Market power or efficiency? An empirical study on the Indonesian fertilizer industry

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ABSTRAK

Artikel ini bertujuan untuk menganalisis struktur pasar, efisiensi, dan determinan kinerja industri pupuk di Indonesia. Studi ini menerapkan kerangka Structure-Conduct-Performance (SCP) yang diusulkan oleh Pemikiran Harvard (kekuatan pasar) dan UCLA-Chicago (struktur efisiensi). Studi ini menggunakan data panel yang disusun dari laporan tahunan produsen pupuk selama periode 2008 – 2017 dan publikasi statistik dari kementerian pertanian. Penelitian ini mengimplementasikan Data Envelopment Analysis (DEA) dan regresi data panel untuk mengestimasi data. DEA merupakan metode non-parametrik yang digunakan untuk mengukur efisiensi teknis dan skala. Sedangkan regresi data panel digunakan untuk mengestimasi determinan kinerja perusahaan (ROA). Hasil penelitian menunjukkan bahwa industri pupuk memiliki kekuatan pasar berdasarkan tiga karakteristik; jumlah incumbent (5), tingkat konsentrasi pasar (95,48 persen), dan kondisi hambatan masuk. Sementara itu, skor efisiensi teknis industri rendah (0,584), tetapi skor efisiensi skala tinggi (0,950). Hasil penelitian juga menunjukkan bahwa kinerja perusahaan ditentukan oleh efisiensi, bukan kekuatan pasar. Efisiensi teknis dan skala berpengaruh positif dan signifikan terhadap kinerja. Di sisi lain, kekuatan pasar berpengaruh negatif dan tidak signifikan terhadap kinerja. Temuan ini mendukung Pemikiran UCLA-Chicago bahwa efisiensi adalah faktor utama kinerja perusahaan.

ABSTRACT

This article aims to analyze the Indonesian fertilizer industry's market structure, efficiency, and performance determinants. This study applies the Structure-Conduct-Performance (SCP) framework proposed by the Harvard (market power) and UCLA-Chicago School (efficiency structure) schools of thought. We run Data Envelopment Analysis (DEA) and panel data regression to analyze the panel data constructed from annual reports of fertilizer

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producers in 2008 – 2017 and statistical publications from the agriculture ministry. DEA is a nonparametric method that measures technical and scale efficiencies. Meanwhile, panel data regression estimates the determinants of firm performance (ROA). The results show that the fertilizer industry has market power based on three characteristics; the number of incumbents (five), degree of market concentration (95.48 percent), and barrier to entry condition. Meanwhile, its industrial technical efficiency score is low (0.584), but its scale efficiency score is high (0.950). The results also show that firm performance is determined by efficiency, not market power. Both technical and scale efficiency positively and significantly affect performance. On the other hand, market power does not significantly affect performance. This finding supports the UCLA-Chicago School that efficiency is the main factor of firm performance.

INTRODUCTION

The fertilizer industry plays a strategic role in the Indonesian agricultural sector's development. The presence of this industry is necessary to ensure the availability of agricultural facilities (fertilizers) quantitatively and qualitatively. Fertilizers in the agricultural production system arguably increase agricultural production (Rehman et al., 2019). Fertilizers are necessary for the entire agricultural development strategy. Currently, the Indonesian fertilizer industry's annual production capacity reached 14.07 million tons, with 66.73 percent of the capacity (9.39 million tons) representing urea fertilizers. The figures position Indonesia as the largest fertilizer producer in Southeast Asia and the fourth urea fertilizer producer worldwide (YARA, 2018).

Figure 1
Fertilizer Production in Indonesia, 2013 – 2019
 Source: PT Pupuk Indonesia (2019)

The Indonesian fertilizer producers belong to the Association of the Indonesian Fertilizer Producers (*APPI – Asosiasi Produsen Pupuk Indonesia*). *APPI* has five members: PT. Pupuk Sriwijaya, PT. Pupuk Kujang, PT. Pupuk Kalimantan Timur, PT.

