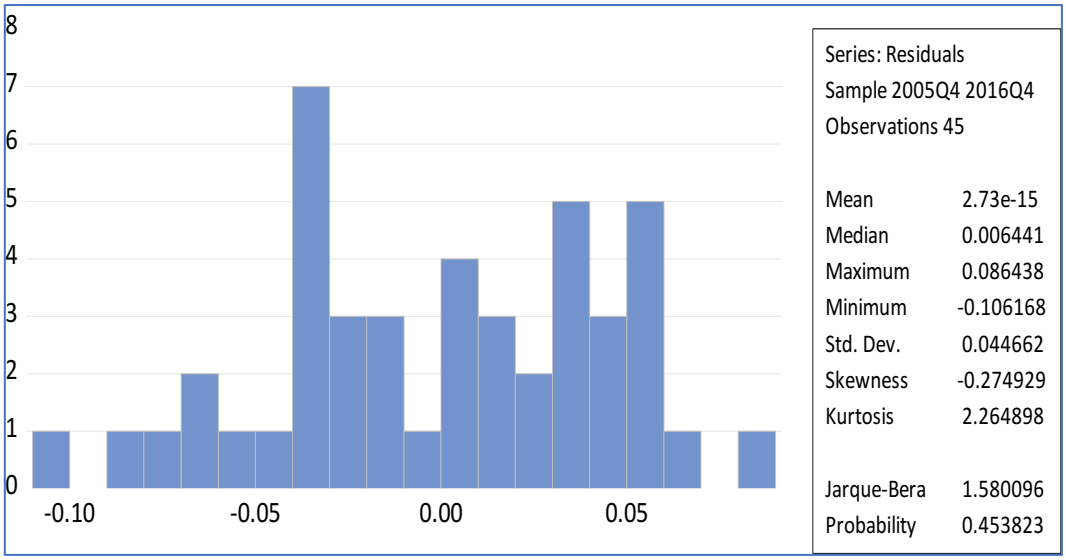


Figure 5.4. Histogram and Jarque-Bera (JB) normality test of the sample

We performed both the White Heteroskedasticity Test and ARCH Heteroskedasticity Test to check for the heteroskedasticity of the residuals in equation (3.18). Both tests have the same null hypothesis of homoscedasticity. The results of the two tests (see Table 5.18) show that the P-values of the two tests' F-statistics are much higher than 0.05, indicating that the null hypothesis of homoscedasticity cannot be rejected. Thus, the ARDL model is free from heteroscedasticity.

The Ramsey RESET test is implemented to check the functional form misspecification of the ARDL model with the null hypothesis of no misspecification in the ARDL model's functional form. Table 5.18 shows that the P-values of t- statistic and F-statistic of the Ramsey RESET test (0.25 and 0.25, respectively) are larger than 0.05. Therefore, we cannot reject the null hypothesis of no specification error, suggesting the ARDL model is well specified.

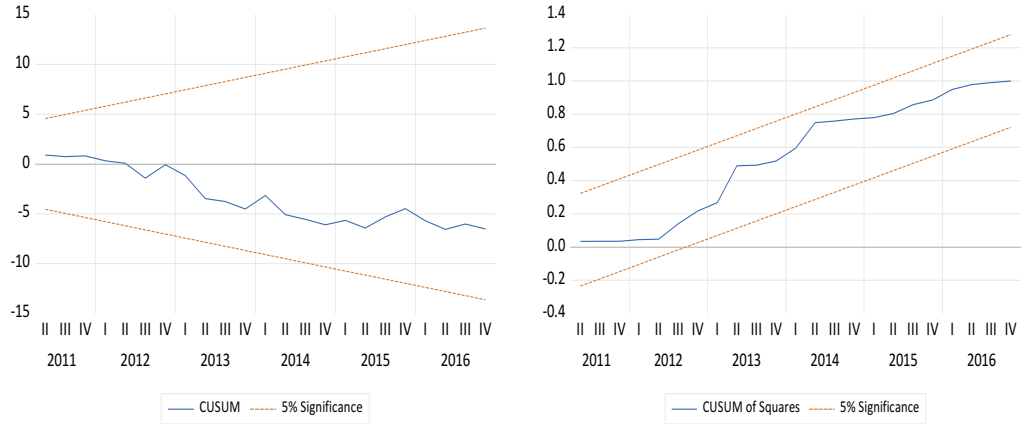
Table 5.18. ARDL model diagnostic tests

Test		**Result**
Breusch-Godfrey Serial -Correlation LM Test	F-stat Obs*R-sqrd.	0.321 (0.862) 2.115 (0.715)
White Heteroskedasticity Test	F-stat Obs*R-sqrd.	0.978 (0.497) 14.106 (0.442)
ARCH Heteroskedasticity Test	F-stat Obs*R-sqrd.	0.429 (0.516) 0.445 (0.505)
Ramsey RESET test	t-stat F-stat	1.182 (0.247) 1.398 (0.247)

Note: *P-values are inside parentheses.*

To test the stability of the ARDL model, we used the Cumulative sum of recursive residuals (CUSUM) and Cumulative sum of square recursive residuals (CUSUMSQ) tests. Particularly, in the CUSUM test, the line of cumulative sum of recursive residuals and both critical bounds at the 5% level of significance are plotted. If the line of cumulative sum of recursive residuals crosses the critical bounds at the 5% level of significance, the model is unstable. The CUSUMSQ test is similar to the CUSUM test. Figure 5.5 shows the results of the CUSUM and CUSUMSQ tests. The plots of both the CUSUM and CUSUMSQ statistics are well within the 5% level of significance critical bounds, indicating the stability of the model.

Figure 5.5. Plots of CUSUM and CUSUMSQ of the sample



5.3.5. Toda-Yamamoto (1995) test results

Based on the above results of the unit root tests, the maximum integrated order of all variables (d_{max}) is I(1). Like the ARDL model, a maximum lag length of four is chosen for the original VAR model of the T-Y test. Based on the AIC criterion, the optimal lag length (k) for the original VAR model is four. The results of the T-Y test for causality directions among the variables are presented in Table 5.19.

