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Measuring Efficiency: Case Study of LQ45 Companies in Indonesia

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Abstract

This study aims to assess the efficiency of LQ45 companies over a five-year period (2016-2020) using Data Envelopment Analysis (DEA). The study applies both the Constant Return to Scale (CRS) and Variable Return to Scale (VRS) methods to evaluate organizational efficiency and productivity. The findings reveal that, on average, LQ45 companies in Indonesia have not yet achieved maximum efficiency, with efficiency trends varying on an year-to-year basis. The primary factor contributing to inefficiency is variable output, particularly 'net income after tax'. Additionally, the study found that *Shariah*-compliant LQ45 companies are generally more efficient than their non-*Shariah* counterparts. The analysis of company efficiency during the COVID-19 pandemic indicates a significant decline, as reflected by substantial drops in output across the majority of companies. Key policy implications for LQ45 companies include promoting optimal capital management, supporting proactive financial strategies, encouraging the adoption of DEA, providing incentives for digital transformation, and fostering ethical financial practices inspired by the *Shariah* principles to enhance sustainability and long-term growth.

Keywords: Constant Return to Scale (CRS), COVID-19, Data Envelopment Analysis (DEA), efficiency, LQ45 company, productivity, *Shariah*-compliant, variable output, Variable Return to Scale (VRS)

Introduction

In tandem with the rapid advancement of science and technology, business competition is intensifying. It brings changes in the corporate environment, such as differences in technology, consumer perception shifts, and product competitiveness (Nasution, 2005). Therefore, businesses must boost their product quality, services, efficiency, and productivity, while simultaneously reducing their production costs. It is essential to measure efficiency and productivity to determine if a company's business processes have improved

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or not?. Productivity growth is a key driver of economic growth and corporate profitability (Nasution, 2006).

Measuring efficiency and productivity remains crucial for businesses, particularly during the COVID-19 pandemic. The effects of the pandemic are not limited to the health aspect; they also have a worldwide economic impact (Naseer et al., 2023). The virus's dissemination and the government's preventative actions against it are the primary reasons for the suspension of manufacturing and consumption in various countries. During the COVID-19 pandemic, a company's productivity remained correlated with its efficiency in utilizing its resources (inputs) to produce its products or services (output) (Arianto, 2020).

Companies listed in the LQ45 stock index, both Shariah-compliant and non-compliant, are preferred by investors due to their greater liquidity than other Indonesian companies. Therefore, companies included in the LQ45 stock index are expected to be productive and efficient, particularly in managing their resources (inputs) to maximize shareholder returns. Every business endeavors to maximize shareholder returns (Kasman & Kasman, 2021). Positive returns growth is possible if the company's income grows. Furthermore, investors consider additional variables when deciding where to spend their capital, such as the company's effectiveness in managing costs to obtain maximum outcomes (Bartol & Martin, 1991).

One of the major characteristics of performance is efficiency (Bartol & Martin, 1991). Due to its ability to boost a company's competitiveness, businesspeople in a variety of nations are placing a growing emphasis on efficiency. Additionally, businesses must be competitive to survive (Amrullah & Eriandani, 2013). Typically, efficiency is described as a company's capacity for manufacturing at the lowest possible cost. Furthermore, efficiency involves managing the relationship between factors affecting input and output, that is, how to efficiently allocate available production components (inputs) to get the best outcomes (outputs) (Fathony, 2013). Traditional financial ratios are deemed inferior to the efficiency method (Berger & Berger, 1997). All inputs and outputs are considered concurrently when estimating the measures of efficiency based on the existing accounting data. Efficient companies are anticipated to have superior performance as compared to inefficient organizations, which would be reflected in their stock price. Changes in stock prices indicate increase or decrease in a company's efficiency (Gu & Yue, 2011a).

Several scholars have studied firm efficiency. Farida and Azhari (2018), measured the efficiency of LQ45 companies using the Data Envelopment Analysis (DEA) approach and examined its effect on stock returns. Soory (2022), used DEA to evaluate the technical efficiency of mining business stock. Al-Nuaimi and Al-Batat (2022) measured and analyzed the link between profit quality and investment efficiency in Iraqi industrial firms. Stević et al. (2022) provided an integrated model that was used to determine the eight-year efficiency of representative transport enterprises. Sánchez and Fonfría (2022) examined the drivers of productivity and its progression over time in the principal sectors of the Spanish defense industry. Kumar (2022) underlined the long-term effects of TPM on the organizational performance of Indian manufacturing companies.

Previous studies explored efficiency and productivity in various sectors; however, there has been a limited focus on the specific impact of the COVID-19 pandemic on LQ45 companies, especially in the context of Shariah and non-Shariah listed firms. While many studies have analyzed efficiency in sectors such as mining, industrial firms, and other stock indices, there remains a research gap when it comes to the efficiency of LQ45 companies. These companies are considered highly liquid and are preferred by investors, making them an important focus for further study. Additionally, there is a need for comparative analysis between Shariah-compliant and non-Shariah firms in the LQ45 index, particularly during periods of economic stress, such as the pandemic. The differences in how these two types of firms manage efficiency and productivity during such crises are not well understood.

Furthermore, while the DEA method has been widely used in prior studies to measure efficiency, only a few studies applied this method specifically to LQ45 companies during the pandemic. The application of DEA in this context would allow for a more detailed understanding of how companies manage their input-output relationships and cost allocation to maximize shareholder returns. This methodological gap presents an opportunity to enhance the existing body of research.

This research aims to measure and analyze the efficiency of LQ45 companies during the COVID-19 pandemic, with a particular focus on comparing the efficiency of Shariah-compliant and non-Shariah firms. It also provides valuable insights for investors, stakeholders, and regulators regarding how these companies manage their resources to maximize

productivity and shareholder returns. Additionally, the study seeks to understand how the performance of these companies during the pandemic might impact Indonesia's broader economic growth and development.

