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ABSTRACT

Does Off-Farm Labor Relax Farmers' Credit Constraints? Evidence from Longitudinal Data for Vietnam*

We examine the relationship between participation in non-agricultural labor activities and farming production decisions, focusing on the use of inputs. In particular, we are interested in the hypothesis that income from non-agricultural labor relaxes credit constraints. Using longitudinal data for Vietnam from 1993-98, we find that households participating in non-agricultural labor activities, consistently with our hypothesis, spend significantly more on seeds, services, hired labor and livestock inputs.

JEL Classification: J43, Q12

Keywords: rural labor markets, linkages, credit constraints, Vietnam

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1. INTRODUCTION

The growth in importance of rural non-farm (RNF) activities, and the corresponding reduction in the importance of on-farm agricultural activities, is a standard feature of economic development. The available evidence suggests the existence of large scale RNF economies in countries at different stages of development.[1] The growth and importance of RNF activities should not be seen in isolation from agriculture, as both sectors are linked through investment, production and consumption decisions throughout the rural economy, and both form part of complex livelihood strategies adopted by rural households.

An agricultural household may diversify into non-agricultural income generating activities for a variety of reasons. Diversification can serve as a response to market failures, such as in credit markets, providing cash and relaxing liquidity or credit constraints in agricultural activities, or in insurance markets, helping spread income risks among different activities. Diversification can also be due to the failure of any one activity to provide sufficient income, or it can reflect the different skills and attributes of individual household members. If the latter is the case and it tends to be the young who are involved in off-farm activities, diversification may reflect a transition period as the household moves out of on-farm activities and into specialization in non-farm activities.

Rural non-farm activities can be found in either high or low return sectors. For both agricultural and non-agricultural income generating activities there is a high productivity/high income sub-sector, confined mostly among privileged, better-endowed groups in high potential areas. High return sectors often have significant barriers to entry, including land, human capital and other productive assets. The low productivity segment usually serves as a refuge for the poorest of the rural poor. This segment includes subsistence agriculture, seasonal agricultural wage labor and various forms of off-farm self-employment. Although the returns to these mostly informal activities are low, they serve as an important coping mechanism.[2]

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[1] See, among others, FAO (1998), Reardon et al. (2001), Lanjouw and Lanjouw (2001), Haggblade et al. (2005) and Davis et al. (2007).

[2] For a discussion of this topic, see Lanjouw and Lanjouw (2001) and Davis et al. (2007).

The objective of this research is to test the hypothesis that participation in non-agricultural labor affects expenditure on farm inputs. The existing empirical literature on household-level links between RNF activities and farming is limited and inconclusive. Collier and Lall (1986) find that, among small farmers in Kenya, crop output is positively associated with non-crop income and liquid assets, after controlling for the level of inputs, and non-farm income contributes directly to the ability to make more productive cropping choices. Evans and Ngau (1991) find that in the Kenyan village of Kutus, households with non-agricultural income are more likely to grow (more profitable) coffee, rather than maize for subsistence. De Janvry, Sadoulet and Zhu (2005) conclude that participation in RNF activities in China has significant spillovers on-farm income, with the effect coming through a rise in agricultural total factor productivity. In contrast, Holden *et al.* (2004) show that in Ethiopia access to RNF activities leads to increased soil erosion and land degradation suggesting a drop in agricultural total factor productivity.

A much larger literature focuses on the conceptually similar role of migration and remittances on agricultural production. One set of studies suggests few links between migration and productive activities, finding instead that migration leads to increased consumption of leisure, durables and housing (Mines and de Janvry, 1982; Durand et al., 1996; Taylor et al., 1996; De Brauw and Rozelle, 2003; Azam and Gubert, 2004). Other studies suggest that migration is accelerating an inevitable transition out of agriculture, and/or fostering forms of agriculture complementary with, though secondary to, off-farm activities (Miluka et al., 2007; Quisumbing and McNiven, 2007; and Brown and Leeves, 2007). De Brauw (2007) finds for Vietnam that seasonal migration leads to less use of agricultural inputs and a shift from labor to more land intensive farming. In contrast, some empirical analyses find evidence that participation in migration fosters household farm investments in sending regions (Lucas, 1987; Dustmann and Kirchkamp, 2002; de la Briere et al., 2002; Woodruff and Zenteno, 2001; Black et al., 2003; Adams, 1991; De Brauw et al., 2003; Rozelle et al., 1999; Mendola, 2004; and Taylor and Lopez-Feldman, 2007).

We test whether diversification into non-agricultural activities is complementary to household farming, consistently with the indication of models in which non-agricultural income serves to overcome credit market failures, or rather if diversification into rural non-

farm activities represents a move away from agriculture. We focus on the experience of Vietnam during the 1990s. Since the reforms of the late 1980s, the country has experienced an economic boom, but rates of growth in agriculture have lagged behind the non-agricultural sector of the economy. One important constraint to agricultural production is access to credit, particularly for producers with small landholdings, and participation in RNF activities may have served to ease this constraint. We develop a simple theoretical model suggesting why this would be the case. We test this hypothesis by using longitudinal household data, covering the period from 1993-98.