Pupuk Iskandar Muda, dan PT. Petrokimia Gresik. The creation of APPI aims to enhance fertilizer producers' contributions to the agricultural development. In 1998, PT. Pupuk Sriwijaya (Pusri) was designated as the parent company that was in charge of four other fertilizer producers. Pusri then spun off by establishing PT. Pupuk Sriwijaya Palembang and changing its name into PT. Pupuk Indonesia Holding Company in 2012.

The creation of APPI followed by the holding company indicates the fertilizer industry's increased market power. Although the creation of the holding seeks to increase the industry's contribution to the agricultural sector, this practice indicates an administrative monopoly market. This behavior arguably erodes fertilizer consumers' bargaining positions.

A main advantage of monopolists is their price-making capability. Li et al. (2017) propose that highly concentrated markets help producers communicate with each other to make common price and output agreements to maximize their monopoly rents. In this respect, concentration indicates incumbents' market power. Mala et al. (2018) and Gonzalez et al. (2019) demonstrate that market power positively affects performance.

Despite their significant market power, the Indonesian fertilizer producers face concrete problems related to raw material prices and procurement. Natural gas as the main production factor is a strategic commodity with relatively high prices (6 dollars per MMBTU) (Ramli, 2020), much higher than natural gas prices in Malaysia, the US, and China (2-3 dollars per MMBTU) (Chandra, 2017). The price differences indicate the less competitive Indonesian fertilizer market. Higher main raw material prices directly affect production costs, leading to inefficiency and higher selling prices. Efficiency is crucial to ensure firms' long-term sustainability because it is the main factor to outcompete (Arsyad & Kusuma, 2014). Guillén et al. (2014); Ye et al. (2012) and Li et al. (2017) show that efficiency positively affects performance.

Based on this condition, this study seeks to investigate the market structure, efficiency level, and the determinants of Indonesian fertilizer producers' performance with two approaches: Harvard (market power) and UCLA-Chicago (efficiency structure). This study is expected to conclude the more dominant factors affect the Indonesian fertilizer producers' performance (market power vs. efficiency) using the Data Envelopment Analysis (DEA) to measure efficiency and panel data regression to analyze the performance determinants.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Harvard School (SCP Paradigm)

Industrial organization (IO) refers to studies on firm behavior within imperfectly competitive markets. Firms must operate in conditions that offer the

highest probable competitiveness and profitability (Meilak & Sammut-bonnici, 2015). Initially, IO mainly analyzes the relationship between market power and performance. For example, Bain positions the SCP concept as the framework to explain the relationships between market structure, behavior, and performance (Lelissa & Kuhil, 2018). The Harvard school (SCP paradigm) argues that highly concentrated industries facilitate collusions effectively (Li et al., 2017). Collusions improve industries' market powers because each market player will communicate effectively to extract monopoly rents by jointly determining output prices and levels (Li et al., 2017). The SCP paradigm considers market power the main determinant of firm performance (Lelissa & Kuhil, 2018). In practice, market power is measured with various methods, including n-firm concentration (CRn), Herfindahl Hirschman Index (HHI), Lerner index, entropy index, Gini index, and Lorenz curve (Ukav, 2017). Besides, Mala et al. (2019); Li et al. (2017); and Ye et al. (2012) use market share as a measure of relative market power.

Table 1
Alternative Measures of Market Power

	Formula	Explanation
Market Share	$MS = \frac{S_i}{\sum_{i=1}^n S_i}$	Relative market power
CRn	$CR4 = \sum_{i=1}^n S_n$	Collusive market power
HHI	$HHI = \sum_{i=1}^n S_1^2 + \dots + S_n^2$	Collusive market power
Lerner Index	$Li = \frac{p - mc}{p} = -\frac{1}{\epsilon_d}$	Monopoly power

Source: Lipczynski et al. (2005); Mala et al. (2018)

The UCLA-Chicago School

The UCLA-Chicago school appears to critique the Harvard school that underscores market power in the SCP framework. The UCLA-Chicago school disagrees against this argument that emphasizes that more highly concentrated industries perform better due to their economy of scale (Lelissa & Kuhil, 2018). The UCLA-Chicago school argues that firms generate higher profits, likely due to improved efficiency levels and not because of greater market power (Demsetz, 1973). Arsyad and Kusuma (2014) consider that managing firms efficiently is the key to winning the market competition. The UCLA-Chicago school also rejects the simple linear relationship proposed by the SCP paradigm that argues that market structures determine firm behavior and eventually performance. In short, the UCLA-Chicago school considers efficiency the main determinant of performance (Lelissa & Kuhil, 2018).