Literature Review

Microeconomic Theory of Production and Efficiency

Efficiency is a central concept in microeconomic theory. It examines the behavior of producers and consumers. Producers seek to maximize their revenue while minimizing costs, thereby achieving efficiency. This study draws upon the production theory, which posits that efficiency in resource allocation leads to higher productivity (Ascarya, 2012b). Efficiency is measured by how well companies manage the relationship between inputs (resources such as labor and capital) and outputs (products or services). For businesses, this involves minimizing costs while maintaining output levels, or maximizing output with given resources, as described by Sadikin (2005).

Islamic Work Ethic and *Shariah* Compliance

The study of *Shariah*-compliant companies introduces a unique framework rooted in Islamic financial principles. *Shariah*-compliant firms adhere to ethical and religious standards that prohibit activities such as gambling, usury, and trade involving forbidden *(haram)* products. The Islamic work ethic emphasizes the principle of *ahlakul karimah* (good moral character), which influences how companies manage resources efficiently and avoid wasteful practices (QS Al-Hashr: 18). This ethical dimension is key to understanding why *Shariah*-compliant firms might achieve higher efficiency, as observed in previous studies. Additionally, the financial ratios outlined by Financial Services Authority (FSA) regulation No. 35/POJK.04/2017 guide *Shariah* compliance in Indonesia.

Frontier Efficiency Theory and Data Envelopment Analysis (DEA)

The current study employs Data Envelopment Analysis (DEA) to measure the efficiency of LQ45 companies. Frontier efficiency theory provides the basis to describe how companies are evaluated in terms of their ability to maximize outputs, given a set of inputs. The DEA method is rooted in this theory and is used to determine the "efficiency frontier" — the best possible performance given the available resources. Companies that operate on this frontier are considered efficient, while those that fall below it are inefficient (Coelli et al., 2005). The study applies both the Constant

Return to Scale (CRS) and Variable Return to Scale (VRS) models within DEA to evaluate the efficiency of LQ45 companies.

Efficiency and Corporate Performance

The concept of efficiency is closely tied to corporate performance. Efficient companies are expected to deliver better financial results and maximize shareholder value (Bartol & Martin, 1991). In particular, the study examines how efficient use of resources impacts stock performance, which is reflected in stock prices of companies listed on the LQ45 index. This relationship between efficiency and stock performance is grounded in the theory of corporate finance, where efficient companies are able to manage costs, maximize returns, and improve competitiveness (Gu & Yue, 2011b).

Impact of Economic Shocks (COVID-19 Pandemic)

The COVID-19 pandemic caused significant economic disruptions that affected companies' productivity and efficiency, globally. This study incorporates crisis management theories to explore how firms adapt their operations in response to such economic shocks. Specifically, it examines how resource utilization and cost management changed during the pandemic and the subsequent impact on corporate efficiency. The theory behind economic shocks helps to explain why firms may have experienced declines in output or productivity during this period (Muzi et al., 2020).

Capital Market and Liquidity Theory

The inclusion of companies in the LQ45 index is based on liquidity and market capitalization criteria. The capital market theory suggests that investors prefer highly liquid companies because they provide greater opportunities for trading and returns. Companies listed on the LQ45 index are, therefore, expected to perform efficiently to attract and retain investors (Kasman & Kasman, 2011). This study also incorporates liquidity theory, which emphasizes the role of liquidity in stock performance and corporate efficiency.

Stock Index

The Indonesia Stock Exchange (IDX) utilizes stock price index to guide investors in making informed capital market investments. The stock price index plays several critical roles, such as indicating stock movement trends, gauging current market conditions, and measuring return rates.

Additionally, it serves as a standard to evaluate portfolio performance, facilitates the creation of portfolios using passive investment strategies, and aids in the development of derivative financial instruments.

The IDX features 11 types of stock price indices, each serving distinct purposes (Indonesian Stock Exchange, 2010). These include the Composite Stock Price Index (JCI), which calculates the stock prices of all listed issuers and the Industry Index (II), which includes all issuers within each industry sector. The LQ45 Index consists of 45 issuers selected on the basis of market capitalization and liquidity, while the Jakarta Islamic Index (JII) includes 30 Shariah-compliant issuers with high liquidity and large capitalization. The Kompas 100 Index comprises 100 issuers that were selected based on similar criteria. While, the BISNIS-27 Index, a collaboration between Harian Bisnis Indonesia and the IDX, consists of 27 issuers. The PPEFINDO25 Index, created in collaboration with the PEFINDO rating agency, includes 25 issuers. While, the SRI-KEHATI Index, in partnership with the Kehati Foundation, includes 25 issuers chosen on the basis of sustainability and environmental criteria. Additionally, the Main Board Index (MBI) comprises issuers on the main board of the exchange. Whereas, and the Development Board Index (DBI) includes those on the development board. Lastly, the Individual Index (II) represents the stock price of each issuer, individually.

LQ45 Indexes Companies

The LQ45 index is one of the major indicators of the Indonesian stock market. It is a composite index representing 45 Islamic and non-Islamic issuers with high liquidity. Since its inception in February 1997, the transaction value on the stock market has been the primary indicator of an issuer's transaction liquidity.

Two steps of selection were utilized to determine the LQ45 stocks. In the first stage, the stock must exceed 95% of the overall annual average value of stock transactions and 90% of the annual average market capitalization, as well as be listed on the IDX for at least 30 trading days. The second stage criterion is the highest order representing the sector in the IDX industrial classification and having the same proportion as other sectors, as well as the highest ranking based on the frequency of transactions.

The LQ45 index employs the same Paasche algorithm and weighted average approach as the IHSG IDX. Consequently, it is evident from the specified criteria that only stocks with substantial liquidity and market size qualify. Regularly, the IDX checks the performance of issuers, which is factored into the compilation of the LQ45 index. Every three months, an evaluation of the stock order's movement is conducted. The shares are replaced every six months, at the beginning of February and August.

Criteria for Shariah Stocks in Indonesia

Shariah stocks are securities that comply with Islamic principles and do not violate the *Shariah* law in the capital market. The Indonesian capital market recognizes two types of *Shariah* stocks. The first comprises the equities that meet the *Shariah* stock selection criteria as outlined in Financial Services Authority (FSA) regulation No. 35/POJK.04/2017, which governs the criteria and issuance of a list of Shariah-compliant securities. The second are "shares listed" as *Shariah* stocks by issuers or Shariah public companies in accordance with Financial Services Authority (FSA) regulation No. 17/POJK.04/2015.