Table 5.19. Toda-Yamamoto (1995) test results (MWald Chi-square statistic) of the sample

Dependent variable	Independent variable				
	LnAGDP	LnBUDINV	LnACRED	LnLABOR	LnRAIN
LnAGDP	-	3.968	10.977**	3.527	0.696
LnBUDINV	13.660***	-	2.819	8.524*	2.207
LnACRED	3.731	16.105***	-	5.215	3.900
LnLABOR	2.100	0.369	1.016	-	2.359
LnRAIN	2.864	4.998	5.702	1.036	-

Notes: **p < 0.1; **p < 0.05; ***p < 0.01.*

The results uncover unidirectional causality running from agricultural credit to AGDP. This finding confirms that agricultural credit leads agricultural performance; no reverse causality is found. The finding is consistent with Chisasa and Makina's (2015) study in South Africa. In addition, three more unidirectional causal relationships are identified: (1) AGDP Granger causes public investment; (2) agricultural labour Granger causes public investment; and (3) public investment Granger causes agricultural credit. The findings drawn from the T-Y test support the result of the ARDL bounds test that indicates the presence of a cointegration relationship among the variables.

5.4. Chapter summary

Chapter 5 examines and discussed the determinants of credit demands, interrelationships among the formal, semi-formal, and informal credit markets, the determinants of credit rationing, and the effects of credit rationing on farm performance based on the data from a farm household survey in 2020. In addition, chapter 5 analyses the credit-agricultural performance relationship at the macro-level using the secondary data from 2004:Q4 to 2016:Q4.

The empirical results show that there are significant differences in the credit demand and credit rationing determinants among the three credit markets, indicating segmentation of the credit markets for agricultural purposes. There are complementary relationships between two pairs of credit markets: formal versus informal and semi-formal versus informal. The relationship between the formal and semi-formal credit markets is positive but not statistically significant. Human capital, social capital, and physical capital factors help smallholder farm households to reduce credit rationing, whereas bad credit history and time to travel to credit sources increases farm households' likelihood of being credit rationed.

The results of the multinomial endogenous treatment effects model confirm that credit rationing in any of the three credit markets severely, negatively affects the agricultural outcome for farm households. This confirms the important role of semi-formal and informal credit in addition to formal credit in enhancing the agricultural performance of smallholder farmers.

The ARDL model's results reveal a cointegration (long-run) relationship exists among agricultural credit, labour, rainfall, public investment, and agricultural GDP. Agricultural credit positively affects agricultural GDP in both the short and long run. The T-Y test result confirms that agricultural credit leads to agricultural GDP; no reverse relationship is found. These findings indicate that a credit-agricultural performance nexus exists in Vietnam, confirming the significant contribution of credit to the growth of the agricultural sector. There are positive, significant impacts of agricultural labour

and rainfall on agricultural GDP, but public investment has no significant effect on agricultural GDP in the long run.

Chapter 6

Conclusions and policy implications

This chapter presents the study's findings and implications. Section 6.1 summarizes the background, research questions, data collection, questionnaire design, and methodology. Section 6.2 provides the study's major findings. Section 6.3 discusses the academic and policy implications of the results. Section 6.4 presents the limitations of the study and the recommendations for future research.

6.1. Study summary

6.1.1. Background and research questions

Vietnam's agricultural sector has become more and more important and irreplaceable in the economy and rural development. Since the "Doi moi" initiative in 1986, Vietnam has successfully transformed from an underdeveloped agricultural economy into a recognized global exporter of many agricultural products such as coffee, rice, and cashew nuts. Although the development of Vietnam's agriculture is undisputable, the sector mainly consists of small-scale producers who cannot take advantage of economies of scale and have lagged behind regional and other developing countries in labour, agricultural land, and water productivity. Therefore, fostering a larger-scale, innovative agricultural sector is an important priority of the Vietnamese government and the farming community for the long-term sustainable development of Vietnam's agriculture.

To accelerate Vietnam's agricultural development, adequate access to agricultural credit is currently needed. The Vietnamese government has tried to meet the credit demand of rural households and the agricultural sector by issuing decrees on credit-related policies for agricultural and rural development. Vietnam's farm households, however, still suffer to a large extent from credit rationing. Credit rationed farmers find it difficult to purchase inputs for agricultural production or to invest in farm-related projects, resulting in fewer farm outputs, less household income and welfare.

Despite the importance of credit in agricultural development in the literature and extensive attention by the Vietnamese government to promoting agricultural credit, no empirical investigation has explored the relationship between credit and Vietnam's agricultural performance at the macro-level. Three credit markets coexisting (formal, semi-formal, and informal) to provide credit to Vietnam's agricultural sector. Studies have investigated farm households' credit demand and credit rationing determinants, and the impact of credit rationing on farm performance in Vietnam.

However, these studies focus on only one or two credit markets (mainly the formal and informal markets). No study simultaneously examines the credit related issues in the three credit markets, leading to biased estimates of credit demand, credit rationing determinants, and credit rationing impact on farm performance. This study extends the literature by analysing the interrelationships among, determinants of farm households' credit demand and credit rationing in all three credit markets, credit rationing impact on farm performance at the micro-level, and the credit-agricultural performance nexus at the macro-level. We aimed to answer the following research questions:

Question 1: Is there any linkage among the formal, semi-formal, and informal credit markets in Vietnam?

Question 2: What determinants affect the farm household's credit demand in formal, semi-formal, and informal credit markets in Vietnam?

Question 3: What determinants affect the probability of the farm household being credit rationed in formal, semi-formal, and informal credit markets in Vietnam?

Question 4: Does credit rationing affect farm performance at the micro-level in Vietnam?

Question 5: Are there short- and long-run relationships between agricultural credit and the performance of the agricultural sector at the macro-level in Vietnam?

6.1.2. Methodology, data collection, and questionnaire design

Different methods were used to answer the study's research questions. The direct elicitation method was used to detect farm households' credit rationing conditions. "Trivariate probit models" were applied to investigate the interrelationships among the different credit markets and the determinants of farm households' credit demand and credit rationing. The impact of credit rationing on farm performance was investigated using the "multinomial endogenous treatment effects" model. All these above methods were used for micro-level analysis. The "indicator saturation" break tests, "Kapetanios (2005)" unit root test with multiple structural breaks, "Autoregressive Distributed Lag" bounds test with structural breaks, and "Toda–Yamamoto (1995) approach to Granger causality" were used to examine the credit-agricultural performance nexus at the macro-level.

