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［報告論文］

Linkages between Farm and Non-farm Sectors: Evidence from Vietnam

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Abstract

This study examines the relation between farm household participation in non-farm activities and agricultural expenditures in Vietnam. We assess the expenses for purchased inputs (such as seeds, fertilizer, breed, feed, herbicide, and pesticide), hired machines, and hired labor by using data from the Vietnam Living Standards Survey 2012. The Instrumental Variables (IV) Tobit approach is applied in our study to obtain a corner solution for the dependent variables and treat the endogeneity problem. We find that household participation in the non-farm sector has a positive and significant impact on agricultural expenses. The results of the average partial effect of non-farm income on agricultural inputs expenses indicate that an additional VND of non-farm income leads to a 0.412 VND increase in agricultural inputs spending. However, our findings show that farm households only use a small proportion of the non-farm income for hiring machines and labor. The results also indicate that the earnings from non-farm activities could relax liquidity constraints through investments in agricultural production. This suggests the existence of a significant synergy between agriculture and non-farm sectors.

Keywords : Vietnam, non-farm sector, agricultural input expenditure, credit constraint, liquidity constraint

1. Introduction

In recent years, rural areas in developing countries have witnessed the contraction of agriculture relative to the size of the rural economy. The progressive transformation of the rural economy is considered an essential feature of the economic development of these areas. The growth in the share of non-farm income in rural households confirms the increased importance of the rural non-farm economy.

The literature argues that households participate in non-farm activities due to pull and push factors. The "pull factors" are at play when non-farm activities offer a higher return compared to farm activities (Barrett et al., 2001). The "push factors" drive households to undertake rural non-farm activities in the presence of certain conditions. Sometimes, farm income is not sufficient to supply sufficient livelihood (Minot et al., 2006), and the

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risks of farming or limited risk-bearing capacity of households may induce household members to engage in non-farm activities to hedge against income and consumption uncertainties (Reardon, 1997; Barrett et al., 2001). Participation in non-farm activities also increases in the absence or failure of credit markets, as households have no choice but to pay for farm inputs with their cash resources (Reardon, 1997).

Although the agricultural sector still plays a central role in rural development, the promotion of complementary engines for rural growth is essential (Davis et al., 2010). The credit and insurance markets are often inadequate and, in some cases, absent in the rural areas of many developing countries. Hence, the role of the non-farm sector is not only consumption smoothing but also relaxing credit constraints on the agricultural production of farm households. In recent years, the relation between agriculture and non-farm sectors has been the primary concern of development economics. Empirical evidence suggests that the income from non-farm activities can provide the capital for farm investments in the case of failure of credit markets or lack of an adequate insurance market (Pfeiffer et al., 2009; Hertz, 2009).

Research on the linkages between the non-farm sector and agricultural inputs use or farm investment has flourished in several countries. The positive relation between non-farm participation and the acquisition of productive agricultural assets has been explored in many countries, including Nigeria, Ghana, Mexico, Bulgaria, the Philippines, and Vietnam (Hertz, 2009; Oseni and Winters, 2009; Pfeiffer et al., 2009; Stampini and Davis, 2009; Takahashi and Otsuka, 2009; Anríquez and Daidone, 2010). Pfeiffer et al. (2009) investigated the impact of off-farm income on agricultural production in Mexico and found that off-farm income has a positive impact on the use of purchased inputs. Oseni and Winters (2009) uncovered a positive and significant relation between non-farm income and participation and crop expenses in Nigeria and, in particular, the payment for hired labor and inorganic fertilizer. Similarly, Anríquez and Daidone (2010) analyzed the effect of non-farm activity on the farm production cost and demand for farm inputs in Ghana. Their results indicate that rural non-farm activity provides significant cost complementarities for the farm sector, and the expansion of non-farm activities increases the demand for farm inputs. Hertz (2009) also found a positive relation between non-farm income and farm input expenditures in Bulgaria. He noted that this is consistent with the presence of a farm credit constraint that induces farmers to fund farm expenditures with non-farm income. Takahashi and Otsuka (2009) showed that the growth in the rural non-farm sector increased investment in tractors in the Philippines. In all these cases, the growth of the non-farm sector is mainly driven by farm credit constraints, which induce the necessity of alternative sources of liquidity (Davis et al., 2009).

