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Farm size and Productivity: Empirical Evidence from Rural Vietnam

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Introduction

The inverse relationship between farm size and land productivity has long been a major hypothesis of agricultural development in developing countries (Sen, 1962). The relationship of farm size and land- as well as labor productivity is central for the design of land reform debates including questions about land ceilings, land redistribution and land market regulations. In Vietnamese agriculture, although land productivity has attained high growth rates, labor productivity remains very low compared to its neighboring countries such as Thailand, Indonesia and the Philippines (Piya et al., 2011). In addition, agriculture in this country is characterized by smallholdings. Mostly, farm sizes are small with an average size of 0.2ha per household member (World Bank, 2000). Land policies in Vietnam have already undergone a number of reforms during the last decades. However, agricultural land market in Vietnam is still so far in its infancy. There exists number of forces both market- and non-market such as imperfect information, high transaction costs, and administrative allocation tempering the development of a free land market (Ravallion & Van de Walle, 2002). Hence, the paper will firstly test the hypothesis of an inverse relationship between farm size and land productivity in Rural Vietnam. Secondly, it will examine how the current farm sizes affect agricultural labor productivity in this country.

Data

The data is extracted from the second wave of the project titled “Impact of shocks on the vulnerability to poverty: Consequences for development of emerging Southeast Asian economies” funded by the German Research Foundation in three central provinces of Vietnam, namely Ha Tinh, Thua Thien Hue, and Dak Lak in 2008. The overall objective of this project is to get better understandings about the dynamics of rural poverty and to develop relevant strategies for sustainable reduction of poverty and inequality. Accordingly, data on various aspects of the socio-economic conditions of households including demographic conditions, education, health, shocks, risks, land, agriculture, off-farm employment, investment, public transfers, consumption and assets are collected. Within the frame of this paper, data on land holdings, agricultural activities, and agricultural assets of rural households will be taken into account. The total sample of three provinces in this project is 2200 households. However, this analysis includes 1750 households for which agricultural production is one of the main income sources in the reference period.

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Methodology

The relationship between productivity and inputs is constructed by the following Cobb-Douglas production function:

(1) $$Y = C\prod_{i=1}^{12} X_i^{\alpha_i}$$

where Y is aggregate value of output, C is constant term, X_i is production direct inputs and productivity influenced factors (e.g. cropping intensity). The relationships between farm size and land productivity, farm size and labor productivity are then investigated through estimating the generalized translog Cobb-Douglas functions on per hectare basis and per man day basis respectively. The estimation is carried out by means of an OLS and a village Fixed-Effects models as follows:

(2) $$\ln Y_{ij}^{land} = \ln C_{ij}^{land} + \sum_{k=1}^{8} \beta_{ijk}^{land} \ln X_{ijk}^{land} + \sum_{k=9}^{12} \lambda_{ijk}^{land} \ln X_{ijk}^{control} + \varepsilon_{ij}^{land}$$

(3) $$\ln Y_{ij}^{labor} = \ln C_{ij}^{labor} + \sum_{k)1}^{8} \beta_{ijk}^{labor} \ln X_{ijk}^{labor} + \sum_{k=9}^{12} \lambda_{ijk}^{labor} \ln X_{ijk}^{control} + \varepsilon_{ij}^{labor}$$

(4) $$\ln Y_{ij}^{land} = \ln C_{ij}^{land} + \sum_{k=1}^{8} \beta_{ijk}^{land} \ln X_{ijk}^{land} + \sum_{k=9}^{12} \lambda_{ijk}^{land} \ln X_{ijk}^{control} + V_j + \varepsilon_{ij}^{land}$$

(5) $$\ln Y_{ij}^{labor} = \ln C_{ij}^{labor} + \sum_{k)1}^{8} \beta_{ijk}^{labor} \ln X_{ijk}^{labor} + \sum_{k=9}^{12} \lambda_{ijk}^{labor} \ln X_{ijk}^{control} + V_j + \varepsilon_{ij}^{labor}$$

where Y_{ij}^{land} is land productivity, X_{ijk}^{land} is input k per hectare basis, Y_{ij}^{labor} is labor productivity, X_{ij}^{labor} is input k per man day basis, $X_{ijk}^{control}$ is agricultural productivity influenced factor of household i in village j, V_j is dummy for village j, $C_{ij}^{land}, C_{ij}^{labor}$ are parameters to be estimated and $\varepsilon_{ij}^{land}, \varepsilon_{ij}^{labor}$ are error terms

Results and Discussion

The relationship between production inputs and land productivity is illustrated by the regression results in Table 1. The estimates by OLS and Fixed-Effects are quite different. When the village level factors such as soil quality, stochastic nature of rainfall, irrigation infrastructure, input and output prices are controlled for, the robustness of the model improves. As shown in Table 1, high level of land productivity in Vietnam is determined by the cropping intensity and the application of irrigation, fertilizer, and seed. Remarkably, labor shows not to be an influential factor in yielding higher output per unit of land. The negative coefficients of farm size both in OLS and Fixed-Effects models and highly significant in Fixed-Effects model affirm the inverse relationship between farm size and land productivity. In other words in Vietnamese agriculture, the larger the size of landholdings the lower the land productivity. Since the value of output and inputs in (2) and (4) were defined as per hectare basis, coefficient for farm size is obviously the sum of factor elasticity of other production inputs minus unity. Therefore, the significantly negative sign of this coefficient in (4) indicates clear evidence of decreasing returns to scale of agricultural production in Vietnam.

