ĐÁNH GIÁ HIỆU QUẢ CỦA CÁC HỘ TRỒNG MẬN TAM HOA TẠI HUYỆN BẮC HÀ TỈNH LÀO CAI: BẰNG CHỨNG TỪ CHỈ SỐ MALMQUIST

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Tóm tắt

Trong nghiên cứu này chúng tôi xây dựng một bộ số liệu chuỗi từ 300 hộ trồng mận Tam Hoa trong ba năm từ 2015 đến 2017 và sử dụng phương pháp Chỉ số Malmquist để đánh giá hiệu quả của các hộ trồng mận. Kết quả cho thấy, nhìn chung, các hộ trồng mận đã đạt hiệu quả trong thời gian nghiên cứu. Tuy nhiên, khi phân tích các thành tố chúng tôi thấy các hộ này còn có thể nâng cao hiệu quả hơn nữa bằng cách điều chỉnh quy mô vườn mận của mình. Kết quả từ mô hình hồi quy Tobit với kỹ thuật bootstrap và 2.000 lần lặp cho thấy số lượng người phụ thuộc trong mỗi hộ gia đình và kinh nghiệm trồng mận của chủ hộ có ảnh hưởng đáng kể đến hiệu quả của các hộ trồng mận".

Từ khoá: *Hiệu quả, DEA, Tobit, Chỉ số Malmquist, mận Tam Hoa, Lào Cai, Việt Nam*

ASSESSING THE EFFICIENCY OF TAM HOA PLUM GROWERS IN BAC HA DISTRICT, LAO CAI PROVINCE: EVIDENCE FROM MALMQUIST INDEX

Abstract

The study constructs a balanced panel data set on 300 Tam Hoa plum farms in Bac Ha district, Lao Cai province in Vietnam during 2015-2017 and uses the Malmquist indices to examine the efficiency of the farms. The results show that the farms are efficiently operating during the study period. However, the decomposition of the Malmquist indices also indicates that the overall performance of the farms could have been increased by improving their scale. Results from Tobit regressions (bootstrapping, 2,000 replications) show that the number of dependants and the householder's experience in growing plum significantly affect the efficiency of the farms.

Keywords: *Efficiency, DEA, Tobit, Malmquist indices, Tam Hoa plum, households, Vietnam.*

1. Introduction

Bac Ha is a remote and mountainous district of Lao Cai province in Vietnam. It is one of the poorest districts of the country where many ethnic minority groups reside. Tam Hoa Plums were first grown in the district in early 1990s. By late 1990s, the plum price was considerably reasonable, at VND 8,000 per kilogram (USD 0.58) (XE, 1999) and the crop was considered as an effective means to help ethnic minority groups in the district to fight again poverty and to prevent the forests from soil erosion. Like many agricultural crops, Tam Hoa plum in the study areas experienced fluctuation. For example, the cultivation area of Tam Hoa plum in the district increased sharply, and reached a peak of 2,300 hectares in 2000. Due to oversupply, the price of Tam Hoa Plums during 2000s plunged dramatically, at almost VND 300 (USD 0.02) per a kilogram. The cultivation area then was reduced to almost 1,000 hectares with an annual production of 3,000 tons (VN Express, 2016).

The current study contributes to the literature in a number of ways. Firstly, it constructs a panel data set on Tam Hoa Plum farms in Bac Ha district, Lao Cai province, Vietnam during 2015 and 2017 to analyse the efficiency of the farms. Secondly, it applies the data envelopment analysis (DEA) techniques to produce the Malmquist indices, which are used to examine the efficiency of the farms. This approach is believed to have not been performed previously in Vietnam. Finally, it examines the impact of influential factors on the efficiency.

The structure of this paper is organised as follows: Section 2 reviews the literature on efficiency of agricultural crop farms in both Vietnam and international. Methodology, data, and variable description are discussed in Section 3 whilst results and discussions are presented in Section 4 and Section 5 concludes.

