EVALUATION OF TOTAL FACTOR PRODUCTIVITY OF FOREIGN DIRECT INVESTMENT ENTERPRISES IN VIETNAM: AN APPLICATION OF MALMQUIST PRODUCTIVITY INDEX

Thi-Hien Vu[1,2], Ke-Chung Peng[3,*], Quang-Trung Ha[2] and Thi-Giang Nguyen[1,2]

[1] Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan.

[2] Department of Economics and Rural Development, Thai Nguyen University of Agriculture and Forestry, Vietnam.

[3] Department of Agribusiness Management, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan.

Abstract
In the process of globalization and international integration, foreign direct investment (FDI) is becoming a crucial part of the social-economic development of Vietnam. This study applied constant returns to scale data envelopment analysis (DEA) and Malmquist Productivity Index (MPI) model to investigate the change in the efficiency of FDI enterprises in Vietnam. The panel data to analysis were collected in the period 2011-2016. The findings showed that there was an increasing trend in total factor productivity (TFP) of FDI firms in 5 studied regions in Vietnam. The Malmquist TFP index of FDI enterprises in industry sector found to be higher than that of agricultural and service firms. This study provides useful evidence for policy designers to create a mechanism to attract FDI flows in Vietnam, especially in the agricultural sector and essential regions.

Keywords: Foreign direct investment (FDI), Malmquist Productivity Index (MPI), Total factor productivity (TFP), Enterprise, Vietnam.

1. Introduction
After more than 30 years of renovation, Vietnam has gained many achievements in socio-economic development, gradually integrating deeply into regional and global economics. To reach those achievements, foreign direct investment (FDI) plays an important role. The contribution of FDI enterprises to gross domestic product (GDP) has increased remarkably, from 15.66 % (2011) to 18.59% (2016) [1]. FDI flows promoted restructuring economic structure towards modernization, was an important factor that promoting the development of many industries, new products, contributed to the formation of a number of key industrial sector of the economy such as oil and gas, electronics, information technology, cement, steel..., increasing production capacity of the economy. In addition, FDI sector also contributed to enhancing Vietnam's export capacity in recent years. Export of FDI enterprises always accounted for a high proportion, over 66% in total export value of Vietnam in the period of 2011-2016 [1]. Moreover, FDI enterprises also contributed to creating many new jobs for local employee in Vietnam [2]. In

fact, over 2.5 million jobs were created in 2011 and nearly 4.2 million jobs of 2016, 1.6 times compared to 2011. The income of employees in FDI enterprises had been improved and increased over the years: 2011 reached 5 million VND/employee/month, 2016 reached 8.5 million VND/employee/month, 1.7 times compared to 2011 [1].

However, besides achievements, FDI firms in Vietnam are facing many problems such as high debt to equity ratio, high rate of loss enterprises. Especially, the rate of loss enterprises with 100% foreign capital was higher than the rate of loss joint-ventures enterprises. In 2011, this figure of enterprise with 100% foreign capital was 46.2% and reached 48.7% in 2016, this figure of the joint-ventures enterprise was 38.8% in 2011 and 43.4% in 2016. By economic activity, agricultural firms had the highest rate of loss FDI enterprises with 54.1% in 2011, increased to 64.2% in 2015 and finally reached 60.5% in 2016 [1]. In addition, FDI enterprises have created many issues for economy of Vietnam such as environmental pollution, rampant exploitation of natural resources, imports backward technologies, evading financial obligations, etc. Therefore, the efficiency of using FDI flows is ineffective and unsustainable.