However, in Albania and Kenya, non-farm employment has been found to have a negative impact (Albania, Kilic et al., 2009; Kenya, Mathenge et al., 2015) on farm input expenditures. In both cases, non-farm employment was considered an alternative to the intensification of farming. Farm households from low-income countries such as Kenya are almost poor; hence, the earnings from non-farm employment are used for household consumption. In these contexts, investing in agricultural production is difficult because households' income is used to ensure food security rather than improve agricultural income. Albania is a representative case of a middle-income country, which is less restricted on credit issues. The credit market, insurance market,

and labor market of middle-income countries are rather developed; thus, the use of non-farm income for investment in agricultural production may not be necessary.

In Vietnam, the *Doi Moi* policy has promoted rural economic transformation and an expansion of the non-farm sector in the rural economy. The openness and liberalization of Vietnamese markets after the reform played an essential role in the development of the non-farm sector. Agriculture grew less rapidly than the rest of the rural economy. The impact of rural households' participation in non-farm activities on agricultural production remains unclear. Therefore, the objective of this research is to investigate whether non-farm income facilitates household spending on agricultural inputs in rural Vietnam. A few studies have previously addressed this issue in the context of Vietnam. In particular, the research of Stampini and Davis（2009）was on the relationship between participation in nonagricultural labor activities and the use of inputs, and De Brauw（2010）investigated the effects of seasonal migration on agricultural production. However, both studies only evaluated the situation of Vietnam during the 1990s, just after the reform, when the non-farm sector had not developed or become popular. The transformation of the rural economy has accelerated in recent years due to the fruitful integration between the Vietnamese economy and new development policies. Hence, in this study, we focus on the experience of Vietnam after 2012.

The remainder of this article is organized as follows. Section 2 discusses the empirical methodology. The third section describes the data used in this study. In Sections 4 and 5, we present the results and provide our conclusive remarks, respectively.

2. Empirical methodology

2.1. Econometric model

The objective of our analysis is to examine the relation between the participation in non-farm employment and agricultural production. Our study concentrates on agricultural input expenses for all farm production activities and addresses three primary sectors: agriculture, forestry, and aquaculture. The dependent variables for input expenses are expressed in purchased inputs, hired machines, and hired labor. The primary explanatory variable is the non-farm income of farm households.

The value of input expenses can be equal to zero because some farm households use self-supplied inputs and do not hire machines and labor. Hence, some observations take a value equal to zero with a positive probability, but the dependent variable is a continuous random variable over strictly positive values（Wooldridge, 2013）. To deal with the zeroes dependent variables, we applied the Tobit model for a corner solution response. The structural equation in the Tobit model reads as follows:

$$y_i^* = \boldsymbol{\beta X_i} + \varepsilon_i, \quad (1)$$

where, $\varepsilon_i \sim N(0, \sigma^2)$, and $y*$ is a latent variable that is observed for values greater than zero. The observed yi is defined as:

$$y_i = \begin{cases} y^* \; if \; y^* > 0, \\ 0 \; if \; y^* \leq 0. \end{cases}$$

Hence, the relation between the non-farm sector and agricultural input expenses is calculated by the following regression equation:

$$Input\_exp_i = \beta_0 + \beta_1 NF_i + \boldsymbol{\beta_2 Z_i} + \varepsilon_i, \quad (2)$$

where $Input\_exp_i$ represents agricultural input expenses for purchased inputs, hired machines, and hired labor.