The remainder of the paper is organized as follows. After describing in Section 2 the economic context for agricultural producers in Vietnam in the 1990s, in Section 3 we present the theoretical model sketching the relationship between farming and non-agricultural labor. Section 4 describes the data, presents our estimation strategy, and discusses the sources of potential bias from omitted variables and endogeneity. Section 5 provides a descriptive analysis of the linkages between farming and non-agricultural labor in Vietnam, and the results of the multivariate analysis. Section 6 concludes, with some policy recommendations.

2. COUNTRY BACKGROUND

In 1986, the government of Vietnam launched a political and economic renewal campaign (Doi Moi), aimed at fostering the transition from a centrally planned economy to a socialist-oriented market economy. This led to an economic boom; from 1992 to 2004, GDP per capita grew over 6 percent a year, while the agricultural sector grew at an annual rate of over 4 percent. Even though by 2004 the share of agriculture and forestry in total GDP had fallen from 33 to 20 percent, the primary sector still employed approximately two thirds of the economically active population.

In agriculture, economic reform centered on two main policies: the liberalization of key agricultural output markets, in particular rice, and the liberalization of fertilizer imports. By 2004 Vietnam had leaped forward to become the world's third largest rice exporter. Changes in urban food demand and increased export opportunities for rice and other crops lead to a growth of the real value of rice production and agricultural income (Benjamin and Brandt, 2002).

Non-agricultural income grew more rapidly, so that from 1993 to 1998 the share of on-farm income dropped from 66 to 61 percent of total income among land-owning households[3]. Non-agricultural labor income accounted for 24 percent in 1993, growing to 28 percent in 1998. Agricultural wage labor and transfers play a minor role in terms of the share of total income, with 4 and 7 percent, respectively. However, in terms of household participation these activities are important, involving 17 and 35 percent of households, respectively, in 1998 (Table 1).

Table 1. Composition of income, and household participation in different labor activities

	Share of income		Share of households with	
	1993	1998	1993	1998
Farm (share)	0.66	0.61	1.00	1.00
Agricultural wages	0.03	0.04	0.12	0.17
Non-agricultural wages	0.05	0.08	0.20	0.31
Non-agricultural self-employment	0.19	0.20	0.37	0.37
Transfers	0.07	0.07	0.36	0.35
Other sources	0.00	0.00		
Total	1.00	1.00		

Source: Calculated by authors, based on RIGA database[4]

Table 2 shows the relative importance of different economic sectors as providers of non-agricultural labor opportunities. Non-agricultural wage employment is made mainly of jobs in manufacturing, construction and services. Non-agricultural self-employment is found in the manufacturing services and in commerce. The relative importance of different sectors does not change over time.

[3] The sample is consistent throughout the paper, and includeds households that control land in both 1993 and 1998. In both survey rounds, land-owning households account for more than 90 percent of rural households.

[4] The Rural Income Generating Activities (RIGA) database consists of datasets from nationally representative household surveys in 15 countries, from four geographical regions. The database was created primarily to construct comparable income aggregates, but includes information on consumption expenditure, agricultural production, market participation and access to agrarian institutions and various types of assets. Details on the project and the dataset can be found at http://www.fao.org/es/ESA/riga/index_en.htm.

Table 2. Participation in non-agricultural labor, by sector of economic activity

	Wage employment		Self employment	
	1993	1998	1993	1998
Mining	0.00	0.01	0.01	0.01
Manufacturing	0.07	0.09	0.13	0.14
Utilities	0.00	0.01	0.00	0.00
Constructions	0.05	0.10	0.00	0.01
Commerce	0.00	0.02	0.14	0.16
Communication	0.01	0.02	0.02	0.02
Finance, Insurance, Business	0.00	0.00	0.00	0.00
Services	0.07	0.11	0.02	0.03
Others	0.00	0.00	0.00	0.00
Total	0.20	0.31	0.28	0.32

Source: ibidem

On-farm income is relatively more important for poorer households. In both 1993 and 1998, the share of income from farming decreases from 70 percent for the first quintile of per capita expenditure to around 50 percent for the top quintile (not shown in tables). Non-agricultural sources of income, on the contrary, increase with the level of welfare from 20 to over 30 percent.

Despite the rather stable numbers over time in terms of income shares, household income generating portfolios became less specialized and increasingly diverse during the 1990s. Defining specialization as at least 75 percent of total income from any one source, the share of households specializing in on-farm activities fell from 52 to 41 percent between 1993 and 1998 (Table 3). The share of households specializing in all other types of income did not change. Diversified households, with no single income source accounting for at least 75 percent of income, increased from 33 to 44 percent. In 1993, diversification is positively associated with welfare status, although the same does not hold for 1998. On-farm specialization is more prevalent among the poor (from 51 to 30 percent along welfare quintiles in 1998), while specialization in non-agricultural self-employment is more prevalent among the better off (5 to 19 percent along welfare quintiles in 1998). Very few household specialize in non-agricultural wage employment, and such specialization does not appear to be correlated with welfare status.

Table 3. Percentage of diversified and specialized households, by expenditure quintile

By expenditure quintile	Diverse Income Portfolio	Farm	Agricultural wages	Non-agricultural wages	Non-agricultural self-employment	Transfers and other
1993						
1	0.29	0.60	0.02	0.01	0.07	0.01
2	0.32	0.59	0.01	0.00	0.07	0.01
3	0.30	0.54	0.02	0.01	0.11	0.02
4	0.38	0.46	0.01	0.01	0.11	0.01
5	0.41	0.38	0.01	0.02	0.14	0.02
Total	0.33	0.52	0.01	0.01	0.10	0.01
1998						
1	0.41	0.51	0.01	0.01	0.05	0.01
2	0.44	0.46	0.02	0.00	0.06	0.00
3	0.45	0.40	0.00	0.02	0.11	0.00
4	0.47	0.35	0.00	0.01	0.14	0.01
5	0.44	0.30	0.01	0.01	0.19	0.01
Total	0.44	0.41	0.01	0.01	0.11	0.01

Source: ibidem.

