Technical efficiency of small-scaled manufacturing enterprises in six different sectors in northern Vietnam

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CHRONICLE	ABSTRACT
	This paper examines the technical efficiency of small-scale manufacturing enterprises in Vietnam. The research uses primary data from a survey from June, 2019 to August, 2019 with 321 observations of six sub-sectors, including Textile, Garment; Building materials; Vegetable, Fruit and Bulb; Manufacture of Steel; Furniture Manufacturing and Food Processing. The research's results show that the mean technical efficiency was 71.26 percent. However, there are considerable differences between sub-sectors ranging from 55.97 percent to 95.97 percent. The above mentioned results indicate that with the same level of inputs, Vietnamese small size enterprises can increase the present level of output by 44.03 percent; 38.05 percent; 30.92 percent; 26.07 percent; 21.05 percent and 4.08 percent for the sectors of Food Processing, Building Material; Textile, Garment; Vegetable, Fruit and Bulb; Manufacture of Steel and Furniture Manufacturing, respectively. The estimated results further suggest that manufacturing small-scale enterprise in Vietnam should improve their technology, labor quality and the initiative of input materials, especially, the sectors of Textile, Garment; Building Materials and Food Processing in order to move the production frontier upward as their technical efficiency are maintaining at low level.

1. Introduction

There are the differences in opinion about small size enterprises around the world. However, based on the state of Vietnam's economy and Vietnamese Law of supporting small and medium size enterprises (2017), the Vietnamese government issued the Decree to guide enterprises receiving the grants (Decree 39/2018/NĐ-CP, March 11, 2018). This Decree defines that an enterprise is small size if it's registered capital has been less than 10 billion Vietnam dong (VND) (approximately 305,000 US dollars (USD)) for the Trade and Services sectors; 20 billion VND (approximately 610,000 USD) for the Agriculture, Forestry and Fishery sectors; as well as for the Industry and Construction sectors. According to the report of Chamber of Commerce and Industry of Vietnam (VCCI) (2019), 98.1 percent of Vietnamese enterprises are small and medium-scale (SMEs), in which the number of the small size enterprises was 114.1 thousand, making up 19.4 percent.

The above-mentioned numbers obviously imply that small size enterprises have held a crucial role in the Vietnamese economy, especially in the case of manufacturing enterprises. They made significant contributions in shifting career structure through job creation. They also attracted labors from agriculture, invested in niche markets, promoted business and developed the production chain (Harvie & Le, 2010). However, despite the fact that the business performance of Vietnamese small-scale manufacturing enterprises has had more stability than this of Vietnamese state companies, it has been lower than the business performance of foreign-invested enterprises in Vietnam (Le, 2017). There are also a number of challenges to small-scale manufacturing enterprises in order to improve their efficiency. Kieu (2019) found that the competitiveness of Vietnamese enterprises in general as well as of small-scale manufacturing enterprises in the competitive market has been low and unstable, in comparison with foreign companies. The majority of Vietnamese enterprises produce on a small scale, with a limited market

share and weak technological potential. In addition, Vietnamese enterprises' human resource quality has not met the requirements, the rate of trained workers is low and the financial resources are limited (VCCI, 2019). Despite of a series of policies from Vietnamese government in supporting and promoting the development of Small-scale manufacturing enterprises, their business performance still maintains a low growth rate because of weak management and capital generation ability (VCCI, 2019). This means that there still exist difficulties for Small-scale manufacturing enterprises in order to raise their business performance. Hence, improving the business efficiency of Small-scale manufacturing enterprises is one of the priorities of the Vietnamese Government in the current period.

There are a large number of researches evaluated the technical efficiency in SMEs. For example, Alvarez and Crespi (2001) conducted the survey for Chilean manufacturing firms and provided the evidence that small firms were less productive than larger ones. These authors also suggested that efficiency was positively associated with the experience of workers, modernization of physical capital and innovation in products. In the other hand, Page (1984) illustrated that the average experience of the labor force within the enterprise, experience of the entrepreneur, age of the establishment's plant and equipment and level of capacity utilization were identified as significant sources of variations in technical efficiency. Another research of Yang *et al.* (2013) carried out the technical efficiency between Outward Foreign Direct Investment (OFDI) firms and non-OFDI firms in Taiwan. Their results indicated that technical efficiency of OFDI Firms is higher than that of non-OFDI firms because of the technological advances. In Vietnam, Vu (2003) examined the technical efficiency of State-Owned Enterprises (SOEs) in the three different cities of Ho Chi Minh, Ha Noi and Hai Phong city in 1997 and 1998. The research illustrated that there are positive changes of the technical efficiency for these enterprises in 1998 in comparison with 2017.

Although there are a number of researches studied the enterprises' technical efficiency in Vietnam, most studies concentrate on large-scale enterprises and state-owned enterprises. This paper aims to evaluate technical efficiency of small-scale manufacturing enterprises, the sector that received less interest than its importance in the Vietnamese economy by surveying 321 observations in the northern region of Vietnam. The study's goal is to evaluate and compare the technical efficiency in six different sectors, thereby proposing feasible solutions to improve business performance for these enterprises in the future.