2. Literature review

Previous studies that used the Malmquist index approach to examine the efficiency of agricultural products/farms are occasional, but those used SFP (stochastic frontier production) & DEA (data envelopment analysis) approaches are not rare. Previous studies used such approaches to inspect the efficiency of agricultural products/farms in both international and Vietnamese context are briefly reviewed bellow.

2.1. International studies

Karimov (2013) collected and pooled data on 178 potato and 145 melon farms from two provinces (Khorezm and Fergana) in Uzbekistan and used bootstrapping DEA methods to examine the efficiency of the farms. The single output is the production of the crops and the inputs included land size (measured in hectares), number of labour days, amount of seeds (measured in kg), Nitrogen fertilisers (measured in kg), Diesel fuel (measured in kg) and other expenses. The results showed that the efficiency of melon farms was higher than that of potato farms and indicated that there was still room for improvement. Particularly, the bias corrected technical efficiency of the pooled sample of potato farms was 0,59 and that of melon was 0.76. The study also generated scale efficiency for the two provinces. The results showed that the scale size of the potato and melon farms in Khorezm was almost perfect (0.96 and 0.96) while the scale size of those in Fergana needed to improve (0.89 for potato farms and 0.9 for melon farms). Apart from the non-parametric analysis, the study also adopted the truncated regression methods to analyse the impact of influential factors (including soil quality, farm size, crop diversification, dependency ratios, willingness to work in a larger land area and distance to market) on the efficiency. The results showed that the soil quality of the farms, farm size and crop diversification had a positive impact on the efficiency and the level of significance ranged from five to one per cent.

Bocher, Simtowe, and Economics (2017) collected cross-sectional data from 400 households in Malawi that produced groundnuts and applied the SFP approach to examine profit efficiency of the crop. The inputs included the prices of labour, seeds, fertilisers and manure. The results showed that the profit efficiency mean was 45 per cent, showing that there was room for improvement. In addition, the study analysed the impact of influential factors on efficiency of the households. The factors include the householder gender, the distance to the nearest market, access to extension services, household size, soil quality and plot size. The results showed that the distance to the nearest market and the plot size had a positive and significant (at one per cent level) on the inefficiency. The impact of good soil quality and access to extension services on the inefficiency is negative and significant at one and five per cent level, respectively.

Külekçi (2010) randomly collected cross-sectional data from 117 farms that grew sunflower in Erzurum in Turkey during 2004 and 2005 and used the SFP approach to examine the efficiency of these farms. The results generate by the SFP showed that the mean technical efficiency of the farms was 0.64, indicating that the farmers could have reduced their inputs by 36 per cent to produce the same amount of outputs. The parametric analysis showed that the influential factors, including the age of the farmers, education of the farmers, experience in growing the crop of the farmers and the access to information were highly associated with lower technical inefficiency. In contrast, household size and access to credit were significantly associated with higher technical inefficiency.

2.2. Studies in Vietnam

Khai, Yabe, Yokogawa, and Sato (2008) collected cross-sectional data from 113 households that grew soybeans in the Mekong River Delta in Vietnam and used the SFP approach to inspect the efficiency of the farmers. The single output was soybean output (measured in kg). The inputs included human labour used (measured in labour days), amount of fertilisers used (measured in kg), amount of pesticides used (measured in ml) and machinery services hired (measured in days). The results showed that the technical efficiency was 73.9 per cent, the allocative efficiency was 51.5 per cent and the economic efficiency was 38 per cent. The study also used the truncated regression models to examine the impact of influential factors on the efficiencies (technical, allocative and economic). The factors included the access to training services (binary variable), the access to credit (binary variable), government subsidy recipients (binary variable), experience in growing soybean (measured in years), the cultivation size (ha) and the provincial dummies. The results showed that the impact of land size was significant (at one per cent level) for all the three models (TE, AE & EE). Its impact was positive for TE, but negative for remaining models. Additionally, the impact of the government subsidy on the TE and EE was positive and significant at 10 per cent level, but that on the AE is not statistically significant.