The criteria for selecting Shariah shares, as determined by the F S A of Indonesia, include restrictions on certain business activities. Issuers must not engage in gambling, trades prohibited under Shariah (such as trade without delivery of goods/services or trading with fake bids), usury-based financial services (including interest-based banks and financing companies), and activities that involve uncertainty (*gharar*), gambling (*maisir*), or conventional insurance. Additionally, they must avoid producing, distributing, or trading goods or services that are unlawful either in substance (*haram li-dzatihi*) or due to their nature (*haram lighairihi*), as determined by the MUI DSN. Transactions involving bribery (*risywah*) are also prohibited.

Furthermore, *Shariah*-compliant issuers must meet specific financial ratios, such as total interest-based debt should not exceed 45% of the total assets and total interest-based income and other non-halal income should not surpass 10% of the total operating income and other revenues. These criteria ensure that *Shariah* stocks adhere to Islamic ethical standards while participating in the capital market.

Methodology

Data

This study aims to assess the performance of LQ45 companies over a five-year period, from 2016 to 2020. It focuses on both *Shariah*-compliant and non-compliant companies included in the LQ45 index. To analyze the efficiency and productivity of these companies, it is important to consider both input and output variables. This study uses input and output factors based on the approach by Ling et al. (2009). Table 1 outlines the specific input and output variables used in this analysis.

Table 1

Grouping of Input and Output Variables

No.	Input	Definitions
1	Total Asset	The total of all assets owned by the company or financial institution that are used to support the company's and financial institution's operations.
2	Current Asset	Assets or assets in the form of cash or other valuables which at any time can be easily converted into cash
3	Current Liabilities	The company's short-term financial obligations
4	Total Expense	with a maturity date of fewer than 12 months.
No	Output	Definitions
1	Net Income after Tax	The total net profit earned in a certain period after deducting income tax.
2	Revenue	Revenue is the amount that a company earns as a result of selling its products and services.

Approach

Data Envelopment Analysis

Data Envelopment Analysis or DEA, a non-parametric quantitative method, is used to gauge the effectiveness and productivity of business units. DEA was first established by (Charnes et al., 1978). Later, Banker et al. (1984) elaborated on this method. The method makes it possible to quantify productivity or efficiency using multiple inputs and outputs.

In order to describe the input and output variables that lead to inefficiency, the Decision-Making Unit (DMU) can be better understood through the application of the DEA approach. Moreover, this technique can

yield data regarding the amount of input and output that needs to be modified in order to get the highest possible relative efficiency rating.

If a business unit can maximize output for a given level of input or minimize costs for a given level of output then it is considered efficient. According to Ozcan (2008) technical efficiency, scale efficiency, cost efficiency, and allocation efficiency are the many dimensions of efficiency. Technical efficiency is the process of converting input into output. This concept only addresses the internal technical link between input and output. Therefore, if a company can lower production costs while maintaining market and standard technology prices for a specific output, it is deemed economically viable.

Figure 1
DEA Method (Ascarya, 2012a)
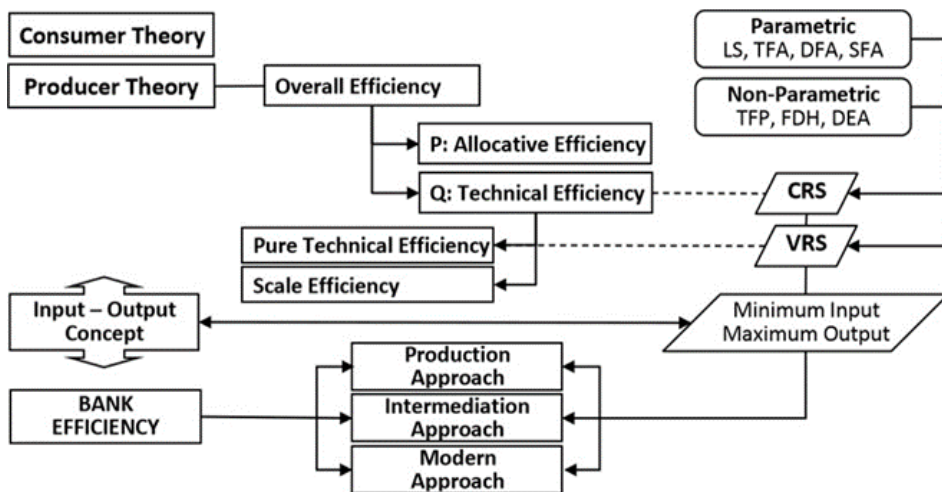
Two basic models used in DEA are Banker, Charnes, & Rhodes (BCR) and Charnes, Chopper & Rhodes (CCR) models. The CCR model makes the assumption that any variation in a DMU's output value would always be equivalent to the addition of a specific input value. This is consistent with the constant production function assumption made by the Constant Return to Scale (CRS) hypothesis. The BCR model, on the other hand, makes the assumption that the change in output value is distinct for each proportion of the variation in input values. This is consistent with the idea of Variable Return to Scale (VRS), which states that different inputs don't always result in the same output. Furthermore, an increase in input multiplied by x would

not result in an equivalent increase in output multiplied by x, since the VRS model implies that the ratio of increase in input to output is different. Alternatively, it might be bigger or smaller. In this paper, the efficiency of the LQ45 companies is calculated by comparing the CRS and VRS models using the production approach, which is adapted to reflect the activities of the organization or company. Since this research uses the production approach, the company is seen as an output producer. Furthermore, this approach describes the input variables as employees and physical capital (Sufian, 2007).

Results

Descriptive Statistics

Table 2 provides information on the input and output variables used in the study to measure the efficiency of LQ45 companies with *Shariah* and non-*Shariah* categories during the five-year observation period, that is, 2016-2020.