The Relationship between Market Power, Efficiency, and Performance

Market power is identical to firms' market structures. Markets controlled by only a few firms are arguably more collusive. Collusion represents incumbents'

strategies to enhance their market power by reducing the competition levels. More highly concentrated markets enable industries to collude more easily. Producers in highly concentrated industries will likely communicate with each other to jointly set the output prices and amounts to generate monopoly rents (Lelissa & Kuhil, 2018). Consequently, increased profits will also enhance profitability. Mala et al. (2018) show that market power positively affects performance. Based on the argument, we propose the following hypothesis:

H1: Market power positively affects performance.

This study proposes that performance is not only affected by market power but also efficiency. Demsetz (1973) argues that firms generate excess profits not because of their market power but improved efficiency levels. Guillén et al. (2014) and Li et al. (2017) empirically demonstrate that efficiency positively affects performance. Efficiency is closely related to production costs and productivity. Improved efficiency indicates enhanced productivity (technical efficiency) and reduced long-term average costs (scale efficiency). Improved technical and scale efficiencies will increase profits and eventually profitability.

H2: Technical and scale efficiencies positively affect performance.

RESEARCH METHODS

The debate on the performance determinant between the Harvard (market power) and UCLA-Chicago (structure efficiency) schools of thought continues until now (Lelissa & Kuhil, 2018). This study seeks to use both schools of thought in the Indonesian fertilizer industry. Specifically, we measure efficiency with DEA and use panel data regression to test the performance determinants.

Data and Variables

This study uses fertilizer producers listed at the Association of Indonesian Fertilizer Producers (*APPI*). We use the panel data from fertilizer producers' 2008-2017 annual financial statements and the Indonesian Agricultural Statistic issued by the Ministry of Agriculture.

Our research variables represent market structure and efficiency as proposed by both schools of thought. In particular, the dependent variable is performance, while the independent variables are efficiency and market power. Besides, this study also adds several control variables.

Following Gonzalez et al. (2019), we use ROA to proxy fertilizer producers' performance. ROA indicates fertilizer producers' ability to manage their assets to generate profits. This study measures ROA with the ratio between after-tax net income and total assets. Next, this study refers to Guillén et al. (2014) dan Li et al. (2017) by

operationalizing market power with two measures: relative (market share) and collusive (CR4) market power. In this context, market share refers to the ratio of sales of firm i to the industry's total share, while CR4 represents the total market share of the four largest players in the industry.

$$MS_i = \frac{\text{Share}_i}{\sum \text{Share}} \dots\dots\dots 1$$

$$CR_4 = \sum_{i=1}^4 \text{Share}_i \dots\dots\dots 2$$

This study applies the nonparametric method of the Data Envelopment Analysis (DEA) for the efficiency variables based on decision-making units (DMUs). Charnes et al. (1978) introduce the CCR model that assumes input-output relationships with constant return scale (crs). Next, Banker et al. (1984) propose the BBC efficiency measurement model that assumes variable return to scale (vrs).