In recent years, the study about the efficiency of FDI flows is conducted by many authors. For example, Vu [2] analysed technical efficiency in FDI enterprises in manufacturing sector of Vietnam in the period from 2009 to 2013 by using stochastic production frontier method; Lei *et al.* [3] employed MPI and DEA as methodology to evaluate the cost and profit efficiency of FDI flow attractiveness in 10 years of China from 1997 to 2008; MPI model applied by Suyanto and Salim [4] to investigate the effect of FDI on pharmaceutical firms in Indonesia over the time 1990-1995. In addition, Globerman [5] investigated the efficiency benefits of FDI flows to industrial manufacturing in Canada. The contribution of FDI flows to the technical efficiency of manufacturing firms in Tunisia was studied by Ghali and Rezgui [6] in the period from 1997 to 2001. The results indicated that FDI flows had a positive effect on technical efficiency of enterprises.

This study aims to analyze the efficiency of FDI enterprises in Vietnam during the period 2011-2016 and in the hope to give empirical evidence to help policymakers to have the right insight for in managing and attracting FDI flows into Vietnam in the future time. To the authors 'knowledge, using MPI and DEA model to analyze the efficiency of FDI firms have not been explored in Vietnam. As such the study would fill up the gap in the literature.

2. Methodology
2.1. Research Model
To evaluate the technical efficiency of firms, this study applied the input-oriented DEA model under constant returns to scale (CRS) which is designed by Charnes *et al.* [7]. This model is expressed as Equation (1):

$$TE = \text{Min}_{\theta_i, \lambda} \, \theta,$$

$$-y + Y\lambda \geq 0,$$

Subject to $\quad \theta x_i - X\lambda \geq 0, \qquad\qquad\qquad (1)$

$$\lambda \geq 0$$

Where, θ denotes the technical efficiency scores of FDI enterprises. According to Farrell [8], the value θ will range from 0 to 1. If the value of $\theta < 1$, implying that the firm will be considered as technical inefficiency. On the other hand, Y and X represent output and input vectors.

Besides, MPI methodology was used to investigate the growth of FDI enterprises over time. This method was applied to show the variation in the efficiency of firms at the observed time and a previous time. Färe *et al.* [9] stated that Malmquist index could be calculated by two components, namely efficiency change (EC) and technical efficiency change (TEC). Then, EC and TEC can be described as Equation (2) and Equation (3):

$$EC = \frac{D_0^{t}(x^t, y^t)}{D_0^{s}(x^s, y^s)} \tag{2}$$

$$TEC = \left[\frac{D_0^{s}(x^t, y^t)}{D_0^{t}(x^t, y^t)} \times \frac{D_0^{s}(x^s, y^s)}{D_0^{t}(x^s, y^s)} \right]^{\frac{1}{2}} \tag{3}$$

From Equation (2) and (3), the Malmquist productivity change index can be estimated as follow:

$M_0\ (x^s,\ y^s,\ x^t,\ y^t) = EC \times TEC$

$$\text{Or } M_0\left(x^s,\ y^s,\ x^t,\ y^t\right) = \frac{D_0^{t}(x^t, y^t)}{D_0^{s}(x^s, y^s)} \times \left[\frac{D_0^{s}(x^t, y^t)}{D_0^{t}(x^t, y^t)} \times \frac{D_0^{s}(x^s, y^s)}{D_0^{t}(x^s, y^s)} \right]^{\frac{1}{2}} \tag{4}$$

Where, x and y are the inputs and outputs vector of FDI enterprises in two periods (s and t); M_0 denotes the TFP value. If the value of $M_0 > 1$, implying that productivity growth of FDI enterprises in the period from s to t. In contrast, if the value of $M_0 < 1$, it indicates that the TFP of FDI firms experienced a declining trend during the period. About the value of EC, if the EC value is greater than 1, it denotes an increasing trend in FDI enterprises efficiency from the period s to t. The value of EC =1, implying that the efficiency of FDI firm does not change in the period (from time s to t). The EC value <1 indicates the decreasing trend in the efficiency of FDI businesses during the period. In addition, the value of TEC denotes the technical efficiency change of FDI firms. TEC >1, meaning that there is an improvement in technological production of FDI firms. If the value of TEC=1, it shows the technical efficiency of enterprises is stable and TEC <1, implying that the technology of FDI firms is out of date.

