

Impact of credit rationing on capital allocated to inputs used by rice farmers in the Mekong River Delta, Vietnam

Impact of
credit rationing
in the MRD

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Cao Van Hon
An Giang University, Long Xuyen, Vietnam, and
Le Khuong Ninh
Can Tho University, Can Tho, Vietnam

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Abstract

Purpose – The purpose of this paper is to estimate the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers in the Mekong River Delta (MRD).

Design/methodology/approach – Based on the literature review, the authors propose nine hypotheses on the determinants of access of rice farmers to credit and four hypotheses on the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers in the MRD. Data were collected from 1,168 farmer households randomly selected out of 10 provinces (city) in the MRD.

Findings – Step 1 of propensity score matching (PSM) with probit regression shows that land value, income, education, gender of household head and geographical distance to the nearest credit institution affect the degree of credit rationing facing rice farmers. Step 2 of PSM estimator identifies that the amount of capital allocated to inputs such as fertilizer and hired labour increases when credit rationing decreases while that allocated to seed and pesticide is not influenced by credit rationing because rice farmers use these inputs adamantly regardless of effectiveness.

Originality/value – This paper sheds light on the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers, which is largely different from the main focus of the extant literature just on the determinants of credit rationing facing farmers in general and rice farmers in particular.

Keywords Credit rationing, Propensity score matching, Input, Mekong River Delta, Probit, Rice farmer

Paper type Research paper

1. Introduction

In rice production, capital plays a crucial role. However, because of low-income owned capital of most rice farmers in the Mekong River Delta (MRD) is insufficient to acquire inputs. Thus, they need to borrow but are often denied due to asymmetric information and limited liability that result in risk for credit institutions. Consequently, only some rice farmers get enough credit while others are given just a proportion of their requests or completely rejected despite being willing to pay higher interest rates. Then, credit rationing emerges as described by [Stiglitz and Weiss \(1981\)](#), amongst others.

Due to credit rationing, a number of rice farmers do not have enough capital to acquire inputs for production so as to achieve maximum rice yield. They may then contemplate two options, i.e. using less of all inputs (the scale effect) or less of the inputs that are not much vital



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to rice yield and income (the substitution effect). The scale effect is flawed since it reduces rice yield and thus adversely affects income of rice farmers. Therefore, they may opt for using less of unimportant inputs while maintaining (or even raising) the amount of other inputs to assure rice yield and income. Such behaviour of farmers significantly affects rice yield, the health of people, the sustainability of rice production as well as the natural environment of the MRD – the rice bowl that accounts for more than half of rice output of Vietnam – but according to our knowledge a little attention has been paid to this issue. The main focus of the extant literature on credit for rice farmers has been the determinants of their access to credit, both formal and informal.

Therefore, this research is conducted to estimate the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers in the MRD. This paper aims to shed light on this issue because Vietnam is a transition economy that has an underdeveloped banking system, making it hard for rice farmers to get access to formal credit. In addition, its agricultural input market is not fully mature, which creates a huge problem for rice farmers to obtain inputs with right quality and prices. Such a situation not only affects rice output of the MRD but also the natural environment of the region as well as the health of people – a deep concern of many parties about the sustainability of rice production in particular and agricultural production in general of the MRD.

This paper is structured as follows. The introduction given in [Section 1](#) is followed by [Section 2](#) and [Section 3](#) are about theoretical background of the empirical model developed to be tested later on. [Section 4](#) is about the methodology and data used in the paper to estimate the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers in the MRD. Then, the results of the paper are presented in [Section 5](#). [Section 6](#) concludes the paper.

2. Theoretical background

Different from a conventional commodity trading, credit transaction is characterized by lags. In other words, a loan is repaid only later at a certain point of time in the future. During that period, under the influence of a number of economic and social factors at both macro and micro levels, the debt repayment capacity of rice farmers may deteriorate but credit institutions seem to be impotent due to asymmetric information and transaction cost. Consequently, credit institutions will ration the amount of credit given to rice farmers who are deemed risky. This phenomenon is known as credit rationing – a term coined by [Stiglitz and Weiss \(1981\)](#).