Diversification into non-agricultural sources of income does not necessarily mean less agricultural production. In 1998 diversified households, as defined above, were responsible for approximately 30 percent of the value of total agricultural production. Indeed, households specializing in non-agricultural self-employment were responsible for 5 percent of the total agricultural production. The continued importance of agriculture among diversified households and households specializing in non-agricultural labor suggests some level of complementarity between on and off-farm income generation strategies.

Despite high levels of growth during the period of economic reform, agricultural households faced significant constraints. While over 90 percent of agricultural households had access to output markets, and most sold a majority of their production, access to land was relatively inflexible. The vast majority of agricultural households had small plots of less than one hectare, and during the 1990s rental and other alternative forms of access to land were not common. Since agricultural labor markets were thin, most households depended on labor by family members; approximately 17 percent of land-owning households supplied agricultural wage labor in 1998, while 29 percent hired in wage labor.

Constraints in access to finance and liquidity for rural producers have been of particular concern.[5] The rural credit market in Vietnam is highly segmented into a formal and informal sector. The formal sector is dominated by the Vietnam Bank for Agriculture and Rural Development (VBARD), one of four state-owned commercial banks, and to a lesser extent by the not-for-profit Vietnam Bank of the Poor (VBP), which was established with a focus on poverty alleviation. The lack of an appropriate legal framework limited the development of microfinance programs during the 1990s, and the financial reforms contributed to the collapse of traditional credit cooperatives collecting small deposit and providing credit to individuals and small businesses. The formal sector, which is partially subsidized, provides resources almost exclusively for production, while the informal sector, with higher interest rates, is geared to a variety of purposes. Given state budget constraints, credit from the formal sector is effectively rationed. Duong and Izumida (2002) estimate that about one out of three rural households is credit constrained.

Before moving to the empirical analysis, in the next section we explore the relationship between farming, credit constraints and non-agricultural labor within a simple theoretical model.

3. A Simple Theoretical Model

A representative agricultural household maximizes utility, which is a function of consumption (C) and leisure (l). Normalizing the price of the only good to one, consumption can be expressed as agricultural output (q) minus the repayment of contracted loans (B, for "borrowing"). If $B<0$, the household is saving part of its liquidity for market purchases of the only commodity in excess of own-production. Agricultural output $q = f\left(l^{HH}, l^{H}, x\right) = f\left(\bar{l} - l^{O} - l, l^{H}, x\right)$ is a function of household farm labor (l^{HH}), hired labor (l^{H}) and other variable inputs (x). Household farm labor is the complement to the total amount of time ($\bar{l}$), after choosing the amount of off-farm labor (l^{O}) and leisure. Utility maximization is subject to a budget constraint, stating that the expense for purchased inputs

[5] See Doung and Izumida (2002), Dufhues (2003), Barslund and Tarp (2007), and the website of Banking With The Poor (http://www.bwtp.org/arcm/vietnam/Vietnam.html).

($w_x \cdot x + w_{l^H} \cdot l^H$) cannot exceed the sum of income from off-farm labor ($w_{l^O} \cdot l^O$) and borrowing. The constrained maximization problem can be expressed as follows:

$$\max_{x,l^H,l^O,l} U\left\{\left[f\left(\bar{l} - l^O - l, l^H, x\right) - B\right], l\right\}$$
$$s.t. \quad w_x \cdot x + w_{l^H} \cdot l^H \le B + w_{l^O} \cdot l^O \qquad (1)$$

The household chooses the amount of variable inputs, hired labor, off-farm labor and leisure that maximize the following Lagrangian function:

$$\mathsf{L} = U\left\{ f\left(\bar{l} - l^O - l, l^H, x\right) - B,\ l\right\} + \gamma \cdot \left[B + w_{l^O} \cdot l^O - w_x \cdot x - w_{l^H} \cdot l^H \right] \qquad (2)$$

where γ represents the shadow price of liquidity. The first order conditions are:

$$\frac{\partial \mathsf{L}}{\partial x} = 0 \quad \Rightarrow \quad U_C \cdot f_x = \gamma \cdot w_x \qquad (3.1)$$
$$\frac{\partial \mathsf{L}}{\partial l^H} = 0 \quad \Rightarrow \quad U_C \cdot f_{l^H} = \gamma \cdot w_{l^H} \qquad (3.2)$$
$$\frac{\partial \mathsf{L}}{\partial l^O} = 0 \quad \Rightarrow \quad U_C \cdot f_{l^{HH}} = \gamma \cdot w_{l^O} \qquad (3.3)$$
$$\frac{\partial \mathsf{L}}{\partial l} = 0 \quad \Rightarrow \quad U_C \cdot f_{l^{HH}} = U_l \qquad (3.4)$$
$$\frac{\partial \mathsf{L}}{\partial \gamma} = 0 \quad \Rightarrow \quad B \ge w_x \cdot x + w_{l^H} \cdot l^H - w_{l^O} \cdot l^O \qquad (3.5)$$

The interpretation of the first order conditions sheds light on three relationships that will prove fundamental for our estimation strategy: 1) between farming and non-agricultural labor; 2) between credit constraints and farming, and 3) between credit constraints and participation in non-agricultural labor.