Table 1

Descriptive Statistics of Shariah and Non-Shariah LQ45 Companies

Variable	Mean	Max	Min
Sharia LQ45 Companies			
Input Variable			
Total Asset	Rp 1.625.707.671.525.780	Rp 68.109.185.213.000.000	Rp 3.731.101.667.891
Current Asset	Rp 1.437.437.932.362.200	Rp 47.980.945.725.000.000	Rp 636.951.781.893
Current Liabilities	Rp 1.035.974.677.978.150	Rp 44.168.467.736.000.000	Rp 255.113.007.336
Total Expense	Rp 848.355.398.901.447	Rp 29.172.636.262.000.000	Rp 86.928.317.112
Output Variable			
Net Income After Tax	Rp 56.887.951.328.547	Rp 2.621.015.140.000.000	Rp (3.296.890.000.000)
Revanue	Rp 902.247.217.102.279	Rp 32.280.391.165.000.000	Rp 31.812.082.281
Non Sharia LQ45 Companies			
Input Variable			
Total Asset	Rp 326.671.533.569.904	Rp 1.511.804.628.000.000	Rp 9.548.631.000.000
Current Asset	Rp 272.782.724.294.729	Rp 1.444.109.967.000.000	Rp 1.960.672.000.000

Variable	Mean	Max	Min
Current Liabilities	Rp 217.802.159.623.163	Rp 1.227.778.831.000.000	Rp 1.760.548.800.000
Total Expense	Rp 43.761.765.606.187	Rp 215.442.000.000.000	Rp 1.942.714.000.000
Output Variable			
Net Income After Tax	Rp 9.017.395.692.544	Rp 34.413.825.000.000	Rp (611.284.000.000)
Revanue	Rp 58.636.095.372.481	Rp 241.064.000.000.000	Rp 3.716.719.000.000

Efficiency of LQ45 Companies

Panel Summary of LQ45 Companies

The efficiency of LQ45 companies both in the *Shariah* and non-*Shariah* categories was checked using the DEA method for each year. Table 4 below provides information on the average value, minimum value, and maximum value of Technical Efficiency (TE), Pure Technical Efficiency (PTE), and Scale Efficiency (SE) of the LQ45 *Shariah* and non-*Shariah* indexed companies over a period of five years with details for 2016 (Panel A), 2017 (Panel B), 2018 (Panel C), 2019 (Panel D), 2020 (Panel E), and the whole period (Panel F).

Table 3

Efficiency Scores (TE, PTE, and SE) of LQ45 Companies

Years/Type of Efficiency	Mean	Min	Max
Panel A (2016)			
TE	0,558	0,028	1,000
PTE	0,704	0,236	1,000
SE	0,813	0,028	1,000
Panel B (2017)			
TE	0,602	0,182	1,000
PTE	0,737	0,202	1,000
SE	0,822	0,306	1,000
Panel C (2018)			
TE	0,608	0,149	1,000
PTE	0,748	0,243	1,000
SE	0,816	0,283	1,000
Panel D (2019)			
TE	0,605	0,090	1,000

Years/Type of Efficiency	Mean	Min	Max
PTE	0,744	0,210	1,000
SE	0,807	0,217	1,000
Panel E (2020)			
TE	0,488	0,093	0,965
PTE	0,650	0,133	0,992
SE	0,758	0,165	1,000

From the table above, it can be seen that the LQ45 companies have the highest average TE in 2018 (0.608), the highest PTE in 2018 (0.748), and the average highest SE in 2017 (0.822). From the efficiency score, it can be concluded that the efficiency of the LQ45 stock indexed company fluctuated on an year-to-year basis and experienced a decrease in efficiency at the end of the research period, that is, 2020.

CRS and VRS Efficiency Scores of LQ45 Shariah and Non-Shariah Companies

Table 4 and 5 present the LQ45 companies' CRS and VRS scores, both of *Shariah* and non-*Shariah* companies, respectively. The data shows that the efficiency of LQ45 *Shariah* and non-*Shariah* companies fluctuates yearly. Also, many companies have not achieved maximum efficiency and some of them have low efficiency. Furthermore, the results of CRS and VRS efficiency scores are also used as dependent variables to measure the effect of independent variables, namely 'good corporate governance' and 'intellectual capital', in the second stage of the analysis in this study.

Table 4

CRS Efficiency Scores of LQ45 Companies

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Ache hardware indonesia	0,932	0,907	0,882	0,965	0,746	Astra International Tbk	0,413	0,436	0,448	0,458	0,357
Adaro energy tbk	0,561	0,656	0,673	0,478	0,388	Bank Central Asia Tbk	0,668	0,758	0,846	0,841	0,596
AKR coprindo tbk	0,497	0,528	0,554	0,501	0,552	Bank Mandiri (Persero) Tbk	0,403	0,312	0,327	0,316	0,209
Aneka tambang tbk	0,287	0,399	0,769	0,920	0,675	Bank Negara Indonesia (Persero) Tbk	0,278	0,295	0,305	0,280	0,123
Bukit Asam Tbk	0,524	0,904	0,928	0,782	0,653	Bank Rakyat Indonesia (Persero) Tbk	0,359	0,366	1,000	0,348	0,203
Chandra Asri Petrochemical Tbk	0,752	0,586	0,495	0,366	0,328	Bank Tabungan Negara (Persero) Tbk	0,177	0,182	0,149	0,090	0,093
Charoen pokphand indonesia	1,000	0,987	1,000	1,000	0,830	Barito Pacific Tbk	0,672	0,461	0,408	0,355	0,318
Erajaya swasembada tbk	0,907	0,896	0,903	1,000	0,965	Bumi Serpong Damai Tbk	0,504	1,000	0,382	0,659	0,101
Indah Kiat Pulp & Paper Tbk	0,334	0,364	0,448	0,251	0,244	Gudang Garam Tbk	0,588	0,606	0,648	0,668	0,696
Indo Tambangraya Megah Tbk	0,697	0,757	0,743	0,875	0,713	H.M. Sampoerna Tbk	1,000	1,000	0,975	0,925	0,804