Credit rationing leads to insufficient capital to buy inputs for production, so rice farmers must contemplate how to allocate the available capital to inputs so as to minimize this adverse effect. To model that behaviour, let us consider a rice farmer who aims to minimize production cost due to credit rationing imposed by the credit institution. This farmer's production function is $y = f(M, N)$, with y being rice output and M, N being inputs. Then, the farmer's minimum cost of production is:

$$\min_{M, N} \{MP_M + NP_N\} \quad (1)$$

given the constraint of $y_0 = f(M, N)$, where P_M and P_N are the price of M and N , respectively. To minimize the cost, the following Lagrangian expression can be used:

$$\ell = MP_M + NP_N + \lambda[y_0 - f(M, N)] \quad (2)$$

The conditions for minimizing the cost read:

$$\frac{\partial \ell}{\partial M} = P_M - \lambda \frac{\partial f}{\partial M} = P_M - \lambda f_M = 0$$

$$\frac{\partial \ell}{\partial N} = P_N - \lambda \frac{\partial f}{\partial N} = P_N - \lambda f_N = 0$$

$$\frac{\partial \ell}{\partial \lambda} = y_0 - f(M, N) = 0$$

Therefore

$$P_M = \lambda f_M \quad (3)$$

$$P_N = \lambda f_N \quad (4)$$

Dividing (4) by (3) gives

$$\frac{P_M}{P_N} = \frac{f_M}{f_N} \text{ or } \frac{f_M}{P_M} = \frac{f_N}{P_N} \quad (5)$$

In Expression (5), f_M is the marginal productivity of input M and f_M/P_M is the marginal productivity of one dong invested in input M . Similarly, f_N/P_N the marginal productivity of one dong invested in input N . According to a principle of microeconomics, $f_M/P_M = f_N/P_N$ means that production cost is minimized given output y_0 , so profit is maximized.

If credit markets are perfect, the source of financing is irrelevant or rice farmers have full access to credit, according to the well-known Modigliani–Miller theorem (Modigliani and Miller, 1958). In other words, rice farmers get sufficient capital to acquire inputs in order to produce the output that minimizes production cost and maximizes profit conforming to Expression (5). However, because rural credit markets are virtually imperfect due to information asymmetry and transaction cost, the Modigliani–Miller theorem does not hold, thus leading to adverse selection and moral hazard and causing risk for the credit institution. As a result, it rations the amount of credit granted to rice farmers, so the latter does not have enough capital to buy the amount of inputs that satisfies Expression (5). Then, the scale effect emerges, affecting the scale of input use but not the relative input intensities – a phenomenon called symmetric credit rationing. In concrete, the scale effect corresponds to the case in which farmers reduce both M and N , so rice yield definitely plunges. Besides the scale effect, there also exists the substitution effect that affects both the level of input use and their relative intensities since more credit rationed inputs will be substituted by less ones (asymmetric credit rationing). In both cases, due to credit rationing rice farmers use an amount of inputs deviating from what is supposed to be the most efficient (i.e. maximizing profit).

Moreover, the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers are non-linear because the marginal productivity varies according to the level of inputs applied. Therefore, to estimate the impact of different degrees of credit rationing, in addition to identifying the treatment effect of using credit using the propensity scores, this paper also estimates the treatment effect of heterogenous intensities of credit rationing facing rice farmers.

3. Impact of credit rationing on the amount of capital allocated to inputs

In order to compute the propensity scores, it is required to specify an empirical model of the determinants of access of rice farmers to credit and then use probit estimator to estimate the

model. In this paper, that empirical model is constructed based on the results of relevant studies. According to them, when making a lending decision, credit institutions take account of collateral and income of the farmer, in addition to their own judgement on traits of the farmer such as land value, income, the duration of residence in the locality, age, education, gender, experience and social status, *inter alia* (Kuwornu *et al.*, 2012; Shoji *et al.*, 2012; Awunyo-Vitor *et al.*, 2014; Moro *et al.*, 2017).

A prerequisite for a rice farmer to get credit from a credit institution is collateral which helps the latter compensate for losses if the former defaults. If the farmer pledges collateral, he in fact signals responsibility to use the loan effectively because if failing, he will lose that valuable collateral. Since collateral mitigates default risk, the credit institution may even reduce interest rates to favour and create a long-lasting relationship with the borrower (Berger *et al.*, 2011). For most cases, collateral must be of high value (e.g. land in the case of rice farmers) so that the credit institution can reimburse for the loss of default resulting from prevalent risks facing the farmer, especially regarding rice yield and price – i.e. determinants of his income and debt repayment capacity (Kislat *et al.*, 2017). In addition, land also enables the farmer to use loans efficiently to repay the debt. As a result, credit rationing may be less severe for those rice farmers having land of higher value (Fletschner, 2009).