NF_i is the non-farm income in the total earnings from non-farm jobs of all members of a household in million VND. The coefficient β_1 indicates the marginal effect of the non-farm income.

$\boldsymbol{Z_i}$ is a vector of variables that comprises the socio-economic characteristics of the *i*-th farm household and regional dummy variables. Z_{i1} is the household head's gender dummy variable, which takes a value equal to one if the head of the household is male. Z_{i2} is the household head's age. Z_{i3} is the education level of the household head, denoted by the number of completed years of schooling. Z_{i4} is the household size, namely, the total number of members of the household. Z_{i5} is an ethnicity variable: it is a dummy variable that equals one if the household head is of *Kinh* ethnicity, the dominant racial identity of Vietnamese people, and zero for other minority ethnicities. Z_{i6} is the number of male workers in the household, and Z_{i7} is the number of female workers. Z_{i8} represents the size of farmland. We also introduced regional dummy variables in the model, and we choose Midland and Northern Mountainous Areas as the base region. ε_i is the error term.

The participation in non-farm activities is not exogenously determined in our model specification. The possible endogeneity of non-farm participation could influence agricultural input expenditure, thus leading to inconsistent estimation results. The endogeneity problem implies that non-farm variables (NF_i) are correlated with the error term (ε_i). To treat this problem, we apply the instrumental variables (IV) approach. The IV framework tries to identify variables that are uncorrelated with ε_i but correlated with non-farm income variables and have no direct effect on agricultural input expenses. In other words, each instrument needs to satisfy two conditions, namely, instrumental relevance and instrumental exogeneity. This enables consistent estimation. A single endogenous regression equation estimates the relation between the instruments and non-farm income, as follows:

$$NF_i = \lambda_0 + \boldsymbol{\lambda_1 Z_i} + \boldsymbol{\lambda_2 I_i} + \mu_i, \quad (3)$$

where NF_i and $\boldsymbol{Z_i}$ have been previously defined, $\boldsymbol{I_i}$ is a vector of instruments, and μ_i is the error term.

μ_i is uncorrelated with ε_i. Hence, we can express it as: $\varepsilon_i = \alpha\mu_i + \xi_i$, where $\xi_i \sim N(0; \sigma^2_{\varepsilon|\mu})$, as ξ_i is uncorrelated with μ_i and has zero mean. This approach jointly estimates two equations using maximum likelihood (Kilic et al., 2009). The likelihood function for the Tobit model with endogenous regressor is expressed as follows:

$$lnL_i = \ln f(y_i|NF_i, \boldsymbol{Z_i}, \boldsymbol{I_i}) + lnf(NF_i|\boldsymbol{Z_i}, \boldsymbol{I_i}), \quad (4)$$

where f(·) is the joint density.

Finally, the IV-Tobit is applied in our study to determine the corner solution for the dependent variables and treat the endogenous regressor.

2.2. Instrumental variables

We identified three instruments that satisfy the two conditions mentioned above. The first instrument, *factory/manufacture location*, is a dummy variable that takes a value equal to one if communes have a factory or manufactory or traditional occupation village located nearby, and zero otherwise. The proximity of a factory or traditional occupation village to the commune facilitates the participation of households in non-farm employment.

The second instrument, *Time_Town*, is the time distance from the commune to the nearest town by private or public transportation. The last instrument, *Time_City*, is the time distance from the commune to the nearest city or provincial capital. These variables could explain the potential household's opportunities for participation in non-farm employment, which depends on whether they live near a town or city and the convenience of the travel time. The relevant data were obtained from the commune survey of VHLSS 2012, conducted on 2,218 communes. However, several surveys reported incomplete answers, which led to a

significant reduction in the sample size of both communes and households.

