Impact of market access infrastructure on smallholder rice commercialization in Vietnam

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ABSTRACT

This paper quantifies the impacts of market access infrastructure on rice commercialization among smallholder farm households using data from the Vietnam Household Living Standards Survey from 2010 to 2020. Rice commercialization is conceptualized as a two-stage process consisting of market participation and commercialization intensity.

The results indicate that rice commercialization among Vietnamese households remains limited, with average marketed shares ranging from 25 to 28 percent over the study period. Market access and the quality of transport connectivity, including, the presence of local markets, and road connectivity, play a decisive role in households' decisions to participate in rice markets. Conditional on participation, however, commercialization intensity is driven mainly by household characteristics such as land size, household size, and income, while infrastructure effects are less consistent. The results also indicate heterogeneous effects of market distance across ethnic groups. Policies should combine targeted investments in market access infrastructure with measures that enhance households' productive capacity in order to increase marketed surplus. Using nationally representative data and a two-stage framework, this study provides new insights into the mechanisms underlying rice commercialization in Vietnam.

1. Introduction

Conceptually, agricultural commercialization is not merely the sale of surplus output after household consumption needs are met. It also reflects the extent to which farmers' production decisions are guided by market signals and comparative advantage (Jaleta et al., 2009; Wakaba et al., 2022). Accordingly, farm households that participate in markets tend to make decisions regarding production scale, crop choice, and resource allocation based on expected profitability and market demand. In contrast, subsistence-oriented households primarily focus on ensuring household food security and engage with markets only in a passive manner. This perspective highlights that commercialization is a multidimensional process that is closely associated with both the decision to participate in markets and the degree of such participation (Von Braun, 1995).

Previous empirical studies indicate that agricultural commercialization generates several tangible benefits. First, commercialization contributes to higher household income, which in

turn improves food security and nutritional outcomes by enabling households to access a more diverse range of foods through markets (Rubhara & Mudhara, 2019; Von Braun & Kennedy, 1994). Second, market participation encourages farmers to invest in production, expand production scale, enhance productivity, and create additional employment opportunities in rural areas (Rabbi et al., 2019; Yaseen et al., 2018; Zondi et al., 2022). Third, agricultural commercialization promotes the development of infrastructure and strengthens linkages within agricultural value chains, thereby supporting sustainable growth in the agricultural sector (Von Braun, 1995; Zhang et al., 2021).

In practice, the level of agricultural commercialization in developing countries remains generally low. Globally, approximately 500 million smallholder farm households provide livelihoods for more than two billion people, yet most of them continue to produce primarily for self consumption (Dube & Guveya, 2016). In sub Saharan Africa and many Asian countries, farmers typically sell only a small share of their output after harvest (Abafita et al., 2016; Ellis, 2000; Jayne et al., 2019).

Existing studies suggest that the determinants of agricultural commercialization can be classified into two broad groups. The first group consists of external factors, including geographical location, market institutions, extension services, access to credit, and rural infrastructure. Within this group, market access infrastructure is considered a central component, as it captures the physical and institutional conditions that shape households' ability to access output markets. In this study, market access infrastructure is operationalized through three dimensions: the presence of local market institutions, distance to markets, and transport connectivity. The second group comprises household specific factors, such as land endowments, labor availability, human capital, demographic characteristics, and livelihood strategies (Abafita et al., 2016; Endalew et al., 2020; Haile et al., 2022; Martey et al., 2012). From a transaction cost perspective, market access infrastructure plays a particularly important role by reducing both fixed and variable transaction costs, improving market connectivity, and strengthening incentives for households to engage in market-oriented production (Dorward et al., 2004; Fan & Chan-Kang, 2005).

However, empirical evidence on the role of market access infrastructure in agricultural commercialization remains inconclusive. Some studies find that long distances to markets and poor transport conditions constitute major barriers to both market participation decisions and the level of commercialization (Gebiso et al., 2023; Tura et al., 2016). In contrast, other studies report that these effects become less pronounced when general infrastructure conditions have improved (Abafita et al., 2016; Haile et al., 2022). This suggests that the impact of infrastructure may depend on spatial and temporal contexts as well as on the stage of farmers' decision making, an issue that has not yet been fully addressed in the existing literature

The Doi Moi reforms and subsequent trade liberalization policies have enabled Vietnam to transform from a food deficit country into one of the world's leading rice exporters (Fortier & Tran, 2013; Nguyen, 2019). Nevertheless, income among rice farming households remains unevenly distributed, and poverty continues to be concentrated primarily in rural areas (Benjamin et al., 2017; Schulte et al., 2023). Approximately 94.7 percent of the poor reside in rural areas, where agriculture remains the main source of livelihood (Schulte et al., 2023), and the risk of falling back into poverty persists in many regions (Ho et al., 2022; United Nations Development Programme [UNDP], 2018). Consequently, promoting rice commercialization is widely regarded as an important pathway for increasing farm household income and improving

the welfare of smallholder farmers.

Although several studies have examined agricultural commercialization in Vietnam, most of this literature focuses on specific agro ecological regions or particular household groups. These studies often do not clearly distinguish between the decision to participate in markets and the decision regarding the intensity of product sales. More recently, Nguyen et al. (2024) provide important evidence on the role of endogenous and exogenous factors in agricultural commercialization in mountainous areas. However, this study does not yet clarify differences in the two stages of decision making. This study analyzes the impact of market access infrastructure on the rice commercialization process of Vietnamese farm households over the period from 2010 to 2020, using the Vietnam Household Living Standards Survey. Rice commercialization is approached as a two-stage process that includes the decision to participate in markets and the intensity of commercialization following participation. Grounded in the transaction cost framework, the analysis emphasizes how variations in market access and local infrastructure shape the distribution of commercialization outcomes across households, rather than focusing solely on intrinsic household characteristics.