Income plays a crucial role in alleviating credit rationing facing rice farmers since income is key to their debt repayment capacity. Rice farmers with high income often use loans wisely, thus allowing them to repay debts and relieving credit rationing (Feder *et al.*, 1990). Besides, high-income farmers often prefer own capital of which cost is lower, especially in transition economies where credit systems are underdeveloped, leading to high information and transaction costs (Fischer *et al.*, 2019). Using own capital emanates creditworthiness, thereby improving access to formal credit for rice farmers. These farmers may also have a better ability to make use of human, financial and material resources to generate income, thereby being less adversely affected by external shocks. Another advantage of those farmers is the large-scale production, so they benefit from economies of scale and the bargaining power when selling rice and purchasing inputs, which enhances efficiency (Tiessen and Funk, 1993). Consequently, higher income helps rice farmers relieve the incidence of credit rationing.

Rice farmers who have resided longer in the locality may face less severe credit rationing since credit institutions would have more information to assess their creditworthiness (Kislat *et al.*, 2017). According to studies on social capital such as Abbink *et al.* (2006), Duffhues *et al.* (2012) and Shoji *et al.* (2012), credit institutions have more time to develop close relationships and effective sanction mechanisms as to rice farmers who have resided longer the locality to screen them and enforce repayment. Longer relationships strengthen trust and enable credit institutions to loose requirements (especially collateral), opening up opportunities for rice farmers to get a better access to credit (Brewer *et al.*, 2014; Kislat *et al.*, 2017). For those rice farmers, credit institutions may first offer small loans (albeit high costs) to maintain and develop long-lasting relationships that benefit both parties.

The effect of age on credit rationing has also attracted numerous empirical studies such as Freeman *et al.* (1998), Winter-Nelson and Temu (2005), Franklin *et al.* (2008) and Awunyo-Vitor *et al.* (2014). According to them, older farmers have well-established economic, social and personal relationships, so it may be easy for them to get support when needed. The assets they have amassed in the course of time also create trust by credit institutions. Moreover, mature farmers are astute in making decisions, especially regarding production, resource use and financing. Thus, they are highly appreciated for creditworthiness, making it more likely for them to get access to credit from credit institutions.

Education – an indispensable constituent of human capital – is closely tied to the degree of credit rationing facing rice farmers (Pham and Izumida, 2002; Kuwornu *et al.*, 2012; Kislat *et al.*, 2017). Rice farmers with a higher education degree may have good managerial capacity to enhance efficiency, thus being better to honour debt repayment and confronting with less

severe credit rationing. They are also capable of acquiring and applying technical advances to production as well as accessing market and credit information. Rice farmers with better education may well perceive and deal with production, financing and market risks. They are more competent in approaching credit institutions, so it is easy for them to get access to formal credit (Fletschner, 2009).

In rural areas, females mostly do housework according to the division of labour in the family, so they may have limited knowledge of borrowing procedures and lack social relations as well as communication skills, making it hard for them to get access to credit (Fletschner, 2009; Alesina *et al.*, 2013). Females play a meagre role in production decisions (i.e. the main source of income) and in the process of using of resources, especially financial ones (Petrick, 2004; Awunyo-Vitor *et al.*, 2014; Tran *et al.*, 2018). Lack of power on such aspects leads credit institutions to viewing females as less competent in terms of honouring debt repayment since they hardly have their husbands' consent for that, so credit institutions may refuse to grant them credit. Females rarely inherit property, thus having no tangible collateral for loans (Fletschner, 2009). However, females are often deemed as prudent ones, implying that they borrow only when necessary and tend to use it properly to ensure repayment (Moro *et al.*, 2017). Because females are supposed to take care of their families, they have a higher propensity to save (albeit small), so there may be always an available source of money to repay due debts. The propensity to save enhances their access to credit given the presence of credit cooperatives, microcredit institutions or semi-formal ones operating via social and professional organizations. As a result, females may have a better access to formal credit than their male counterparts (Fletschner, 2009).

Asymmetric information prevails in rural credit markets since it is difficult for credit institutions to fetch right information about farmers due to geographical distance (Cerqueiro *et al.*, 2011; Bellucci *et al.*, 2013; Witte *et al.*, 2015; Kislal *et al.*, 2017). Because rice farmers disperse over a vast rural area, geographical distance and the resulted degree of asymmetric information between a credit institution and a farmer are substantial. Consequently, many farmers are denied access to formal credit for lack of information since the information needed for screening, monitoring and enforcing repayment is costly to obtain and less precise given a larger geographical distance between the credit institution and the farmer. In other words, geographical proximity helps credit institutions have in-depth understanding of the farmer's creditworthiness. The closer the farmer resides, the higher possibility credit he is granted because he has opportunities to build intimate relationships with the credit institution and is better able to grasp borrowing procedures. Also, it is easy for credit institutions to scrutinize production and other hidden activities of the farmer (Gershon *et al.*, 1990; Degryse and Ongena, 2005; Barslund and Tarp, 2008). Thus, it is more profitable for credit institutions to lend to farmers who reside nearby or geographical distance has an adverse impact on access to credit of rice farmers.