Hoang Linh (2012) used data on 595 households that grew rice in all rice cultivation areas in Vietnam and used the bootstrapped DEA techniques to inspect the efficiency of the farmers. The data are obtained from the Vietnam Living Standards Survey (VLSS) 2004. The study used the rice production (measured in kg) as the single output. The inputs included fertilisers, pesticides, seeds, labour (family and hired, measured in VND thousands), value of household fixed assets and equipment (measured in VND thousands), expenditure on hiring assets and maintenance (measured in VND thousands), spending on fuel and small tools (measured in VND thousands) and other expenditures. The results showed that the bias-corrected technical efficiency was 0.678. It also showed that farms located in the South was more efficient that those located in the North and the Centre (the bias-corrected efficiency was 0.701, 0.690 and 0.621, respectively). In addition, large farms were more efficient than small ones (the bias-corrected efficiency was 0.697 and 0.667, respectively). Also, diversified farms were found to be more efficient that those grew rice only (the bias-corrected efficiency was 0.701 and 0.668, respectively). The results also showed that the farms needed to adjust their size to reach the optimal level (the scale efficiency of all farms was 0.89). When the sample was split by region, it showed that farms located in the South were sill more efficient than those located in the North and the Centre (the scale efficiency was 0.911, 0.895 and 0.857, respectively). Results from the parametric analysis showed that the householder age was negatively associated with the technical efficiency (significant at five per cent level for the standard Tobit and the weighted Tobit models, but insignificant for the stochastic frontier model). The land to labour ration showed a positive impact on the technical efficiency (significant at five per cent level for the standard Tobit and the weighted Tobit models, but insignificant for the stochastic frontier model). In addition, the impact of the householder primary education on the technical efficiency was positive (significant at ten per cent level for the standard Tobit and the weighted Tobit models and at five per cent level for the stochastic frontier model).

In conclusion, the most popular technique used in previous studies is SFP and the most common indicator used to judge efficiency of the farms is technical efficiency. The most popular inputs used are labour and capital or their proxies. The outputs used in previous studies vary. Results are mixed depending on the context of the study such as time, location, data type and farms type. The influential factors used in previous studies are from both internal and external. To the best of the author's knowledge, there has not been a study used Malmquist indices to examine the performance of farms in Vietnam.

3. Methodology, data and variable selection

3.1. Conceptual framework and methodology

A farm can use n inputs to produce m outputs. Its production and decision-making process can be affected by both internal and external factors such as characteristics of the farm, the social, economic and political situations. This process is described in Figure 1 bellow.