Figure 2
Technical and Scale Efficiencies
Source: Banker et al. (1984), modified

Figure 2 illustrates the technical and scale efficiencies. OE refers to a constant return to scale production curve, AD represents a variable return to scale production curve, B is an inefficient reference point, B₂ represents an efficient reference point (crs approach), B₁ represents a reference point with technical efficiency, but scale inefficiency (vrs approach), and C is a reference point with technical and scale efficiencies in the most productive scale. Below the C point, the relationships between inputs and outputs are increasing return to scale. Above the C point, the relationships between inputs and outputs are decreasing return to scale. Equation (3) calculate the efficiency score:

$$\text{Technical efficiency; } \theta_{\text{crs}} = \frac{GB_2}{GB} \dots\dots\dots 3$$

Following Rahim and Shah (2019), this study uses total assets and operational costs as the input proxies and sales as the output proxy. The following mathematical formula measures efficiency (Benicio & De Mello, 2015).

$$\begin{aligned} \text{Max TE}_{\text{crs}} &= \frac{\sum_{j=1}^s u_j y_{j0}}{\sum_{i=1}^r v_i x_{i0}} \\ \text{st. } \frac{\sum_{j=1}^s u_j y_{jk}}{\sum_{i=1}^r v_i x_{ik}} &\leq 1, k = 1, \dots, n \dots\dots\dots 4 \\ u_j, v_i &\geq 0 \forall j, i \end{aligned}$$

While the following is the BBC efficiency measurement model (Benicio & De Mello, 2015):

$$\begin{aligned} \text{Max TE}_{\text{vrs}} &= \frac{\sum_{j=1}^s u_j y_{j0}}{\sum_{i=1}^r v_i x_{i0}} - u^* \\ \text{st. } \frac{\sum_{j=1}^s u_j y_{jk}}{\sum_{i=1}^r v_i x_{ik}} - u^* &\leq 1, k = 1, \dots, n \dots\dots\dots 5 \\ u_j, v_i &\geq 0 \forall j, i \end{aligned}$$

Based on both models, we obtain the efficiency scale with the following equation:

$$SE_i = \frac{TE_{i,\text{CRS}}}{TE_{i,\text{VRS}}} \leq 1 \dots\dots\dots 6$$

TE_{crs} is the crs efficiency model, TE_{vrs} is the vrs efficiency model, s is the number of observations, r represents the number of observation inputs, v_i refers to input weights, u_j is output weights, y_{jk} is j th output of the k th DMU, x_{ik} is the j th input of the k th DMU, u^* is the scalar factor, and SE is the scale efficiency. The DEA efficiency measure results in relative efficiency levels between producers (DMU) with efficiency scores ranging from zero (inefficient condition) to one (efficient condition).

Furthermore, in practice, performance is not only affected by market power and efficiency. This study also includes several control variables to better estimate results and mitigate the omitted variable bias (OVB). Referring to Li et al. (2017), this study employs risk (debt to asset ratio) and firm size (total assets) as the control variables. We also include the highest retail price (*HET – Harga Eceran Tertinggi*) as an additional control variable.

Model Specification

This study seeks to investigate the determinants of the performance of the Indonesian fertilizer industry with the Harvard (market power) and Chicago (structure efficiency) approaches. Following prior studies of Guillén et al. (2014); Li et al. (2017), the following is our empirical model:

$$ROA_{it} = \alpha + \beta_1 Power_{it} + \beta_2 TE_{it} + \beta_3 SE_{it} + \beta_4 Control + \varepsilon_i \dots\dots\dots 7$$

where ROA is performance (return on assets), *Power* refers to market power (market share), *TE* represents technical efficiency, *SE* is scale efficiency, *Control* represent control variables (firm size [*SIZE*], risk [*RISK*], and highest retail price [*HET* – *Harga Eceran Tertinggi*]), α is constant, β_1 is the parameter of market power, β_2 refers to the parameter of technical efficiency, β_3 is the parameter of scale efficiency, β_4 is the parameters of the control variables, ε is error, i is the i_{th} individual observation, and t represents the t_{th} year.

Panel Data Estimation Technique

The panel data estimation allows the presence of unobserved individual characteristics (α_i). The random effect model assumes random α_i . Meanwhile, the fixed-effect model assumes that α_i contains the time-invariant heterogeneity effect. Accordingly, this study proposes the use of fixed-effect panel regression because of the possible unobserved individual characteristic from (1) firms' different locations, (2) human resource quality, (3) firms' internal policies, and (4) local regulations. Besides, our observation period is longer than the number of observations that the fixed effect is considered more appropriate (Gujarati and Porter, 2015). Prior studies, Guillén et al. (2014); Li et al. (2017); and Gonzalez et al. (2019) also employ the fixed effect. However, we still run the Hausman test to ensure the suitability of the fixed effect. In this test, H_0 predicts that the model follows the random effect and H_A predicts that the model follows the fixed effect.