2. Literature review

Kinda *et al.* (2009) compared the firm productive performance in eight manufacturing industries between five Middle East and North African economies and 17 other developing countries by using the data from World Bank. They pointed out that firm performance discrepancies were explained by the differences in the quality of infrastructures, education of the labors and financial cost. Abegaz (2013) studied about the technical productivity for Ethiopian manufacturing areas hiring 10 or more employees during the 13-year period and found that the mean efficiency predicts for the mostly region was around 56 percent. Meanwhile, Hailu and Tanaka (2015) measured the index of the Ethiopian manufacturing area by using an establishment-level census panel dataset from 2000 to 2009. Their results suggested that the main problem, common to all the manufacturing sectors, would be the powerlessness of companies to operate at the full production ability, which was mainly caused by the lack of providing of raw materials.

Oguchi *et al.* (2006) conducted the study relating to technical efficiency between large firms SMEs in Malaysian Manufacturing. This research's results showed that these firms' technical efficiency over the 7-year period, from 1992 to 1999, was 62.4%. However, this study also indicated that SMEs were less efficient than the large firms in term of industry level. Conversely, the SMEs were more efficient than large firms in the Resource−based Industrial Cluster. On the other side, Charoenrat *et al.* (2013) used inefficient technical effect model and stochastic frontier analysis to analyze the technical productivity of Thailand's manufacturing SMEs and key factors which affected it. An analysis about cross-sectional date from a 2007 census showed that while the mean of Thai SMEs' technical productivity was of 87.7%, the weighted average technical productivity of their manufacturing SMEs was almost 50%, signifying the technical inefficiency in large scale, which reduced these firms' potential turnouts. The inefficient impact model exhibited that the size, age, skilled labor, ownership characteristics and location of firm were firm-specific elements that considerably influenced the technical inefficiency of production. This study further found that the key measures to increase Thai manufacturing SMEs' technical productivity were sufficient supply of inputs, access to credit facilities, extended infrastructural development and training programs for staffs. Their estimated results not only exhibited that Thailand had to face a strong competition in both domestic and foreign markets, but also implied their difficulties in integrating international production.

There have not been any independent researches focusing on Vietnamese small-scaled firms. However, recently, it has been a growing number of studies investigating the technical productivity implementation of SMEs in Vietnam, especially in ownership areas and industries. They included: Vu (2003); Rand et al. (2004); Pham *et al.* (2009); Nguyen *et al.* (2005); Ha and Carlin (2007); Nguyen and Truong (2007); Tran *et al.* (2008) and Le *et al.* (2018). These researches investigated technical productivity against the best practice manufacture frontier which derived from the respective patterns. Based on a lot of datasets covering different periods, they suggested that there has been no firmness in the technical productivity implementation of SMEs in Vietnam.

One of the first researches of Vietnamese firms' technical productivity was Vu (2003), who concentrated on State-Owned Enterprises (SOEs) in three particular cities including Ho Chi Minh, Ha Noi and Hai Phong. The results showed that these enterprises obtained a relatively quite high level of productivity in two years 1997 and 1998, reached approximately 79% of

the manufacturing frontier. These also suggested a positive change in the technical productivity level in 1998 in comparison with the previous year.

Nguyen *et al.* (2005) investigated the technical efficiency of forms operating in the textile and garment areas in Vietnam over 4-year period from 1997 to 2000. Their estimated results exhibited that the technical efficiency level was 79.2% for enterprises in the textiles sub-area and 81.5% for ones in the garments sub-zone. Go further, Tran *et al.* (2008) carried out a research on technical efficiency level for Vietnamese manufacturing SMEs in the non-state area. Their results indicated that the technical productivity level for these SMEs was 79.6% in 1996, which increased to 86.7% in the following year.

Nguyen and Truong (2007) used data envelopment analysis (DEA) and found a low level of technical productivity for factories in Vietnam, whereas the figure for manufacturing companies during a period of two years, from 2001 to 2003, was only 47.5%. Similarly, Ha and Carlin (2007) applied DEA to conduct an examination for manufacturing factories in Vietnam from 2001 to 2005 and found that their technical productivity was in the range of 45-53%, depending on their kind of ownership.

Other researches on Vietnamese SMEs also indicated similar results. For instance, the study of Rand et al. (2004) revealed that the technical efficiency level of Vietnamese manufacturing SMEs was in the same range as that showed in other developing nations. They used firm survey data conducted in these stages including 1990/1991, 1995/1996 and 2000/2001 and exhibited that the technical efficiency was average at about 61%. The earlier study conducted by Tybout (2000) showed that Vietnamese manufacturing SMEs are quite efficient with regard to their best practice frontier but it is impossible to conclude that manufacturing SMEs in Vietnam are more efficient than their counterparts in developing countries. Pham *et al.* (2009) found the technical productivity level for Vietnamese manufacturing firms at 62% in 2003. Meanwhile, Nguyen *et al.* (2007) used panel data for 1,492 manufacturing factories from firms census implemented in 2000 and 2003 by Vietnam Statistics Office (GSO) and exhibited that these firms' technical efficiency level 39.9% and 49.7% by using the DEA and SFPE approach, respectively.

In summary, the evaluation and analyses in technical efficiency and productivity growth in Vietnam as well as in other developing countries have shown that there is a considerable change of the technical efficiency level across sub-areas within the manufacturing region, by the size of firms and the ownership of enterprises. These studies signified that technical efficiency of SMEs generally in developing countries and particularly in Vietnam tended to increase, but their technical efficiency still maintained at low levels. This was because of the quality of infrastructures, education, skilled labor as well as the limitation of financial sources.