Off-farm labor and the scale of agricultural production are jointly determined. In order to explore the endogenous relationship, imagine that the price of variable inputs (w_x) drops. For simplicity, let us assume that the marginal utility of consumption is constant (not an unbelievable hypothesis for poor rural households). For condition (3.1), the household reacts

by increasing the use of variable inputs x. This increases the marginal product of other inputs, so for conditions (3.2) and (3.3) to hold, the household needs to increase the use of hired labor and household farm labor – with an overall expansion of farming. Condition (3.4) –jointly with (3.3)- implies that total household labor does not vary, so that off-farm labor drops. Therefore – at least in absence of constraints on borrowing – there is an inverse relationship between the scale of farming and participation in off-farm labor activities.

If credit becomes more constrained, increasing the shadow price of money γ, the economic cost of purchased production inputs grows. According to conditions (3.1) and (3.2), the household will use less hired labor and other variable inputs. Also the opportunity cost of household farm labor grows, because the wage from off-farm activities works as a substitute for borrowed cash. The use of household labor on-farm decreases. Therefore, there is an inverse relationship between credit constraints and the scale of farming

When credit becomes more constrained, conditions (3.3) and (3.4) imply that leisure will be more costly. The household will reduce the consumption of leisure and increase labor supply –so that the sum of l^O and l^{HH} will grow. As the use of household labor on-farm decreases –as discussed in the previous paragraph, the supply of off-farm labor grows[6]. Therefore, there is a positive relationship between credit constraints and participation in non-agricultural labor.

The above results hold also in a more complex model in which household utility depends also on consumption of a different market commodity. They will prove fundamental for the discussion of the direction of the bias potentially associated with OLS estimation of the relationship between the purchase of farm inputs and participation in non-agricultural labor.

4. DATA AND METHODOLOGY

4.1. DATA

We use data from the Vietnam Living Standard Survey (VLSS) for 1992-93 and 1997-98, which form part of the RIGA dataset, a cross-country database composed of comparable variables and income aggregates from selected household surveys. Both VLSS93 and

[6] If the marginal utility of consumption is not constant, the possibility that the relationship between non-agricultural labor and agricultural credit constraints is negative cannot be excluded.

VLSS98 are multi-purpose surveys, in line with Living Standard Measurement Study (LSMS) surveys, and collect information on household composition, education, health, employment, migration, housing, fertility, agricultural and non-agricultural businesses, consumption, income and access to credit. The household questionnaire is complemented by a community survey. The VLSS93 was based on a nationally representative sample of 4,800 households, interviewed between October 1992 and October 1993 (Scott 1992). Five years later, a repeat survey was conducted on a sample of 6,000 households. As many as possible of the households interviewed in 1992-93 were re-included in the sample, to allow for panel comparisons. New households were added (from the sample of the Multi-Purpose Household Survey) in order to reach 6,000 observations.

Attrition is low at around 10 per cent. Only 495 households of the VLSS93 sample were not re-interviewed in 1997-98. Ninety-six were dropped because three communes of the Red River Delta area were not included in the sample; for another forty-six, no information is available, 281 households had moved, nineteen were temporarily away, twelve refused to answer and seventeen did not respond for other reasons (World Bank 2001, p.23). Previous empirical work in agricultural household modeling has shown that the attrition does not lead to systematic bias (see for example de Brauw, 2007). We therefore proceed without applying attrition correcting techniques.

We restrict our analysis to a sub-sample of 2,922 panel households that owned land in the twelve months preceding both surveys. Our results are therefore conditional on owning land.

4.2. Estimation Methodology

We aim to estimate the following model:

$$INPUT_i = b0 + b1*D\_NFL_i + b2*X_i + b3*CC_i + u_i \quad (4)$$

Where INPUT is the quantity of the farming production factor (i.e. seeds, fertilizers, etc.), X is a vector of household characteristics (including land size), D_NFL is a dummy variable for participation in non-agricultural labor activities, CC a dummy for credit constraints, i is the index for households, and u is the error term.

We face two kinds of problems.[7] First, as discussed in the theoretical section, farming and non-agricultural labor decisions are made jointly. The more the household farms, the less it is likely to engage in other forms of labor, so that the reverse causality is negative. This implies a negative correlation between participation in non-agricultural labor and the error term (in fact, when u grows, INPUT grows, and this makes D_NFL decrease); therefore, because of endogeneity, OLS estimates of b1 will be biased downward.

The second problem is that we do not have a convincing variable for credit constraints[8]. Omitting the credit constraints determines a further bias of the OLS estimate of b_1.[9] The sign of the bias is given by the product of the signs of the covariance between credit constraint and the dependent variable, on one side, and of the covariance between credit constraint and the dummy for participation in non-agricultural labor activities. In section 3, we showed that the former is negative -as credit constraints in farming reduce the use of inputs- and that the latter is positive -i.e. that households react to credit constraints in farming by engaging more in non-agricultural labor[10]. Therefore, omission of the credit constraint variable implies a negative bias of the OLS estimate of b1.