Building on the stated objective, this study addresses two research questions. First, how does market access infrastructure shape Vietnamese farm households' decisions to participate in rice markets? Second, conditional on participation, to what extent does market access infrastructure influence the intensity of rice commercialization at the household level? The findings of this study provide important policy insights for designing interventions that improve market access infrastructure and promote rice commercialization among smallholder farmers.

This study makes a contribution to the literature in three ways. To begin with, it distinguishes between market participation and commercialization intensity, allowing for a clearer understanding of how the role of market access infrastructure may vary across different stages of the commercialization process. In addition, rather than relying on a single proxy, the study adopts a multidimensional approach to measuring market access infrastructure, incorporating local market presence, distance to markets, and transport connectivity. Finally, by using nationally representative household data from Vietnam, the study offers new evidence on how commercialization patterns differ across ethnic groups and geographical contexts, thereby highlighting the uneven nature of market integration among smallholder farmers.

The rest of this paper is organized as follows. Section 2 presents the theoretical framework and a review of the relevant literature. Section 3 introduces the data and the empirical methodology. Section 4 presents and discusses the empirical results. Section 5 concludes by outlining the main findings, policy implications, and avenues for future research.

2. Theoretical background and literature review

2.1. Theoretical background

Development economics and agricultural economics theories indicate that the degree of smallholder commercialization does not merely capture a mechanical response to price signals. Instead, it is shaped fundamentally by transaction costs. Within the non separable agricultural household framework, when transaction costs are present, production, consumption, and market exchange decisions are jointly determined and cannot be treated as independent choices (Barrett & Swallow, 2006; Janvry et al., 1991; Singh et al., 1986). An important implication is that household commercialization can be interpreted as a two-stage decision process. The first stage concerns whether the household participates in output markets as a seller, while the second stage

concerns the intensity of sales conditional on participation.

Transaction cost theory provides a rigorous explanation for why many farm households either do not sell or sell only negligible quantities, even when prevailing market prices exceed unit production costs (Janvry et al., 1991). Building on this framework, Key et al. (2000) distinguish between proportional and fixed transaction costs. Proportional transaction costs rise with the quantity marketed and include, for example, transport expenses and costs associated with market imperfection. Fixed transaction costs are incurred regardless of sales volume and include activities such as acquiring market and buyer information and negotiating contractual terms. Proportional transaction costs drive a wedge between the farm gate price received by households and the market price, whereas fixed transaction costs generate a participation threshold. When marketed volumes are small, the expected gains from selling may be insufficient to offset fixed costs, leading households to rationally opt out of the output market (Goetz, 1992; Key et al., 2000).

Building on this framework, market access infrastructure can influence commercialization through several key channels. First, the presence of local market institutions, such as daily, periodic, or wholesale markets, reduces fixed transaction costs by lowering search costs and facilitating buyer and seller interactions. As a result, these factors are expected to have a stronger effect on the decision to participate in markets than on the intensity of sales. Second, distance to markets and the quality of transport connectivity affect proportional transaction costs. Greater distance increases transport costs and market risks, while improved road infrastructure enhances connectivity and reduces marginal transaction costs. These factors can therefore influence both the likelihood of participation and the volume of output sold. Third, improvements in infrastructure may alter local market conditions by increasing competition among buyers and reducing information asymmetries. This, in turn, can strengthen incentives for farm households to engage more actively in market transactions (Fackler & Goodwin, 2001; Poulton et al., 2010).

2.2. Literature review and research gap

Studies on agricultural commercialization show that it is a process shaped by both external factors and household-level characteristics. Recent studies also tend to distinguish between whether households select into market participation and the level of sales once they participate, particularly in contexts where smallholder farmers still maintain semi-subsistence production (Haile et al., 2022; Wakaba et al., 2022).

A strand of empirical research focuses on the role of Market access infrastructure and transaction costs. Renkow et al. (2004) develop a framework to measure fixed transaction costs among semi-subsistence households in Kenya and show that such costs are associated with market participation. Martey et al. (2012), in a study of smallholder commercialization in Ghana, apply a Tobit model to analyze the degree of commercialization for maize and cassava. Wakaba et al. (2022) examine commercialization and market participation among potato farmers in Kenya, highlighting transaction-related factors such as market distance as important determinants.

However, Gebremedhin et al. (2009) highlight the role of institutional services, including credit, input supply, and extension, alongside market conditions in shaping commercialization among smallholders in Ethiopia. Using a two-stage framework, Haile et al. (2022) show that the

factors influencing the decision to participate in markets differ from those determining the volume sold among maize farmers in Southwest Ethiopia. Zondi et al. (2022) likewise find that commercialization outcomes for indigenous crops reflect a combination of socioeconomic characteristics and Market access infrastructure.

In addition, household characteristics play an important role in agricultural commercialization. Gebremedhin et al. (2009) highlight the importance of production support services in facilitating commercialization, while Endalew et al. (2020) show that factors such as farm size, farming experience, and extension services are associated with wheat commercialization. Haile et al. (2022) further demonstrate that production factors and household characteristics influence both market participation and the quantity supplied.

Some studies explicitly document spatial heterogeneity and uneven Market access infrastructure across regions and groups. Abafita et al. (2016) show that households in remote areas and ethnic minority groups face more limited access to markets and information, which constrains their participation in market-oriented activities. Renkow et al. (2004) further link higher transaction costs to poor infrastructure and remoteness, while Gibson and Rozelle (2003) highlight how road access is associated with improved rural welfare. Using panel data, Dercon and Hoddinott (2005) also demonstrate that weaker linkages to market towns are associated with more constrained livelihood strategies.