3. Survey data

This paper' data was collected from small-scale enterprises located in six different provinces in the northern Vietnam, including Thai Nguyen, Bac Ninh, Vinh Phuc, Hai Duong, Quang Ninh and Phu Tho. It covered three areas: the central, the east and the west. 321 questionnaires were randomly collected based on the number of businesses situation in sub-sector of each province, and all surveyed companies have been operating in the sector of manufacturing, in which 58 enterprises are operating in Textile and Garment, 37 Building Materials, 75 Vegetable, Fruit and Bulb, 55 Manufacture of Steel, 42 Furniture manufacturing and 54 Food processing. The survey was conducted from June to August 2019.

Table 1
Observations by Sub-sectors

Sub-Sectors	Number of Observation	Percentage
Textile, Garment	58	18.07
Building Materials	37	11.52
Vegetable, Fruit and Bulb	75	23.36
Manufacture of Steel	55	17.13
Furniture Manufacturing	42	13.08
Food Processing	54	16.82
Total	321	100.00

Source: The survey from June to August in 2019

The paper's questionnaire chiefly examined the enterprise's performance and business environment. It included common information, infrastructure, sales, degree of competition, capacity, capital, labors, financial background, innovation and technology. The survey focused on small-scale enterprises that hire more than 5 and less than 50 permanent and temporary workers. To get unbiased predictions of the whole firms and ensure sufficient representation of the model, this research adopted a strict stratified incidental sampling, introduced by Asakawa *et al.* (2010), which takes full account of the business, industry and regional differences as above mentioned. In comparison with simple incidental sampling, this study avoids the overconcentration of samples in secure firms or areas, declines predictive errors and enhances accuracy (Asakawa et al, (2010). The study process was divided into two stages: (1) measuring whether the sample company satisfy the standards by phone before making an appointment for an official interview and (2) conducting face-to-face ones with executives of the firms. The collected data expressed in table 2 indicates that the highest average sales belongs to small-scale manufacturing enterprises in the sector of Manufacture of Steel with 17,679 million VND, followed by Food Processing and Building Materials sectors with 12,762 and 10,875 million VND, respectively. The figures for enterprises operating in the sector of Textile, Garment and the sector of Furniture Manufacturing are lower with 7,545 and 10,622 million VND, correspondingly. Meanwhile, the average sales of enterprises in Vegetable, Fruit and Bulb sector just reaches 5,893 million VND.

Table 2

Average sales by Sub-secto   **Unit: Million VND**

Sub-Sectors	Average Sales	SD	Max	Min
Textile. Garment	7.545	342	17.984	836
Building Materials	10.875	984	25.352	2.980
Vegetable. Fruit and Bulb	5.893	346	7.878	1.786
Manufacture of Steel	17.679	423	39.571	11.212
Furniture Manufacturing	10.622	1.021	19.382	4.962
Food Processing	12.762	1.936	28.324	4.236

Source: The survey from June to August in 2019

Table 3

Average labor by Sub-sectors   Unit: Labors

Sub-Sectors	Average Labor	SD	Max	Min
Textile, Garment	12	2.109	21	5
Building Materials	19	4.031	30	8
Vegetable, Fruit and Bulb	7	1.112	10	2
Manufacture of Steel	15	2.342	25	7
Furniture Manufacturing	10	3.329	20	3
Food Processing	10	3.295	32	3

Source: The survey from June to August in 2019

Table 3 shows that the average labor working in Building Materials enterprises is 19 and this number in Manufacture of Steel companies is 15, highest among six selected sectors. This should be explained that they are heavy industry sectors so that they frequently require a higher number of workers than other sectors. The average labor working in Furniture Manufacturing sector and Food Processing sector is equal with about 10 labors per enterprise, in comparison with 12 labors of Textile, Garment sector and 7 labors of Vegetable, Fruit and Bulb sector.

Table 4

Average capital by Sub-sectors   Unit: Million VND

Sub-Sectors	Average Capital	SD	Max	Min
Textile, Garment	4.436	342	10.845	861
Building Materials	6.834	984	17.342	2.030
Vegetable, Fruit and Bulb	3.096	346	6.008	1.236
Manufacture of Steel	12.672	423	37.161	5.302
Furniture Manufacturing	3.890	1.021	9.022	1.403
Food Processing	7.766	1.936	19.240	3.006

Source: The survey from June to August in 2019

Table 4 illustrates that Steel enterprises require a higher amount of capital than others. The average capital for each Manufacture of Steel firm is 12,672 million VND. The Food Processing and Building Material enterprises also require a relatively high amount of capital with 7,766 and 8,834 million VND respectively. Meanwhile, the average capital amount for each Vegetable, Fruit and Bulb company is much lower with 3,096 million VND.