We use both primary and secondary data. The primary data were used for micro-level analysis while the secondary data were used for macro-level analysis. The secondary data are quarterly time-series data of Vietnam on AGDP, agricultural credit, agricultural labour, public investment, and rainfall that were used to answer research question five. Secondary data were collected from different sources including Bloomberg, State Bank of Vietnam, the General Statistics Office of Vietnam, and the Climate Change Knowledge Portal (World Bank). To collect primary data from farm households in

Vietnam, a structured survey questionnaire was used. The survey questionnaire focused on farm households' credit demand and credit rationing conditions, farm households' characteristics and farm performance, and the agricultural credit characteristics of formal, semi-formal, and informal credit markets.

A multi-stage disproportionate stratified random sampling method was used to collect primary data in three provinces (Ha Noi, Hai Duong, and Ha Nam) in the Red River Delta. The survey was conducted from April to July 2020. Before conducting the survey, the survey questionnaire was pre-tested with a small number of farm households in three provinces to check the consistency, accuracy, and completeness of the survey questions. A total of 750 farm households participated in the survey, generating 648 usable questionnaires (86.4%).

6.2. Major findings

6.2.1. The linkages among formal, semi-formal, and informal credit markets

For research question 1, the trivariate probit model's results reveal complementary relationships among two pairs of credit markets (formal versus informal and semi-formal versus informal). However, the relationship between semi-formal and informal credit markets is weaker than that between the formal and informal markets. The complementary relationship between formal and semi-formal credit is not statistically significant. This can possibly be explained by the limited outreach of semi-formal credit providers, the small value of semi-formal loans, and differences in the target client groups of formal and semi-formal credit providers.

6.2.2. The determinants of credit demand

The study's independence test for households' credit demand in the formal, semi-formal, and informal credit markets is statistically significant, suggesting that the trivariate probit model is more appropriate than univariate probit models when investigating the credit demand determinants in different credit markets. In general, the results of TVPM (used to answer the research question 2) show dissimilarities among the determinants of farm households' credit demands in the different markets. Physical assets exhibit a negative relationship with farm household's probability of having credit demand in all three markets. Farming experience is significantly, negatively associated with households' ability to have semi-formal and informal credit demand. In contrast, the household head's age has a positive impact on a household's credit demands in semi-formal and informal credit markets. Male-headed households are more likely to have formal credit demand but less likely to have semi-formal credit demand. Travelling time to the nearest semi-formal credit source has a

positive association with household's probability of having formal and informal credit demand. A bad credit history has a positive relationship with farm household's probability of having credit demands in all three markets.

6.2.3. The determinants of credit rationing

The study's results show that the trivariate probit model is suitable for simultaneously investigating farm households' credit rationing in formal, semi-formal, and informal credit markets since the interdependence of credit rationing in the different credit markets is confirmed. For research question 3, we find that farm households' credit rationing condition is a function of human capital, social capital, physical capital, credit history, geographical, and other demographic profile factors. In general, human capital, social capital, and physical capital factors help smallholder farm households reduce credit rationing, whereas a bad credit history and travel time to credit sources increase the farm households' likelihood of being credit rationed. Additionally, there are significant differences in credit rationing determinants among the three credit markets, indicating segmentation of the credit markets for agricultural purposes.

6.2.4. Credit rationing's impact on farm performance

For research question 4, farm households' credit rationing in the three credit markets is significantly, positively correlated with farm performance through unobserved factors, supporting the use of the endogenous model to investigate credit rationing's impact on farm performance. The multinomial endogenous treatment effects model's results confirm the significant, negative effects of credit rationing in the formal, semi-formal, and informal credit markets on farm performance. The negative impacts of credit rationing in each credit market under the exogenous assumption are lower than under the endogenous assumption. The results indicate that besides formal credit, semi-formal, and informal credit play important roles in improving farm households' agricultural performance.

6.2.5. Agricultural credit's impact on agricultural GDP

The results of the indicator saturation break tests confirm that all variables used in the ARDL models have structural breaks, suggesting the use of multiple structural break unit root tests. Two break dates in agricultural GDP (2008:Q2 and 2011:Q1) reflect real changes in Vietnam's agricultural sector. Thus, these break dates are incorporated into the ARDL model when investigating agricultural credit's impact on agricultural GDP to avoid biased estimates. For research question 5, the ARDL model's results confirm the cointegration (long-run) relationship among agricultural credit, labour, rainfall, public investment, and agricultural GDP. Agricultural credit positively influences agricultural GDP in both the short and long run. The results also show the positive, significant effects

of labour and rainfall on agricultural GDP in the long run. However, public investment does not significantly influence agricultural GDP in the long run. The T-Y test's result reveals a unidirectional causal relationship running from credit to agricultural GDP.

6.3. Research implications

Based on the research's findings, this study provides several academic and policy implications.

6.3.1. Academic implications

In Vietnam and other developing countries, three credit markets coexist to provide credit to the agricultural and rural sectors: the formal, semi-formal, and informal credit markets. We confirm the existence of interrelationships among the different credit markets in Vietnam (i.e., complementary relationships among two pairs of credit markets: formal versus informal and semi-formal versus informal). The results support the use of the trivariate probit model and suggest that future research should consider and address these relationships when investigating the credit demand determinants of farm households in the formal, semi-formal, and informal credit markets.

The study's results also confirm correlations of credit rationing in different credit markets exists. Unobserved factors (e.g., the entrepreneurial capacity of the farm household) could affect a household's likelihood of being simultaneously credit rationed in different credit markets. Thus, future research should pay attention to the correlations of credit rationing in the different credit markets when examining the determinants of farm households' credit rationing.

We find endogenous issues when investigating the impact of credit rationing on farm performance. Specifically, farm performance (proxied by net farm revenue) is positively correlated with the credit rationing condition of Vietnam's farm households in the formal, semi-formal, and informal credit markets. Thus, we support the use of econometric models that can deal with the endogenous issues (such as the multinomial endogenous treatment effects model) when examining the credit rationing -farm performance relationship.

At the macro-level, we use the quarterly time series data to investigate the credit-agricultural GDP nexus. This study contributes to this field of econometrics by using a newly developed method for detecting structural breaks in time series (i.e., the indicator saturation method) and an advanced econometric model (an auto-regression distributed lag model) that can deal with problems of time series analysis (such as small sample size, endogeneity, and serial correlation). The detection of and significant impact of structural breaks on agricultural GDP suggests that, to achieve more accurate

results, future research should pay attention to and incorporate structural breaks in econometric models when using time series data.