Similar to land productivity, labor productivity in Vietnamese agriculture is mostly influenced by cropping intensity, irrigation, fertilizer, and seed (Table 2). Amount of labor also does not help to increase and even temper labor productivity. There is one point in which land productivity differs

Table 1: Cobb-Douglas production function for land productivity

	(2) OLS		(4) Fixed-Effects	
Independent variables	**coef**	**se**	**coef**	**se**
log of irrigation cost per hectare	-0.034**	0.014	0.046***	0.015
log of fertilizer cost per hectare	0.376***	0.055	0.233***	0.019
log of pesticide cost per hectare	0.023	0.023	0.031*	0.018
log of seed cost per hectare	0.008	0.016	0.074***	0.013
log of man days per hectare	-0.007	0.048	0.017	0.034
log of hired machine cost per hectare	-0.051***	0.013	-0.003	0.012
log of agricultural asset per hectare	0.040***	0.011	0.019*	0.010
log of farm size	-0.006	0.062	-0.141***	0.040
log of irrigated land	0.200***	0.047	0.124***	0.031
log of land use intensity	0.780***	0.143	0.754***	0.050
log of land fragmentation	0.040	0.063	0.214***	0.053
log of livestock revenue per hectare	-0.033***	0.011	0.004	0.010
_cons	5.935***	0.545	5.525***	0.245
Number of observations	1,750		1,750	
Village fixed effects	No		Yes	
Adjusted R2	0.521		0.371	

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Source: Author's calculation

Table 2: Cobb-Douglas production function for labor productivity

	(3) OLS		(5) Fixed-Effects	
Independent variables	**coef**	**se**	**coef**	**se**
log of irrigation cost per man day	0.059***	0.017	0.007	0.016
log of fertilizer cost per man day	0.400***	0.035	0.281***	0.020
log of pesticide cost per man day	0.022	0.026	0.002	0.015
log of seed cost per man day	0.075***	0.029	0.070***	0.017
log of man days	0.026	0.046	-0.081**	0.034
log of hired machine cost per man day	0.011	0.019	-0.005	0.017
log of agricultural asset per man day	0.053***	0.011	0.038***	0.011
log of farm size per man day	0.426***	0.054	0.462***	0.027
log of irrigated land	0.207***	0.032	0.115***	0.024
log of land use intensity	0.333***	0.048	0.348***	0.036
log of land fragmentation	0.052	0.055	0.191***	0.041
log of livestock revenue per man day	0.023	0.023	0.044***	0.016
_cons	4.574***	0.410	5.032***	0.224
Number of observations	1,750		1,750	
Village fixed effects	No		Yes	
Adjusted R2	0.691		0.541	

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Source: Author's calculation

from labor productivity. It lies on the positive relationship between farm size and labor productivity. That means, larger farms have higher labor productivity than smaller farms. The agricultural assets including tractors and harvesters show a high positive correlation with labor productivity. Similar to the coefficient of farm size in model (2) and (4), the negative coefficient of man days in model (5) implies an existence of decreasing returns to scale in Vietnamese agriculture

The inverse relationship between farm size and land productivity in Rural Vietnam can be firstly explained by decreasing returns to scale in agricultural production. Small farms have better production performance (Chand et al., 2011) especially considering the low level of mechanization level. Secondly, this inverse relationship is ascribed to the application of larger amount of inputs in production on small farms due to the imperfections of land, labor and credit markets. Theoretically, agricultural labor productivity can be decomposed into two components, namely land productivity and land-man ratio. Therefore, labor productivity can increase either by increasing land productivity or improving land-man ratio (Fan & Chan-Kang, 2005). The higher labor productivity on larger farms in Table 2 is explained by the high land-man ratio in these farms. Generally in Rural Vietnam, despite land productivity has increased over the last decades it is not high enough to compensate the too small land-man ratio. As a result, labor productivity in Rural Vietnam remains very low.

Conclusions and Recommendations

The empirical results support the notion of an inverse relationship between farm size and land productivity in Rural Vietnam. Since the inverse relationship was found in both the OLS and Fixed-Effects model, robustness of results can be assumed. This inverse relationship is attributed to the presence of decreasing returns to scale in Vietnamese agriculture and the excessive utilization of labor and other complementary inputs on smaller farms due to the poor land-man ratio. This poor land-man ratio is alleged by the imperfections of land and credit markets in rural areas and labor market as a whole. The low land-man ratio is also an explanation for the low labor productivity among smaller farms. These findings call for the improvement of land-man ratio in Rural Vietnam in order to increase farmers' income. Promoting more and better non-farm employment opportunities in rural areas deserves more policy discussion.

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