Table 5

Average Value of Intermediate inputs by Sub-sectors   Unit: Million VND

Sub-Sectors	Average Value of Intermediate inputs	SD	Max	Min
Textile, Garment	3.126	312	11.158	1014
Building Materials	5.443	1.080	12.095	3.137
Vegetable, Fruit and Bulb	2.616	416	9.886	1.861
Manufacture of Steel	11.128	521	29.614	4.929
Furniture Manufacturing	2.281	991	8.936	952
Food Processing	8.239	2.162	21.140	3.942

Source: The survey from June to August in 2019

Intermediate inputs consist of raw materials and fuels which are used for production. Table 5 shows that the average values of intermediate inputs of Manufacture of Steel and Food Processing enterprises are the highest with 11,128 and 8,239 million VND, respectively, followed by Building Materials and Textile, Garment sectors with 5,443 and 3,126 million VND, respectively. These figures for Vegetable, Fruit and Bulb and Furniture Manufacturing enterprises are significantly lower with above 2,000 million VND.

4. Methodology

Productivity and efficiency illustrate the economic appearances of every company performance. The development of productivity and efficiency is the most important growth as it concentrates on growth quality. That is reason why theoretical and empirical works on enterprise performance concentrate on determining firm efficiency (Storey, 1990). Meanwhile, average labor productivity had been used as a method of efficient analysis until Farrell (1957) found a measurement to determine efficiency. His framework gets an efficient production frontier which is the output that an excellent efficient enterprise could obtain from any given combination of inputs. In his framework, the implementation of a productive unit will be determined against that efficient frontier (Farrell, 1957).
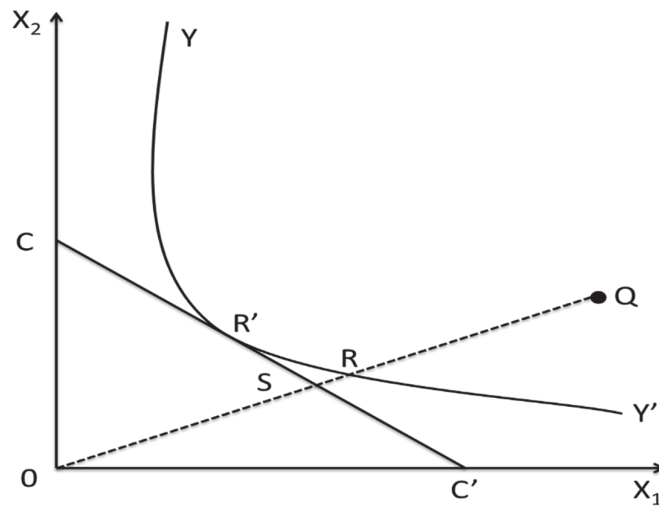
Fig. 1. Technical and Allocative Efficiency

The logic of Farell's efficiency method is shown in figure 1. With stable returns to scale, the isoquant YY' is the efficient production frontier. The minimum set of inputs per unit of output to produce a unit of output is illustrated by the isoquant. Each element of inputs along the isoquant is investigated as technically efficient, whereas any point on the right and above it, such as point Q, is showed as technically inefficient. The technical efficiency level is performed by OR/OQ in the above graph. Meanwhile, the allocative efficiency of manufacturer at point Q is displayed as the ratio of OS/OR. In this case, the objective of cost minimization is the isocost-line CC'. Therefore, the technical and allocative efficient point is R'. The total efficiency (which is also called economic efficiency) is balanced to OR/OQ × OS/OR = OS/OQ (Murillo-Zamorano, 2004). According to Kalirajan and Shand (1999), a determination of technical efficiency in the i-th enterprise can be defined as:

$$TE = Y_i / Y_i^*$$ (1)

where Y_i and Y_i^* are actual and optimum output, respectively. Eq. (1) is a simple way used to determine technical efficiency. The actual output can be seen in this one. However, the maximum potential output is not recognizable and must be predicted. A ratio of one in the above equation shows that the enterprise is technically efficient and operates on the production frontier. A series of methods have been constructed for investigating production frontier. Several researchers widely classified them into two main frameworks: stochastic frontier analysis (SFA) and data envelopment analysis (DEA) (Kalirajan & Shand, 1999; Kumbhakar & Lovell, 2003; Murillo-Zamorano, 2004; Coelli *et al.*, 2005). The SFA is a parametric measurement, which uses an econometric technique by defining a stochastic production function which considers that the failure item is composed by two components. The first factor is the typical statistical noise which exhibits randomness. The second one shows technical efficiency which is generally considered in the literature to follow a one-sided distribution (Kumbhakar and Lovell, 2003; Murillo-Zamorano, 2004). This framework has the benefit that statistical noise and incidental variation of the frontier across enterprises can be differentiated from inefficiency by specifying parameters in the error term (Alvarez & Crespi, 2003; Murillo-Zamorano, 2004). On the other hand, the DEA is a non-parametric measurement, which does not distinguish between statistical noise and technical efficiency. Thus, it is considered as a non-statistical measurement as the inefficiency scores and the envelopment surface are calculated rather than evaluated. The DEA is flexible in the sense that it is a nonparametric method that does not ask any functional form assumptions. The non-parametric technique is often connected with DEA that is based on a mathematical model to evaluate the optimal level of output conditional on the quantity and mix of inputs (Murillo-Zamorano, 2004). A comparison of DEA and the SFA is shown in Fig. 2.
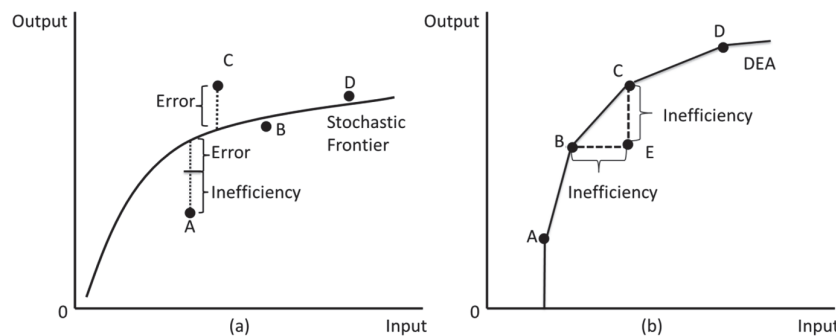
Fig. 2. SFA Frontier and DEA Frontier