6.3.2. Policy implications

In research question 1, the study's results show the complementary relationships between informal and formal credit markets and between the informal and semi-formal credit markets. These results indicate that the growth of the informal market does not hinder the development of the formal and semi-formal credit markets. In addition, in research question 4, we demonstrate that reducing credit rationing in the informal market significantly increases farm performance, confirming the importance of the informal credit market to Vietnam's smallholder farm households. However, the existence of an informal credit market is still controversial in Vietnam and in other developing countries. The informal credit market in Vietnam is still underdeveloped and remains largely neglected by policymakers. Therefore, the government should reassess the importance of informal credit providers and develop new policies to integrate the informal sector with the semi-formal and formal sectors to form a more efficient and cohesive rural credit market rather than trying to shrink the informal sector (Khoi et al., 2013; Tran et al., 2016). The government should support the establishment of legal advisory organizations at the village level to help farmers prepare loan contracts with informal lenders, ensuring compliance with legal regulations, increasing the transparency of informal loan contracts, and minimizing risks to both farmers and lenders.

The relationship between the semi-formal and formal credit markets is not statistically significant, reflecting the fragmentation and lack of interaction between these markets. Therefore, the government should focus on policies to expand the outreach of semi-formal lenders and provide training programmes for rural households to understand the differences in loan procedures, interest rates, and collateral requirements between the formal and semi-formal credit markets.

In research question 2, the study's results show disadvantaged farm households (such as households with fewer assets) are more likely to have a credit demand. In research question 3, physical capital factors, especially house value, significantly lessen farm households' credit rationing in Vietnam. This implies that Vietnamese credit providers rely on collateral to grant credit. Disadvantaged households (the poor with fewer assets) are often rationed out of credit markets. Thus, the government should revise its policies to create incentives and reduce the risks for formal credit institutions when granting uncollateralized credit, such as exemption from corporate income tax for these loans and offering a local government guarantees to replace farm households' physical collateral. Formal credit institutions should focus more on providing collateral-free credit to the joint liability group of

farmers with clear, specified joint liability procedures and rules for group members. In addition, credit providers should be encouraged to work closely with smallholder farmers to understand more about farm households' production, management, risk, and entrepreneurial ability to grant unsecured loans for profitable agricultural projects.

Female-headed farm households are more likely to demand semi-formal credit, indicating that the semi-formal credit sector might better serve the disadvantaged groups of borrowers (such as women) (Le, 2011). However, the semi-formal credit market is still small with limited coverage (Truong et al., 2020). This issue originates from both policy-related aspects (e.g., not able to access commercial funding) and the semi-formal credit providers themselves (limited human resources, technology, poor governance, etc.) (Bui, 2017). Thus, it is important for the government to revise and amend related policies to create a more favourable environment for the development of the semi-formal credit market. In addition, the government should provide management and technology training programs for semi-formal credit providers to enhance their management and governance practices.

Farm households with a bad credit history have a higher probability of demanding credit. A bad credit history indicates the poor repayment reputation of farm households, and lenders might be reluctant to grant these households credit despite how good their agricultural projects might be. Thus, these households' access to credit is more restricted. To deal with this issue, the government should focus on improving the insurance market for agricultural production to reduce the risks for both farm households and credit providers. Additionally, credit providers should be encouraged to pay more attention to and carefully analyse new agricultural projects of farm households with a bad credit history rather than heavily rely on their reputation.

This study confirms that the education level of the household head reduces a farm household's probability of being credit rationed in the formal and semi-formal credit markets. Thus, the government should encourage and provide a conducive environment for rural education, especially aiming at smallholder farm households. Besides the government support, farmers should invest more in education to achieve more knowledge and better skills to mitigate credit rationing.

Participating in socio-economic organizations reduces farmer credit rationing in the semi-formal and informal credit markets. Thus, smallholder farmers should be encouraged to become members of such organizations to increase their knowledge, reputation, social and agricultural production networks, so improving their access to credit.

Travel time to the nearest credit source is a major barrier to farmers in getting formal and semi-formal credit. The longer the time farmers need to travel, the greater the transaction costs they have to incur when applying for credit. To reduce this problem, formal and semi-formal credit providers should be encouraged to extend their branch networks in rural areas or to develop internet or mobile banking to help farmers reduce transaction costs and so access financial services such as loans more easily.

In research question 5, this study's findings demonstrate that agricultural credit plays an essential part in boosting Vietnam's agricultural performance in the long run, suggesting that the Vietnamese government should continue to enhance credit flows into the agricultural sector. However, the impact of agricultural credit on agricultural GDP is much lower than agricultural labour in the long run (a one percent increase in agricultural credit and labour results in 0.19 percent and 1.01 percent increase in agricultural GDP, respectively). This result implies that the government should focus not only on the strategies to expand agricultural credit but also on the solutions to enhance the efficiency of agricultural credit. Furthermore, to deal with the negative impact of the two-quarter lag of agricultural credit on agricultural GDP in the short run, formal credit institutions should be encouraged to work closely with farmers and agricultural enterprises to offer flexible lending periods and amounts (especially for short-term loans) that are compatible with the real situation of agricultural production.

The dominant and positive impact of agricultural labour on agricultural GDP confirms the crucial role of labour in stimulating agricultural production in the long run. The strong impact of labour, however, indicates that Vietnam's agricultural sector relies on the intensive use of labour during the study period. Hence, focusing on training and education for farmers to increase labour skills and expertise would enhance Vietnam's agricultural performance. Another solution to improve the efficiency and productivity of farming practices is applying modern farm technologies (both biochemical and mechanical advances) to reduce the intensive use of labour in the agricultural sector.

The influence of rainfall on agricultural GDP, in the long run, suggests that weather-related factors significantly affect the performance of Vietnam's agricultural sector. In fact, Vietnam is one of the countries most affected by climate change, including the change in pattern and intensity of precipitation. Thus, the government should pay more attention to improve the farming practices and technological adaption of the agricultural sector to increase the adaptive capacity to cope with climate change issues.