In rural areas, social relationships fostering commercial transactions play a certain role to farmers (Baird and Gray, 2014). In fact, social relationships help minimize risks stemming from external factors by sharing human, material and financial resources to smooth consumption and create funds to protect oneself. Individuals who are respected by the community for social positions will be better able to take advantage of this aspect to bring about benefits. Besides helping to form a solid foundation to improve the quality of decisions, social relationships also facilitate information exchanges in various scales and scopes, depending on the degree of intimacy and openness. This helps farmers improve the ability to adapt to natural, social and economic environments in order to mitigate risks. Social relationships make it more efficient to exchange information amongst individuals, thereby increasing its accuracy, comprehensiveness and value. If heads or members of rice households hold a position in government organizations or businesses, there will be an advantage because they may have better relevant information and may be guaranteed by a

third party, which largely contributes to mitigating the degree of credit rationing. In addition, people having social positions are often deemed prestigious and often try to honour debt repayment debts to maintain positions and reputations. This enables credit institutions to grant them more credit (Qin *et al.*, 2018).

Another important determinant of credit access for rice farmers is the number of years engaged in rice production (say, experience). Rice farmers face multiple risks with respect to production, market and financing, requiring them have a certain knowledge accumulated over the time when taking part in rice production. Rice production is a continuous learning process in which farmers learn from their own previous experience, exchange information with others or carry out research with scientists. Such an understanding is crucial, helping them cope with uncertainties regarding policy, production, weather and market. Knowledge as a inherent product of experience enhances rice farmers' capacity of identifying problems, finding out and applying proper solutions to tackling risks that threat to ruin their business. It also guides farmers towards sustainable production to enhance productivity and build trust with credit institutions that allows them to get better access to credit (Sumane *et al.*, 2018).

Based on the abovementioned arguments, this paper specifies an empirical model to estimate the impact of pertinent factors on credit rationing facing rice farmers in the MRD as follows:

$$\begin{aligned} \text{creditationing}_i = & \beta_0 + \beta_1 \text{land}_i + \beta_2 \text{income}_i + \beta_3 \text{residence}_i + \beta_4 \text{age}_i + \beta_5 \text{education}_i \\ & + \beta_6 \text{gender}_i + \beta_7 \text{distance}_i + \beta_8 \text{socialposition}_i + \beta_9 \text{experience}_i + \varepsilon_i \end{aligned} \quad (6)$$

In Model (6), the dependent variable (creditationing_i) is constructed based on the ratio of the amount of formal credit granted to the farmer and the amount of credit he has applied for (borrowrate_i). If $\text{borrowrate}_i \geq 1$, there is no credit rationing, so creditationing_i has a value of 0. If $0 \leq \text{borrowrate}_i < 1$, there is credit rationing, so creditationing_i has a value of 1. Model (6) will be estimated using probit estimator to identify the propensity scores. Based on the propensity scores identified, this paper uses propensity score matching (PSM) to compute the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers, which includes the amount of capital used to buy seed (seed_i), fertilizer (fertilizer_i), pesticide (pesticide_i) and to hire labour (hiredlabour_i).

It is expected that seed_i is not affected by credit rationing because this input is vital to rice yield, so the amount of seed used hardly varies according to the degree of credit rationing. Indeed, if not using the right amount of seed of proper quality, there exists a risk of bad harvest that is costly to make it up because seed of low quality often sprouts and grows poorly.