2.2. Data Source and Variables

To evaluate the efficiency of FDI enterprises, this study used the panel data which is reported by Vietnamese General Statistic Office during the period from 2011 to 2016 [1]. Two inputs (number of employees and capital) and one output (Net turnover) are used in the analysis. FDI enterprises are further classified by economic activities, i.e., agricultural, industrial, and services firms and regions.

This study employed the DEAP version 2.1 program [10] to measure the technical efficiency and TFP of FDI enterprises in Vietnam from 2011-2016. The summary of inputs and output variables are illustrated in Table 1 as follow:

Table 1. Average inputs and output variables of FDI firms, 2011-2016

Regions/Economics sector	Number of emloyees (Person)	Capital (Bill. VND)	Fixed capital (Bill. VND)	Output-Net turnover (Bill. VND)
By regions				
Red River Delta	844988.17	1147745.58	421008.02	1210447.27
Northern midlands and mountain areas	170045.67	127744.48	70660.65	236312.00
North Central Coast and South Central Coast	201798.83	233823.47	175776.38	103757.88
Central Highlands	9985.17	10913.10	3245.83	20552.32
South East	1789773.17	1989076.30	867406.38	1685595.90
By economic sectors				
Agriculture	10410.50	10224.48	4721.27	10169.18
Industry	3008411.83	2191737.35	1133111.63	2846759.83
Trade and services	264029.33	1507766.82	459966.28	535703.80

As can be seen in Table 1, on average, there is a difference in net turnover of FDI enterprises. Out of 5 regions, FDI firms in the South East of Vietnam show the highest net turnover (1685595.90 Bill. VND) whilst the lowest value belongs to the Central Highland region (20552.32 Bill. VND). By economics activities, the net turnover of industrial FDI firms is higher than in other sectors.

3. Results and Discussion
3.1. Technical efficiency of FDI enterprises in Vietnam
The DEAP 2.1 version is applied to estimate the technical efficiency (TE) of FDI firms and the results of TE are presented in Table 2. The average TE of FDI enterprises during the period from 2011 to 2016 was 0.835. This means that the FDI enterprises achieved 83.5% technical efficiency and FDI firms could expand their efficient score by decreasing 16.5% of input used. The findings show that the average TE of firms in the Red River Delta region was found to be fully efficient in the period of 2011-2016. It is followed by regions, i.e., Central Highlands, Northern Midlands and mountain areas, and South East, with average TE score of 0.974, 0.896, and 0.834, respectively. FDI firms in the North Central Coast and South Central Coast of Vietnam has the lowest TE (0.473) because it is one of the regions having difficulty in geographical location, access resources and attract invest in Vietnam. In other words, to improve

the efficiency, FDI enterprises in this region need to decline its inputs by 52.7% and keep the output levels is constant.

Table 2. Technical efficiency of FDI enterprises in Vietnam from 2011 to 2016

Regions	2011	2012	2013	2014	2015	2016	Average
Red River Delta	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Northern Midlands and mountain areas	0.931	0.749	0.693	1.000	1.000	1.000	0.896
North Central Coast and South Central Coast	0.786	0.583	0.442	0.515	0.255	0.256	0.473
Central Highlands	1.000	1.000	1.000	1.000	1.000	0.844	0.974
South East	1.000	0.866	0.681	0.980	0.475	1.000	0.834
Average	0.940	0.840	0.763	0.899	0.746	0.820	0.835

Moreover, the average TE of FDI firms found to be the highest in 2011 (0.940), while the lowest score in two years, 2013 and 2015 (0.763 and 0.746, respectively).