In the context of Vietnam, Cazzuffi et al. (2020) use panel data to assess the impact of agricultural commercialization on rural household welfare in Vietnam. Schulte et al. (2023) examine the role of commercialization in asset accumulation and poverty reduction in rural areas. Nguyen et al. (2024) measure the level of commercialization and analyze its determinants among farmers in mountainous regions of Vietnam. While these studies provide important evidence, there remains a gap in analyzing the role of market access infrastructure across different stages of the rice commercialization process at the national level.

Based on the above discussion, this study addresses four main research gaps. First, it clarifies the differential role of market access infrastructure in shaping market participation decisions and commercialization intensity. Second, it adopts a multidimensional approach to measuring Market access infrastructure, including market presence, distance, and transport connectivity. Third, it provides national-level empirical evidence for Vietnam while accounting for heterogeneity across household groups and spatial contexts. Fourth, from a methodological perspective, existing studies often rely on single-equation models such as Tobit or OLS, which do not adequately address selection bias arising from farmers self-selecting into market participation. By applying a two-stage framework that models both the selection and outcome processes, this study provides more consistent estimates of commercialization intensity.

3. Data and methodology

3.1. Description of the study area

Vietnam offers a relevant empirical setting for examining agricultural commercialization in Southeast Asia. As a lower middle-income country undergoing rapid structural transformation, it has made substantial progress in market integration and rural infrastructure, while persistent regional disparities in development and market access remain. These contrasting conditions make Vietnam a suitable case for analyzing how market access infrastructure influence smallholder commercialization.

Vietnam is currently one of the world's leading agricultural exporters, with rice playing

a central role in the economy as well as in food security and rural livelihoods. However, the degree of rice commercialization among farm households varies substantially across agro - ecological regions. Descriptive statistics from the Vietnam Household Living Standards Survey (VHLSS) indicate, large scale rice producing regions oriented toward commercial production, such as the Mekong River Delta, typically report marketed shares of about 70 to 75 percent, while the Southeast region reaches approximately 55 to 60 percent. By contrast, other regions display much lower levels of commercialization, with marketed shares of around 25 to 30 percent in the Red River Delta, about 15 to 20 percent in the Central and Central Highlands regions, and only about 08 to 10 percent of total rice output being sold in the Northern mountainous areas of Vietnam.

3.2. Descriptive method of data analysis

This study uses data from the Vietnam Household Living Standards Survey for the years 2010, 2012, 2014, 2016, 2018, and 2020. These nationally representative surveys have been conducted by the General Statistics Office of Vietnam every two years since 2000 with technical assistance from the World Bank with both household and commune survey. The household survey collects detailed information about households, such as demographic information, education, employment and labor force participation, income, expenditure, health, housing, durable goods, fixed assets, and participation in poverty programs. The commune survey collects basic information regarding demography, socioeconomic characteristics, and the infrastructure of communes. In this study, the analytical sample is restricted to households that produce rice, as this group constitutes a substantial share of Vietnam's agricultural sector.

The study measures the degree of commercialization using a household commercialization index defined as the share of output sold on the market (Strasberg et al., 1999; Von Braun & Kennedy, 1994). The index is specified as follows:

$$HCI_{it} = \frac{\text{Total value of rice sold by household } i \text{ in year } t}{\text{Total value of rice produced by household } i \text{ in year } t} \times 100 \quad (1)$$

where: HCIit Household commercialization index of ith household in crop sales expressed as a percentage in year *t*. HCI has a value between zero and one hundred, inclusive. A value closer to zero would indicate a subsistence-oriented household and a value closer to one hundred imply a highly commercialized household.

3.3 Econometric analysis

The analytical framework consists of two stages. First, a selection equation is estimated using a Probit model to determine the probability that a household sells rice. Second, the commercialization intensity equation is estimated using Ordinary Least Squares. The explanatory variables included in the two equations are described in Table 1 and are estimated using the full sample of rice producing households. The two-stage structure of the model is specified as follows:

The selection equation is specified as:

$$Parti_{it}^{*} = Z_{it}\gamma + \delta_p + u_{it} \quad (2)$$

$$Parti_{it} = \begin{cases} 1 \; if \; Parti_{it}^{*} > 0 \\ 0 \; otherwise \end{cases} \quad (3)$$

where $Parti_{it}^{*}$is the latent variable representing the household's propensity to sell rice, $Parti_{it}$ is the observed market participation decision, and Z_{it} is a vector of explanatory variables included in the selection equation, δ_p denotes province fixed effects.

The intensity equation for commercialization intensity is specified as:

$$HCI_{it} = X_{it}\beta + \delta_p + \varepsilon_{it}, \qquad \text{if } Parti_{it} = 1 \tag{4}$$

where HCI_{it} is the household commercialization index, X_{it} is a vector of explanatory variables included in the outcome equation, and δ_p denotes province fixed effects.

Under the standard Heckman assumptions, the error terms u_{it} and ε_{it} are jointly normally distributed with correlation ρ. The expected value of the intensity equation conditional on market participation is given by:

$$E(HCI_{it} \mid Parti_{it} = 1, X_{it}, Z_{it}) = X_{it}\beta + \rho\sigma_{\varepsilon}\lambda(Z_{it}\gamma) \tag{5}$$

where $\lambda(Z_{it}\gamma)$ is the inverse Mills ratio. A statistically significant coefficient on the inverse Mills ratio indicates the presence of sample selection bias.

Province fixed effects are included in both the selection and commercialization intensity equations to control for unobserved, time-invariant provincial characteristics, such as agro-ecological conditions, market development, and institutional factors. These factors may affect both market participation and commercialization intensity; thus, their inclusion helps account for spatial heterogeneity and reduces potential estimation bias.