Different from seed_i , fertilizer_i is expected to be influenced by credit rationing, implying that rice farmers will use less of this input due to the scale and substitution effects as credit is rationed. Given the scale effect, when credit is rationed, the amount of capital allocated to fertilizer decreases due to the lack of funds available for production. In such a case, rice farmers reduce the amount of fertilizer applied each time or/and adjust the time of applying it because the effectiveness of fertilizer depends on the time of application. Colour of rice plant leaves signals the time when the rice plant absorbs fertilizers most efficiently. Based on that, rice farmers adjust the type and the amount of fertilizers to suit their own financial stand. Moreover, there are several types of fertilizers displayed for sales that can replace one another while maintaining the same effect. Due to inadequate knowledge of farmers (i.e. more fertilizer would bring better yields), lack of due diligence in taking care of the crop and the influence input sellers via deceiving marketing tricks, quite a number of rice farmers use so much fertilizers that their marginal productivity approaches zero. Thus, when credit is rationed, rice farmers tend to reduce the amount of fertilizers applied. As to the substitution effect, when

credit is rationed, rice farmers will use more of family labour to take care of the crop instead of fertilizers. This substitution may not be perfect but has a certain effect on rice yield as a traditional Vietnamese saying goes “the first is water, the second is fertilizer, the third is diligence, the fourth is seed”.

For pesticide, the primary goal of rice farmers when using it is to control pests. Mainly due to humid climate and the triple cropping, pests grow and spread rapidly in rice fields. As a result, farmers tend to use an amount of highly toxic pesticides that well exceeds the amount prescribed by experts for an expectation of having strong instant effects, which is adamant since it has deeply rooted in their mind. Rice farmers even increase the amount of pesticides applied if the previous application has not proved effectual. They also mix up various types of pesticides without caring about its true therapeutic effect because they do not trust the quality of the pesticides. According to them, doing so may save time, opportunity cost, labour loads and can control pests effectively. Increasing a small amount of pesticide applied each time dramatically pushes up the total amount of pesticides used in rice production, thus endangering the natural environment, the health of people and the sustainability of rice production of the region. This behaviour appears when nearby rice farmers show that it brings about strong effects without being aware of such characteristics as the timing of application, types of pests and financial capacity. After spraying, a bit of pesticide may remain. Farmers then pour it directly in the field or spray again where diseases seem to be more serious. Moreover, using fertilizers with an overdose enables rice plant to grow fast but also fosters the wide spreading of pests, requiring more pesticides to be applied later on and on. Given this fact, $pesticide_i$ is expected not to be influenced by the degree of credit rationing facing the farmer.

When the amount of fertilizers used decreases because of credit rationing, rice farmers use less of hired labours to fertilize. Thus, hiredlabour_{*i*} has an inverse relationship with the degree of credit rationing facing the farmer.

4. Methodology and data

It is hard to estimate the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers due to the selection bias, implying the assignment to treatment (i.e. having a full access to credit) is non-random and depends the farmer's traits. This paper addresses this problem by using a relatively large size data set of 1,168 rice farmers, which allows us to employ a semi-parametric PSM estimator. PSM is commonly used in empirical studies (Rosenbaum and Rubin, 1983; Bento and Jacobsen, 2007; Roberts and Key, 2008; Briggeman *et al.*, 2009; Pufahl and Weiss, 2009; Katchova, 2010; Ciaian *et al.*, 2012) due to its ability to control the selection bias by constructing the counterfactual. The counterfactual is what would have happened to those rice farmers who had in fact got a full access to credit, if they had not. The key assumption of PSM is that rice farmers selected into treatment (i.e. having a full access to credit) and non-treatment groups have potential outcomes in both states – the one in which they are observed and the one in which they are not actually observed. Let $D = 1$ denotes the state where rice farmer i gets a full access to credit (i.e. the treatment) and $D = 0$ denotes the state when he does not get a full access to credit (the control).

PSM is employed to determine the difference between the treatment and the control, which is called the average treatment effect on the treated (ATT), after controlling for differences amongst them. For a given rice farmer who gets a full access to credit, the observed mean amount of capital allocated to an input is $E(Y_1|D = 1)$ and the unobserved (hypothetical) mean amount of capital allocated to an input is $E(Y_0|D = 1)$. Similarly, for a given rice farmer who does not get a full access to credit, the observed mean outcome is $E(Y_0|D = 0)$ and the unobserved (hypothetical) mean outcome that a rice farmer who does not get a full access to

credit would have realized had they indeed has a full access to credit $E(Y_1|D = 0)$, where $E(\cdot)$ is the expectation operator in each of the expressions. Following [Rosenbaum and Rubin \(1983\)](#), the parameter of interest in this paper is the ATT.

$$ATT = E(Y_1 - Y_0|D = 1) = E(Y_1|D = 1) - E(Y_0|D = 1)$$

The central interest of impact evaluation of this paper is not on $E(Y_0|D = 0)$ but $E(Y_0|D = 1)$. For that purpose, PSM uses balancing scores to extract the observed mean outcome of the farmers who do not get a full access to credit and are most similar in observed traits to the farmers who get a full access to credit, i.e. it uses $E(Y_0|D = 0)$ to estimate the counterfactual $E(Y_0|D = 1)$. In order for the true parameter to be estimated, it is required that:

$$E(Y_0|D = 1) - E(Y_0|D = 0) = 0$$

which ensures that the ATT is free from self-selection bias.