3.2. Total Factor Productivity of FDI enteprises in Vietnam
The Malmquist DEA model was employed to measure EC, TC and TFP of FDI firms in the period from 2011 to 2016. The results of using MPI model are illustrated in Table 3 as follow:

Table 3. Malmquist index summary of regions and economic sectors mean, 2011-2016

Regions/economic sector	Efficiency change	Technical change	TFP
By regions			
Red River Delta	0.953	1.134	1.081
Northern midlands and mountain areas	1.014	1.141	1.157
North Central Coast and South Central Coast	0.803	1.147	0.921
Central Highlands	0.967	1.026	0.992
South East	1.000	1.055	1.055
By economic sectors			
Agricultural	1.005	1.063	1.068
Industry	1.000	1.288	1.288
Trade and services	1.000	1.063	1.063

By region, the findings revealed that FDI companies in three regions, namely Red River Delta, Northern midlands and mountain areas and South East region, had a positive change in TFP. FDI enterprises in the Northern midlands and mountain areas and South East were found to have the highest TFP (1.157), followed by Red River Delta (1.081) and South East (1.055), implying that the average productivity growths of FDI firms were 15.7% for the Northern midlands and mountain areas, 8.1 % for Red River Delta, and 5.5% for South East region. The productivity growth of FDI firms can be explained by an improvement in technology as well as attract activities of provinces in these regions. Take Thainguyen province for example, one of provinces in the Northern midlands and mountain areas, have achieved successes in attracting FDI flows in recent years. Thanks to the spillover effect of Samsung project, total FDI in Thainguyen during 2012-2017 rose 70 times compared to the 1993-2011 period [11]. This means that FDI enterprises have begun focusing on difficult regions as Northern midlands and mountain areas, where has cheap human resources, to develop investment. By economic activities, FDI firms in the industrial sector had the highest TFP (1.288), followed by agricultural FDI enterprises (1.068) while FDI companies in trade and services sector had the lowest productivity growth in the period from 2011 to 2016.

The annual mean change of FDI enterprises in studied regions is represented in Table 4 as follow:

Table 4. Malmquist index summary of annual means of FDI firms in Vietnam

Year	Efficiency change	Technical change	TFP change
2011-2012	0.880	1.088	0.958
2012-2013	0.888	1.052	0.934
2013-2014	1.058	1.265	1.338
2014-2015	0.797	1.233	0.983
2015-2016	1.137	0.900	1.023
Mean	0.944	1.099	1.038

Table 4 shows that, on average, the efficiency, technical and TFP changes over time of FDI firms in 5 regions of Vietnam were 0.944, 1.099 and 1.038, respectively. These results show a growth in TFP of FDI firms despite a decline in investment efficiency. In addition, the finding also indicated that there was a fluctuation in TFP of FDI firms in studied regions of Vietnam during the period 2011-2016. The growth in investment activities of FDI firms found to be the highest in the time 2013-2014 because of technical and efficient improvement. This finding is consistent with the previous results of Le *et al.* [12], and Parichatnon *et al.* [13].

4. Conclusions

This study employed CRS-DEA and MPI model to evaluate technical efficiency and TFP change of FDI enterprises in Vietnam during the time period of 2011-2016. The results show that firms operated at 83.5 % of their optimal scale, implying that FDI enterprises need to decrease 16.5% of inputs used to become full efficiency.

The findings of MPI model indicate that the growth in TFP was found in all FDI firms by economic sectors, i.e., agriculture, industry, and trade and services. Out of 5 regions, the growth in TFP of firms in the Northern midlands and mountain areas was the highest, with 15.7% during the period from 2011 to 2016. For annual changes, FDI enterprises in studied regions experienced an increasing trend in TFP from 2011 to 2016, with an average of 3.8%. These findings indicate that foreign enterprises also achieved efficiency when they invest in Vietnam market. In other words, the findings of this study provide empirical evidence to attract FDI flows in Vietnam. Furthermore, FDI firms still play an important role in the process of industrialization and modernization of the Vietnamese's economy. Therefore, the government should implement policies to attract and encourage FDI enterprises to invest in essential economic sectors, and develops sustainably in a long time.

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