2.3. The average partial effect

The partial effects of Tobit models are less straightforward than those obtained by a linear model because the Tobit is non-linear. According to Wooldridge (2013), in the Tobit or IV Tobit models, the partial effect on the expected value (censored and uncensored observations) is calculated as follow:

$$\frac{\partial E(y|\boldsymbol{X})}{\partial X_i} = \Phi\left(\frac{\boldsymbol{X\beta}}{\sigma}\right)\beta_i, \quad (5)$$

where $\Phi(\cdot)$ represents the cumulative normal distribution function.

$\Phi(\boldsymbol{X\beta}/\sigma)$ is the scale factor and is always between zero and one because $0<\Phi(\boldsymbol{X\beta}/\sigma)<1$ for any values of the explanatory variables.

X is a vector of explanatory variables, and σ is $\sigma_{\varepsilon|\mu}$.

The average partial effect (APE) indicates a unit change in an independent variable X_i that affects all zero and non-zero observations and can be computed as follow:

$$APE = n^{-1}\sum_{i=1}^{n}\Phi\left(\frac{\boldsymbol{X\beta}}{\sigma}\right)\beta_i. \quad (6)$$

3. Data

Table 1: Descriptive statistics of the variables used in the analysis

	Explanation	Whole country
Dependent variables		
Purchased inputs	The total purchased inputs expenses including seed, young animals, fertilizer, feed, herbicide, pesticide, and medicines (million VND)	19.95
Hired Machine	Hired machines cost (million VND)	1.65
Hired Labor	Hired labor cost (million VND)	2.42
Household socio-economic characteristics variables		
Head's gender	male=1, female=0	0.83
Head's age	Years	48.92
Head's education	Completed years of schooling	6.68
Household size	Number of household members	4.04
Ethnicity	*Kinh*=1, other ethnicity=0	0.74
Male labor	Number of male workers	1.22
Female labor	Number of female workers	1.43
Land		
Farm land	Hectare (including crop land, forest land, water surface, garden, and shifting cultivation farm land)	0.86
Non-farm variable		
Non-farm income	Million VND	40.94
Regional dummy variables		
RRD	Red River Delta	0.22
MNM	Midland and Northern Mountainous (base region)	0.24
NCC	Northern and Central Coast	0.24
CHL	Central Highland	0.07
SEA	Southeastern Area	0.05
MRD	Mekong River Delta	0.18
Instrumental variables		
Factory/manufacture location	The factory or manufactory or traditional occupation village is located near the commune from which people commute every day. Yes=1, no=0.	0.65
Time_Town	The time distance from the commune to the nearest town (minute)	31.79
Time_City	The time distance from the commune to the nearest city (minute)	86.58
Number of observations		4,823

1) Source: VHLSS 2012.

2) VND is Vietnam's currency (Vietnamese Dong).

3) 1 million VND = 47.62 US$ in 2012 (calculated based on *tradingeconomics.com*).

All data used in this study are from the Vietnam Living Standards Survey 2012 （VHLSS, 2012） conducted by the General Statistics Office of Vietnam. This survey was arranged in collaboration with the World Bank. The sample used by the survey was stratified by urban and rural regions. In this study, we only use the rural data. There are 6,696 rural households in the survey. However, this article only focuses on the rural farm households that participate in agricultural, forestry, and aquaculture activities. We aggregate the three primary sectors （agriculture, forestry, and aquaculture） to evaluate the effect of non-farm employment on all farm activities, not only on a specific sector. Some farm households in the survey report missing values for agricultural family labor and are, therefore, discarded. These missing values exist due to some households, the agricultural activity is not the primary nor the second main job. Therefore, those households were not investigated. In addition, we rely on the VHLSS（2012） for the identification of suitable instrumental variables （IVs）. The commune survey collects the socio-economic characteristics of the communes, which can be used as instruments in our models. The final number of households in this study is 4,823.

Table 1 reports the descriptive statistics for the dependent and independent variables included in the analysis as well as the general characteristics of the farm households in the country.