Although commercialization intensity is a fractional variable bounded between zero and one hundred, the intensity equation in the Heckman two-step model is specified as linear for methodological consistency. The classical Heckman framework assumes a linear outcome equation, allowing sample selection bias to be corrected through the inverse Mills ratio in a tractable manner. Since the intensity equation is estimated conditional on market participation, the commercialization ratio exhibits continuous variation within the unit interval and shows no mass points at the bounds. In this setting, the linear specification provides a reasonable approximation of the conditional expectation function and enables straightforward interpretation of marginal effects.

To identify the Heckman selection model, variables capturing the presence of local market institutions (daily, periodic, and wholesale markets) are included in the selection equation but excluded from the intensity equation as exclusion restrictions. Consistent with transaction cost theory, these variables primarily reduce fixed transaction costs associated with market entry, such as search and matching costs, and thus influence the decision to participate in rice markets rather than the intensity of commercialization conditional on participation.

Table 1

Summary of the Variable Description

Variables	Description	Category	Measurement	Expected sign	
				Market participation ***(Parti)***	**Intensity of participation** ***(HCI)***
Gender	Gender of the household head	Dummy	1: Male 0: Female	+/-	+/-
Age	Age of the household head	Continuous	Year	+/-	+/-
Edu	Highest grade completed by the household head (1–12)	Continuous	Year	+/-	+/-
Ethnic	Ethnicity of the household head (Kinh refers to the ethnic majority in Vietnam)	Dummy	1: Kinh[a] 0: Minority	+	+
Hhsize	Total number of household members	Continuous	Numeric	-	+/-
FarmUnion	Participation in the Farmers' Union	Dummy	1: Yes 0: No	+/-	+/-
WomenUnion	Participation in the Women's Union	Dummy	1: Yes 0: No	+/-	+/-

Variables	Description	Category	Measurement	Expected sign	
				Market participation ***(Parti)***	**Intensity of participation** ***(HCI)***
Poor	Whether the household is classified as poor in the survey year	Dummy	1: Yes 0: No	-	-
Income	Annual per capita income of the household	Continuous	Million VND[b]	+	+
Internet	Whether the household used the internet in the past 30 days	Dummy	1: Yes 0: No	+	+
Farmsize	Total cultivated land area of the household	Continuous	Hectare	+	+
Diversification	Whether the household diversifies into crops other than rice	Dummy	1: Yes 0: No	-	-
Credit	Whether the household has access to credit from a formal	Continuous	Million VND	+	+
Phone	Whether the household head uses a phone	Dummy	1: Yes 0: No	+/-	+/-

Variables	Description	Category	Measurement	Expected sign	
				Market participation ***(Parti)***	**Intensity of participation** ***(HCI)***
Computer	Whether the household head uses a computer	Dummy	1: Yes 0: No	+	+
Dmarket	Presence of a daily market within the village or hamlet	Dummy	1: Yes 0: No	+	+
Ddist	Distance to the nearest daily market	Continuous	Kilometres	-	-
Pmarket	Presence of a periodic market within the village or hamlet	Dummy	1: Yes 0: No	+	+
Pdist	Distance to the nearest periodic market	Continuous	Kilometres	-	-
Wmarket	Presence of a wholesale market within the village or hamlet	Dummy	1: Yes 0: No	+	+
Wdist	Distance to the nearest wholesale market	Continuous	Kilometres	-	-
InterRoad	Whether the village or hamlet has road access to the district or	Dummy	1: Yes 0: No	+	+

Variables	Description	Category	Measurement	Expected sign	
				Market participation ***(Parti)***	**Intensity of participation** ***(HCI)***
	province				
CommRoad	Presence of an internal commune road	Dummy	1: Yes 0: No	-	-
Ethnic_Ddist	Interaction between the ethnicity of the household head and distance to the daily market			-	+

Note. a Kinh is a majority ethnic in Vietnam; b Vietnamese Dong (VND). The researcher's data analysis

4. Result

4.1. Descriptive statistics of rice commercialization

Table 2

Descriptive Statistics Characteristics of Rice Producer Households

Variable names	2010	2012	2014	2016	2018	2020
Household Commercialization Index (HCI)	25.18 (32.80)	27.16 (33.63)	24.02 (32.87)	27.97 (36.08)	27.53 (35.60)	26.05 (35.20)
Gender (1:Male)	0.85 (0.35)	0.84 (0.36)	0.84 (0.37)	0.84 (0.36)	0.84 (0.37)	0.85 (0.36)
Age (year)	46.90 (12.95)	48.43 (13.02)	49.27 (13.20)	50.57 (12.63)	51.25 (12.20)	50.80 (12.38)
FarmUnion (1: Yes)			0.50 (0.50)	0.52 (0.50)	0.49 (0.50)	
WomenUnion (1: Yes)			0.09 (0.29)	0.09 (0.28)	0.09 (0.28)	
Internet (1: Yes)				0.09 (0.28)	0.26 (0.44)	0.47 (0.50)
Diversification (1: Yes)	0.27 (0.44)	0.28 (0.45)	0.29 (0.45)	0.24 (0.43)	0.23 (0.42)	0.22 (0.41)
Phone (1: Yes)	0.60 (0.49)	0.76 (0.43)	0.86 (0.34)	0.89 (0.31)	0.93 (0.26)	0.95 (0.21)
Computer (1: Yes)	0.05 (0.22)	0.06 (0.24)	0.09 (0.28)	0.09 (0.28)	0.08 (0.28)	0.08 (0.27)
Ethnic (1:Kinh)	0.71 (0.45)	0.72 (0.45)	0.72 (0.45)	0.75 (0.43)	0.70 (0.46)	0.66 (0.48)
Hhsize	4.22 (1.52)	4.13 (1.52)	4.13 (1.56)	3.95 (1.54)	3.94 (1.59)	4.00 (1.66)
Edu (Year)	6.73 (3.49)	6.89 (3.46)	6.95 (3.47)	7.13 (3.40)	5.68 (4.19)	5.76 (4.22)
Farmsize (Hecta)	0.63 (1.12)	0.67 (1.29)	0.62 (1.35)	0.38 (0.75)	0.62 (1.01)	0.59 (0.99)
Income (Million VND)	0.98 (0.95)	1.45 (1.15)	1.76 (1.40)	2.01 (1.48)	2.51 (1.76)	2.84 (2.16)
Credit (Million VND)	2.53 (6.88)	2.88 (8.12)	15.91 (43.28)	18.45 (47.00)	19.42 (44.58)	29.32 (144.91)
Poor (1: Yes)	0.15 (0.36)	0.17 (0.37)	0.16 (0.36)	0.15 (0.36)	0.12 (0.33)	0.09 (0.29)
Dmarket (1:Yes)	0.21 (0.41)	0.25 (0.43)	0.26 (0.44)	0.27 (0.44)	0.28 (0.45)	0.26 (0.44)
Ddist (kilometres)	4.64 (8.34)	4.15 (6.22)	4.43 (7.29)	4.07 (6.66)	4.07 (6.28)	4.75 (7.06)
Pmarket (1:Yes)	0.12 (0.32)	0.11 (0.31)	0.13 (0.33)	0.14 (0.34)	0.14 (0.35)	0.14