Using the probit estimator, a probability for each farmer of getting a full access to credit (propensity score) is computed. Based on this propensity score, for each treated observation a counterfactual is estimated using the kernel matching procedure. This allows to compare each treated observation only with controls having similar values of observable traits. To assure that the compared rice farmers are not too different in terms of propensity score, this paper employs matching with calliper of 0.01.

The empirical model specified previously requires data on the determinants of access of rice farmers to credit and variables capturing the amount of capital allocated to inputs. The data used in this paper were collected through direct interviews with heads of 1,168 rice households randomly selected out of 10 provinces and city in the MRD. In each province (city), the village with the largest area of land devoted to rice production from the district with the largest area of land devoted to rice production was picked up. In each village, 200 rice farmers were randomly chosen for interview. Questionnaires were directly administered through face-to-face interviews with household heads. Yet, due to difficulties in reaching household heads, being refused to be informants and missing information, we were able to create a data set of 1,168 rice farmers as much.

The size of the sample is sufficiently large and diverse to represent the target farmers of interest, which includes 118 rice farmers in An Giang (10.1 per cent of the total sample), 76 in Bac Lieu (6.51 per cent), 87 in Ca Mau (7.45 per cent), 116 in Can Tho (9.93 per cent), 100 in Hau Giang (8.56 per cent), 94 in Kien Giang (8.05 per cent), 269 in Soc Trang (23.03 per cent), 112 in Tien Giang (9.59 per cent), 104 in Tra Vinh (8.90 per cent) and 92 in Vinh Long (7.88 per cent). The data obtained include socio-demographic traits of rice farmers such as age, education, gender, major occupation, farming experience, family size, duration of residence in the locality and distance to the nearest credit institution, in addition to the amount of capital allocated to each input.

5. Findings

5.1 Sample description

The sample includes 1,168 rice farmers randomly selected out of provinces (city) of the MRD. The average age of household heads is 51.62 ([Table I](#)). Number of people per household is 3.19. The farmers have resided in the locality quite long (47.31 years on average). Their level of education is rather low, with an average schooling of 6.34 years. Education reflects the ability to acquire and apply technical advances and market information in production. Such a low level of education may adversely affect rice yield and production efficiency of the farmers.

Although the farmers have resided in the locality quite long (47.31 years on average), due to lack of collateral (the average of agricultural land area is only 18,000 m² per household with

3.19 people each), it is hard for them to get access to credit due to uncertainties in the rice market (especially regarding price) and about weather, which create substantial risks for credit institutions. Long distance to credit institutions (8.48 km) also hinders rice farmers' access to credit since this intensifies the degree of information asymmetry and pushes up transaction cost for both parties (i.e., farmers and credit institutions).

The average size of loans from credit institutions to a farmer is 23.82 *m* per year. As much as 870 farmers (74.49 per cent) were able to borrow only a part of the amount of credit they requested from credit institutions or totally denied, implying that they are credit rationed and face difficulties in financing production. A much smaller proportion of the surveyed farmers (25.52 per cent) are not rationed by credit institutions (Table II).

5.2 Determinants of rice farmers' access to credit

Several factors do affect the access of rice farmers to credit. The results shown in Table III are based on a probit model, which identify the factors that affect the likelihood of a rice farmer getting access to credit. Rice farmers with a higher value of agricultural land are less credit rationed as *landvalue_i* has a negative coefficient at a significance level of 10 per cent. Given the fact that *income_i* has a negative coefficient at a significance level of five per cent, credit rationing is less likely to occur with rice farmers of high income. Identically, *education_i* also has a negative coefficient at a significance level of five per cent, divulging that it is easier for better educated rice farmers to borrow from credit institutions as compared to others.

Meanwhile, the positive coefficient at a significance level of 10 per cent of *gender_i* implies that credit rationing is more possible to appear with male rice farmers than with female ones. As mentioned, the geographical distance of the rice farmer from the nearest credit institution is a proxy for the degree of information asymmetry and transaction cost. Table III shows that the further away a rice farmer is located from a credit institution, the more probable credit rationing occurs because *distance_i* has a positive coefficient at a significance level of 1 per cent. Other variables such as *residence_i*, *age_i*, *position_i* and *experience_i* have coefficients that are not statistically significant, so there is no conclusion about the effect of the duration that a farmer has resided in the locality, age and social position of household heads on the likelihood of credit rationing.