4. Results

4.1. First-stage regression

Table 2: First stage regression

	Non-farm income	
	Estimation	S.E.
Household characteristics		
Head's gender	-2.479	[1.57]
Head's age	0.149***	[0.05]
Education	2.075***	[0.18]
Household size	5.449***	[0.58]
Ethnicity	13.081***	[1.58]
Farm land	-5.407***	[0.49]
Male labor	9.974***	[1.07]
Female labor	5.812***	[1.22]
Regional dummy (base region = MNM)		
RRD	8.573***	[2.13]
NCC	-3.241*	[1.70]
CHL	-10.994***	[1.82]
SEA	9.108***	[3.39]
MRD	-2.796	[1.86]
Instrumental variables		
Time_Town	-0.057**	[0.02]
Time_City	-0.025**	[0.01]
Factory/manufactory location	7.787***	[1.26]
Constant	-27.043***	[4.33]
Number of observations	4823	
R^2	0.25	
F-test for instruments	22.96***	

1) ***,**,* indicate statistical significant at 1%, 5%, 10% level, respectively.

2) RRD: Red River Delta, MNM: Midland and Northern Mountainous, NCC: Northern and Central Coast, CHL: Central Highland, SEA: Southeastern Area, MRD: Mekong River Delta.

3) Values in parentheses indicate robust standard errors.

4) Author's estimation.

The table 2 reports the first stage regression estimation of the non-farm income equation. It shows the relevance of the instruments. The result indicates that three instrumental variables（Time_Town, Time_City, and factory/manufactory location）are highly significant. As expected, the time distances from the commune to the nearest town and city have a negative impact on non-farm income. The location of factory or manufactory near the commune is positively associated with non-farm income. The F-test demonstrates the relevance condition of all instruments. The result of this test is 22.96（greater than 10）which indicates that these instruments are strong instrumental variables.

4.2. The effect of non-farm income on agricultural inputs expense

The results regarding the influence of the non-farm income on agricultural input expenses are presented in Table 3. As discussed above, we examine the impact of non-farm activities on purchased inputs, hired machines, and hired labor expenses for agricultural production. We compute the robust standard errors clustered at the commune level to avoid the intragroup correlation. The number of observations equal to zero for purchased inputs, hired machines, and hired labor expenses is 123, 1,918, and 2,429, respectively. Both the Two Stage Least Square（2SLS）and IV Tobit estimations address all three kinds of agricultural inputs expenditures. In the 2SLS model, robust standard errors are indicated in the estimation. The results show that non-farm income only has a positive effect on purchased agricultural inputs and hired machines cost, while the coefficient on hired labor is not statistically significant. The coefficients on purchased inputs in both 2SLS and IV Tobit regressions are nearly equal. On the other hand, these figures are different for hired machines and hired labor. This may reflect the fact that the number of observations equal to zero for hired machines and hired labor is large, while this figure for purchased inputs is small.

The results of the IV Tobit model indicate that the coefficients on the non-farm income variables for all three agricultural expenses are positive and significant. The coefficients on purchased inputs, hired machines, and hired labor are 0.524, 0.237, and 0.167, respectively. This indicates that the earnings from non-farm activities have a positive effect on agricultural input expenses, hiring machine cost, and hired labor cost in farm households in Vietnam.

The coefficients on the male labor variable are negative in the hired machines and hired labor models, while the coefficient on female workers is only significant in the hired machines model. This indicates that a higher number of male family workers reduces the cost of hired machines and hired labor. Thus, male labor seems to be the primary source of labor for farm activities. In addition, agricultural expenses increase when the cultivated land size increases.