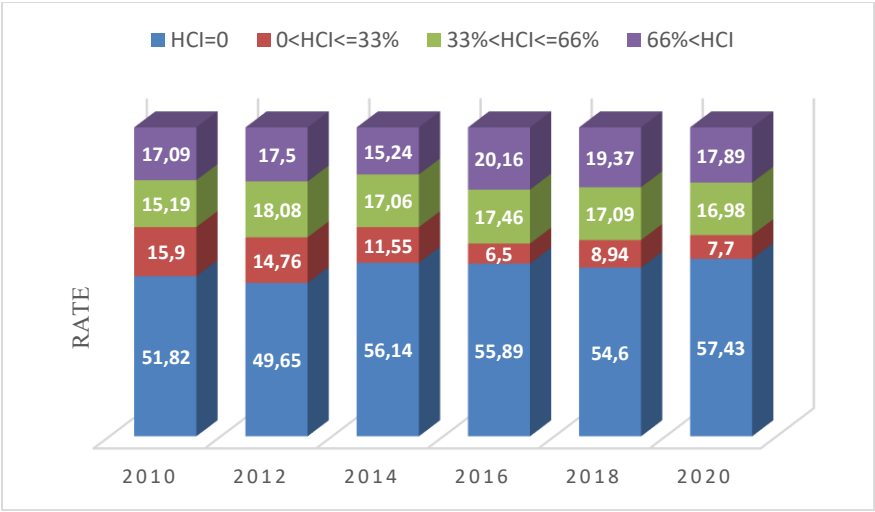
Variable names	2010	2012	2014	2016	2018	2020
						(0.35)
Pdist (kilometres)	3.39 (7.87)	3.03 (5.05)	4.23 (9.01)	3.35 (5.95)	3.81 (6.93)	4.53 (7.71)
Wmarket (1:Yes)	0.04 (0.20)	0.04 (0.19)	0.06 (0.24)	0.04 (0.20)	0.03 (0.17)	0.05 (0.21)
Wdist (kilometres)	10.58 (23.56)	9.25 (14.58)	10.88 (17.61)	10.12 (14.15)	11.52 (14.86)	12.19 (16.52)
InterRoad (1:Yes)	0.29 (0.45)	0.27 (0.44)	0.24 (0.43)	0.28 (0.45)	0.24 (0.43)	0.26 (0.44)
CommRoad (1:Yes)	0.73 (0.45)	0.73 (0.44)	0.79 (0.40)	0.80 (0.40)	0.81 (0.39)	0.82 (0.39)
Number of observations	3,792	3,617	2,848	10,573	12,309	10,966

Note. Standard deviations are reported in parentheses. Data source: VHLSS 2010-2020; authors' calculations. Blank cells indicate that the variable was not collected in the corresponding survey round

Table 2 shows that over the period from 2010 to 2020, the average level of rice commercialization among Vietnamese farm households remained relatively stable, fluctuating between 25 and 28 percent. This level reflects the widespread reality that most rice producing households continue to operate under a semi subsistence production system, in which rice is used both for household consumption and for sale on the market in limited proportions. The large standard deviations observed across years indicate substantial heterogeneity among households in their degree of participation in rice markets.

Figure 1

The Rate of Rice Commercialization by Households over the Years



Note. Authors' calculations using VHLSS data, 2010-2020

Figure 1 illustrates that more than 43 percent of households sell rice in the market. The share of households that do not engage in commercialization, defined as having an HCI equal to zero, consistently accounts for the largest proportion, ranging from 49.65 percent in 2012 to 57.43 percent in 2020. By contrast, households with a moderate level of commercialization, defined as having 33 percent < HCI ≤ 66 percent, remain relatively stable at around 15 to 18 percent. The share of highly commercialized households, with HCI greater than 66 percent,

shows a slight upward trend from 15.24 percent in 2014 to 20.16 percent in 2016, but does not exceed 20 percent in any year. These figures indicate that although Vietnam is one of the world's leading rice exporting countries, the proportion of farm households engaging in rice markets at a high level of commercialization remains limited. This pattern shows little change over the ten-year period, suggesting that households have not experienced a substantial transition from subsistence-oriented production toward large scale, market-oriented production.