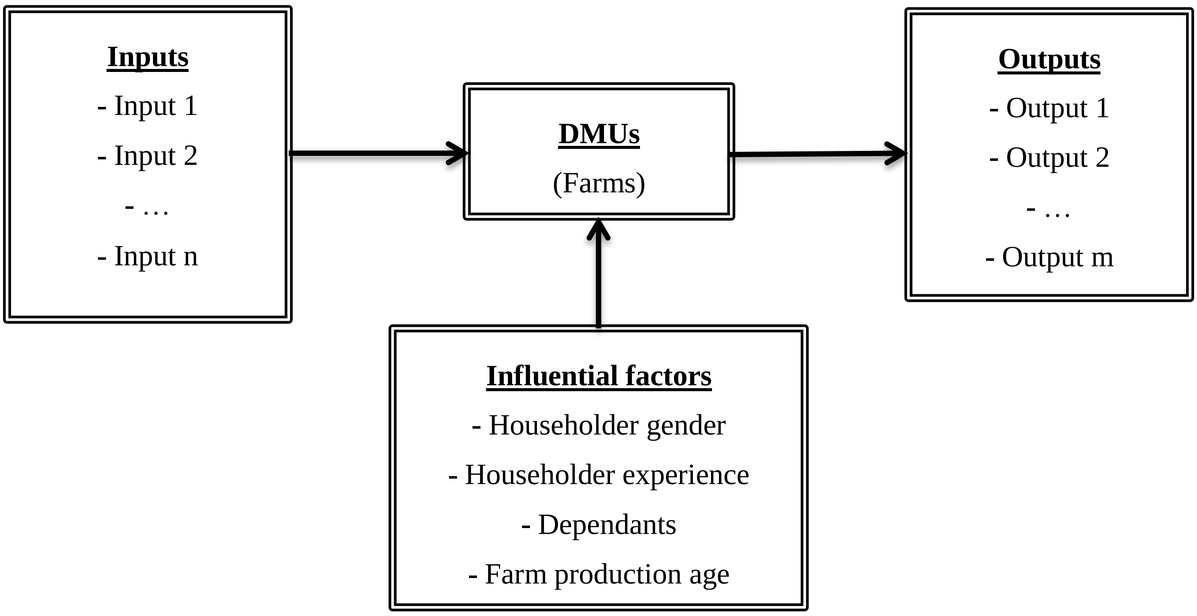

Figure 1. Conceptual framework of institutional decision-making process

Note. DMU is Decision Making Unit

Source. Designed by the author with ideas adopted from the literature.

Basically, data envelopment analysis (DEA) approach examines whether or not the combination of inputs and outputs of a firm is optimal. This combination can be viewed from two perspectives: one is known as input-oriented approach where the firm has control over its inputs, hence can minimise the use of its inputs to produce given outputs. The other approach is seen as output-oriented approach where the organisation can maximise its outputs using given inputs (Coelli, Rao, O'Donnell, & Battese, 2005). The current study follows the output-oriented approach with an assumption that the manager or director or owner of the enterprise tends to maximise outputs with given or limited inputs. For example, the firm is assumed to manage its best to maximise gross or net revenue and, or profit with given or limited employees or capital. The technical efficiency with output-oriented approach can be obtained by solving the following problem:

$$\max_{\theta,\lambda}\theta$$

$$\text{Subject to}\begin{cases}-\theta y_i + Y\lambda \geq 0\\ x_i - X\lambda \geq 0 \quad (3.1)\\ I1'\lambda = 1\\ \lambda \geq 0\end{cases}$$

Where $1 \leq \theta \leq \infty$, θ is a scalar representing technical efficiency, I1 is an I x 1 vector of ones and $\theta - 1$ is the proportional increase in outputs (y_i), which could be obtained by the i^{th} firm with fixed inputs (x_i). λ is a vector of weights, representing the distance between an efficient firm and its peers. Y and X represent the matrices of outputs and inputs, respectively, of all farms in the data.

Conventional DEA methods are usually used to deal with cross-sectional data to provide a snapshot of efficiency of institutions/organisations. However, to deal with panel data to produce efficiency of such organisations over time (dynamic settings) the Malmquist index (Malmquist, 1953) approach is an ideal option (Cooper, Seiford, & Zhu, 2004). The present study takes an advantage of the availability of panel data during 2001-2015 on farms operating in Vietnam to generate the total factor productivity change and its components. These are believed to give more insights into the efficiency of the universities. The Malmquist Total Factor Productivity (TFP) Index (The Malmquist total factor productivity change and the Malmquist indices are used interchangeably in the current study) was first introduced by Caves, Christensen, and Diewert (1982a, 1982b). The index is calculated by measuring the radial distance of the output (y) and input (x) vectors in t and t+1 period. The Malmquist index for period t is defined as follows:

$$m_o^t\left(y_i^t, y_i^{t+1}, x_i^t, x_i^{t+1}\right) = \frac{d_o^t\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^t\left(y_i^t, x_i^t\right)} \quad (3.2)$$

Where m_o denotes the Malmquist index and d_o refers to the output distance function.