The parameters of household head's gender show that head's gender has no effect on the purchasing inputs, while male household head tends to spend more on hiring machines and hiring labor for agricultural production activity. The age of household head also does not influence the purchasing inputs. However, households whose head are older less spending on hired machine and hired costs than younger ones. The education level of household head seem to not effect on the agricultural expenses. The coefficients of household size indicate that large farm households spend less hired machines and hired labor costs. The result of ethnicity variable shows a positive significant in cases of purchased inputs and hired labor. It means that *Kinh* households

Table 3: Effect of non-farm activities on agricultural input expenses

Independent variables	Purchased Inputs		Hired Machines		Hired Labor	
	2SLS	IV Tobit	2SLS	IV Tobit	2SLS	IV Tobit
Non-farm variables						
Non-farm income	0.501***	0.524***	0.044***	0.273***	0.034	0.167**
	[0.13]	[0.14]	[0.01]	[0.07]	[0.03]	[0.08]
Household socio-economic characteristics variables						
Household head's gender	2.421	2.834	0.184	0.923*	0.427	2.427***
	[2.53]	[2.59]	[0.15]	[0.54]	[0.33]	[0.85]
Household head's age	-0.099	-0.084	-0.005	-0.045**	-0.036**	-0.066**
	[0.08]	[0.09]	[0.01]	[0.02]	[0.01]	[0.03]
Education	-0.301	-0.176	-0.084**	-0.548***	-0.06	-0.303*
	[0.34]	[0.36]	[0.04]	[0.16]	[0.09]	[0.20]
Household size	-1.405	-1.476	-0.079	-1.276***	-0.136	-1.076**
	[0.82]	[0.88]	[0.09]	[0.39]	[0.20]	[0.46]
Ethnicity	8.943**	8.713**	0.189	-2.301**	2.536***	2.871*
	[2.82]	[3.03]	[0.35]	[1.28]	[0.62]	[1.56]
Farm land	10.088***	10.812***	1.372***	2.927***	2.349***	4.786***
	[1.16]	[1.22]	[0.19]	[0.52]	[0.38]	[0.73]
Male labor	-1.397	-1.778	-0.368**	-2.544***	-0.456	-1.663**
	[2.24]	[2.32]	[0.18]	[0.78]	[0.43]	[0.99]
Female labor	-0.443	-0.343	-0.233	-1.435***	-0.137	-0.173
	[2.15]	[2.22]	[0.15]	[0.59]	[0.43]	[0.81]
Regional dummy (base region = MNM)						
RRD	-7.875**	-8.246**	0.843***	-0.107	0.291	1.256
	[3.88]	[3.98]	[0.26]	[1.02]	[0.53]	[1.36]
NCC	-7.241***	-7.963***	0.887***	2.443***	1.046*	4.674***
	[2.53]	[2.60]	[0.17]	[0.63]	[0.46]	[1.30]
CHL	10.414***	10.071**	0.915***	4.166***	4.288***	11.428***
	[2.54]	[2.61]	[0.25]	[0.95]	[0.61]	[1.59]
SEA	-1.687	-3.086	-0.493	-4.949***	3.835***	4.753***
	[8.00]	[8.11]	[0.44]	[1.69]	[1.13]	[2.14]
MRD	6.755**	3.717	3.519***	4.351***	2.383***	7.365***
	[3.08]	[3.32]	[0.33]	[0.74]	[0.44]	[1.17]
Constant	-1.486	-4.194	-0.819	1.65	-1.021	-12.763***
	[6.17]	[6.62]	[0.64]	[2.44]	[1.13]	[3.39]
Number of observations	4,823	4,823	4,823	4,823	4,823	4,823
Centered R_squared	-0.122		0.004		0.054	
Uncentered R_squared	0.015		0.129		0.095	
Zero observations		123		1,918		2,429
Positive observations		4,700		2,905		2,394
Wald test of exogeneity χ^2		18.56***		15.99***		5.44**
Weak identification test	22.959		22.959		22.959	
Overidentification test (Hansen J statistic χ^2)	1.931		4.585		0.808	
p-value	0.381		0.101		0.668	

1) ***,**,* indicate statistical significance at the 1%, 5%, 10% level, respectively.

