# Efficiency of Pharmaceutichal Industry

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# The Efficiency of the Pharmaceutical Industry in Indonesia: A Stochastic Frontier Approach

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**Abstract:** This study investigates the efficiency of the pharmaceutical industry in Indonesia. The data used in this study are secondary data from 2000-2015 obtained from Badan Pusat Statistik. The method of study is the quantitative approach to use the Stochastic Frontier Approach. The finding results indicated that the pharmaceutical industry in Indonesia during 2000-2015 technically has not optimal efficiencies, see from the result of reached an amount of 0.96455986. The capital variable has negative and significant effect on the output produced by the producer in the pharmaceutical industry, while the labor variable has positive and significant effect on the output produced. Limited human resources professionals will make the development of innovations to make the pharmaceutical industry as a priority industry in the Industrial Revolution 4.0 will be inhibited so that the pharmaceutical industry was not achieving optimal efficiency.

**Keywords:** Pharmaceutical industry; stochastic frontier approach; technical efficiency

**JEL Classification:** L65, O14

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## 1. INTRODUCTION

The industry is supporting economic activities in Indonesia because it provides a useful commodity for the community (Bashir, et al., 2019 and Gunadi, 2018). The industrial sector became one of the sectors that are large enough to contribute to the economy in the amount of 21.22 percent in 2017. Indonesia's economic growth grew by 5.07 percent in 2017 due to higher growth in the business field. One of them is the manufacturing sector that accounted for 0.91 percent. Non-oil processing industry subsectors, one of which has the chemical, pharmaceutical, and traditional medicine (Fokunang et al., 2011). This sector grew by 4.53 percent in 2017 and the highest growth in Quarter 1-2017 by 8.34 percent. However, at the end of 2017, the industry experienced negative growth of 5.46 percent and continued to decline until the first quarter of the year 2018 by 6.30 percent.

Table 1 illustrates that the pharmaceutical industry in Indonesia, more use of imported raw materials than traditional medicine industry. More than 80% of pharmaceutical raw materials have to be imported. The pharmaceutical industry is also driven by the Ministry of Health to be more independent in doing so can suppress the production of drug prices and reduce dependence on imported raw materials (Simatupang, 2016) and Kaplan & Laing, 2005).

According to the ministry of industry, restrictions on imports of raw materials potentially disruptive to the export-oriented products for the pharmaceutical industry is one of the priority industries poised to capitalize on the opportunities of the Industrial Revolution 4.0 (Bashir et al., 2019; and Vasin et al., 2018). Security of supply of raw materials is one of the important factors in preparing the Industrial Revolution 4.0 that rely on process automation and standardization of products (Lavinda, 2018) and Zhong, Xu, Klotz, & Newman, 2017), resulting in increasing competitiveness in order to expand market share, the company sued the pharmaceutical industry to be more productive and efficient in running the company's operations (Hanggraeni, 2011).

**Table 1.** Use of Raw Materials Industry Import and Local Pharmaceutical Products and Traditional Medicines Products Industry 2001-2015

| YEAR | Manufacture of Pharmaceutical Products | | Traditional Medicinal Products Industry | |
|---|---|---|---|---|
| | Imported Raw Materials | Local Raw Materials | ImportedRaw Materials | Local Raw Materials |
| | % | % | % | % |
| 2001 | 64.80 | 35.20 | 5.29 | 94.71 |
| 2002 | 52.75 | 47.25 | 20.25 | 79.75 |
| 2003 | 53.92 | 46.08 | 0.99 | 99.01 |
| 2004 | 57.27 | 42.73 | 0.69 | 99.31 |
| 2005 | 53.18 | 46.82 | 3.36 | 96.64 |
| 2006 | 64.47 | 35.53 | 7.23 | 92.77 |
| 2007 | 64.75 | 35.25 | 0.76 | 99.24 |
| 2008 | 93.86 | 6,14 | 0.18 | 99.82 |
| 2009 | 92.27 | 7.73 | 0.83 | 99.17 |
| 2010 | 84.97 | 15.03 | 2.43 | 97.57 |
| 2011 | 83.01 | 16.99 | 5.95 | 94.05 |
| 2012 | 48.82 | 51.18 | 2.43 | 97.57 |
| 2013 | 53.25 | 46.75 | 1.37 | 98.63 |
| 2014 | 53.86 | 46.14 | 21.79 | 78.21 |
| 2015 | 46.15 | 53.85 | 82.86 | 17.14 |
| Total | 80.8% | 19.2% | 10.3% | 89.68% |

**Source:** The Central Bureau of Statistics (Author's processed, 2019)

## 2. LITERATURE REVIEW

Approach Structure Conduct Performance (SCP) which was built by a Harvard economist, namely Edward S. Mason (1949) and colleagues Joe. S. Basin (1959) found a strong correlation between an industry market structure, business practices and behavior of the parties forming the market and the performance of the industry itself (Janah, 2008). Edward S. Masson (1988) in Ward (2008) states that there is a fairly high rise in the market, it must look at the performance of the market first. Outreville (2014) said performance can be seen from the behavior that reflected the market structure. So the performance of a company can be seen from the structure of the market that will affect the behavior of the market.