If the firm is technically efficient in both periods, then the denominator in Equation 3.2 equals one and therefore:

$$m_o^t\left(y_i^t, y_i^{t+1}, x_i^t, x_i^{t+1}\right) = d_o^t\left(y_i^{t+1}, x_i^{t+1}\right) \quad (3.3)$$

Similarly, the Malmquist index for period t+1 is defined as:

$$m_o^{t+1}\left(y_i^t, y_i^{t+1}, x_i^t, y_i^{t+1}\right) = \frac{d_o^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^{t+1}\left(y_i^t, x_i^t\right)} \quad (3.4)$$

If the firm is technically efficient in period t+1, then the numerator in Equation 3.4 equals one.

The total factor productivity change (TFPCH) between period t and period t+1 is:

$$\begin{aligned}\text{TFPCH} &= \left[m_o^t\left(y_i^t, y_i^{t+1}, x_i^t, x_i^{t+1}\right) * m_i^{t+1}\left(y_i^t, y_i^{t+1}, x_i^t, x_i^{t+1}\right)\right]^{\frac{1}{2}}\\ &= \left[\frac{d_o^t\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^t\left(y_i^t, x_i^t\right)} * \frac{d_o^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^{t+1}\left(y_i^t, x_i^t\right)}\right] \quad (3.5)\end{aligned}$$

Equation 3.5 above can be re-written as:

$$\text{TFPCH} = \frac{d_o^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^t\left(y_i^t, x_i^t\right)} * \left[\frac{d_o^t\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^t\left(y_i^t, x_i^t\right)} * \frac{d_o^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_o^{t+1}\left(y_i^t, x_i^t\right)}\right]^{\frac{1}{2}} \quad (3.6)$$

In Equation 3.6, the ratio outside the square bracket measures technical efficiency change (EFFCH) while those inside the square bracket measure technological change (TECHCH). Or:

TFPCH = EFFCH * TECHCH (3.7)

EFFCH shows how well the firm is in managing its inputs and outputs. If a firm could have used fewer inputs than its current inputs to keep its outputs unchanged, it is considered inefficient. Similarly, if a firm could have produced more outputs than its current outputs using the same amount of inputs, it is not efficient.

Technology is assumed to change or develop overtime. A firm that is able to apply or update to new technology likely to be efficient (by either minimising the use of inputs or maximising outputs) and the availability of panel data allows to observe this change over time. TECHCH shows the ability of the firm to catch up with modern technology (Coelli et al., 2005).

Färe, Grosskopf, Norris, and Zhang (1994) decomposed EFFCH into pure technical efficiency change (PECH) and scale efficiency change (SECH) for further analyses as follows:

EFFCH = PECH * SECH (3.8)

Where:

$$\mathrm{PECH} = \frac{d_v^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_v^t\left(y_i^t, x_i^t\right)} \quad (3.9)$$

$$\mathrm{SECH} = \frac{\dfrac{d_c^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}{d_v^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right)}}{\dfrac{d_c^t\left(y_i^t, x_i^t\right)}{d_v^t\left(y_i^t, x_i^t\right)}} \quad (3.10)$$

$$\mathrm{SECH} = \frac{d_c^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right) * d_v^t\left(y_i^t, x_i^t\right)}{d_v^{t+1}\left(y_i^{t+1}, x_i^{t+1}\right) * d_c^t\left(y_i^t, x_i^t\right)} \quad (3.11)$$

Where c and v represent constant returns to scale and variable returns to scale, respectively.

PECH mainly captures changes in managerial performance (by either following best management practices or choosing optimal input combinations) of the firm.

Microeconomic theory proves that one of the fundamental objectives of a firm is to operate at its most productive size. If the size of the firm is excessively large or small, it may not be efficient to reduce inputs such as cost or increase outputs such as revenue or profit. In the current study, SECH reflects how optimum the scale size of the firms is in terms of using fixed inputs to increase the outputs.