4.2. Household rice market participation options

Table 3

Results of the Rice Market Participation Selection Equation

Independent variables	Years					
	2010	**2012**	**2014**	**2016**	**2018**	**2020**
Gender	-0.067	-0.101	-0.161	-0.017	-0.041	-0.049
	(0.077)	(0.077)	(0.118)	(0.062)	(0.059)	(0.043)
Age	0.001	0.001	0.003	0.004***	0.005***	0.002
	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
Edu	0.003	0.002	0.017	0.001	0.002	0.002
	(0.009)	(0.010)	(0.011)	(0.006)	(0.004)	(0.004)
Ethnic	0.364***	0.329***	0.135	0.348***	0.351***	0.141**
	(0.113)	(0.118)	(0.127)	(0.067)	(0.058)	(0.064)
Hhsize	-0.193***	-0.173***	-0.235***	-0.118***	-0.151***	-0.128***
	(0.020)	(0.021)	(0.023)	(0.011)	(0.010)	(0.010)
FarmUnion			0.056	0.065*	0.004	
			(0.063)	(0.033)	(0.030)	
WomenUnion			0.069	0.039	0.051	
			(0.136)	(0.073)	(0.072)	
Poor	-0.125	-0.119	-0.153	-0.085*	0.014	-0.017
	(0.082)	(0.082)	(0.093)	(0.051)	(0.049)	(0.059)
Income	-0.129***	-0.102***	-0.168***	-0.051***	-0.042***	-0.018**
	(0.041)	(0.028)	(0.030)	(0.012)	(0.010)	(0.008)
Internet				0.051	0.019	-0.049
				(0.056)	(0.037)	(0.036)
Farmsize	3.062***	3.601***	2.458***	2.731***	2.698***	2.775***
	(0.130)	(0.148)	(0.128)	(0.085)	(0.061)	(0.070)
Diversification	0.076	0.200***	0.260***	0.219***	0.191***	0.321***

Independent variables	Years					
	(0.060)	(0.061)	(0.066)	(0.036)	(0.033)	(0.037)
Credit	0.005	-0.002	0.001	-0.000	-0.001***	-0.000*
	(0.004)	(0.003)	(0.001)	(0.000)	(0.000)	(0.000)
Phone	-0.089	-0.041	0.071	0.038	0.025	-0.073
	(0.060)	(0.071)	(0.093)	(0.053)	(0.055)	(0.070)
Computer	-0.237*	0.157	-0.030	-0.007	0.098*	-0.017
	(0.127)	(0.114)	(0.112)	(0.058)	(0.053)	(0.058)
Dmarket	0.067	0.108	0.110	0.088**	0.030	0.130***
	(0.076)	(0.078)	(0.084)	(0.042)	(0.040)	(0.043)
Ddist	-0.020***	0.046	-0.013**	-0.028***	-0.010***	-0.016***
	(0.005)	(0.101)	(0.006)	(0.004)	(0.003)	(0.003)
Pmarket	0.213**	-0.082	-0.096	-0.123**	0.011	0.084*
	(0.089)	(0.088)	(0.102)	(0.051)	(0.046)	(0.047)
Pdist	-0.007*	-0.054	-0.006	-0.002	0.000	-0.002
	(0.004)	(0.103)	(0.005)	(0.003)	(0.002)	(0.003)
Wmarket	-0.280*	-0.016**	0.092	-0.056	0.160*	-0.041
	(0.145)	(0.007)	(0.139)	(0.084)	(0.088)	(0.077)
Wdist	-0.002	-0.000	0.005**	0.002	-0.002*	-0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
InterRoad	-0.127**	-0.065	-0.062	0.023	0.043	0.064*
	(0.061)	(0.062)	(0.071)	(0.036)	(0.034)	(0.036)
CommRoad	0.017	0.001	0.252***	-0.051	0.041	-0.000
	(0.059)	(0.061)	(0.076)	(0.040)	(0.037)	(0.040)
Ethnic_Ddist	-0.033***	-0.019	0.005	0.020**	0.005	0.009
	(0.013)	(0.012)	(0.015)	(0.008)	(0.006)	(0.006)
_cons	-0.632***	-0.854***	-0.460	-1.150***	-1.153***	-0.962***
	(0.240)	(0.252)	(0.283)	(0.185)	(0.152)	(0.162)
N	3,792	3,617	2,846	10,573	12,304	10,965

Note. The dependent variable is a binary indicator of market participation. The model is estimated using a Probit specification. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Data analysis result of the research

The estimation results show that the presence of a daily market (Dmarket) has a positive and statistically significant effect in some years, particularly in 2016 and 2020. This result is consistent with arguments in previous studies that Market access infrastructure and lower transaction costs can encourage farm households to participate in markets (Gebiso et al., 2023;

Renkow et al., 2004; Wakaba et al., 2022). In contrast, distance to daily markets (Ddist) has a negative and statistically significant effect in most years, consistent with empirical evidence showing that market distance is an important barrier to smallholder farmers market participation (Haile et al., 2022; Martey et al., 2012).

However, for other types of markets, the results are not consistent. The variables Pmarket and Wmarket change in both sign and statistical significance across years, while Pdist and Wdist generally do not have stable effects. This result is consistent with a group of studies suggesting that the impact of market access may weaken or become less clear after controlling for household characteristics and local conditions (Gebremedhin et al., 2009; Haile et al., 2022; Martey et al., 2012; Zondi et al., 2022). This indicates that the effect of each type of market depends strongly on the local spatial context and market structure.