According to Prajanti and Setiawan (2011) explains that the production function is defined as a technical relationship between inputs to outputs, which this relationship shows


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the output as a function of the symbolic input. The production function can be written as follows:

$$Q = f(X_1, X_2, X_3, \ldots\ldots X_n)$$

Where: Q is output, $X_1$ ... $X_n$ is various inputs that contribute to generate the Q output capable inputs used in the production process there are relatively fixed inputs and variable input. Inputs used in the production process, among others, capital, labor, dummy, and others. In economics, the output is denoted by Q, while inputs (factors) that are used typically (for simplicity) consist of capital input (K) and labor (L).

The production function Cobb-Douglas exponential or is already widely used in studies of the empirical production function, especially since Charles W.Cobb and Paul H. Douglas started using it at the end of 1920. This function or equation involves two or more variables, which one variable called the dependent variable or explained (dependent variable), and the other is called the independent variable or explain variable (Cobb and Douglas, 2010). Mathematically, Cobb-Douglas production function can be written as follows:

$$F(K, L) = AK^{\alpha}L^{\beta}$$

Where: A = Productivity; K = Capital; L = Labor; and α and β = output elasticity of labor and capital. Where A, α, and β are positive constants. When the Cobb-Douglas function is expressed in relation between X and Y, it can be written:

$$Y = f(X_{1,}, X_2 \ldots, X_n)$$

For simplicity, this equation is transformed into a linear form, namely:

$$lnY = lna + b_1 lnX_1 + b_2 lnX_2 + \cdots + b_n lnX_n + e$$

Agner and Chu (2006) developed a deterministic parametric frontier approach through the specification of homogeneous frontier production function Cobb-Douglas that require all observations are at or below the frontier. The model can be written as follows(Coelli et al., 2005).

$$lnq_i = x_i'\beta - u_i$$

Where: $q_1$ represents the output of the i is the firms; $X_i$ is a K × 1 vector containing the logarithm of the input; β is the unknown parameter vector and ui is a non-negative random variable associated with technical inefficiency. B parameter vector elements obtained by linear or quadratic programs.

Nicholson (2002) explains that efficiency is the ability to achieve the expected results (output) at the expense of (input) is minimal. An activity is said to be efficient if the activities have reached the target (output) to sacrifice (input), the lowest, so no waste. Efficiency is the ratio of the value added generated an industry with the inputs used in the form of labor, raw materials, capital, and others(Lieberman & Kang, 2008). Efficiency cannot be separated from the allocation of inputs in the production. Production will be efficient if economically at a level output when no other process that can produce a similar output with lower cost (Hasibuan, 1993).

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## 3. MATERIALS AND METHODS

This study used secondary data of pharmaceutical products industry (ISIC code 21012) in Indonesia from 2000 to 2015 were obtained from the Central Bureau statistically. The data used is the data of capital and labor in the pharmaceutical industry from 2000 to the 2015. This study uses the quantity of technical analysis is Stochastic Frontier Deterministic Parametric through frontier production function specification homogeneous Cobb Douglass requiring all observations under the frontier. The model can be written as follows (Coelli et al., 2005):

$$\ln q_i = x_i\beta - u_i$$

Where: q represents the company to the output-1, xi is the logarithm vector output, ß is the vector of unknown parameters and ui is a non-negative random variable associated with technical inefficiency. Ss parameter vector elements obtained by the linear or quadratic program.

Stochastic Frontier Approach used to estimate the Cobb Douglas production function using panel data on a parametric approach Stochastic Frontier with the following functions:

$$Y = \beta_0 X_1 . \beta_1 X_2 . \beta_2 X_3 e^u$$

Is transformed into a linear form of logarithms with the following functions:

$$lnO_i = \ln \beta_0 + \beta_1 lnK_i + \beta_2 L_i + v_i - u_i$$

Where: Y = Output; $K_1$ = fixed capital; $L_2$ = the number of workers $ß_0$ = intercept; $ß_1$ = coefficient of parameter estimators where I = 1,2, ....; and vi- u = is the error term (Effect of technical inefficiency in the model). Coefficient values expected: $ß_1$, SS2,> 0, meaning that the results of Stochastic Frontier estimate a production function above is expected to give a positive value estimated parameters.