Both the endogeneity and the omitted variable problems could be addressed through instrumental variables estimation. We would need to find instruments that are: 1) correlated with participation in non-agricultural labor; 2) uncorrelated with the error term, i.e. uncorrelated with the dependent variable, conditional on X, but through the channel of non-agricultural labor, and 3) uncorrelated with the omitted credit constraint variable (Murray 2006). We will make an attempt at this, in Section 5.

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[7] Measurement error does not appear to be a problem, as we focus on a dummy for participation rather than on the level of income from non-agricultural labor activities.

[8] The community questionnaire of VLSS93 did not include a detailed credit module. A credit section appeared in the household questionnaire of both VLSS93 and VLSS98. However, the module covered only effective choices to lend and borrow, and no information on borrowing intentions and opportunities.

[9] As we account for household fixed effects, this is a concern only for time variant credit constraints.

[10] On the other hand, if credit constraints in agriculture are correlated with credit constraints limiting the access to non-agricultural labor activities, non-agricultural labor and the omitted variable may be negatively correlated. In this case, OLS estimates of b_1 may be biased upward. Unfortunately, we have no access to information on credit constraints to non-agricultural labor activities.

However, if estimation via OLS provides a positive and significant estimate of b1, given our analysis of the direction of the bias we can conclude that non-agricultural labor provides funds for farming. Correction of the downward bias would simply reinforce the magnitude of the result, without changing its nature.

In order to avoid the bias due to the omission of unobserved and unobservable household characteristics, we exploit the longitudinal nature of the data and estimate model (1) in differences, therefore netting out household fixed effects. We look at expenditure on inputs. We study expenditure rather than quantity, because information on the latter is either missing, or incomplete or difficult to compare. In particular, quantities are surveyed only for chemical fertilizers and hired labor. As for the former, quantities of different kinds of fertilizers are not easily comparable and cannot be summed. As for hired labor, the number of person days is recorded only in 1998, while in 1992-3 the survey inquired only the value of the expenditure. We therefore estimate the following set of regressions:

$$\Delta LCOST_i = b_0 + b_1 * \Delta D\_NFL_i + b_2 * \Delta X_i + b_3 * REG_i + \varepsilon_i \qquad (5)$$

Where Δ indicates the difference between 1998 and 1993, LCOST is the natural logarithm of the yearly market expenditure in an agricultural input[11], ε is the error term, i is the index for households, and b are parameters to estimate. Because of the survey design, error terms are correlated within the sampling units. We compute robust standard errors through the *cluster* option in STATA. As dependent variables, we use the natural logarithm of market expenditure on livestock inputs, seeds, chemical fertilizers, organic fertilizers, pesticides, services and hired labor[12].

The vector of regressors X includes the size of owned land, its square, household size, the number of household members in working age, the number of male working-age members, the average level of education, and an index of access to infrastructure. Land is the main

[11] We actually take the natural logarithm of one plus the expenditure, to avoid losing observations for households that do not purchase the input.

[12] We also checked the relationship between size of owned land and participation in non-agricultural labor, finding no significant correlation.

input in agricultural production. Household size, its composition, and education proxy labor and income earning potential. Infrastructure proxies market access.

We also include a vector REG of regional dummies, picking up the different speed of agricultural development. The coefficients b_3 correspond to the coefficients on the interaction between a time dummy variable and the regional dummies in a Least Squares Dummy Variables model.

To evaluate the robustness of OLS estimates from model 5, we will replicate the analysis using matching techniques and instrumental variables estimation.

5. RESULTS

5.1. DESCRIPTIVE ANALYSIS

Half of the households participate in non-agricultural labor activities in 1992-93. The share grows to 57 percent in 1997-98. Mobility in and out of off-farm labor is however higher than these figures suggest. In fact, only 29 percent of households never engage in non-agricultural labor, and about one family out of three enters or leaves non-agricultural labor between 1993-98 (Table 4). Such mobility is a valuable source of information for the multivariate analysis.

Table 4. Mobility in and out of non-agricultural labor activities between 1993-98.

Share of households	No off-farm Labor in 1998	With off-farm Labor in 1998	Total
No off-farm Labor in 1993	0.29	0.21	0.50
With off-farm Labor in 1993	0.14	0.36	0.50
Total	0.43	0.57	1.00

Source: Authors' calculation, VLSS93 and VLSS98. Number of observations: 2922.

Table 5 compares land ownership, use of agricultural inputs and access to credit for households with and without off-farm labor income. The latter farm less land (on average 0.48 hectares versus 0.53). On the other hand, they are significantly more likely to purchase seeds, fertilizers, pesticides, services and labor.

Table 5. Land ownership, agricultural inputs and access to credit, by participation in non-agricultural labor activities (pooled data 1993-98)

	No off-farm labor	With off-farm labor	Mean difference
Number of observations	2785	3059	
Average size of owned land (ha)	0.53	0.48	-0.053***
Purchases seeds (Share)	0.54	0.63	0.091***
Purchases organic fertilizers	0.02	0.03	0.012***
Purchases chemical fertilizers	0.96	0.98	0.020***
Purchases pesticides	0.83	0.84	0.011
Purchases services	0.42	0.51	0.095***
Hires labor	0.26	0.31	0.049***
Purchases other inputs	0.84	0.84	0.006
Purchases livestock inputs	0.75	0.85	0.094***
VBARD present in the community (a)	0.78	0.74	-0.042**
Borrowed money (Share)	0.50	0.59	0.093***
Lives in credit constrained community	0.49	0.50	0.004

Source: VLSS93 and VLSS98. Legend for significance of mean difference: *p<0.1, **p<0.05, ***p<0.01. Note: (a) data available only for 1998.