Criteria	Mean	SD	Min	Max
Age of household head (years)	51.62	12.31	20	80
Number of people per household	3.19	1.16	1	9
Schooling of household head (years)	6.34	3.32	0.00	16.00
Residence in the locality (years)	47.31	13.57	2	80
Area of agricultural land (m ²)	18,000	16.95	5,000	150,000
Distance to the nearest credit institution (km ²)	8.48	6.50	3	33
Formal loan (million dong/year)	23.82	52.92	0.000	575.000

Source(s): The authors' survey (2015)

Table I.
Characteristics of rice
farmers in the MRD

Criteria	Number of observations (farmers)	Total per cent
Non-rationed	298	25.52
Rationed	870	74.48
Total	1,168	100.00

Source(s): The authors' survey (2015)

Table II.
Status quo of the
access to credit of rice
farmers

Table III.
Determinants of credit
rationing facing rice
farmers

	Variable	Estimated coefficient	Z-value
C	<i>Constant</i>	1.1116***	3.69
Landvalue _{<i>i</i>}	Value of land (VND million)	−0.0003*	−1.95
Income _{<i>i</i>}	Income (VND million)	−0.0023**	−2.11
Residence _{<i>i</i>}	Residence in the locality (years)	0.0004	0.09
Age _{<i>i</i>}	Age of household head	−0.0056	−0.92
Education _{<i>i</i>}	Schooling of household head (years)	−0.0342**	−2.58
Gender _{<i>i</i>}	Gender of household head (male = 1)	0.2381*	1.81
Distance _{<i>i</i>}	Distance to the nearest credit institution (km)	0.0186***	3.16
Position _{<i>i</i>}	Position of household head (yes = 1)	−0.0466	−0.49
Experience _{<i>i</i>}	Number of years engaging in rice production	−0.0058	−1.25
Number of observations (<i>N</i>)		1,168	
Significance level		0.0000	
Log likelihood		−625.5982	
Note(s): (*), (**) and (***) designate statistical significance at the 10%, 5% and 1%, respectively			
<i>Dependent variable: creditrationing_{<i>i</i>}</i> (1 if there is credit rationing and 0 if otherwise)			
Source(s): The authors' survey (2015)			

*5.3 Impact of credit rationing on the amount of capital allocated to inputs
used by rice farmers*

According to [Table IV](#), the amount of capital allocated to fertilizer and hired labour is affected by credit rationing while that allocated to seed and pesticide is not, as expected. Specifically, both *fertilizer_i* and *hiredlabour_i* have negative coefficients at the same significance level of 1 per cent, which implies that when facing credit rationing, farmers tend to use less of those inputs. This finding is consistent with the theoretical background reviewed and identical to those of [Lee and Champer \(1986\)](#) and [Blancard et al. \(2006\)](#). Such an effect occurs since most rice farmers in the MRD improperly apply fertilizers well above the dosages recommended by rice experts and extension workers, which is a consequence of the fact that fertilization regimes have remained based on farmers' experience and habit but not been updated to match the nutrition demand of the plant and soil ([World Bank, 2017](#)). Rice farmers overuse fertilizers also because a lot of poor quality and cheap fertilizers are displayed for sales and traders tend to give inferior information to farmers for the former's own favour. When the amount of fertilizers applied drops because of credit rationing, the amount of labour hired also diminishes accordingly.

The coefficients of seed_i and pesticide_i are negative but not statistically significant, divulging that the amount of capital allocated to seed and pesticide is not influenced by credit rationing because farmers use these inputs rigidly for a fear of bad harvests that will certainly deprive them of income. This finding also reflects the fact that rice farmers in the MRD overuse seed, which results in such a high density that adversely affects yield while asking for more pesticide applied to control pests.

Table IV.
Impact of credit
rationing on the
amount of capital
allocated to inputs

Inputs	Estimated coefficient	t-value
Seed _i	-0.004	-1.162
Fertilizer _i	-0.029**	-2.265
Pesticide _i	-0.012	-0.815
Hiredlabour _i	-0.034***	-2.577
Note(s): (*), (**) and (***) designate statistical significance at the 10%, 5% and 1%, respectively		
Source(s): The authors' survey (2015)		

As mentioned previously, the amount of capital allocated to inputs for rice production depends on the degree of credit rationing facing the farmer. The influence of credit rationing on the amount of capital allocated to inputs is basically non-linear as a consequence of diminishing marginal productivity of inputs perceived by rice farmers.