Technical efficiency value can be determined from the data with Frontier Software Version 4.1c. If the value of technical efficiency that has been processed using a Stochastic Frontier nearing the added value and the cost of associate use and equal to one (= 1) then it is efficient, whereas when the value of technical efficiency of less than one, then the inputs used are inefficient.

Maximum likelihood estimation was better than Ordinary Least Square Estimation. This is caused by maximum likelihood estimation is able to describe the real state of the population in the form of the average value of samples or any other value that is best able to show the state of the sample, while the Ordinary Least Square Estimation only able to describe the real state of the population in the form of the average value of the sample. A variety of tests necessary to ensure the model specification. The test includes testing the existence of a standard deviation for maximization or minimization or test sigma-squared ($\sigma^2$), test the accuracy of the model maximum likelihood estimation or test gamma (γ), test the effect of inefficiency in the model or z test, a technical test comparison of models or test LR ( λ) and the independent variable significance test or t-test.

Sigma squared test ($\sigma^2$) is a statistical value calculation used to determine how the distribution of data in the sample, and how close individual data to the mean or average value of the sample. Criteria for acceptance of the null hypothesis ($H_o$) t <t table and acceptance criteria Ha namely t> t table. While, Gamma test is one of the associative non-parametric test. Gamma measures the relationship between two variables ordinal scale that


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can form into a contingency table. This test is to measure the relationship that is symmetrical meaning that variable A and variable B can be mutually correlated.

- The null hypothesis ($H_0$): γ = 0: The model to be used is OLS model
- The alternative hypothesis ($H_a$): γ ≠ 0: The model to be used is a model MLE (maximum likelihood estimation).

Acceptance criteria for the null hypothesis ($H_0$) t-test < t-table and acceptance criteria Ha namely t-test > t-table.

The Z-test is a statistical test using normal distribution approach. Z test can be used to test large-sized sample data. Tests on the presence or absence until inefficiency did use z-test, where the test criteria of this test are to compare the counted value with a z z table. Here's the formula used to calculate the value of z is calculated.

$$Z = \frac{\lambda}{se(\lambda)}$$

Where: λ is the coefficient of the variable λ (gamma) produced and estimated production function model; se(λ) is the standard error of λ which is also produced from production function model estimation. The preparation of the hypothesis of the Z test is as follows:

- $H_o$ λ = 0: no influence inefficiency or fully efficient output
- $H_a$ λ = 0: No effect on output inefficiency

Criteria arithmetic test if the value of z> z table then $H_o$ is rejected, it means that there are significant inefficiencies in the production process.

## 4. RESULTS AND DISCUSSION

The following is the value added of the pharmaceutical industry in Indonesia during 2000-2015. Value added is obtained from the difference in the value of output produced during production and the costs incurred to produce (intermediate costs).

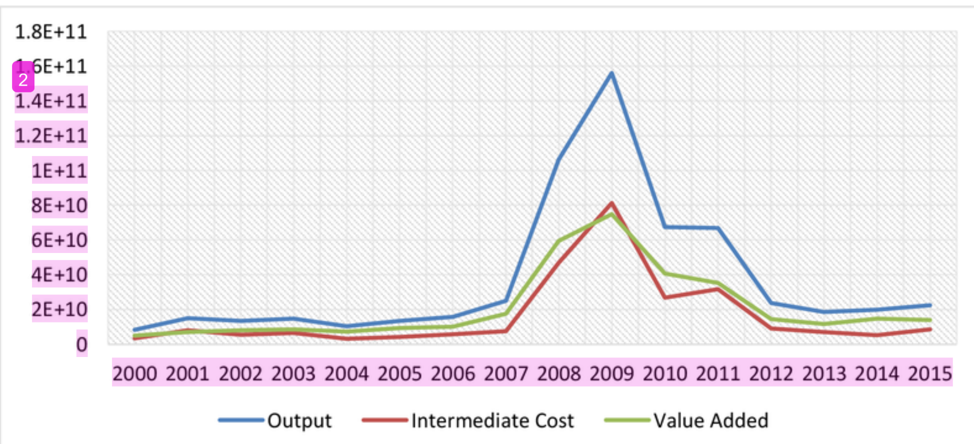


**Figure 1.** The Added Value of the Pharmaceutical Industry in Indonesia
**Source:** Badan Pusat Statistik (Author's processed, 2019)

Based on the Figure 1, it can be seen that the value added of the pharmaceutical industry is always higher than the middle costs incurred except in 2001 and 2009. Added value in 2009 was the highest added value during of 2000-2015. However, the intermediate costs incurred in that year were greater than the value added generated. This was due to the high use of raw materials used for production despite the increased output.