ANALYSIS AND DISCUSSION

Descriptive Statistics

Table 2
The Descriptive Statistics of the Research Variables

Variable	n	Mean	Median	Std. Dev.	Min.	Max.
ROA	50	5.76	5.44	5.51	-6.98	18.98
MS	50	20.00	14.94	14.26	3.64	47.05
CR4	50	95.09	94.91	0.61	94.37	96.36
Technical efficiency	50	0.59	0.61	0.30	0.06	1.00
Scale efficiency	50	0.95	0.99	0.08	0.53	1.00
DAR	50	55.15	59.17	19.39	6.17	90.81
Asset	50	16.12	16.04	0.70	15.15	17.53
Price	50	1452.44	1500.00	118.27	1104.40	1500.00

Source: PT Pupuk Indonesia (2019), processed.

We generate 50 observations from five firms in the 2008-2017 period. Firms' profitabilities vary from -6.98 to 18.98, and their market shares range from 3.64 percent to 47.05 percent. These firms also exhibit relatively high market concentration degrees with the CR4 mean score of 95.00 percent. These firms also exhibit relatively a low technical efficiency score (mean=0.59) and an almost maximum scale efficiency

score (mean= 0.95). For the control variables, the firms' abilities to pay liabilities (DAR) vary much from 6.17 to 90.81. Their asset values also vary from Rp3.8 trillion to Rp41.05 trillion. The 2008-2017 composite *HET* (urea and non-urea fertilizers) is 1,450 rupiah.

Market Structure

We run the market structure analysis based on three indicators referring to the market structure framework: the number of producers, the degree of market concentration, and entry barriers. Only five fertilizer producers belong to APPI – an early indicator of the oligopolistic fertilizer industry. Next, the fertilizer industry's market concentration (CR4) in 2008-2017 is high (94.37 percent - 95.84 percent), suggesting further that the industry is a tight oligopoly.

Table 3
The Characteristics of the Indonesian Fertilizer Industry's Market Structure

Indicator	Year							
	2011	2012	2013	2014	2015	2016	2017	2018
Σi	5	5	5	5	5	5	5	5
CR4	95.15	94.89	94.87	94.94	94.37	94.37	95.51	95.17
MES	44.18	45.01	43.21	47.05	45.18	41.80	38.86	43.70

Explanation: Σi is the number of fertilizer producers, CR4 is the market share of the four largest producers, MES is the minimum efficient scale.

The industry exhibits a relatively high entry barrier for several reasons. First, the industry has an entry barrier from the economy of scale. This industry's minimum efficient scale (MES) score is 43.38 percent, indicating a significant entry barrier. New entrants have to incur much higher costs than incumbents' long-term minimal costs (Blees et al., 2003). Second, the entry barrier is also due to raw materials. Natural gas as the main raw material of fertilizers is a strategic commodity that requires high transaction costs to generate contracts. Meanwhile, the distribution costs are very high if the plant locations are not close to raw materials. Third, the entry barrier is also due to the permit regulations. Based on these three characteristics, the Indonesian fertilizer industry exhibits a tight oligopoly market, although administratively, the fertilizer market is monopolistic because of the establishment of PT. Pupuk Indonesia Holding Company.

The Fertilizer Industry Efficiency

Our DEA efficiency measurements of the five Indonesian fertilizer producers show varying results. The average score of the industry's technical efficiency (using the constant return to scale approach) is only 0.584, implying that a part of the production process (0.416) is lost due to process inefficiency. Hence, the fertilizer producers are still inefficient. In a similar vein, the technical efficiency measure using the variable return to scale also results in 0.590, indicating that a part of the production process (0.410) is lost due to process inefficiency. The findings suggest that the Indonesian fertilizer industry has not used their inputs not optimally, as shown by the

low productivity levels of their production factors. Specifically, PT. Pupuk Kalimantan Timur is the producer with the highest technical efficiency level while PT. Pupuk Iskandar Muda has the lowest efficiency level. In practice, firms can enhance their technical efficiency by improving their technology and managerial (Arianto et al., 2020).