Aigner *et al.* (2007), Meeusen and Van den Broeck (2007), and Battese and Corra (2007) further developed the stochastic frontier production model independently and simultaneously. In this model, they proposed a composed failure term that captures the impacts of exogenous shocks beyond the management of the analyzed units in supplement to technical efficiency. The model' errors are also achieved in the output and observation estimations. This study conveys the stochastic frontier production function to estimate technical efficiency of small-scale manufacturing enterprises in Vietnam. The first reason is that there is the disassociation of the incidental variation of the frontier cross firms, the impacts of determination failure and other incidental shocks from the impact of inefficiency. The second cause for this is that the capability of the stochastic frontier measurement considers both elements beyond the management of the enterprise and firm-specific factor. It is thus more appropriate for reality. The generalized functional equation in the Cobb-Douglas case of the stochastic production function can be specified as:

$$Y_i = x_i.\beta + V_i + U_i, i = 1,...,N \tag{2}$$

where

Yi is the production (or the logarithm of production) of the *i-th* firm.

x_i is a $k \times 1$ vector of (or transformation of) the input quantities of the *i-th* firm.

β is a vector of unknown parameters.

Vi are random variables that are assumed to be independently and identically distributed (*iid*) as N $(0, \sigma^2_v)$.

Ui are non-negative random variables, which are considered to account for technical inefficiency in production and to be *iid* as N $(0, \sigma^2_u)$. It is considered to be half-normal, exponential and truncated from below at zero. The maximum likelihood can be applied to check the coefficients of the aloft production function. The likelihood function is described in terms of the variance parameters of the frontier function:

$$\sigma^2 = \sigma^2_{v+} \sigma^2_u \text{ and } \gamma = \sigma^2_u / \sigma^2 \tag{3}$$

where σ^2_v is the variance of noise and σ^2_u is the variance of inefficiency effects. If the value of σ^2 is equal to zero, then Ui is also zero which means the firms are fully efficient, γ value is from one to zero. The deviations from the frontier are blamed for stochastic error if the γ value is zero. By contrast, they are due to technical inefficiency if its value is one. A software package that is the most generally applied to predict the random production frontiers in the literature is FRONTIER 4.1, which was established by Coelli (1996). The software program includes three prediction stages. The first stage is Ordinary Least Squares (OLS) estimating of the production function which supplies unbiased predictors for all the β excluding the intercept. The OLS forecast is then applied as starting value to predict the final maximum likelihood model. The next stage implements a two-phase grid search of the likelihood function value that is predicted for different values of γ with the β parameters derived in the OLS. The third and final steps determine the final maximum likelihood estimates (MLE) with an iterative Davidon-Fletcher-Powell algorithm. This step applies the β's value from the OLS and γ value from the intermediate stage as beginning values (Coelli, 1996). There are some selections of functional forms for the frontier of production. The most general functional forms for the random frontier production function are the Cobb-Douglas production function and the Transcendental-logarithm (Translog) production function. A hypothesis examination is carried out to choose the functional form of the random frontier production function:

$$H^1_0: \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = 0 \tag{4}$$

Table 5
Generalized Likelihood Ratio Test for Functional Form
Null Hypothesis: H_1^0: $\beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = 0$ (Production function is Cobb-Douglas)

	LR Statistics	$x^2_{0.95}$ Value	Decision
Textile, Garment	72.32	17.26	Reject H_1^0
Building Materials	243.36	17.26	Reject H_1^0
Vegetable, Fruit and Bulb	353.78	17.26	Reject H_1^0
Manufacture of Steel	106.53	17.26	Reject H_1^0
Furniture Manufacturing	163.91	17.26	Reject H_1^0
Food Processing	98.42	17.26	Reject H_1^0

Source: Author's calculation

The test results are shown in Table 6 which exhibited the Translog specification is suitable for this research. The Translog random production function can be described as bellow equation:

$$\text{Ln } Y_i = \beta_0 + \beta_1 lnK_i + \beta_2 lnL_i + \beta_3 lnME_i + \beta_4 (lnK_i)^2 + \beta_5 (lnL_i)^2 + \beta_6 (lnME_i)^2 \tag{5}$$
$$+ \beta_7 lnK_i lnL_i + \beta_8 lnK_i lnME_i + \beta_9 lnL_i lnME_i + V_i + U_i$$

where:

Yi = Output of enterprise i

Ki = Value of Capital of enterprise i

Li = Labor input of enterprise i

MEi = Value of Intermediate inputs for enterprise i

Vi = Random error in which $vi \sim N\ (0,\ \sigma^2_v)$

Ui = Technical Inefficiency in which $ui \sim N\ (\mu_i,\ \sigma^2_u)$

Capital: A number of capital input measurements have been applied in many empirical researches. For instance, Hossain and Karunaratne (2004) identified capital input as the gross fixed assets aggregated from book values such as machinery, tools, office equipment, transport, land and buildings.