Variables reflecting transport connectivity (InterRoad, CommRoad) also do not show a consistent pattern. This result is more cautious compared to studies emphasizing the positive role of roads and transport infrastructure in improving market access and rural welfare (Gibson & Rozelle, 2003; Nguyen, 2019). In other words, in the context of this study, the direct effect of market access infrastructure on the selection to sell rice is not stable across years.

Kinh households have a higher probability of participating in markets in most years. This result is consistent with studies emphasizing that households in remote areas or belonging to disadvantaged groups often face greater constraints in market access, information, and transaction conditions (Abafita et al., 2016; Renkow et al., 2004). The interaction term between ethnicity and distance to market is only significant in a few years and changes sign across periods, and therefore does not show a clear and stable pattern.

Other control variables show relatively stable results. Household size has a negative and statistically significant effect, while farm size has a strong and consistent positive effect. This result is consistent with studies suggesting that land size and production capacity are important conditions for generating surplus and participating in markets (Gebremedhin et al., 2009; Wakaba et al., 2022). Per capita income has a negative effect in most years, suggesting that households with higher income sources may be less dependent on selling rice. Meanwhile, diversifying into crops other than rice shows a positive and increasingly clear effect, consistent with evidence that diversification improves market participation (Gebiso et al., 2023; Wakaba et al., 2022).

4.3. Intensity of household participation in the rice market

Table 4

Results of the Rice Market Participation Intensity Equation

Independent variables	Years					
	2010	2012	2014	2016	2018	2020
Gender	-0.561	-0.204	-1.365	-0.453	-1.258	0.294
	(1.255)	(1.212)	(2.001)	(1.014)	(0.913)	(0.751)
Age	-0.065*	-0.016	-0.002	-0.029	-0.048**	-0.031
	(0.037)	(0.037)	(0.046)	(0.024)	(0.023)	(0.025)
Edu	0.083	0.164	-0.016	0.025	0.034	-0.027

Independent variables	Years					
	2010	2012	2014	2016	2018	2020
	(0.155)	(0.154)	(0.192)	(0.101)	(0.062)	(0.066)
Ethnic	2.607	0.915	3.414	3.501***	-1.048	-1.201
	(1.928)	(2.035)	(2.430)	(1.356)	(1.052)	(1.118)
Hhsize	-1.156***	-1.533***	0.015	-0.763***	-0.897***	-0.583***
	(0.326)	(0.308)	(0.396)	(0.197)	(0.169)	(0.173)
FarmUnion			1.758	0.063	0.524	
			(1.159)	(0.631)	(0.553)	
WomenUnion			-1.459	-0.252	2.230*	
			(2.477)	(1.315)	(1.227)	
Poor	-1.326	1.902	1.673	-1.800*	-0.276	1.091
	(1.638)	(1.511)	(1.834)	(1.023)	(0.984)	(1.209)
Income	0.709	1.147***	1.024**	0.945***	0.516***	0.151
	(0.632)	(0.400)	(0.460)	(0.203)	(0.156)	(0.133)
Internet				-0.244	0.668	1.428**
				(1.006)	(0.632)	(0.620)
Farmsize	1.830***	1.311***	0.553	0.990***	1.138***	1.232***
	(0.382)	(0.343)	(0.384)	(0.340)	(0.264)	(0.284)
Diversification	-0.714	-2.022**	-0.998	-3.302***	-1.590***	-0.284
	(1.041)	(1.027)	(1.244)	(0.687)	(0.595)	(0.668)
Credit	-0.127*	-0.052	-0.011	0.010*	-0.001	0.000
	(0.070)	(0.061)	(0.014)	(0.006)	(0.006)	(0.002)
Phone	-0.404	2.014*	-2.816	-1.109	-0.255	-0.153
	(0.980)	(1.147)	(1.729)	(0.989)	(1.026)	(1.266)
Computer	3.447*	0.741	0.398	0.779	0.192	1.545
	(1.985)	(1.719)	(1.975)	(0.962)	(0.862)	(0.993)
Ddist	-0.065	-0.292**	-0.103	-0.113	-0.111	-0.271***
	(0.104)	(0.131)	(0.135)	(0.091)	(0.072)	(0.074)
Pdist	-0.037	0.137	0.185*	-0.045	0.002	-0.011
	(0.075)	(0.124)	(0.102)	(0.059)	(0.041)	(0.045)
Wdist	0.021	0.049	-0.043	-0.054**	-0.037*	0.049**
	(0.029)	(0.037)	(0.039)	(0.023)	(0.019)	(0.019)
InterRoad	-0.638	0.342	-1.185	-0.967	1.507***	-0.635
	(0.986)	(0.989)	(1.283)	(0.605)	(0.576)	(0.603)
CommRoad	0.168	0.942	-3.125**	0.626	-0.129	-0.376
	(0.996)	(0.997)	(1.437)	(0.700)	(0.664)	(0.750)
Ethnic_Ddist	0.276	0.350	0.600**	0.095	0.198*	0.405***
	(0.215)	(0.220)	(0.270)	(0.150)	(0.119)	(0.121)
_cons	52.088***	50.016***	58.455***	70.773***	65.221***	69.706***
	(4.441)	(4.355)	(5.377)	(4.740)	(2.857)	(3.179)

Independent variables	Years					
	2010	2012	2014	2016	2018	2020
IMR (Inverse Mills Ratio)	-10.405***	-12.159***	-19.621***	-10.241***	-14.554***	-15.043***
	(1.420)	(1.320)	(1.804)	(1.027)	(0.818)	(0.850)
N	3,792	3,617	2,846	10,573	12,304	10,965

Note. The dependent variable is the household commercialization index (HCI), measured as the share of output sold. The model is estimated using the second stage of the Heckman selection model. The inverse Mills ratio (IMR) is included to correct for potential sample selection bias arising from non-participation in markets. A statistically significant coefficient on the IMR indicates the presence of selection bias. Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Data analysis result of the research

The results of the commercialization intensity equation indicate that the effect of market access infrastructure on the share of output sold is less stable than its effect on the participation decision. Distance to daily markets (Ddist) has a negative and statistically significant effect in some years, particularly 2012 and 2020, consistent with Haile et al. (2022). However, this effect is not consistent across all years, suggesting that distance plays a weaker role in determining commercialization intensity than in the decision to participate in the market.