In 1998, three households out of four live in a community where VBARD is present. The share is significantly higher for households not engaged in non-agricultural activities (78 versus 74 percent). About 55 percent of households owe money to an individual, company or financial institution, or paid back the debt during the twelve months preceding the interview. Without controlling for other household characteristics, borrowing seems positively associated with RNF income, as the share is higher for households engaged in non-agricultural labor activities (59 versus 50 percent). However, this reflects actual borrowing, rather than borrowing intentions or credit constraints.

We exploit information from the community survey and attempt to define a dichotomous farming constraint variable, taking a value of one if "availability of inputs" is considered the main problem faced by farmers in the community[13]. Using this definition, about half households live in a constrained community, and this value does not change with participation in non-agricultural labor.

We find limited evidence of positive dynamic relationship between input constraints and participation in non-agricultural labor. In 1993, about 50 percent of households participated in non-agricultural labor activities, independently from living in a constrained community or not (not shown in tables). However, initial input constraint is associated with a stronger move towards non-agricultural labor, with participation increasing by 9 percent –from 50 to 59 percent- versus 6 percent. Unfortunately, our variable is a very poor approximation for credit constraint status, which is best ascertained via direct questions at the household level (Petrick, 2005; Feder et al., 1989 and Barham, Boucher and Carter, 1996). As we do not dispose of satisfactory information on household-level credit constraints, we will estimate model (5) omitting credit constraints variables.

5.2. MULTIVARIATE ANALYSIS

5.2.1. Ordinary Least Squares

Complete results of the estimation of equations (5) are presented in Table A1 in the Appendix. The size of land is positively associated with expenditure in farm inputs –specifically, in inputs for livestock, chemical fertilizers, pesticides, services and hired labor. The sign of the second derivative is negative. Household size and the number of members in working age are positively correlated with expenditure in seeds, chemical fertilizers and pesticides (signaling higher farming intensity), and negatively correlated with expenditure for hired services, probably because work by household members serves as substitute to such inputs. After controlling for time invariant unobserved household characteristics –which include entrepreneurship and general abilities- the level of education is significantly and positively associated with expenditure in livestock, chemical fertilizers and farming services

[13] In 1998, the wording is changed to "Capital, sources of materials".

only. Access to infrastructure is associated with higher expenditure in livestock inputs, and with lower expenditure in chemical fertilizers.

Table 6 reports the coefficients b_1 in equations (5), and their clustered standard error. Participation in non-agricultural labor is associated with a significant increase in expenditure on livestock, seeds, services and hired labor. When a family engages in non-agricultural labor, it spends on average 21 percent more in seeds, 25 percent more on services, and 26 percent more on hired labor than if it worked exclusively in agricultural activities. The effect on fertilizers and pesticides is not statistically significant. Eventually, engagement in non-agricultural labor is associated with an increase by 35 percent in market expenditure for livestock inputs.

Table 6. Percentage effect of participation in non-agricultural labor activities on market expenditure for agricultural inputs – OLS estimation.

	OLS	
Dependent variable. Log of cost expenditure on:	% effect of participation in non-ag. Labor	Clustered Standard Error
Livestock, total	0.345***	0.104
Seeds	0.209*	0.114
Chemical fertilizers	0.064	0.055
Organic fertilizers	-0.022	0.036
Pesticides	-0.052	0.078
Services	0.245**	0.124
Labor	0.258***	0.095

Number of observations: 2864. Legend: * p<0.1; ** p<0.05; *** p<0.01

The results are qualitatively robust to the specification of the model. They hold in a very parsimonious specification (including for example only land size and participation in non-agricultural labor) and when the set of regressors is expanded. Similar evidence is also found when the level of non-agricultural labor income rather than a dummy for participation is considered – although in this case the magnitude of the coefficients is likely to be affected by measurement error.

We argued above that OLS estimates of b_1 from model (5) are biased downward, both because of endogeneity of non-agricultural labor and for the omission of credit constraints variables. As most coefficients are positive and statistically significant, we can conclude that the evidence is consistent with the hypothesis that non-agricultural labor helps relaxing credit constraints, allowing increasing the market expenditure on farm inputs.

5.2.2. Matching

We check the validity of OLS results through the use of matching techniques. The purpose of matching is to reduce selection bias by ensuring that the analysis of the effect of the non-agricultural labor is performed confronting a treatment and a control group of comparable characteristics (common support). One important limit is that the two sub-samples are identified on the basis of observable characteristics. Nonetheless, matching represents a complement to regression analysis in that it needs not rely on a determined specification of the relationship between dependent variable and household characteristics, and does not require that the selection of treatment and control sub-samples be based on exogenous characteristics.

Following Ñopo (forthcoming), we perform matching on observed characteristics rather than on a propensity score. This avoids any kind of parametric assumption on the specification of the model for expenditure in farm inputs. The idea can be summarized as follows:

1. consider one arbitrary household (the order does not matter), involved in non-agricultural labor in 1998 (treatment);
2. select all the households that in 1993 had the same characteristics as the one considered in step 1, and do not participate in non-agricultural labor in 1998 (controls);
3. with all the units selected in step 2, construct a synthetic household, which is the match for the household considered in step 1. Measure the average change in expenditure on each farm input;
4. put the observations of both households (the real one participating in non-agricultural labor, and the synthetic one which does not) in two separate samples of matched households; compare the change in expenditure on each farm input;

5. repeat steps 1-4 until all the participating households have been considered.