Labor: The number of workers is general as a determination of labor input (e.g., Hossain and Karunaratne, 2004; Sehgal and Sharma, 2011). This research revealed that labor was similarly determined by the total of permanent as well as temporary workers.

Intermediate inputs: Similar to Lundvall and Battese (2000) and Aggrey et al. (2010), this study applied the aggregated value of starting materials, fuels like oil, charcoal and electricity for energy.

The second line of Eq. (5) contains the squared terms of the input elements, whereas the third line describes the interaction terms among the inputs.

5. Results and discussions

This part describes the estimated results obtained for the aggregate manufacturing small-scale manufacturing enterprises and individual sub-sectors. The result description also includes the comparison between technical efficiency levels for the sub-sector and other studies about Vietnam as well as other countries. The comparison further serves illustrative purpose, where in technical efficiency is predicted following the best respective actual frontier, which is not the same across countries, industries, time, sizes of enterprises or types of ownerships. In addition, empirical studies have different sample sizes and use different proxies for their output and input variables, depending on the data availability. This makes a comparison of results with other studies even more futile or questionable.

Table 7
Estimated Frontier Production Function

		Textile, Garment		Building Materials	
		Coeff	S.E	Coeff	S.E
Constant	β_0	2.305	3.495	-1169.609	1480.636
K (Capital)	β_1	1.108	1.482	1002.469	1329.019
L (Labor)	β_2	0.325	0.737	-63.146	55.895
M (Intermediate inputs)	β_3	-0.328	0.597	57.848	49.137
K^2	β_4	0.070	0.001	-245.833	315.025
L^2	β_5	0.069	0.209	-0.874	0.420
M^2	β_6	0.002	0.008	-1.601	0.718
$K \times L$	β_7	-0.219	0.270	26.895	27.108
$K \times M$	β_8	0.100	0.276	-14.430	17.911
$L \times M$	β_9	0.010	0.031	1.677	0.808
Sigma – square (σ^2)		0.010		0.235	
Gamma (γ)		0.580		0.430	
Log likelihood		0.118		-19.817	

Table 7
Estimated Frontier Production Function (continued)

		Vegetable, Fruit and Bulb		Manufacture of Steel	
		Coeff	S.E	Coeff	S.E
Constant	β_0	-532.735	284.544	-14.641	90.574
K (Capital)	β_1	134.794	189.817	34.401	18.895
L (Labor)	β_2	13.252	8.345	0.751	8.298
M (Intermediate inputs)	β_3	40.355	12.560	7.771	13.156
K^2	β_4	-0.488	37.002	9.910	2.444
L^2	β_5	-0.203	0.113	1.008	0.501
M^2	β_6	-0.750	0.317	0.291	0.562
$K \times L$	β_7	-2.357	2.429	-2.323	2.062
$K \times M$	β_8	-6.973	3.384	1.542	1.722
$L \times M$	β_9	-0.152	0.268	-1.532	0.619
Sigma – square (σ^2)		0.235		0.305	
Gamma (γ)		0.810		0.860	
Log likelihood		-25.027		-23.632	

Table 7
Estimated Frontier Production Function

		Furniture Manufacturing		Food Processing	
		Coeff	S.E	Coeff	S.E
Constant	β_0	425.841	351.742	-332.889	219.347
K (Capital)	β_1	183.289	177.241	104.915	97.022
L (Labor)	β_2	16.203	18.377	-41.908	37.311
M (Intermediate inputs)	β_3	10.724	20.351	65.775	44.340
K^2	β_4	-8.573	31.890	-7.709	15.247
L^2	β_5	-0.241	0.252	-0.142	0.975
M^2	β_6	0.188	0.345	-1.086	1.491
$K \times L$	β_7	-4.327	4.705	11.546	10.838
$K \times M$	β_8	-6.190	7.884	-15.468	11.116
$L \times M$	β_9	0.173	0.456	0.858	2.238
Sigma – square (σ^2)		0.546		0.703	
Gamma (γ)		0.920		0.900	
Log likelihood		-28.395		-44.144	

Source: The outcome from production function is tested by DEAP software

Table 7 briefly shows the estimated frontier production function results of the prediction data from June to August, 2019. Manipulating production theory for the stochastic frontier production model, three inputs including Output (Y), Capital (K) and Labor (L) are described in Eq. (5). The coefficients for capital are significant and positive for all cases, which illustrates that capital is a vital factor in production for manufacturing small-scale enterprises in Vietnam.

Hence, it is suggested that the capital is adequately supplied and managed in time for production and the business needs have significant impact on the business performance as well as the existence and future development of the small-scale manufacturing enterprises in Northern Vietnam. However, capital mobilization is just only one step of firms' production and operation, which is more important and decisive than capital mobilization is the effective allocation and use of capital. Therefore, enterprises must take measures to use and expand their business capital effectively to develop and gain the advantages in the fierce market competition.