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Indocement Tunggal Prakarsa Tbk	0,782	0,503	0,440	0,496	0,462	Jasa Marga (Persero) Tbk	0,350	0,447	0,648	0,525	0,362
Indofood CBP Sukses Makmur Tbk	0,613	0,637	0,741	0,774	0,756	Medco Energi Internasional Tbk	0,547	0,265	0,198	0,259	0,165
Indofood Sukses Makmur Tbk	0,583	0,550	0,519	0,589	0,542	Sarana Menara Nusantara Tbk	1,000	1,000	1,000	0,981	0,779
Japfa Comfeed Indonesia Tbk	0,677	0,705	0,697	0,733	0,768	Timah Tbk	0,385	0,407	0,375	0,452	0,529
Kalbe Farma Tbk	0,746	0,776	0,776	0,757	0,685	Tower Bersama Infrastructure Tbk	0,539	1,000	0,557	0,557	0,511
Media Nusantara Citra Tbk	0,323	0,364	0,349	0,497	0,389	Vale Indonesia Tbk	0,470	0,484	0,480	0,571	0,511
Merdeka Copper Gold Tbk	0,028	0,946	1,000	0,545	0,411						
Mitra Keluarga Karyasehat Tbk	1,000	0,982	0,927	0,950	0,904						
Pabrik Kertas Tjiwi Kimia Tbk	0,339	0,363	0,450	0,252	0,245						
Pakuwon Jati Tbk	0,724	0,729	0,906	1,000	0,425						
Perusahaan Gas Negara Tbk	0,459	0,611	0,423	0,482	0,394						
PP (Persero) Tbk	0,285	0,288	0,273	0,235	0,179						

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Semen Indonesia (Persero) Tbk	0,674	0,519	0,533	0,583	0,551						
Summarecon Agung Tbk	0,235	0,202	0,242	0,209	0,131						
Unilever Indonesia Tbk	1,000	0,954	1,000	0,930	0,922						
United Tractors Tbk	0,418	0,437	0,466	0,482	0,406						
Wijaya Karya (Persero) Tbk	0,201	0,306	0,283	1,000	0,164						
XL Axiata tbk	0,601	0,624	0,597	0,697	0,666						

Table 5

VRS Efficiency Scores of LQ45 Companies

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Ache hardware indonesia	1,000	0,957	0,924	1,000	0,756	Astra International Tbk	0,929	1,000	1,000	1,000	0,896
Adaro energy tbk	0,679	0,880	0,838	0,743	0,561	Bank Central Asia Tbk	0,906	0,957	1,000	1,000	0,917
AKR coprindo tbk	0,509	0,530	0,565	0,513	0,557	Bank Mandiri (Persero) Tbk	1,000	0,827	0,892	0,887	0,872
Aneka tambang tbk	0,290	0,402	0,777	0,923	0,675	Bank Negara Indonesia (Persero) Tbk	0,686	0,710	0,738	0,757	0,742
Bukit Asam Tbk	0,530	0,981	1,000	0,818	0,665	Bank Rakyat Indonesia (Persero) Tbk	0,911	0,948	1,000	1,000	0,955

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Chandra Asri Petrochemical Tbk	0,755	0,648	0,598	0,459	0,441	Bank Tabungan Negara (Persero) Tbk	0,338	0,363	0,400	0,414	0,414
Charoen pokphand indonesia	1,000	0,988	1,000	1,000	0,831	Barito Pacific Tbk	0,675	0,611	0,636	0,528	0,519
Erajaya swasembada tbk	0,969	0,925	0,919	1,000	0,976	Bumi Serpong Damai Tbk	0,513	1,000	0,403	0,684	0,163
Indah Kiat Pulp & Paper Tbk	0,539	0,694	0,860	0,595	0,585	Gudang Garam Tbk	0,812	0,845	0,886	0,940	0,992
Indo Tambangraya Megah Tbk	0,721	0,776	0,753	0,906	0,743	H.M. Sampoerna Tbk	1,000	1,000	1,000	1,000	0,904
Indocement Tunggal Prakarsa Tbk	0,989	0,544	0,440	0,511	0,489	Jasa Marga (Persero) Tbk	0,395	0,593	0,744	0,581	0,363
Indofood CBP Sukses Makmur Tbk	0,619	0,655	0,742	0,777	0,849	Medco Energi Internasional Tbk	0,622	0,415	0,358	0,351	0,304
Indofood Sukses Makmur Tbk	0,810	0,809	0,826	0,859	0,869	Sarana Menara Nusantara Tbk	1,000	1,000	1,000	0,994	0,781
Japfa Comfeed Indonesia Tbk	0,682	0,707	0,718	0,744	0,768	Timah Tbk	0,440	0,429	0,385	0,464	0,542
Kalbe Farma Tbk	0,754	0,776	0,777	0,758	0,699	Tower Bersama Infrastructure Tbk	0,636	1,000	0,668	0,628	0,530
Media Nusantara Citra Tbk	0,326	0,366	0,357	0,537	0,433	Vale Indonesia Tbk	0,472	0,486	0,482	0,573	0,511

LQ45 Sharia	2016	2017	2018	2019	2020	LQ45 Non Sharia	2016	2017	2018	2019	2020
Merdeka Copper Gold Tbk	1,000	1,000	1,000	0,595	0,475						
Mitra Keluarga Karyasehat Tbk	1,000	1,000	1,000	1,000	0,907						
Pabrik Kertas Tjiwi Kimia Tbk	0,575	0,692	0,864	0,599	0,592						
Pakuwon Jati Tbk	0,724	0,731	0,907	1,000	0,425						
Perusahaan Gas Negara Tbk	0,622	0,633	0,707	0,702	0,589						
PP (Persero) Tbk	0,330	0,399	0,433	0,410	0,312						
Semen Indonesia (Persero) Tbk	0,703	0,566	0,576	0,696	0,647						
Summarecon Agung Tbk	0,236	0,202	0,243	0,210	0,133						
Unilever Indonesia Tbk	1,000	0,960	1,000	0,949	0,941						
United Tractors Tbk	0,678	0,785	0,919	0,916	0,721						
Wijaya Karya (Persero) Tbk	1,000	1,000	1,000	1,000	0,896						
XL Axiata tbk	0,604	0,627	0,598	0,701	0,666						

In addition to providing an analysis of the overall efficiency score of the LQ45 companies, this study also provides information on the average efficiency of each company. Table 6 below shows the average efficiency scores of LQ45 companies, both *Shariah* and non-*Shariah*. Out off the 45 companies, 29 are classified as *Shariah* and 16 as non-*Shariah* companies. The results showed that none of the LQ45 indexed companies, both the *Shariah* and non-*Shariah* categories, achieved maximum efficiency (1,000) during the five-year observation period using either the CRS or VRS approaches.