The findings also suggest that public investment does not significantly affect agricultural performance in the long run, which may be due to the inefficiency of public investment projects. Thus, the Vietnamese government should concentrate on enhancing the evaluation and management of the projects funded by the State budget to attain better investment outcomes for the agricultural sector.

6.4. The study's limitations and future research

This study investigates only the determinants of one aspect of credit demand (i.e., whether farm households need credit for agricultural purposes) and does not examine factors affecting the amount of credit demand. In addition, the credit demand and credit rationing determinants, the interrelationships of credit demands and the impact of credit rationing on farm performance may vary across different farming regions. Therefore, future studies should include the investigation of the determinants of credit demand amount and expand the research area outside the RRD for a better understanding of farm households' credit demand, credit rationing, and the impact of credit rationing on farm performance in Vietnam.

The number of farm households being price rationed, risk rationed, and transaction cost rationed in each credit market and the total study sample were quite small (see Table 4.3). For example, only 4, 5, 2, and 11 farm households were risk rationed in the formal, semi-formal, informal, and overall study sample, respectively. Thus, this study did not investigate the determinants of each type of credit rationing (e.g., the determinants of risk rationing) and the impact of each type of credit rationing on farm performance. Similarly, because of the limited number of farm households being credit rationed in two or three markets simultaneously, we did not examine the impacts of credit rationing in two or three markets simultaneously on farm performance. Future research can increase the sample size to achieve sufficient observations to examine these issues.

At the macro-level, the study period is quite short because of the unavailability of agricultural credit and rainfall data in Vietnam. In addition, there are no data on semi-formal and informal agricultural credit at the macro-level. Thus, we did not investigate the impact of semi-formal and informal credit on agricultural GDP at the macro-level. Future research can use a longer study period and incorporate semi-formal and informal credit into the empirical models (when data are available) to achieve better results.

Finally, the study's results do not account for the impact of the COVID-19 pandemic because the data period for this study (both primary and secondary data) does not include the COVID-19 pandemic period. In fact, the Covid-19 pandemic might influence the production and consumption

of agricultural products, thereby affecting farm households' credit demands, credit rationing conditions, and the efficiency of agricultural production. Future research could examine the COVID-19 pandemic period to enrich our understanding of how unexpected events such as the COVID-19 pandemic influence farm households' credit demands, credit rationing, and farm performance.

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Appendix A
Simple falsification test results

Table A.1. Full estimates of the METE model for ln(Farmrev)

Variable	(1) Rationed in formal market only	(2) Rationed in semi-formal market only	(3) Rationed in informal market only	(4) ln(Farmrev)
Hedu	-1.249*** (0.424)	-1.856*** (0.648)	0.567 (0.573)	0.191*** (0.038)
Farmexpe	-0.161*** (0.037)	-0.345*** (0.071)	-0.188*** (0.0490)	0.014*** (0.002)
Familysize	0.509*** (0.152)	0.395* (0.222)	0.657*** (0.194)	-0.046*** (0.014)
Socstatus	-2.203* (1.178)	-0.308 (1.258)	-0.479 (1.182)	0.157*** (0.055)
Socecogroup	-0.079 (0.195)	-1.169*** (0.362)	-0.629** (0.277)	-0.011 (0.018)
Farmlandsize	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)
Badhisfor	2.035*** (0.581)	0.467 (0.937)	1.616** (0.788)	0.060 (0.068)
Badhissemi	0.412 (1.278)	3.874*** (0.945)	-4.422 (2.260)	-0.029 (0.106)
Badhisinfor	1.346 (1.554)	2.305 (1.547)	4.984*** (1.425)	0.074 (0.150)
HAN	0.237 (0.493)	0.171 (0.720)	0.046 (0.607)	0.005 (0.043)
HAID	0.107 (0.473)	0.234 (0.679)	-0.244 (0.638)	0.026 (0.043)
Hgender	0.487 (0.436)	-0.571 (0.556)	-0.026 (0.552)	-0.008 (0.037)
Hage	0.052 (0.440)	0.371 (0.631)	1.227** (0.533)	-0.126*** (0.040)
Mainagrincome	0.223 (0.396)	0.501 (0.563)	-0.200 (0.510)	0.076** (0.035)
Durableval	-0.272 (0.398)	-0.549 (0.601)	-1.797*** (0.617)	0.001 (0.035)
Houseval	-0.951** (0.409)	-1.885*** (0.563)	-1.474*** (0.519)	
Fortime	0.041** (0.016)	-0.008 (0.023)	-0.037 (0.025)	
Semitime	0.025 (0.019)	0.074*** (0.023)	0.012 (0.026)	
R_1				-0.285*** (0.075)
R_2				-0.499*** (0.083)
R_3				-0.485*** (0.098)
$\lambda(R_1)$				0.098* (0.056)
$\lambda(R_2)$				0.254*** (0.058)
$\lambda(R_3)$				0.144** (.061)
Cons	-3.430*** (1.030)	0.357 (1.480)	-2.244 (1.391)	8.208*** (0.079)
Log likelihood	-614.74955			
Wald $\chi^2(71)$	525.12***			
Number of obs	628			

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01; standard errors are in parentheses. Columns (1), (2), and (3) present the first stage, and column (4) presents the second stage of METE model.*

Table A.2. Tests of the validity of instrumental variables (OLS with dependent variable ln(Farmrev))

Variable	Coefficient
Hedu	0.218*** (0.0389)
Farmexpe	0.020*** (0.0024)
Familysize	-0.063*** (0.0139)
Socstatus	0.193*** (0.0583)
Socecogroup	0.013 (0.0176)
Farmlandsize	0.00002*** (0.00004)
Badhisfor	-0.036 (0.0711)
Badhissemi	-0.163 (0.1063)
Badhisinfor	-0.149 (0.1496)
HAN	0.016 (0.0450)
HAID	0.050 (0.0445)
Hgender	-0.010 (0.0384)
Hage	-0.163*** (0.0417)
Mainagrincome	0.071* (0.0364)
Durableval	-0.041 (0.0433)
Houseval	0.041 (0.0365)
Fortime	-0.002 (0.0018)
Semitime	-0.001 (0.0018)
Joint significance of IVs	***F (3, 609) = 1.12***
Cons	8.161*** (0.0929)
Number of obs	628

***Notes**: **p < 0.05; ***p < 0.01; standard errors are in parentheses.*

Appendix B
Survey Questionnaire

Survey questionnaire for determinants and impact of agricultural credit on Vietnam agricultural performance

Questionnaire No._____

Instructions: For each question with brackets provided, please tick [√] your answer(s); otherwise, please follow the instructions given to answer the questions. Your participation is voluntary, and your answers will be kept confidential.