Similarly, the coefficients for labor and intermediate inputs are also significant and positive in many cases. This indicates that labor and material play an important role in production for small size firms in Vietnam. The estimated results also suggest that Vietnamese small-scale manufacturing enterprises significantly rely on labors and intermediates to increase their output. However, the labor reliance could exert difficulties for these firms because Vietnamese labor tends to look for opportunities from big companies, especially labors with high qualifications (International Labor Organization, 2018). At the same time, many small-scale manufacturing enterprises depend on raw material from the Chinese market, which thus sometimes causes obstacles for their production (Vu & Thi, 2019). As the consequences, these firms should move up their value chain and improve their competitive capacity based on improving their business efficiency. They should focus on imposing proper policies, including salary, bonus and other supports for their employees. Simultaneously, they also should be proactive in domestic raw material sources for their long-term plans instead of heavily relying on imported intermediate inputs.

In the case of Building materials and Food processing sectors, the estimated results indicate that labor is insignificantly negative. The survey results show that employees working in these firms have low qualifications. For example, labors in Building materials and Food processing sectors is 0.8 years of education lower than Textile, Garment sector. Meanwhile, the requirement of qualification and education for these jobs should be higher this in Textile, Garment enterprises (Tran, 2008). Additionally, the number of employees in Building materials and Food processing enterprises is redundant, and some of them do not meet the business requirement. The study's results suggest that small-scale enterprises in Building materials and Food processing sectors should build proper strategies as well as policies to improve their labor's productivity throughout short-term training courses. Similarly, the estimated coefficient of Intermediate inputs is insignificantly negative in the case of Textile, Garment Enterprises. This is explained that these enterprises frequently use local workers who tend to change job, and their managers thus have passive to organize and plan intermediate inputs for production, compensating for spending time to train the new workers. Therefore, this has negative impacts on the efficiency of enterprises.

In estimated frontier production model, the maximum likelihood estimates also supply forecasts of the variance parameters sigma-squared (σ^2) and gamma (γ) (Aigner *et al.*, 2007). The first variance parameter, σ^2, describes whether there is technical inefficiency or not. The second variance parameter, γ, determines whether all deviations from the frontier are due to stochastic error or technical inefficiency.

Table 7 shows that all the variance parameters in the estimated stochastic production functions are statistically significant in the cases that technical inefficiency is detected. Moreover, the σ^2 parameter is significantly different from zero, ranging from 0.010 to 0.703. This suggests that all firms are not technically efficient. The value of the other variance parameter, γ, ranges from 0.430 to 0.92, indicating that technical inefficiency describes 43.00 percent to 92.00 percent of the all variation from the frontier. As shown in Table 8, Vietnamese small-scale manufacturing enterprises have operated at the different levels of technical efficiency. The mean technical efficiencies of sectors range from 55.97 percent to 95.92 percent. The Food Processing and Building Materials sectors have the lowest average technical efficiency level of 55.97 percent and 61.95 percent,

respectively. As the above mention, the insignificantly negative coefficient of Labor in Food Processing and Building Materials frontier functions implies that labors in Food Processing and Building Materials enterprises have not affected production efficiency. Meanwhile, the Furniture Manufacturing sector has the highest average technical efficiency with 95.92 percent. This result is similar to the research of Harvie and Le (2010). Because Furniture Manufacturing enterprises tend to use simple technology in their production, they could easily reach the best practice frontier. The average technical efficiency of Manufacture of Steel and Vegetable, Fruit and Build sectors also reached 78.95 percent and 73.93 percent correspondingly, reflecting that although the technical efficiency of these enterprises is higher than this of Textile, Garment, Building Materials and Food Processing enterprises, they have not effectively used their resources.

Table 8
Average Technical Efficiency

Sectors	Number	Average
Furniture Manufacturing	42	95.92
Manufacture of Steel	55	78.95
Vegetable, Fruit and Bulb	75	73.93
Textile, Garment	58	69.08
Building Materials	37	61.95
Food Processing	54	55.97
All Enterprises	321	71.26

Source: Author's calculation

The distribution of technical efficiency is large in Furniture Manufacturing sector. There are five Furniture Manufacturing firms have technical efficiency higher than 80 percent, and the remaining are under 70 percent in technical efficiency. Meanwhile, the technical efficiency of firms in Textile, Garment**,** Building Materials and Food Processing sectors is also lower than 70 percent. In aggregate, the average technical efficiency of small-scale manufacturing enterprises in in this study is 71.26 percent. This figure is lower than the technical efficiency level of 78.9 percent predicted for state-owned manufacturing companies in Vietnam in 1998 (Vu, 2003). However, it is higher than Vietnamese SMEs' technical efficiency level in the study of Nguyen *et al.* (2007), who found that this level was only 50 percent for manufacturing SMEs cross all kinds of ownership in Vietnam. It is also higher than the technical efficiency level of Vietnamese manufacturing firms of different ownership forms and sizes, which was 62 percent (Pham *et al.* 2009). The estimated results further show that Vietnamese manufacturing small size firms can decrease the level of inputs by 28.74 percent to gain the same level of output.