Table 6

Average Efficiency Score of LQ45 Shariah and Non-Shariah Companies

LQ45 Sharia	CSR	VRS	LQ45 Non Sharia	CRS	VRS
Ache hardware indonesia	0,887	0,909	Astra International Tbk	0,422	0,965
Adaro energy tbk	0,551	0,755	Bank Central Asia Tbk	0,742	0,956
AKR coprindo tbk	0,526	0,542	Bank Mandiri (Persero) Tbk	0,313	0,896
Aneka tambang tbk	0,610	0,694	Bank Negara Indonesia (Persero) Tbk	0,256	0,727
Bukit Asam Tbk	0,758	0,866	Bank Rakyat Indonesia (Persero) Tbk	0,455	0,963
Chandra Asri Petrochemical Tbk	0,505	0,537	Bank Tabungan Negara (Persero) Tbk	0,138	0,386
Charoen pokphand indonesia	0,963	0,955	Barito Pacific Tbk	0,443	0,594
Erajaya swasembada tbk	0,934	0,955	Bumi Serpong Damai Tbk	0,529	0,552
Indah Kiat Pulp & Paper Tbk	0,328	0,683	Gudang Garam Tbk	0,641	0,895
Indo Tambangraya Megah Tbk	0,757	0,794	H.M. Sampoerna Tbk	0,941	0,981
Indocement Tunggal Prakarsa Tbk	0,537	0,496	Jasa Marga (Persero) Tbk	0,466	0,535
Indofood CBP Sukses Makmur Tbk	0,704	0,756	Medco Energi Internasional Tbk	0,287	0,410

LQ45 Sharia	CSR	VRS	LQ45 Non Sharia	CRS	VRS
Indofood Sukses Makmur Tbk	0,557	0,841	Sarana Menara Nusantara Tbk	0,952	0,955
Japfa Comfeed Indonesia Tbk	0,716	0,734	Timah Tbk	0,429	0,452
Kalbe Farma Tbk	0,748	0,752	Tower Bersama Infrastructure Tbk	0,633	0,692
Media Nusantara Citra Tbk	0,384	0,423	Vale Indonesia Tbk	0,503	0,505
Merdeka Copper Gold Tbk	0,586	0,768			
Mitra Keluarga Karyasehat Tbk	0,953	0,977			
Pabrik Kertas Tjiwi Kimia Tbk	0,330	0,687			
Pakuwon Jati Tbk	0,757	0,766			
Perusahaan Gas Negara Tbk	0,474	0,658			
PP (Persero) Tbk	0,252	0,389			
Semen Indonesia (Persero) Tbk	0,572	0,621			
Summarecon Agung Tbk	0,204	0,197			
Unilever Indonesia Tbk	0,961	0,963			
United Tractors Tbk	0,442	0,835			
Wijaya Karya (Persero) Tbk	0,391	0,974			
XL Axiata tbk	0,637	0,648			

Although, no companies achieved maximum efficiency, there are companies that came close and companies that achieved low efficiency. In case of LQ45 companies, based on the CRS approach, five companies occupy the top four ranks with near-maximum efficiency, including Charoen Pokphand Indonesia (0.963), Unilever Indonesia Tbk (0.961), Mitra Keluarga Karya Sehat Tbk (0.953), and Erajaya Swasembada Tbk

(0.934). Meanwhile, for non-*Shariah* LQ45 companies, two companies have near-maximum efficiency values, including Sarana Menara Nusantara Tbk (0.952) and H.M. Sampoerna Tbk (0.941).

Furthermore, in case of LQ45 *Shariah* companies, based on VRS analysis, six companies almost achieved maximum efficiency, including Mitra Keluarga Karyasehat (0.977), Wijaya Karya (Persero) Tbk (0.974), Unilever Indonesia Tbk (0.963), Charoen Pokphand Indonesia (0.955), Erajaya swasembada Tbk (0.955), and Ache hardware Indonesia Tbk (0.909). Meanwhile, in case of non-*Shariah* LQ45 companies, five companies almost achieved maximum efficiency, including H.M. Sampoerna Tbk (0.981), Astra International Tbk (0.965), Bank Rakyat Indonesia (Persero) Tbk (0.963), Bank Central Asia Tbk (0.956), and Sarana Menara Nusantara Tbk (0.955).

Comparison of Efficiency Trends of LQ45 Shariah and Non-Shariah Companies

Figure 2

*Comparison of Efficiency Trends of LQ45 Shariah and Non-Shariah Companies*
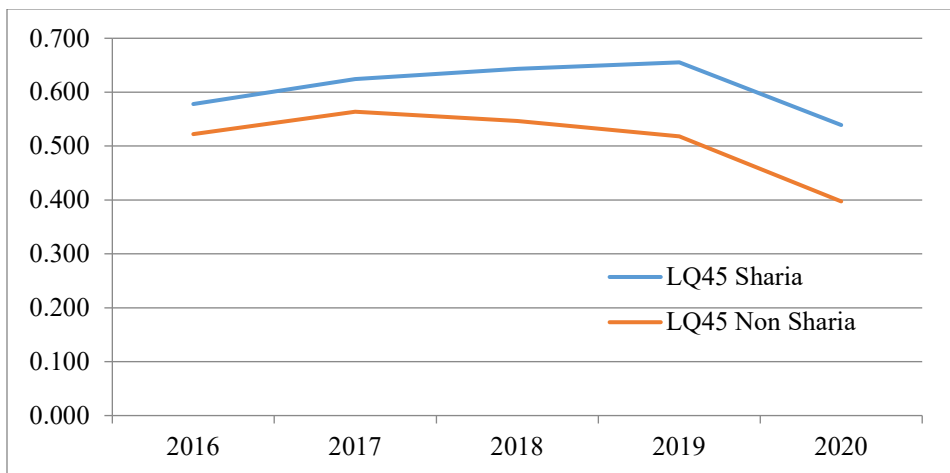
Figure 2 shows that the efficiency value of LQ45 *Shariah* companies is higher than non-*Shariah* LQ45 companies, as shown by the efficiency graph. Furthermore, this pattern indicates that the trend of LQ45 company efficiency fluctuates year-to-year. For example, in non-*Shariah* LQ45 companies, there was an increase in efficiency from 2017 to 2019. Then, in

2020, the efficiency trend was reversed. Furthermore, non-*Shariah* LQ45 companies also experienced a rise in efficiency in 2017. In the next three years, their efficiency decreased. The year 2020 is when the COVID-19 pandemic began to spread throughout Indonesia. Thus, one of the factors for the decline in the efficiency of LQ45 companies can be the impact of the COVID-19 pandemic, which disrupted their operational activities.