For other types of markets, Pdist and Wdist show unstable signs and statistical significance, indicating that the effect of market access on commercialization intensity is not clear. This finding is in line with studies suggesting that the impact of market access may weaken after controlling for household characteristics and local conditions (Gebremedhin et al., 2009; Haile et al., 2022; Zondi et al., 2022).

InterRoad is positive and significant only in 2018, while CommRoad is negative in 2014 and insignificant in other years. These results are more cautious than those of Gibson and Rozelle (2003) and Nguyen (2019), who emphasize the positive role of roads in improving market access, local market development, and rural welfare. This difference may arise because the present study focuses on commercialization intensity conditional on market participation, rather than the overall effects of transport infrastructure.

Regarding household characteristics, household size has a negative and significant effect in most years, consistent with Haile et al. (2022). In contrast, farm size has a strong and consistent positive effect, aligning with studies highlighting the role of land size and production capacity in generating marketable surplus (Gebremedhin et al., 2009; Nguyen et al., 2024; Wakaba et al., 2022).

Per capita income has a positive and significant effect in several years, indicating that better-off households tend to sustain higher sales levels. In contrast, livelihood diversification has a negative effect in some years (2012, 2016, 2018), suggesting that allocating resources to other activities may reduce the share of rice sold.

The interaction between ethnicity and distance to markets (Ethnic_Ddist) is positive and significant in 2014, 2018, and 2020, implying that the effect of distance on commercialization intensity differs across ethnic groups. For Kinh households, greater distance is associated with higher commercialization intensity, suggesting that only households with sufficient surplus can overcome transaction costs and, once participating, tend to sell a larger share. For other ethnic groups, distance does not generate a similar positive effect, reflecting a greater reliance on

informal outlets or subsistence-oriented production. However, as this effect is not consistent over time, it should be interpreted with caution.

Notably, the Inverse Mills Ratio (IMR) is negative and statistically significant in all years. In the Heckman framework, the IMR is derived from the selection equation and included in the intensity equation to correct for sample selection bias. The negative sign indicates a negative correlation between the error terms of the two equations, meaning that unobserved factors increasing the likelihood of participation are associated with lower commercialization intensity. This confirms the presence of selection bias and supports the use of the Heckman model to obtain consistent estimates.

5. Conclusion

This study examines the role of market access infrastructure in the commercialization of rice among smallholder farmers in Vietnam, approaching from two aspects: the selection to participate in markets and the intensity of commercialization. The results show that the level of rice commercialization remains relatively low and changes only slightly over the period 2010 - 2020, reflecting the common characteristic of semi-subsistence production in rural areas.

The empirical results indicate that market access infrastructure has a clearer effect on the decision to participate in markets than on commercialization intensity. The presence of a local market tends to increase the probability that smallholder farmers sell rice, while greater distance to markets reduces the likelihood of participation in many years. However, for commercialization intensity, these factors do not show consistent effects, implying that once smallholder farmers participate in the market, the share of output sold depends more on production capacity and household characteristics. In addition, ethnic minority households located farther from markets tend to face greater disadvantages in both market participation and commercialization intensity. Although the effect is not consistent across all years, it points to persistent constraints related to remoteness and limited market access among these groups.

Based on these findings, the study suggests several policy directions. First, priority should be given to developing and improving the effectiveness of local markets, rather than focusing only on large-scale transport infrastructure, which shows unstable effects on commercialization intensity. Second, to enhance commercialization intensity, priority should be given to reducing transaction costs for smallholders through the organization of village-level collection points, mobile procurement services, standardization (post-harvest grading (drying, storage)), and the provision of real-time price information. These interventions help aggregate output, reduce per-unit marketing costs, and improve access to buyers without requiring land expansion. These interventions are consistent with the evidence that farm size and internal consumption pressure are key factors determining commercialization intensity. Third, support programs should be differentiated across household groups: for smallholder farmers located far from markets or belonging to ethnic minorities, it is necessary to strengthen market channels, information access, and intermediary services; while for smallholder farmers already participating in markets, support should focus on improving production scale and efficiency to increase the share of output sold.

In addition, the study has several limitations. The VHLSS data used are nationally representative repeated cross sections, which do not allow the analysis to track commercialization dynamics for the same household over time. The infrastructure variables mainly capture presence and distance and therefore do not fully reflect the quality of market connectivity. The analysis focuses on rice, so the findings may not generalize to agricultural

products with higher commercial value.

Future research could employ panel data, incorporate more detailed spatial information, or extend the analysis to other crops in order to better clarify how the role of infrastructure evolves in Vietnam's agricultural commercialization process. Finally, the results reveal substantial differences across ethnic groups and agro ecological regions, pointing to the need for deeper inquiry into commercialization under conditions of spatial and social inequality. Subsequent studies could focus on specific vulnerable groups to inform more targeted and effective policy interventions.

SCIENTIFIC CONTRIBUTION

The manuscript clearly identifies a research gap; the manuscript provides new datasets or empirical evidence; the manuscript presents statistically and practically significant findings; the manuscript offers policy/managerial/technological implications.

AUTHOR CONTRIBUTIONS

CRediT: **Tran Le Dieu Linh**: Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization; **Truong Dang Thuy**: Methodology, Formal Analysis, Writing - Review & Editing, Visualization.

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