Section 1. Borrow from Formal, Semi-Formal, and Informal Credit Markets for Agricultural Activities in 2019

1.1. Did you have any credit demand for agricultural activities in 2019?

a. YES [ ] b. NO [ ] (***If NO, please go to Section 2***)

1.2. What was your credit demand for agricultural activities in 2019 in each credit market? *Please state the amount*

a. **Formal credit markets** (state-owned banks, private commercial banks, licensed micro finance institutions (MFIs), cooperative banks) _____ (VND million)

b. **Semi-formal credit markets (**non-governmental organizations (NGOs), unlicensed MFIs, Women's Unions, Farmers' Associations, Vietnam General Confederation of Labour (VGCL)) _____ (VND million)

c. **Informal credit markets** (Moneylenders, relative and friends, pawnshops, ROSCAs, Input suppliers, Middlemen (agricultural product collectors)) _____ (VND million)

1.3. Did you borrow from any credit source for agricultural activities in 2019?

a. YES [ ] (***If YES, please go to question 1.5***) b. NO [ ]

1.4. **If NO in Q.1.3**, why did you not borrow from any credit source? (*You can tick [√] more than one answer)*

a. High interest rate [ ]
b. Do not have adequate documents [ ]
c. Do not have enough collateral [ ]
d. Bad credit histories [ ]
e. Fear of rejection [ ]
f. Fear of being in debt [ ]
g. Fear of losing collateral [ ]
h. Lack of credit supplier [ ]
i. No idea about where to borrow [ ]
j. Complications of loan application and process [ ]

k. Others (*Please specify*) _____

(Please go to Section 2)

1.5. How many credit providers did you approach in 2019? *Please state* _____

1.6. How many times did you apply for agricultural credit in 2019? *Please state* _____

1.7. Which credit market(s) did you borrow from for agricultural activities in 2019? (*You can tick [√] more than one answer*)

a. **Formal credit markets** (state-owned banks, private commercial banks, licensed microfinance institutions (MFIs), cooperative banks) [ ]

b. **Semi-formal credit markets (**non-governmental organizations (NGOs), unlicensed MFIs, Women's Unions, Farmers' Associations, Vietnam General Confederation of Labour (VGCL)) [ ]

c. **Informal credit markets** (Moneylenders, relative and friends, pawnshops, ROSCAs, Input suppliers, Middlemen (agricultural product collectors)) [ ]

1.8. The credit market(s) you **did not** borrow from (Q.1.7), what is/are the reason(s) for your decision not to borrow? (*You can tick [√] more than one answer for each market you DID NOT borrow from)*

	Formal	**Semi-formal**	**Informal**
a. No demand	[ ]	[ ]	[ ]
b. Can borrow from other market(s)	[ ]	[ ]	[ ]
c. High interest rate	[ ]	[ ]	[ ]
d. Do not have adequate documents	[ ]	[ ]	[ ]
e. Do not have enough collateral	[ ]	[ ]	[ ]
f. Bad credit histories	[ ]	[ ]	[ ]
g. Fear of rejection	[ ]	[ ]	[ ]
h. Fear of being in debt	[ ]	[ ]	[ ]
i. Fear of losing collateral	[ ]	[ ]	[ ]
j. Lack of credit supplier	[ ]	[ ]	[ ]
k. No idea about where to borrow	[ ]	[ ]	[ ]
l. Complications of loan application and process	[ ]	[ ]	[ ]
m. Business performance was not good	[ ]	[ ]	[ ]
n. Unfriendly credit officers	[ ]	[ ]	[ ]
o. Extra money requested for approval	[ ]	[ ]	[ ]
p. Others (*Please specify*): _____	_____	_____	_____

1.9. The reason(s) for your decision not to borrow in Q.1.8, what is the MOST IMPORTANT reason in each credit market? (*Please only choose answer for each market you DID NOT borrow from)*

	Formal	**Semi-formal**	**Informal**
a. No demand	[ ]	[ ]	[ ]
b. Can borrow from other market(s)	[ ]	[ ]	[ ]
c. High interest rate	[ ]	[ ]	[ ]
d. Do not have adequate documents	[ ]	[ ]	[ ]
e. Do not have enough collateral	[ ]	[ ]	[ ]
f. Bad credit histories	[ ]	[ ]	[ ]
g. Fear of rejection	[ ]	[ ]	[ ]
h. Fear of being in debt	[ ]	[ ]	[ ]
i. Fear of losing collateral	[ ]	[ ]	[ ]
j. Lack of credit supplier	[ ]	[ ]	[ ]

k. No idea about where to borrow	[ ]	[ ]	[ ]
l. Complications of loan application and process	[ ]	[ ]	[ ]
m. Business performance was not good	[ ]	[ ]	[ ]
n. Unfriendly credit officers	[ ]	[ ]	[ ]
o. Extra money requested for approval	[ ]	[ ]	[ ]
p. Others (*Please specify*): _____	_____	_____	_____

1.10. The credit market(s) you **did borrow** from (Q.1.7), did the total loan amount you received equal the amount you applied for? (*Please ONLY answer the credit market(s) you borrowed from)*

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

1.11. For the credit market(s) from which you **received loan amounts less than applied for**, what are the reason(s) you get less than the amount applied for? (*You can tick [√] more than one answer*)

	Formal	**Semi-formal**	**Informal**
a. Do not have enough collateral	[ ]	[ ]	[ ]
b. Bad credit histories	[ ]	[ ]	[ ]
c. Do not have adequate documents	[ ]	[ ]	[ ]
d. Uncertain monthly income	[ ]	[ ]	[ ]
e. No referee	[ ]	[ ]	[ ]
f. No support from credit officers	[ ]	[ ]	[ ]
g. Agricultural project(s) not good enough	[ ]	[ ]	[ ]
h. Others (*Please specify*): _____	_____	_____	_____

1.12. What was the total loan amount you applied for in each credit market in 2019? (*Please skip the credit market(s) you DID NOT apply for any loan*)

a. Formal credit market: _____ (VND million)
b. Semi-formal credit market: _____ (VND million)
c. Informal credit market: _____ (VND million)