Impact of COVID-19 on LQ45 Company Efficiency

Figure 3

Impact of COVID-19 on LQ45 Company Efficiency
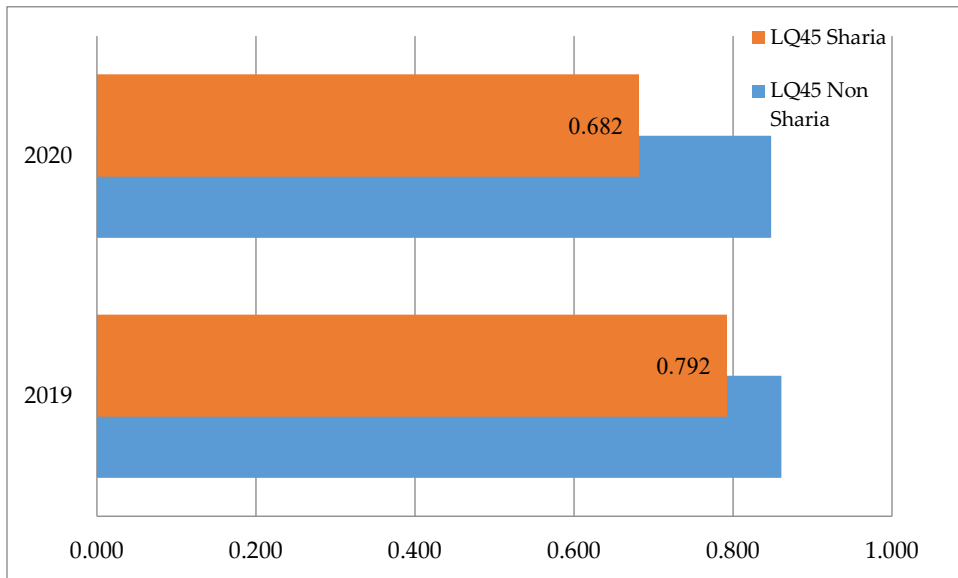
The above figure 3 above graphically presents the efficiency of the LQ45 companies, both *Shariah* and non-*Shariah*, during the COVID-19 pandemic. The graph shows that there has been a decrease in the efficiency of LQ45 companies, both *Shariah* and non-*Shariah*, during the COVID-19 pandemic. In 2019, the average efficiency of LQ45 *Shariah* companies had a value of 0.792, which decreased to 0.682 in 2020. The same happened to non-*Shariah* companies. The efficiency score of non-*Shariah* LQ45 companies also reduced from 0.861 in 2019 to 0.848 in 2020. Hence, it can be concluded that the COVID-19 pandemic affected the efficiency of both types of LQ45 companies.

Discussion

The current study found that the efficiency of the LQ45 companies fluctuated year-to-year during the observation period (2016-2020). Moreover, based on the average efficiency score per company, no company consistently achieved maximum efficiency. Some companies came close to achieving maximum efficiency, while others showed low efficiency.

If a company can use its inputs to generate the maximum possible outputs without wasting resources, then it is considered efficient (Naufal & Firdaus, 1996). In line with Prativi et al. (2020), an institution is said to be efficient if it can produce a well-defined output to a certain level of input or maximize costs (input) to achieve a certain level of output. In the case of LQ45 companies, both Shariah and non-Shariah, the leading cause of inefficiency during the five-year observation period was found to be the output variable, namely 'net profit after tax'. Inefficiency due to this variable can be caused by the company having a higher marginal cost of capital than the company's operating profit level after tax. This situation illustrates that most companies have not used the cost of capital efficiently and their capital use policies have not been optimal (Hidayat, 2006).

The second finding of this study concerns the comparison of the efficiency of LQ45 Shariah and non-Shariah companies. The results show that Shariah LQ45 companies have a higher efficiency trend than non-Shariah LQ45 companies. One of the reasons why Shariah LQ45 companies are more efficient than non-Shariah companies is the ratio of debt owned to the company's total assets. Almost all Shariah LQ45 companies have a debt percentage compared to total assets not exceeding 45%. While, for non-Shariah LQ45 companies, most have debt percentages above 45% of total assets. According to OJK law No. 35/POJK.04/2017, which outlines the criteria for issuing a Shariah securities list, as well as shares listed by issuers or Shariah public companies in accordance with OJK regulation No. 17/POJK.04/01, the total amount of interest-based debt cannot exceed 45% of the value of total assets.

The effect of the percentage of total debt not exceeding 45% of total assets enables the LQ45 *Shariah* companies in management accounting to manage their holdings, including short-term assets, more efficiently. Thus, the LQ45 *Shariah* companies rely more on their own assets, rather than on the debts of third parties. During the COVID-19 pandemic, some LQ45

Shariah companies implemented the "Cash is King" principle, so that the total value of their current assets remained substantial. In contrast, the majority of non-*Shariah* LQ45 businesses have few existing assets because they prioritize paying off debts owed to third parties. During the COVID-19 pandemic, not all companies received credit restructuring facilities from third parties; however, in order to maintain credit collectibility, the affected company was required to pay a certain amount of debt. The implication is that the company's cash cannot be allocated to working capital but must be used to settle its debts.