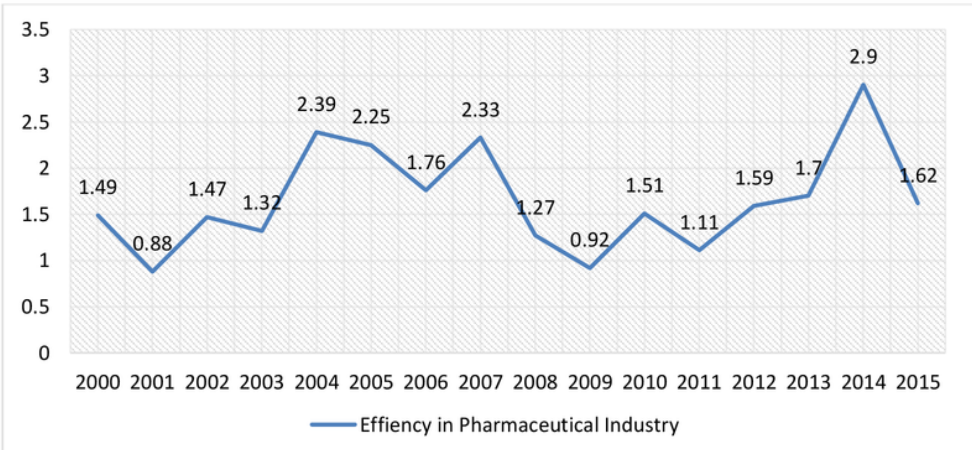


**Figure 2.** The Efficiency of Pharmaceutical Industry in Indonesia, 2000-2015
**Source:** Badan Pusat Statistik (Author's processed, 2019)

Efficiency measurement is used to see the performance of an industry based on the costs incurred during the production process and the value added generated. The development of the level of efficiency of the pharmaceutical industry is determined by the comparison of the added value generated with the intermediate costs incurred during the production process. The following is general efficiency of the pharmaceutical industry during 2000-2015.

Although the highest value added of the pharmaceutical industry occurred in 2009, the most optimal efficiency during of 2000-2015 was in 2014. This was caused by the value added generated higher than the value of input/intermediate costs incurred during the production process. While the lowest efficiency values occurred in 2001 is 0.88. This is because the use of intermediate costs during the production process is quite high but does not increase output or the added value generated.

Table 2 show that the capital variable (K) has a coefficient of -2.0616647. This means that if the use of capital variable increases by one percent it will reduce output by 2.0616647 percent. The intended capital is depreciation of fixed capital. While, labor variable (L) has a coefficient of 1.23958. This means that if the use of labor variables increase by one percent it will increase output by 1.23958 percent.

The t-test is used to see the significance of the influence of the independent variable on the dependent variable. The significance of this influence can be estimated by comparing the value of t-count with t-table at $\alpha = 5$ percent and degree of freedom (df) 14 which is 1.7613. Based on the estimation it can be concluded that the capital variable has negative and significant effect on output can be seen from the value of t-test < t-table (-5.153764 < 1.7613). This also means that capital has a negative influence on the output produced. The labor variables has positive and significant effect on the output of the Indonesian pharmaceutical industry. This can be seen through the value of t-ratio > t-table 2.698 > 1.761. This means labor has a positive relationship with output. The greater labor force expended, the ability of the pharmaceutical industry to produce output is also greater. The model estimation results, technical efficiency using the Stochastic Frontier Production Function are as follows:

**Table 2.** Estimation Results of Frontier Production Functions

| Variable | MLE (Maximum Likelihood Estimation) | | |
|---|---|---|---|
| | Coefficient | Standard-Error | t-ratio |
| Constant | 460.08362 | 1.0000864 | 460.04385 |
| Ln K | -2.0616647 | 0.40003084 | -5.153764 |
| Ln L | 1.2395802 | 0.45944317 | 2.6980055 |
| Sigma-squared (s) | 49.733125 | 17.320352 | 2.8713692 |
| Gamma (γ) | 0.00004198 | 0.024549 | 0.0017101841 |