2) RRD: Red River Delta, MNM: Midland and Northern Mountainous, NCC: Northern and Central Coast, CHL: Central Highland, SEA: Southeastern Area, MRD: Mekong River Delta.

3) The values in the parentheses indicate the robust standard errors clustered at the commune level.

4) Instrumental variables: *Factory/manufacture location, Time_Town, Time_City.*

5) Author's estimation.

tend to purchase more agricultural inputs and hired labor cost for production than others minorities. The reason could be that the farming practices of minor ethnicities are shifting cultivation with less use inputs. In addition, the minor ethnicities mainly live in the remote areas and far away from the town, city, and center areas. Thus, they face many difficulties and limitations in access to agricultural input markets as well as new farming techniques. While, the coefficients of ethnicity in hired machine equation are negatively significant in IV-Tobit model and is not significant in 2SLS model. It indicates that ethnicity seems to be no effect for hired machines cost in agricultural production.

For the regional dummy variables, the coefficients of CHL and MRD are positively significant. It means that both regions spend the purchased inputs, hired machines and hired labor in agricultural production higher than MNM region. NCC region has negatively significant in purchased inputs equation and positively significant in the hired machines and hired labor equations. It implies that this region spends a lower purchased inputs cost and higher hired machines and hired labor cost than MNM region. While, the parameters of RRD are negatively significant in the purchased inputs model and not statistically significant in the hired machines and hired labor models. The parameters of SEA are not statistically significant in the purchased inputs model, negatively significant in the hired machines model, and positively significant in the hired labor model. However, the mean of purchased inputs, hired machines, and hired labor expenses of RRD and SEA regions are higher than MNM region. The non-farm income and non-farm participation rate of those two regions also are higher than the remaining regions（see Table 4）. It indicates, for the developed regions where high opportunity participation in non-farm employment, this income source may be sufficient to guarantee for farm living, hence, the investment more in farm activity seem not be necessary.

The Wald test of exogeneity on the Chi-squared of the instrumented variables was performed on all three IV Tobit regressions. The null hypothesis is the absence of endogeneity in the estimation. The results of the Wald test in the three models are all significant at the 1% level. This means that the null hypothesis is rejected, that is, non-farm income is an endogenous variable. Thus, our estimation based on IVs to treat the endogeneity problem is adequate.

The weak identification test and overidentification test of the validity of the instruments are performed on 2SLS regression. The value of Stock-Yogo（2005）weak identification test statistics is 22.959. P-value

Table 4: Agricultural inputs expenses, non-farm income and its share by regions

	Purchased inputs (million VND)	Hired Machine (million VND)	Hired Labor (million VND)	Non-farm income (million VND)	Non-farm participation rate (%)
Whole country	19.95	1.65	2.42	40.94	73
RRD	18.78	1.39	1.21	58.90	86
MNM	15.29	0.44	0.54	29.84	64
NCC	13.81	1.28	2.21	40.28	70
CHL	26.35	1.47	5.79	21.41	72
SEA	31.87	1.39	7.10	49.73	83
MRD	29.88	4.22	4.02	40.62	72

1) Source: VHLSS 2012.
2) RRD: Red River Delta, MNM: Midland and Northern Mountainous, NCC: Northern and Central Coast, CHL: Central Highland, SEA: Southeastern Area, MRD: Mekong River Delta.

Table 5: Average partial effect of non-farm income on agricultural expenses of all households

	Average partial effect	S.D.	t-value	p-value (one-tail)
Purchased inputs	0.412	0.159	2.591	0.005
Hired Machine	0.107	0.116	0.922	0.178
Hired Labor	0.037	0.055	0.673	0.250

1) Author's calculation.

of this statistic is almost equal to 0.10. From this result we consider the null hypothesis of weak identification is almost rejected. The overidentification test Hansen J statistic are 1.931 with p-value 0.381 for purchased inputs; 4.585 with p-value 0.101 for hired machines; and 0.808 with p-value 0.668 for hired labor. The joint null hypothesis that the instruments are valid instruments is not rejected for purchased inputs, hired machines, and hired labor equations.