An interesting finding was the decline in the LQ45 companies' efficiency trend during the pandemic. The leading cause of declining efficiency were the output variables, namely 'net income after tax' and 'revenue'. During the observation period covering the COVID-19 pandemic, almost all companies experienced a significant decline in net income after tax and revenue. The decline is also related to costs and expenses; thus, during economic crises, the management must make efficient decisions in terms of costs, especially in terms of the company's production and operational expenses due to the decline in people's purchasing power. In addition to cost efficiency, companies also need to be proactive, innovative, and creative in marketing their products, diversifying products, seeking new market penetration, and looking for supportive marketing activities (Purnama, 2021).

In addition to achieving efficiency, further efforts are required to supplement a company's profit-maintenance plan in the face of escalating commodity prices. Moreover, a pandemic that restricts people's mobility necessitates that businesses sell their offline and online items with initiative, creativity, and originality. Since businesses are beginning to sell their products online, the increasingly strong competition on digital marketplaces presents an additional obstacle. Other domestic and international businesses offer comparable products at varying prices. Consequently, it is crucial to quickly adapt and seize commercial opportunities by diversifying products, conquering new markets, and pursuing supplementary marketing efforts (Purnama, 2021).

Conclusion

This study attempted to examine the efficiency of LQ45 *Shariah* and non-*Shariah* businesses over a five-year period (2016-2020). The BCC or

VRS model was used as the principal model for measuring bank efficiency. The results of DEA analysis indicated that the average efficiency of LQ45 firms that do not attain maximum efficiency (1,000) fluctuates year-to-year. Several businesses attained their maximum level of efficiency, while others remained inefficient. The variable responsible for inefficiency is the 'net income after taxes', which is an output variable.

The efficiency of LQ45 companies fluctuated on a year-to-year basis during the five-year observation period (2016-2020). Based on the average efficiency score per each company, it was found that no company consistently achieved maximum efficiency. However, some companies came close to achieving maximum efficiency, while others had low efficiency. The main factor causing inefficiency remains the output variable, namely 'net income after tax'. The comparison of the efficiency of LQ45 *Shariah* and non-*Shariah* companies shows that *Shariah* LQ45 companies have a higher efficiency trend than LQ45 non-*Shariah* companies. One of the reasons why the prior companies are more efficient than non-*Shariah* LQ45 companies is due to the ratio of debt owned to the company's total assets. Almost all *Shariah* LQ45 companies have a debt percentage compared to total assets that does not exceed 45%. In contrast, for non-*Shariah* LQ45 companies, most have a debt percentage of more than 45% of total assets.

Recommendations

The findings provide several important policy implications that can guide regulators, investors, and corporate managers to improve the efficiency and performance of companies listed on the LQ45 index, both *Shariah*-compliant and non-*Shariah*. Firstly, encouraging optimal capital management is crucial. *Shariah*-compliant companies benefit from adhering to the 45% debt-to-total-assets ratio, as mandated by Financial Services Authority regulation No. 35/POJK.04/2017. This highlights the importance of effective debt management and regulators should consider expanding these guidelines to non-*Shariah* companies to foster disciplined debt management. Reducing excessive reliance on debt can lead to better capital allocation and increased operational efficiency.

Furthermore, supporting resilient corporate practices during economic shocks is essential. The COVID-19 pandemic revealed vulnerabilities in many businesses, highlighting the need for policymakers to implement

programs that promote proactive financial management, especially during crises. Such programs may include incentives for diversifying income streams, building stronger cash reserves, and fostering innovation in operational strategies to adapt to disruptions including pandemics.

Policymakers should also promote the use of Data Envelopment Analysis (DEA) as a benchmarking tool. DEA has proved to be a more comprehensive method for measuring efficiency than traditional accounting ratios. Regulators can encourage its adoption by incorporating DEA into corporate reporting standards, allowing companies to benchmark performance more effectively. Offering workshops and training programs to familiarize corporate stakeholders with DEA would also promote its adoption across various industries.

Facilitating digital transformation is another key policy implication. Many companies, particularly during the pandemic, struggled with inefficiencies related to operational and production expenses. Policymakers can support digital solutions by offering tax incentives or subsidies for digital transformation initiatives, such as automation and e-commerce integration, helping companies reduce costs and boost productivity.

Debt restructuring and financial support for vulnerable firms is also critical. Non-*Shariah* companies, which experience lower efficiency due to higher debt ratios, can benefit from debt restructuring programs. These programs may provide temporary relief, such as deferred loan payments or reduced interest rates, allowing businesses to allocate more resources toward productivity and recovery.

Lastly, encouraging ethical financial practices may also have a positive impact. The higher efficiency observed in *Shariah*-compliant companies demonstrates the benefits of ethical financial management. Policymakers may promote the adoption of *Shariah* principles within broader corporate governance practices, even for non-*Shariah* companies, fostering a more sustainable and responsible business environment. This may also include developing guidelines for ethical investments, prudent debt management, and responsible financial practices aligned with long-term sustainability goals.

Limitations

While this research provides valuable insights into the efficiency of LQ45 *Shariah* and non-*Shariah* companies, it is not without its limitations.

Firstly, the study is limited to a five-year observation period, that is, from 2016 to 2020. Thus, it may not capture long-term trends in company efficiency, particularly in periods of economic stability or post-pandemic recovery. Future research could extend the observation period to include more recent data and investigate how companies adapt their efficiency strategies over a longer timeframe.

Secondly, the study focuses solely on LQ45 companies, which are considered highly liquid and preferred by investors. This may limit the generalizability of the findings to other sectors or less liquid companies in Indonesia. Future research should broaden the sample to include companies from different stock indexes or industries to provide a more comprehensive view of corporate efficiency across the market.

Another limitation is the use of Data Envelopment Analysis (DEA) as the sole method for measuring efficiency. While DEA is a robust tool, it may not capture all aspects of company performance. Future studies may combine DEA with other efficiency measurement methods or financial analysis techniques to provide a more holistic assessment of company performance.

Lastly, this research does not explore deeply the qualitative factors that may influence company efficiency, such as leadership, corporate culture, or external market conditions. Future research may incorporate qualitative data through case studies or interviews to better understand the internal and external factors that drive efficiency. Exploring these aspects would provide a richer understanding of the dynamics affecting corporate performance.

Conflict of Interest

The author of the manuscript has no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

The data associated with this study will be provided by the corresponding author upon request.

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