We base the matching on farming characteristics and on participation in non-agricultural labor in 1993. More specifically, we consider:

a) land size in 1993 and in 1998, classified in four categories, broadly corresponding to quartiles (less than 0.22 hectares, 0.22-0.33 hectares, 0.33-0.66 hectares and more than 0.66 hectares);
b) a dummy variable for the purchase of each category of input in 1993 -seven categories, i.e. livestock inputs, seeds, chemical fertilizers, organic fertilizers, pesticides, services and hired labor;
c) a dummy variable for participation in non-agricultural labor in 1993.

The idea is to compare the change in input expenditure of two households that had the same farming characteristics in 1993 (size of land and combination of purchased inputs), control the same amount of land in 1998 (not necessarily the same as in 1993), and were equal as far as concerns participation in non-agricultural labor in 1993. The two households differ only for participation in non-agricultural labor in 1998. The common support is made of 2,275 households out of 2,922.

By considering the change in expenditure on each farm input in the period 1993-98 (rather than the level in 1998), we net out the household fixed effect. Results of the matching are reported in Table 7.

Table 7. Percentage effect of participation in non-agricultural labor activities on market expenditure for agricultural inputs – Matching

	Matching		
Dependent variable. Log of cost expenditure on:	% effect of participation in non-ag. Labor	Clustered Standard Error	OLS for comparison: % effect of participation in non-ag. Labor
Livestock, total	0.589***	0.131	0.345***
Seeds	0.433***	0.119	0.209*
Chemical fertilizers	-0.005	0.06	0.064
Organic fertilizers	0.000	0.048	-0.022
Pesticides	0.050	0.076	-0.052
Services	0.459***	0.126	0.245**
Labor	0.191*	0.112	0.258***

Number of observations: 2275. Legend: * p<0.1; ** p<0.05; *** p<0.0

The comparison of the two samples shows that participation in non-agricultural labor is associated with higher expenditure in livestock inputs by 59 percent, in seeds by 43 percent, in services by 46 percent and in hired labor by 19 percent. No significant impact is found for fertilizers and pesticides. The results of the multivariate analysis presented in the previous section are therefore broadly confirmed.

5.2.3. Instrumental Variables

We perform one further check of the validity of OLS results through the use of instrumental variables. If our assumptions on the endogeneity bias and on the omitted variable bias are correct, instrumental variables will lead to higher estimates of the effect of participation in non-agricultural labor. Such estimates will also be less precise, as the instrumental variable technique exploits only part of the correlation between the variable of interest and the dependent variable, i.e. the one that is picked by the correlation with the instruments. Finding variables that are correlated with non-agricultural labor and uncorrelated with the error term in equation (5) and with omitted credit constraints is not trivial. We choose three instruments: 1) a dummy variable for the existence of off-farm employment opportunities in the commune in 1993; 2) the change in a dummy variable for the existence or a factory within 10 kilometers of distance from the commune; 3) the implementation of a public

program focusing on employment generation or on infrastructure and economic development in the period 1993-98.

The existence of off-farm activities at the commune level indicates demand for off-farm labor. Similarly, the opening of a factory and the realization of public projects create non-agricultural jobs, thus increasing the availability of off-farm labor opportunities. All three instruments are expected to be positively correlated with entry in non-agricultural labor.

The first stage regression confirms our expectations. Complete results of the estimation are presented in Table A2 in the Appendix. Once controlling for household fixed effects, few variables significantly affect the probability of participation in non-agricultural labor. The likelihood of participation grows with household size, reflecting the increased supply of labor, and with average education, a sign that the non-farm sector is made of jobs with higher returns to education.

Participation is lower in the North West, the Central Highlands region and the Mekong Delta, while elsewhere it does not differ statistically from the Red River Delta region. All instruments are individually significant. Preexistence of non-agricultural employment, the opening of a factory and the realization of public projects significantly increase the likelihood to engage in non-agricultural labor.

The three instruments pass the Hansen J test for all dependent variables but the expenditure on pesticides. In all other cases but two, the Wu-Hausman F-test fails to reject the null hypothesis that the dummy for participation in non-agricultural labor is exogenous. Therefore, in most cases instrumental variable estimation is not required. The only exceptions are the expenditure on seeds and services. The instrumental variable estimation shows that participation in non-agricultural labor is associated with a significant increase in the market expenditure on seeds. Also the effect on the purchase of services is positive, although not statistically significant. As expected, IV coefficients are larger than the ones from OLS, and much less precisely estimated. This is consistent with our theoretical analysis, which suggested a downward bias for OLS, and contributes to validating our estimation approach.