Apart from internal factors, external factors such as social-economic-political situations can also play an important role on the efficiency of a firm. To analyse the impact of such factors on the efficiency (generated by the non-parametric analysis) of the universities, a parametric analysis is conducted using the following latent variable model:

$$y_i^* = \beta x_i + \varepsilon_i \quad (3.12)$$

Where x_i represents a vector of external variables, β is a vector of unknown parameters to be estimated, ε_i is a random error. The latent variable y_i^* is tied to the observed technical efficiency scores by the following measurement model:

$$y_i = \begin{cases} y_i^* \text{ if } 0 < y_i^* < 1 \\ 1 \text{ if } y_i^* \geq 1 \\ 0 \text{ if } y_i^* \leq 0 \end{cases} \quad (3.13)$$

Since the technical efficiency scores range between zero and one, either Tobit or truncated regressions can solve the problem in Equation 3.12 (Long & Freese, 2014). Although parameters generated by a truncated regression are closer to true values than those produced by a Tobit regression (Simar & Wilson, 2007). Tobit regression is widely applied. In addition, no observations with a zero value exist and are excluded from the data set that used for the current study. For these reasons, the present study applies Tobit regressions. To make results of the current study more robust, bootstrap with 2,000 replications is applied.

3.2. Data source, descriptive statistics and variable description

3.2.1. Data source and descriptive statistics

Three hundred households that grew Tam Hoa Plum were repeatedly surveyed during 2015-2017 making a total sample of 900 observations. These households are selected from three communes, Ban Hoi, Na Hoi and Ta Chai, representing three economics regions of Bac Ha district in Lao Cai province. In each household, characteristics of the householder, of the household and of the region where the household located are collected. Data were collected only from farms that have given production.

Table 1 shows descriptive statistics of the selected variables. The statistics show that the householders have long experience in growing the crop. Particularly, on average, a householder had almost 23 years of experience in growing Tam Hoa plum. There were almost three labours in a household and the number of dependants was approximately 2 persons. The farm production age was approximately 17 years. The statistics show that the farms are not in the most productive stage, which should be between five to ten years old. Each household used approximately 87 plum trees. On average, each household used 19 labour days to care about their plum farm and invested almost 4.6 VND million on their plum farm annually. Approximately, the annual plum production was one ton per farm and annual income from plum was 28.7 VND millions.

Table 1: *Descriptive Statistics*

Variable	Mean	S.D.[a]	Min	Max
1. Non-parametric analysis				
Outputs				
- Annual plum production (kg)	1,009.81	822.93	100.00	15,000.00
- Annual plum income (VND thousands)	28,704.39	15,969.23	3,500.00	96,000.00
Inputs				
- Number of labours (persons)	2.79	0.93	0.00	6.00
- Number of plum trees planted	87.14	44.40	15.00	280.00
- Investment (VND thousands)	4,590	2,680	1,000	50,000
- Labour days used for plum production	19.36	8.90	2.00	50.00
2. Parametric analysis				
Independent variables				
- Householder gender (1=male, 0=otherwise)	N/A[b]	N/A	N/A	N/A
- Householder experience in growing plum (years)	22.84	6.21	10.00	37.00
- Dependants (persons)	2.18	1.08	0.00	5.00
- Plum farm production age (years)	17.07	6.05	5.00	34.00
Dependent variable				
- Efficiency scores	1.16	0.28	0.72	3.10

Note. [a]Standard Deviation, [b]Not Applicable.

Source: Calculated from the surveyed data.

3.2.2. Variable description

The currents study follows previous studies and bases on information available in the data set to choose the following inputs, outputs and influential factors:

Four inputs, including the number of labours in the household, the number of labour days used in each year to grow plum, the number of plum trees and investment in growing plum, are selected for the current study. Two outputs, including plum production and income from plum are chosen for the current study.