1.13. What was the total loan amount you received from each credit market in 2019? (*Please skip the credit market(s) you DID NOT borrow from*)

a. Formal credit market: _____ (VND million)
b. Semi-formal credit market: _____ (VND million)
c. Informal credit market: _____ (VND million)

1.14. Did any of your loan in 2019 require collateral? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

1.15. What types of collateral were required in each credit market? (*You can tick [√] more than one answer*)

	Formal	**Semi-formal**	**Informal**
a. Property (land or building)	[ ]	[ ]	[ ]
b. House	[ ]	[ ]	[ ]
c. Machinery and equipment	[ ]	[ ]	[ ]
d. Saving books	[ ]	[ ]	[ ]

e.	Receivable	[ ]	[ ]	[ ]
f.	Personal properties (e.g., gold, car, motorbike, mobile phone, stocks, etc)	[ ]	[ ]	[ ]
g.	Durable assets (e.g., home appliances, TV, etc)	[ ]	[ ]	[ ]
h.	Others (*Please specify*): _____	_____	_____	_____

1.16. What were the highest and lowest interest rates you paid for your loans in 2019 in each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Highest interest rate (per month)	_____	_____	_____
b. Lowest interest rate (per month)	_____	_____	_____

1.17. What was the average duration of your loans in 2019 in each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Short term (less than 1 year)	[ ]	[ ]	[ ]
b. Medium term (1-5 years)	[ ]	[ ]	[ ]
c. Long term (more than 5 years)	[ ]	[ ]	[ ]

1.18. What was your loan payment method in each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Daily	[ ]	[ ]	[ ]
b. Weekly	[ ]	[ ]	[ ]
c. Monthly	[ ]	[ ]	[ ]
d. Quarterly	[ ]	[ ]	[ ]
e. Semi-annual	[ ]	[ ]	[ ]
f. Annually	[ ]	[ ]	[ ]
g. Others (*Please specify*)	_____	_____	_____

1.19. How long did it take to process your loan in 2019 from each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Within one day	[ ]	[ ]	[ ]
b. Less than 1 week	[ ]	[ ]	[ ]
c. 1 week	[ ]	[ ]	[ ]
d. 2 weeks	[ ]	[ ]	[ ]
e. 3 weeks	[ ]	[ ]	[ ]
f. 1 month	[ ]	[ ]	[ ]
g. More than 1 month	[ ]	[ ]	[ ]

1.20. What difficulties did you face when you borrowed from each credit market in 2019? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Complicated loan process	[ ]	[ ]	[ ]
b. High administration fee	[ ]	[ ]	[ ]
c. Unfriendly credit officers	[ ]	[ ]	[ ]
d. Extra money requested for approval	[ ]	[ ]	[ ]

e.	High value of collateral	[ ]	[ ]	[ ]
f.	Inconsistent credit rules, laws, regulations	[ ]	[ ]	[ ]
g.	Others (*Please specify*): _____	_____	_____	_____

1.21. What is the status of your existing loan in each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Fully paid	[ ]	[ ]	[ ]
b. Current outstanding	[ ]	[ ]	[ ]
c. Overdue	[ ]	[ ]	[ ]
d. Restructured	[ ]	[ ]	[ ]
e. Others (*Please specify*): _____	_____	_____	_____

1.22. Were there any other charges on your loan in 2019 besides the interest rate in each credit market? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

1.23. If **YES in Q.1.22,** what were these charge(s)? (*You can tick [V] more than one answer*) (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. Administrative or service fees	[ ]	[ ]	[ ]
b. Insurance fee	[ ]	[ ]	[ ]
c. Guarantee fee	[ ]	[ ]	[ ]
d. Referee fee	[ ]	[ ]	[ ]
e. Others (*Please specify*): _____	_____	_____	_____

(Please go to Section 3)

Section 2: Non-borrower

*This section is to be completed by respondents who did **not borrow** for agricultural activities in 2019*

2.1. Do you have any credit demand for agricultural activities in the future?

a. YES [ ] b. NO [ ] (***If NO, please go to Section 3***)

2.2. **If YES in Q.2.1**, do you intend to borrow in the future?

a. YES [ ] b. NO [ ] (***If NO, please go to Section 3***)

2.3. **If YES in Q.2.2**, where do you intend to borrow? (*You can tick [V] more than one answer*)

a. State-owned banks [ ]
b. Private commercial banks [ ]
c. Licensed micro finance institutions [ ]
d. Cooperative banks [ ]
e. Non-governmental organizations [ ]
f. Women's Unions [ ]
g. Unlicensed micro finance institutions [ ]
h. Farmers' Associations [ ]
i. Vietnam General Confederation of Labour [ ]

k. Money lenders [ ]
l. Relative and friends [ ]
m. Pawn shops [ ]
n. ROSCAs [ ]
o. Input suppliers [ ]
p. Middlemen (fruits collectors)) [ ]
q. Others (*Please specify*): _____

Section 3. Credit history and relationships with credit providers
This section is to be completed by ALL RESPONDENTS

3.1. Does your household head have contact with existing financial institutions (i.e., state-owned banks, private commercial banks, licensed microfinance institutions, cooperative banks)?
a. YES [ ] b. NO [ ]

3.2. Does your household head have at least one account (savings account, checking account, credit account) at financial institutions?
a. YES [ ] b. NO [ ]

3.3. How long is the relationship between you and financial institutions (having contact with a bank officer having a loan, using bank services)? *(If you have no relationship, please skip this question and go to Q.3.4). Please state* _____(years)

3.4. Did you receive any credit from each credit market in the last three years?

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

3.5. Were you unable to make repayment on loan(s) in part or in full from each credit market at some point of time in the last three years? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

3.6. Did you have the loan restructured from each credit market in the last three years? (*Please skip the credit market(s) you DID NOT borrow from*)

	Formal	**Semi-formal**	**Informal**
a. YES	[ ]	[ ]	[ ]
b. NO	[ ]	[ ]	[ ]

Section 4. Geography-related factors
This section is to be completed by ALL RESPONDENTS