Table 8. Percentage effect of participation in non-agricultural labor activities on market expenditure for agricultural inputs – Instrumental Variable estimation

Dependent variable. Log of cost expenditure on:	**Instrumental Variables:** % effect of participation in non-ag. labor (IV)	Clustered Standard Error	OLS for comparison: % effect of participation in non-ag. Labor
Livestock, total	0.285	1.822	0.345***
Seeds	4.033*	2.205	0.209*
Chemical fertilizers	0.27	0.933	0.064
Organic fertilizers	0.441	0.499	-0.022
Pesticides	-1.236	1.454	-0.052
Services	3.209	2.691	0.245**
Labor	1.384	1.577	0.258***

Number of observations: 2811. Legend: * p<0.1; ** p<0.05; *** p<0.01

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

We examined the linkages between off-farm labor and farming using longitudinal data from Vietnam, covering the period from 1993-98. With complete and competitive markets, household and hired labor are perfect substitutes, and the allocation of household labor to farming and other activities does not affect the use of other inputs. However, when credit markets are incomplete, participation in off-farm labor may serve to relax credit constraints, providing cash for market purchases of agricultural inputs. The continued relevance of agricultural production, in terms of output, among agricultural households with diversified income generation strategies as well as households specializing in activities other than agriculture suggests some level of complementarity between on and off-farm income generation strategies.

With a simple theoretical model, we show that credit constraints may induce an increase in total labor supply, with a shift from on-farm to off-farm labor. Further, the empirical analysis shows that in Vietnam the allocation of household labor between agriculture and other activities affects farming choices. Our results are consistent with the existence of a liquidity constraint, and with the hypothesis that non-agricultural labor helps relaxing such constraint.

Agricultural households participating in non-agricultural labor spend significantly more for livestock inputs, seeds, services and hired labor.

Rural development, in the context of missing and/or incomplete credit markets, depends on the interaction between agricultural and non-agricultural activities. Rural income generating activities are inextricably linked. In the context of rationed state credit and lack of an institutional framework for alternative sources of credit, such as microfinance, participation in rural non-farm activities appears to relax production constraints in agriculture. Our results suggest that further development of rural credit markets would help farmers improving production efficiency. In the meanwhile, fostering access to non-agricultural activities, for example through higher labor mobility, may serve as a substitute for access to credit.

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Appendix II

Table A1. Complete results of the estimation of model (5).

Dependent variable: change in expenditure for:	Livestock	Seeds	Chemical fertilizers	Organic fertilizers	Pesticides	Services	Hired Labor
	Coefficients						
Size of owned land (ha)	0.393*	0.166	0.758***	0.118	0.581***	0.636***	0.886***
Square of size of owned land (ha)	-0.044**	-0.019	-0.065***	-0.011	-0.048***	-0.038*	-0.052**
Household members in working age (number)	0.004	0.125*	0.017	-0.081***	-0.043	-0.230***	-0.095
Male household members in working age	-0.087	-0.212**	-0.042	0.048	0.014	0.000	0.013
Household size	0.065	0.055	0.101***	0.025*	0.110***	0.055	-0.052
Average adult education, in years	0.084**	0.015	0.042**	0.009	0.025	0.135***	-0.016
Index of access to infrastructure	0.216***	-0.017	-0.142***	0.003	-0.064	0.133	-0.005
Regional dummy: Northeast (omitted Red River delta)	1.313***	0.583**	0.527***	-0.067	0.920***	-0.279	-0.301
Northwest	1.147***	0.024	2.109***	0.184	0.871*	-1.003**	0.663
North Central coast	0.830***	0.777***	0.280***	-0.055	0.746***	-1.442***	0.231
South Central coast	0.504*	-0.507	0.455*	-0.287*	0.762**	1.211**	-0.727*
Central highlands	-0.362	-0.509	2.214***	0.219	1.230**	-1.502**	-0.366
Southeast	0.110	0.211	0.372	0.383	0.498*	0.586	-0.704**
Mekong delta	-0.704***	-0.733**	0.092	-0.112	0.168	-1.021**	-0.391
Participation in RNF labor	0.345***	0.209*	0.064	-0.022	-0.052	0.245**	0.258***
Constant	-0.033	0.883***	0.032	0.082	0.287**	1.687***	0.462***
R-2	0.07	0.05	0.15	0.02	0.06	0.09	0.03

Number of observations: 2811. Legend: * p<0.1; ** p<0.05; *** p<0.01. Note: all variables are changes from 1993-1998, except regional dummies.

Table A2. Estimation of linear first stage regression for IV.

Dep. Variable: dummy for participation in RNF labor	Coeff.	Clustered Std. Err.
Size of owned land (ha)	-0.021	0.039
Square of size of owned land (ha)	-0.002	0.004
Household members in working age (number)	0.019	0.015
Male household members in working age	-0.002	0.018
Household size	0.041***	0.009
Average adult education, in years	0.024***	0.007
Index of access to infrastructure	0.018	0.016
Regional dummy: Northeast (omitted Red River delta)	-0.027	0.050
Northwest	-0.176*	0.101
North Central coast	0.074	0.057
South Central coast	-0.082	0.053
Central highlands	-0.211***	0.059
Southeast	-0.050	0.046
Mekong delta	-0.170***	0.053
Dummy: non-farm sector employs people in the commune in 1993	0.083**	0.038
Community labor developmen program	0.074**	0.034
Change in presence of factory within 10 km from commune	0.057**	0.029
Constant	-0.005	0.047
Number of observations	2811	
R2	0.06	

Legend: * p<0.1; ** p<0.05; *** p<0.01. Note: all variables are changes from 1993-1998, except the regional dummies, the dummy for non-farm employment in the commune in 1993, and the dummy for community labor development programs, which refers to the period 1993-98.