Table 4
The Average Score of the Indonesian Fertilizer Producers' Efficiency, 2008 – 2017

Producer	Technical Efficiency (CRS model)	Technical Efficiency (VRS model)	Scale Efficiency	RTS Condition
1	0.373	0.375	0.996	drs
2	0.500	0.577	0.913	drs
3	0.654	0.732	0.887	drs
4	0.725	0.745	0.967	drs
5	0.516	0.521	0.988	drs
Average Industry Efficiency	0.554	0.590	0.950	drs

Explanation: The efficiency score ranges from zero to one. Score one represents maximal efficiency. Producers: 1) PT. Pupuk Iskandar Muda, 2) PT. Pupuk Kujang Cikampek, 3) PT. Petrokimia Gresik, 4) PT. Pupuk Kalimantan Timur, and 5) PT. Pupuk Sriwijaya Palembang. Meanwhile, rts is retrun to scale, crs is constant return to scale, vrs is variable return to scale, and drs is decreasing return to scale.

The scale efficiency measurement finds opposite results. Scale efficiency scores are the differences between the crs and vrs technical efficiency models. The Indonesian fertilizer industry is relatively efficient, with an average efficiency score of 0.950, likely because of no significant differences between the crs and vrs technical efficiency scores. The findings indicate that the industry's production scale is close to the maximum condition (Watkins et al., 2014). Table 6 in the appendix presents the efficiency analysis for each producer in each year.

The Relationships between Market Power, Efficiency, and Performance

We use the fixed-effect panel regression to investigate the relationships between market power, efficiency, and performance. This study presents three estimation results based on the empirical models. The estimation model (1) explains the effects of market power and efficiency on performance without including the control variables, the estimation model (2) includes the control variables, and model (3) focuses on the impact of efficiency on performance. The Hausman tests for the three models reject the hypotheses, suggesting that the fixed-effect model is more appropriate.

The estimation models (2) and (3) consistently exhibit qualitatively similar results. However, model (1) is very different than the results of estimation (2) and (3). In particular, the results of estimation (1) indicate the omitted variable bias problem. First, the R^2 value is relatively low (only 29.92 percent). Second, the coefficients of technical and scale efficiencies are great. Hence, it is instrumental to add other control variables besides firm size, risk, and price to predict the Indonesian fertilizer industry

performance better.

Table 5
The Estimation Results

Dependent Variable: ROA					
Variable	Model (1)		Model (2)		Model (3)
Market share	-0.399 (0.368)		-0.229 (0.287)		
Technical efficiency	7.504 ** (2.240)		5.316 ** (2.001)		5.441 ** (1.986)
Scale efficiency	22.931 ** (8.288)		15.276 ** (7.186)		14.955 * (7.141)
Risk			-0.083 ** (0.035)		-0.084 ** (0.035)
Firm size			-5.37 *** (1.193)		-5.454 *** (1.183)
Price			0.01 * (0.004)		0.01 ** (0.000)
Constant	-12.479 (10.973)		69.835 (19.748)		66.597 (19.235)
R ²	0.299		0.608		0.602
F-stat	5,96		10,07		12,07
Prob f-statistic	0.002		0.000		0.000
N	50		50		50

Note: Table 3 presents the estimation results using the fixed-effect models. Market share is firms' sales share, technical and scale efficiencies are estimated using DEA, risk is operationalized with debt to asset ratio, firm size represents total assets, and price is operationalized using the average highest retail prices. The Hausman tests reject H₀: random-effect model. *, **, *** significant at $\alpha = 10\%$, 5%, and 1%, respectively.