Log like-hood function = -0.53956369
Mean eff. in year = 0.96455986
Level significant = 5 %
t-table (5%, 14) = 1.7613
t-table (1%, 14) = 2.624

**Source**: Author's use Stochastic Frontier Approach (2019)

Simply rewritten as follows:

$$lnYit = \ln 460.08362 - 2.0616647 lnK_{it} + 1.239580 lnL_2$$

The efficiency in this study can compare the gamma coefficient with the standard gamma error. $z = Gamma/(se.gamma)$ The calculated z value is 0.0000419847/ 0.024549818 = 0.00171018376. The calculated z value is 0.001710183 percent of the output produced. In this case, the hypothesis is accepted, the production output is not fully efficient. The result of the calculation of technical efficiency in mind the use of capital and labor as inputs Indonesian pharmaceutical industry has already reached efficiencies technically though not optimal.

Based on estimates obtained the highest technical efficiency occurred in 2009 which amounted to 0.9648 or nearing one and 2004 is the year in which the technical efficiency of the lowest in the pharmaceutical industry. It can be seen from the picture above that 2004 closest to the center point of the image. The average efficiency of the pharmaceutical industry is equal to 0.96455986 of a frontier or maximum production, i.e. less than 1. This means that the use of factors of production is not technically efficient. This is in line with research from Fazri et al. (2017) argue that most of the processing industry in Indonesia increased efficiency unless the timber industry.

Overall the pharmaceutical industry in Indonesia has a high efficiency although not optimal. If the pharmaceutical industry wants to achieve maximum efficiency, the pharmaceutical industry must increase its output only amounted to 3,544 using the same input. The cause of the pharmaceutical industry has not yet reached the optimal technical efficient due to the raw materials used in the production process using more than 80.00 percent of imported raw materials. The use of high import raw materials caused by the production of local raw materials has not been going well. This is because the raw materials of the pharmaceutical industry in the country are still not able to provide the basic materials needed by the pharmaceutical industry in terms of both types, supply, and price competitive. If the raw materials are not available in the country, the pharmaceutical manufacturers have to import raw materials or intermediate materials from abroad, so it is done in the country only a final stage of the formation of raw materials. This can lead to greater production costs which impact inefficiency to the pharmaceutical industry and also lead to dependence on imported raw materials and prone to fluctuating currency exchange rates.

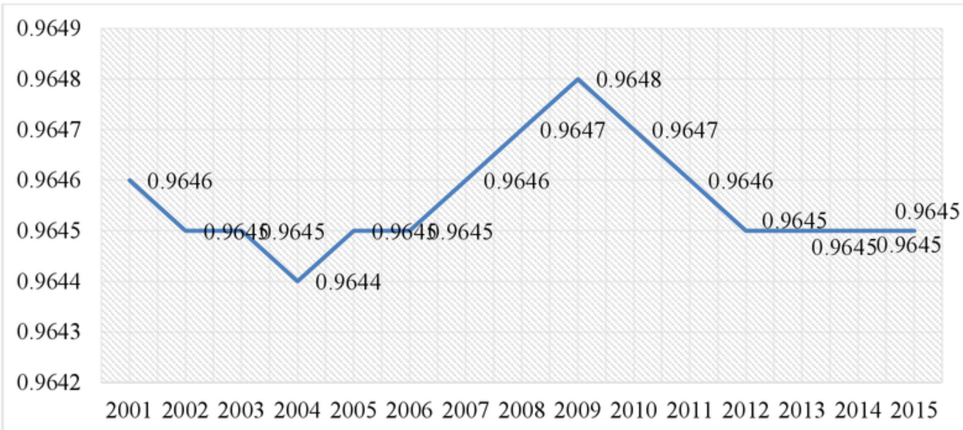


**Figure 3.** Technical Efficiency in Pharmaceutical Industry
**Source:** Stochastic Frontier (Author's processed, 2019)

Constraints on imported raw materials above are not produced in the country is better utilization of natural resources of plants, animals, minerals and mineral and gas is still limited. Not only that, the lack of research for innovation and technology transfer also provide obstacles for Indonesia to produce pharmaceutical raw materials.

## 5. CONCLUSION

The pharmaceutical industry in Indonesia in 2000-2015 are technically not achieving optimal efficiency (0.9646). This is due to the pharmaceutical industry uses imported raw materials more than 80 percent of the production process. The low quality of labor in Indonesia least impact on the performance of the pharmaceutical industry. Limited human resources professionals will make the development of innovations to make the pharmaceutical industry as a priority industry in the Industrial Revolution 4.0 will be inhibited so that the pharmaceutical industry was not achieving optimal efficiency.

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