4.3. The average partial effect

From Equation (6), we can deduce the average partial effect of a change in non-farm income on the spending on agricultural inputs and other costs (Table 5).

Table 5 shows the result of the average partial effect of non-farm income on agricultural expenses for all households. The t-values of the average partial effect of non-farm income on purchased inputs, hired machines, and hired labor are calculated. The t-value is high in the purchased inputs case, and low in the hired machines and hired labor cases. This implies that the APE of the purchased inputs is statistically significant, while those for the hired machines and hired labor are not statistically significant. Therefore, the result indicates that an additional VND in non-farm income leads to a 0.412 VND increase in the spending on purchased agricultural inputs.

Overall, our results confirm the impact of non-farm income on agricultural input expenses. Farm households that participate in the non-farming sector use this source of income to invest more in agricultural inputs such as seeds and fertilizer. The investment in these high-yielding inputs aims to raise the agricultural output as well as productivity and production efficiency. On the other hand, the use of this source of income for hiring machines and labor seems limited because these costs are somewhat secondary. The mechanization of agricultural production is still limited in Vietnam, especially in small farms. Thus, farmers tend to use simple equipment more than machines. Hiring labor for production is also not necessary for small farms. Finally, our analysis is consistent with the hypothesis that non-farm income can relax the credit constraints on agricultural production.

5. Conclusions

In a perfect market system, farm households can separate production and consumption activities because the market functions could fill the gap between the two even when the funds destined to production are not sufficient. However, in rural developing countries such as Vietnam, the credit and insurance markets are often imperfect, farm households face credit constraints and are often unable to ensure against production risks. Seeking an alternative income source is, therefore, necessary to overcome these constraints. Kilic et al. (2009) suggested that non-farm earnings may lead to a decline in households' risk and provide capital for agricultural expenses and long-term investment,

thus overcoming the credit and insurance market failures. Thus, participation in non-farm activities could help farmers loosen credit constraints. The linkage between the farming and non-farming sectors implies that non-farm income might be used for agricultural production, thus increasing the spending cost on production.

Our analysis results confirm a significant and positive relation between participation in non-farm activities and agricultural expenses in Vietnam. This result indicates that Vietnamese farm households access other income sources through the non-farm sector and use these earnings for agricultural production, in particular, to purchase agricultural inputs, hire machines, and hire labor to compensate for family labor. However, our findings show that farm households only use a small proportion of the non-farm income for hiring machines and labor. Although our research is not a direct test of whether farm households are credit constrained, the estimation results seem consistent with this hypothesis. Non-farm income is thought to relax liquidity constraints in Vietnam. There seems to be a significant synergy between agriculture and non-farm sectors. Access to non-farm income sources facilitates farm households in achieving optimal use of inputs or adopting new technologies in agricultural production, thus enhancing productivity.

The non-farm sector also supports agriculture through a positive impact on farm investment and applying new technology. Therefore, to develop rural economies, policies targeting farm households should consider the non-farm sector. Encouraging the development of non-farm activities is essential. New policies should support the link between the agricultural and non-farm sectors. For example, policies can support farm households to access the market in order to facilitate farmers to conduct trading their agricultural products after processing. In particular, policies focusing on the promotion of non-farm employment should toward sustainability and stable jobs, namely develop the handicraft village or small-industry job in the rural areas. In addition, policies should focus on the rural areas, especially the poor and mountainous areas where are difficult in the transportation, market access, and trading. Thus, policies should support the construction of infrastructure, communication, and market infrastructure in the rural area. Those policies may help the rural labors to access to non-farm activities, such as, migrate to the big cities, and also facilitate for trading the agricultural commodities to the other regions. Therefore, this could create the non-farm employment opportunities and promote the development of agricultural production.

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