Apart from the internal factors, it is necessary to consider the impact of external factors (also known as environment factors) on the plum farms' efficiency. Based on literature and the availability of the data, four external variables are used for the parametric analysis in the current study. These variables include household head gender, household head experience in growing plum, the number of dependants in the household and the farm production. It is expected that males may be better in growing plum, hence its impact on the efficiency may be positive. Similarly, the impact of household head experience is expected to be positive. In contrast, the number of dependants in the household is expected to be negative. The production of the farm follow the inverted U-shaped, particularly, in the early and late stages (years), the plum trees have lower production that middle stage. Therefore, the impact of the farm production age on the efficiency may be mixed.

4. Results and discussions

4.1. The efficiency of Bac Ha Plum farms

The Malmquist index approach generates the total factor productivity change (TFPCH) and its components for each study period (annual means) and for the entire study period (Mean). The overall efficiency of the plum farms can be examined by analysing the TFPCH. In addition, their efficiency can be periodically analysed in detail by decomposing the TFPCH into components. These are presented in Table 2.

Of the 300 farms, 86 are found inefficient, accounting for almost 29 per cent. Among the three communes, Ban Hoi had the largest number of farms inefficient (46 farms, accounted for approximately 15.3 per cent), followed by Na Hoi (34 farms, accounted for approximately 11.4 per cent) and Ta Chai (6 farms, accounted for 2 per cent). More details on these findings are available on request.

Table 2: *Malmquist Index Summary of Annual Means*

Year	EFFCH[a]	TECHCH[b]	PECH[c]	SECH[d]	TFPCH[e]
2016	1.000	1.000	1.000	1.000	1.000
2017	1.133	1.131	1.144	0.990	1.282
Mean	**1.064**	**1.064**	**1.070**	**0.995**	**1.132**

Note. [a]Technical efficiency change, [b]Technological change, [c]Pure technical efficiency change, [d]Scale efficiency change, [e]Total factor productivity change.

Source: Calculated from the surveyed data.

Despite the inefficiency of the scale size of the farms (the scale efficiency change – the SECH mean is 99.5 per cent), the total factor productivity mean shows that during the study period, the sampled farms were efficient (the TFPCH is 113.2 per cent). This achievement is mainly contributed by applying modern technology (the technology efficiency change – the TECHCH is 106.4 per cent) and by applying advanced management methods (the pure efficiency change – the PECH is 107 per cent). This finding implies that the efficiency of the farms could have been increased by 0.5 per cent by adjusting the scale size of the farms.

One of the advantages of using the Malmquist index approach is that efficiency can be generated in each study period (year in the context of the current study) and for the entire study periods for comparisons. The results show that compared to 2016, the efficiency of the farms in 2017 is higher by 28.2 per cent (the TFPCH in 2016 is 100 per cent compared to that in 2017 is 128.2 per cent).

4.2. The impact of influential factors on the efficiency of the plum farms

Based on literature and the availability of the data, five influential variables are selected to examine their impact on the efficiency of the plum farms, which have been generated from the non-parametric analysis. Table 4 presents results generated from Tobit regressions (bootstrap, 2,000 replications).

Table 4: *The Impact of Influential Factors on the Efficiency of Plum Farms*

	Coef.[a]	S.E.[b]	P>z
Householder gender (1=male, 0=otherwise)	0.0243	0.0337	0.4700
Farm production age (natural log)	0.0299	0.0384	0.4360
Experience of the householder in growing plum (natural log)	0.0832	0.0443	0.0600
Dependants (persons)	-0.0416	0.0085	0.0000
Constant	1.0650	0.1826	0.0000

Note. [a]Coefficients, [b]Standard error.

Source. Author's calculations.