To provide a more precise picture of the impact of credit rationing on the amount of capital allocated to inputs used by rice farmers, this paper uses the method conducted by [Ciaian *et al.* \(2012\)](#) to divide the sample into six categories with descending degrees of credit rationing. Specifically, the first category includes rice farmers with $0 \leq \text{borrowrate}_i < 0.2$, category 2 with $0.2 \leq \text{borrowrate}_i < 0.4$, category 3 with $0.4 \leq \text{borrowrate}_i < 0.6$, etc. [Table V](#) shows the estimated result received from comparing category 2 with category 1, category 3 with category 2, category 4 with category 3, etc.

[Table V](#) shows that only category 2 allocates more capital to the seed as compared to category 1 as the degree of credit rationing diminishes but the increase is of meagre magnitude because farmers use seed adamantly, as previously explained. Similar to the seed, the amount of capital allocated to pesticide increases as the degree of credit rationing reduces when comparing category 2 with category 1 because rice farmers heavily depend on this input for an expectation of protecting rice plants from being adversely infected by pests, especially given the obvious presence of climate change, leading to a recurrence of serious disease outbreaks that confront rice farmers with huge production risk.

Fertilizer and hired labour have positive coefficients with varying degrees of significance for all comparisons in [Table V](#). The amount of capital allocated to fertilizer increases as credit rationing drops but the magnitude of the increase is uneven since the amount of fertilizer applied depends on the growth stage of rice plants and the farmer's own judgement. All the comparisons for hired labour have positive coefficients, which means that when rice farmers face less severe credit rationing, they use more of hired labour to take care of their crop. This reflects the reality of rice production in the MRD that is basically labour intensive.

6. Conclusion

Credit rationing prevails for rice farmers in the MRD due to asymmetric information and limited liability. Credit rationing affects the amount of capital allocated to inputs used in rice production of farmers through the scale and substitution effects. These effects result in bad consequences for the natural environment of the region, the health of people as well as income of rice farmers overthere.

Based on the relevant theoretical background, this paper uses PSM to estimate the effect of credit rationing on the amount of capital allocated to inputs for rice production, concerning seed, fertilizer, pesticide and hired labour. The result shows that land value, income and level of education of household head contribute to relieving the degree of credit rationing facing rice farmers in the MRD. Meanwhile, rice farmers who are male or reside afar from credit insitutions tend to confront with more severe credit rationing. It is also found that the amount

Categories compared	Seed	Fertilizer	Pesticide	Hired labour
(2) vs (1)	0.020*** (3.189)	0.089*** (3.963)	0.078*** (3.317)	0.072*** (3.112)
(3) vs (2)	-0.002 (-0.049)	0.044*** (3.116)	0.005 (0.251)	0.024* (1.645)
(4) vs (3)	0.008 (1.204)	0.068** (2.542)	0.027 (0.094)	0.052* (1.886)
(5) vs (4)	0.010 (1.075)	0.049* (1.674)	0.020 (0.578)	0.077** (2.109)
(6) vs (5)	0.009 (0.922)	0.086*** (2.578)	0.005 (0.129)	0.126*** (3.477)

Note(s): (*), (**), (***) designate statistical significance at the 10%, 5% and 1%, respectively

Source(s): The authors' survey (2015)

Table V.
Impact of credit
rationing on capital
allocated to inputs

of capital allocated to fertilizer and hired labour decreases when credit rationing intensifies while that allocated to seed and pesticide is not influenced. When the degree of credit rationing varies, rice farmers adjust the amount of capital allocated fertilizer and hired labour accordingly but that allocated to seed and pesticide seem to be rigid.

It can be inferred from the results of the paper that rice farmers in the MRD need to reduce the amount of pesticide applied because they have used too much of it in rice production. Reducing the use of pesticide will relieve the pressure of credit rationing and debt for them. This also helps to reduce harmful effects of pesticide on the natural environment and the health of people. For this to become true, the government needs to enact strict regulations on using pesticide alongside with sanctions to contain the overuse of pesticide and to limit the production and import of toxic pesticide. The same thing should be done for the use of non-organic fertilizers in rice production. Meanwhile, rice farmers need to apply the programs called “3 reduction – 3 increase” and “1 must – 5 decrease”. They should also improve knowledge on acquiring and apply technological advances to rice production so as to raise rice yield and income.

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Corresponding author

Le Khuong Ninh can be contacted at: lekhuongninh@gmail.com

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