4.1. How long does it take from your house to the nearest formal credit source? *Please state* _____(minutes)

4.2. How long does it take from your house to the nearest semi-formal credit source? *Please state* _____(minutes)

4.3. How long does it take from your house to the main road? *Please state* _____(minutes)

4.4. How long does it take from your house to the main market? *Please state* _____(minutes)

Section 5. Household's demographics, social-economic activities, and farm performances
This section is to be completed by ALL RESPONDENTS

5.1. What is the gender of the household head?
a. Male [ ] b. Female [ ]

5.2. What is the household head's age?
a. Below 25 [ ]
b. 25-35 [ ]
c. 36-45 [ ]
d. 46-55 [ ]
e. 56-65 [ ]
f. Above 65 [ ]

5.3. Which ethnic group are you belong to?
a. Kinh [ ]
b. Khmer [ ]
c. Cham [ ]
d. Tay [ ]
e. Others (*Please specify*): _____

5.4. What is the highest educational or professional qualification of the household head?
a. No formal education [ ]
b. Primary school [ ]
c. Secondary school [ ]
d. Highschool [ ]
e. College diploma/certificate [ ]
f. Bachelor degree [ ]
g. Post graduate degree [ ]
h. Others (*Please specify*) _____

5.5. How many times did your household head talk to neighbors in average per week? *Please state* _____

5.6. How long has your household head experienced farming activities? *Please state* _____(years)

5.7. How many members are there in your household? *Please state* _____(persons)

5.8. How many members under 14 years old are there in your household? *Please state* _____(persons)

5.9. How many members over 65 years old are there in your household? *Please state* _____(persons)

5.10. How many members working on the farm are there in your household? *Please state* _____(persons)

5.11. Does your household head hold any position at the village level or higher?

a. YES [ ] b. NO [ ]

5.12. What is your farmland size? *Please state* _____(m2)

5.13. What is the total savings amount of your household?

a. Less than VND 1 million [ ]
b. More than VND 1 million to VND 5 million [ ]
c. More than VND 5 million to VND 10 million [ ]
d. More than VND 10 million to VND 15 million [ ]
e. More than VND 15 million to VND 20 million [ ]
f. More than VND 20 million to VND 25 million [ ]
g. More than VND 25 million to VND 30 million [ ]
h. More than VND 30 million to VND 35 million [ ]
i. More than VND 35 million [ ]

5.14. How many social and economic groups does your household head participate in? *Please state* _____

5.15. What is your household's land area registered with a red book? P*lease state* _____(m2)

5.16. What is the total value of your household's durable assets (*including TVs, radio/CD/Video/DVD player, mobile phone, refrigerator, air conditioner, washing machine, water heater, motorcycle, bicycle, boat, feed grinding machine, rice milling machine, grain harvesting machine, pesticide sprayers, tractor, plough, cart, car, computer/laptop*)

a. Less than VND 10 million [ ]
c. More than VND 10 million to VND 20 million [ ]
d. More than VND 20 million to VND 30 million [ ]
e. More than VND 30 million to VND 40 million [ ]
f. More than VND 40 million to VND 50 million [ ]
g. More than VND 50 million to VND 60 million [ ]
h. More than VND 60 million to VND 70 million [ ]
i. More than VND 70 million to VND 80 million [ ]
j. More than VND 80 million [ ]

5.17. What is the total value of your house(s)?

a. Less than VND 100 million [ ]
b. More than VND 100 million to VND 300 million [ ]
c. More than VND 300 million to VND 500 million [ ]
d. More than VND 500 million to VND 700 million [ ]
e. More than VND 700 million to VND 900 million [ ]
f. More than VND 900 million to VND 1100 million [ ]

g. More than VND 1100 million to VND 1300 million [ ]
h. More than VND 1300 million to VND 1500 million [ ]
i. More than VND 1500 million to VND 1700 million [ ]
j. More than VND 1700 million to VND 1900 million [ ]
k. More than VND 1900 million [ ]

5.18. What is the main source of your household income?
a. Farming/cropping [ ]
b. Livestock [ ]
c. Farm labourer [ ]
d. Non-farm labourer [ ]
e. Family business (vendor) [ ]
f. Others (*Please specify*) _____

5.19. What was the average total farm income per month of your household in 2019 (*i.e., total farm revenue minus farm expense*s)? *Please state the amount* _____(million VND)

5.20. What was the average total non-farm income per month of your household in 2019? *Please state the amount* _____(million VND)

5.21. What is your main occupation?
a. Crop farmer [ ]
b. Livestock and poultry raiser [ ]
c. Fisherfolk [ ]
d. Other (*Please specify*) _____

5.22. What was the average total value of the agricultural output per month of your household in 2019 (*i.e., total value of farm output (output self-consumed, already output sold, and output stocked)*? *Please state the amount* _____ (million VND)

5.23. What was your average net farm revenue per month in 2019 (*i.e., total revenue from selling agricultural products minus any adjustments, such as accounting for returns, refunds, and discounts*)? *Please state the amount* _____ (million VND)

5.24. What was/were the agricultural products of your household in 2019? (*You can tick [V] more than one answer*)
a. Rice [ ]
b. Maize [ ]
c. Potato [ ]
d. Cassava [ ]
e. Peanut [ ]
f. Soybean [ ]
g. Vegetables [ ]
h. Cow/bull/buffalo [ ]
i. Horse, Pony [ ]
j. Pig [ ]
k. Sheep, Goat [ ]
l. Chicken, Duck, Quail [ ]
m. Fish [ ]
n. Shrimp [ ]

o. Crab [ ]
p. Oyster [ ]
q. Other (*Please specify*) _____

5.25. What was the main agricultural product of your household in 2019? (*Please choose only one answer)*

a. Rice [ ]
b. Maize [ ]
c. Potato [ ]
d. Cassava [ ]
e. Peanut [ ]
f. Soybean [ ]
g. Vegetables [ ]
h. Cow/bull/buffalo [ ]
i. Horse, Pony [ ]
j. Pig [ ]
k. Sheep, Goat [ ]
l. Chicken, Duck, Quail [ ]
m. Fish [ ]
n. Shrimp [ ]
o. Crab [ ]
p. Oyster [ ]
q. Other (*Please specify*) _____

I agree to participate in this study **[ ]**

Your participation in this survey is greatly appreciated. Thanks for your time and if you have further comments, please feel free to comment in the space provided below. Once again, we assure that your identity will remain ***STRICTLY CONFIDENTIAL****.*

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