Table 5 generally demonstrates that market power exhibits an insignificant impact on performance while scale and technical efficiencies positively affect performance. Estimations (1) and (2) (with and without control variables), the estimation results consistently show that market power (efficiency) negatively (positively) affects performance. Estimation (3) (ignoring market power) also consistently demonstrates that efficiency positively affects performance. The findings are similar to Ye et al. (2012); Guillén et al. (2014); Li et al. (2017); and Gonzalez et al. (2019). Similarly the results support the UCLA-Chicago school that efficiency is the main source of performance. Conversely, the findings do not support the relative market power hypothesis because market power does not affect performance. Specifically, the coefficient score of scale efficiency (15.27) is about three times greater than technical efficiency (5.21). Hence, the marginal effect of scale efficiency is greater than technical efficiency. However, fertilizer producers must generally improve their scale and technical efficiencies because both variables positively affect performance.

For the control variables, risk (DAR) negatively affects performance. This finding is in line with prior studies (Salim & Yadav, 2012; Li et al., 2017). In this regard, fertilizer producers need to manage their liabilities optimally because higher liabilities may incur greater expenses and eventually erode profits and profitability.

Next, firm size negatively affects performance. This result is not consistent with prior studies (Guillén et al., 2014; Davydov, 2016). However, the finding indicates that fertilizer producers have sizable productive assets that erode their profitability. This result is also consistent with the measurement of fertilizer producers' technical efficiency, demonstrating low technical efficiency. Meanwhile, price (*HET*) positively affects performance, suggesting that higher *HET* will be followed by improved performance.

Discussions

Our results support the UCLA-Chicago school arguing that efficiency is the main performance driver, not market power (share). The findings indicate the importance of improving efficiency levels for all fertilizer producers. Both technical and scale efficiencies positively affect performance. Specifically, scale efficiency has a marginal effect three times greater than technical efficiency. On the other hand, using market power as a strategy to improve performance is less appropriate. The finding does not support the SCP (Harvard) paradigm's argument that highly concentrated industries earn greater profits because the players can collude by jointly setting prices and outputs (Li et al., 2017).

The hypothesis supported by the Harvard school arguing that market power is the main performance determinant does not apply in the Indonesian fertilizer industry. We conjecture the following argument to explain the results. The fertilizer industry is highly regulated. The producers cannot set prices freely because of the *HET* regulations. The finding does not support the natural role of oligopolists and/ or monopolists that usually act as price takers. Despite its tight oligopoly market structure, *HET* regulations cause the fertilizer producers to remain price takers. Table 3 presents that prices positively affect performance. Thus, their performance will arguably improve when the government sets higher *HET*. Further, the fertilizer industry also has to face regulations regarding subsidized fertilizer procurement and distribution. PT. Pupuk Indonesia Holding Company is in charge of distributing fertilizers based on marketing zones. Lastly, the number of fertilizers produced depends on the definitive need plans of farmer groups (*RDKK – rencana definitif kebutuhan kelompok tani*). Hence, the fertilizer producers cannot set the output numbers easily to maximize profits because the production size refers to *RDKK*.

CONCLUSIONS, LIMITATIONS, AND SUGGESTIONS

This study seeks to explain the performance drivers of the Indonesian fertilizer industry using the Harvard (market power) and UCLA-Chicago (structure efficiency) schools of thought. The market power analysis uses three indicators: the number of fertilizer producers, the degree of market concentration, and entry barriers. Based on these three characteristics, the fertilizer industry exhibits a tight oligopoly or administratively monopolistic market. The industry has a very high concentration

level (94.37 percent). It also has a high entry barrier from its economy of scale, the availability and access to raw materials (natural gas), and licenses for firm establishment. Next, the industry exhibits relatively low technical efficiency levels with average scores of 0.584 (the crs model) and 0.590 (the vrs model) and a relatively high scale efficiency score (0.950).

In general, our results support the UCLA-Chicago school arguing that efficiency is the main performance driver. Both technical and scale efficiencies positively affect the Indonesian producers' performance. Conversely, market share as a proxy of market power has an insignificantly negative impact on performance. Thus, this study shows the importance of improving efficiency for the entire fertilizer producers.