Results presented in Table 4 show that the impact of the household head gender on the efficiency is not statistically significant as expected. This finding implies that the knowledge inequality between males and females in the study areas may have been considerably close. Similarly, the impact of the farm production age on the efficiency is not significant. As expected, experience in growing plum of the household head on the efficiency is positive and significant at ten per cent level. For example, a one-year increase in the household head experience (in growing plum) is associated with approximately eight-percentage point increase in efficiency. The number of dependants significantly reduces the efficiency. Particularly, one dependant increased in the household is significantly (at one per cent level) associated with a decrease of approximately four percentage-point in efficiency.

5. Conclusion

The current study constructs a balanced panel data set on Tam Hoa plum farms in Bac Ha district, Lao Cai Province, Vietnam during 2015-2017 and uses non-parametric analysis methods to examine the performance of the institutions. The results show that approximately 70 per cent of the farms was productive during the study period. The farms in 2017 were more efficient that those in 2016. The results also indicate that efficiency of the farms could have been increased more by adjusting their scale size. Apart from the non-parametric analysis, the present study also performs a parametric analysis using Tobit (bootstrap with 2,000 replications) to analyse the impact of influential factors on the efficiency of the farms. The impact of the number of dependants and the householder's experience in growing plum is significant at one and ten per cent level, respectively, but that of other factors is not statistically significant. Despite considerable efforts of the authors, information on other inputs (rather than the current such as irrigation, fertilisers, cultivation methods) that may have an impact on efficiency of the farms has not been collected and added to the Tobit model. Further studies should be able to shed more light by collecting and using such information.

REFERENCES

[1]. Bocher, T. F., Simtowe, F. J. J. o. D., & Economics, A. (2017). *Profit Efficiency Analysis among Groundnut Farmers from Malawi*. *9* (10), 278-288.

[2]. Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982a). Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers. *The economic journal, 92*(365), 73-86.

[3]. Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982b). The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica: Journal of the Econometric Society*, 1393-1414.

[4]. Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An Introduction to Efficiency and Productivity Analysis* (Second ed.): Springer Science & Business Media.

[5]. Cooper, W. W., Seiford, L. M., & Zhu, J. (2004). Data Envelopment Analysis. In *Handbook on Data Envelopment Analysis* (pp. 1-39): Springer.

[6]. Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *The American Economic Review*, 66-83.

[7]. Hoang Linh, V. (2012). Efficiency of Rice Farming Households in Vietnam. *International Journal of Development Issues, 11*(1), 60-73.

[8]. Karimov, A. (2013). Productive Efficiency of Potato and Melon Growing Farms in Uzbekistan: A Two Stage Double Bootstrap Data Envelopment Analysis. *Journal of Agriculture, 3*(3), 503-515.

[9]. Khai, H. V., Yabe, M., Yokogawa, H., & Sato, G. (2008). Analysis of Productive Efficiency of Soybean Production in The Mekong River Delta of Viet Nam. *Journal of Faculty of Agriculture Kyushu University, Fukuoka, Japan, 53*(1), 271.

[10]. Külekçi, M. (2010). Technical efficiency analysis for oilseed sunflower farms: a case study in Erzurum, Turkey. *Journal of the Science of Food Agriculture, 90*(9), 1508-1512.

[11]. Long, J. S., & Freese, J. (2014). *Regression Models for Categorical Dependent Variables Using Stata* (3rd ed.): Stata Press.

[12]. Malmquist, S. (1953). Index Numbers and Indifference Surfaces. *Trabajos de estadística, 4*(2), 209-242.

[13]. Simar, L., & Wilson, P. W. (2007). Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. *Journal of Econometrics, 136*(1), 31-64.

[14]. VN Express. (2016). *Bac Ha Tam Hoa Plums*. Retrieved from https://vnexpress.net/thoi-su/vuong-quoc-man-tam-hoa-bac-ha-3411233.html

[15]. XE. (1999). *XE Currency Table: USD - US Dolla*r. Retrieved from https://www.xe.com/currencytables/?from=USD&date=1999-01-01

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