The estimated technical efficiency level found in this study is also higher than the mean technical efficiency of Malaysian manufacturing SMEs during 1992-1999, which was 62.33 percent (Oguchi *et al.,* 2006). This also higher than the mean technical efficiency of the best actual frontier in developing countries, which ranged from 60 percent to 70 percent (Tybout, 2000). In the opposite side, the average technical efficiency of northern Vietnamese small-scale firms is lower than this level of Thailand's industries, which was of 87.7 percent (Wiboonchutikula, 2002). This study's estimated results might suggest that the northern Vietnamese small-scale manufacturing enterprises operate more efficiently than the average level of SMEs in developing world. However, this study focuses on firms in six provinces, it is impossible to conclude that Vietnamese small-scale enterprises are more efficient than their counterparts in other countries.

Table 9a
Frequency Distribution of Technical Efficiency Level

TE Range (%)	Furniture Manufacturing		Manufacture of Steel		Vegetable, Fruit and Bulb	
	No	(%)	No	(%)	No	(%)
<0.30	0	0.00	0	0.00	1	1.33
0.30 – 0.40	0	0.00	0	0.00	0	0.00
0.40 – 0.50	0	0.00	0	0.00	1	1.33
0.50 – 0.60	0	0.00	1	2.70	8	10.67
0.60 – 0.70	0	0.00	2	5.41	14	18.67
0.70 – 0.80	0	0.00	18	48.65	24	32.00
0.80 – 0.90	5	8.62	16	43.24	24	32.00
0.90 – 1.0	53	91.38	0	0.00	3	4.00
Total	58	100	37	100	75	100

Source: Author's calculation

Table 9b
Frequency Distribution of Technical Efficiency Level

TE Range (%)	Textile, Garment		Building Materials		Food Processing	
	No	(%)	No	(%)	No	(%)
<0.30	1	1.82	3	7.14	9	16.67
0.30 – 0.40	0	0.00	4	9.52	6	11.11
0.40 – 0.50	9	16.36	6	14.29	5	9.26
0.50 – 0.60	4	7.27	5	11.90	11	20.37
0.60 – 0.70	9	16.36	6	14.29	7	12.96
0.70 – 0.80	17	39.91	4	9.52	6	11.11
0.80 – 0.90	12	21.82	9	21.42	2	3.70
0.90 – 1.0	3	5.45	5	11.90	8	14.81
Total	55	100	42	100	54	100

Source: Author's calculation

Tables 9a and 9b show that the majority of enterprises in the aggregate sample as well as in the sub-sector samples reached above 50 percent of technical efficiency. However, there are still a large number of enterprises having low efficiency. Typically, many enterprises in Building Materials and Food Processing sectors have the estimated technical efficiency less than 30 percent. For example, there were nine firms in Food Processing sector and three firms in Building Materials sector, accounting for 16.67 percent and 7.14 percent, respectively. The survey shows that there are many small-scale family firms in this region in a traditional way, in which the firm owners play various roles in their operation. For example, they are the directors caring about production, searching markets, etc. They also work as employees and as the foster sister who takes responsibility for looking for accommodation, water, and pick-up workers. Besides, there are some other issues as administrative procedures and informal charges. Therefore, this exerts negative influences on their enterprise's performance in general and efficiency in particular.

6. Conclusion

Manufacturing small-scale enterprises not only make considerable contributions to the state and local economies but also significantly address the unemployment and poor-skill labors in Vietnam's provinces. Although there are some previous researches discussing Vietnamese SMEs and across the world, no studies have focused on analyzing technical efficiency for small-scale enterprises. This paper has addressed the gap and evaluated the economic performance of small-scale manufacturing enterprises in the northern Vietnam by using primary data from a survey, conducted from June to August, 2019. By examining a stochastic frontier production function with 321 observations of small-scale manufacturing enterprises in six different provinces in Vietnam, the paper has empirically analyzed these enterprises' technical efficiency performance. Overall, the paper's estimated results have shown that they operate at a moderate level of technical efficiency. The results also indicate that the technical efficiency level of small-scale enterprises was lower than that found by (Vu, 2003) and Harvie and Le (2010). Meanwhile, this level was higher than that examined by Tybout (2000), Tran et al. (2008) and Pham et al. (2009). However, the technical efficiency of the sub-area has had a significant difference. While the technical efficiency for firms in the Furniture Manufacturing sector was at quite high level with 95.92 percent, Manufacture of Steel and Vegetable, Fruit and Bulb sectors were at moderate level with above 70 percent and three remaining sectors reached below 70 percent, even Food Processing sector was only 55.97 percent.

The results suggest that Vietnamese small-scale enterprises should improve their technology, employee quality and the initiative of input materials, especially in Textile, Garment, Building Materials and Food Processing sectors in order to move the production frontier upward as their technical efficiency has maintained at a low level. More productive technology and the better production frontier will allow these enterprises to avoid potential risks such as labor intensive, low skill employees as well as low value-added trap. Furthermore, small size enterprises in these regions need to make better use of their resources to increase output from the current level of inputs. The difference in technical efficiency levels across sub-sectors suggests that obvious policies should be increased for each sub-sector. However, better human capital, which can meet the rapid alteration in the economy of Vietnam, is the key importance for a better technical efficiency implementation of small-scale enterprises. Therefore, skillful labor recruitment is an important strategy to help these enterprises overcome existing problems today.

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3444