This study employs a nonparametric approach (DEA) to measure efficiency that produces relative efficiency scores between producers, not absolute efficiency conditions. Meanwhile, data limitation leads us to only use two input proxies to measure efficiency (total assets and operational costs). Next, this study only uses 50 observation data, consisting of five fertilizer producers for ten years (2008-2017). Consequently, our analysis exhibits a relatively low degree of freedom. Another caveat is that we do not include the collusive market power (CR4) into the model to predict performance because it will strongly correlate with market share.

We advise future studies to observe data from longer observation periods and add other input proxies to measure technical and scale efficiencies. Besides, they can consider using the Feasible Generalized Least Square (FGLS) to estimate the performance determinants if the panel data is not completely or evenly available.

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APPENDIX

Table 6
Fertilizer Producers' Efficiency Scores, 2008 – 2017

i	Year	CRS Approach: Technical Efficiency	VRS Approach: Technical Efficiency	Scale Efficiency	Return to Scale Form
1	2008	0.397	0.415	0.958	drs
1	2009	0.642	0.642	1	drs
1	2010	1	1	1	-
1	2011	0.307	0.307	0.998	drs
1	2012	0.055	0.055	1	-
1	2013	0.513	0.513	1	drs
1	2014	0.237	0.237	1	-
1	2015	0.137	0.137	1	-
1	2016	0.255	0.255	1	-
1	2017	0.186	0.186	1	-
2	2008	0.529	1	0.529	-
2	2009	1	1	1	-
2	2010	0.263	0.263	1	-
2	2011	0.602	0.613	0.982	drs
2	2012	0.953	1	0.953	-
2	2013	0.704	0.84	0.839	drs
2	2014	0.509	0.61	0.835	drs
2	2015	0.128	0.13	0.99	drs
2	2016	0.129	0.129	1	-
2	2017	0.183	0.183	1	-
3	2008	0.914	0.982	0.931	drs
3	2009	0.903	0.992	0.91	drs
3	2010	0.61	0.676	0.902	drs
3	2011	0.673	0.759	0.886	drs
3	2012	0.746	0.853	0.874	drs
3	2013	0.784	0.893	0.879	drs
3	2014	0.689	0.766	0.899	drs
3	2015	0.621	0.675	0.92	drs
3	2016	0.292	0.398	0.733	drs
3	2017	0.308	0.328	0.941	drs
4	2008	0.474	0.525	0.902	drs
4	2009	0.54	0.595	0.909	drs
4	2010	0.564	0.588	0.959	drs
4	2011	0.725	0.757	0.958	drs
4	2012	0.87	0.889	0.979	drs
4	2013	0.489	0.503	0.972	drs
4	2014	1	1	1	-

i	Year	CRS Approach: Technical Efficiency	VRS Approach: Technical Efficiency	Scale Efficiency	Return to Scale Form
4	2015	0.891	0.895	0.996	drs
4	2016	0.751	0.754	0.996	drs
4	2017	0.941	0.946	0.995	drs
5	2008	0.6	0.606	0.989	drs
5	2009	0.269	0.278	0.968	drs
5	2010	0.203	0.203	0.998	drs
5	2011	0.893	0.897	0.995	drs
5	2012	0.992	1	0.992	-
5	2013	0.7	0.705	0.993	drs
5	2014	0.534	0.534	0.999	drs
5	2015	0.345	0.357	0.965	drs
5	2016	0.341	0.346	0.987	drs
5	2017	0.28	0.282	0.991	drs

Note: Table 4 shows summarized efficiency statistics by producers and years. The efficiency scores range between 0 and 1. Score 1 represents maximum efficiency, while scores below 1 indicate inefficiency levels. Producers: 1: PT. Pupuk Iskandar Muda; 2: PT. Pupuk Kujang Cikampek; 3: PT. Petrokimia Gresik; 4: PT. Pupuk Kalimantan Timur; dan 5: PT. Pupuk Sriwijaya and drs is decreasing return to scale