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# Banking productivity analysis in Indonesia: Empirical evidence using Malmquist Productivity Index based DEA and an Error Correction Model approach

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**Abstract**
The level of productivity can be used as a benchmark for assessing the performance of a bank so that we can find out how efficient a bank's performance is or how banking productivity is so that we can still get maximum and efficient performance amidst the many choices of customers in choosing a bank. This research examines how banking productivity has changed in Indonesia, using banking report data in Indonesia for the 2017-2022 period. Data Envelopment Analysis (DEA) linear programming model, which is used based on the Malmquist Index to measure changes in Total Factor Productivity (TFP). Regression model to describe what variables influence changes in banking productivity in Indonesia. With the Error Correction Model, the Loan-to-Deposit Ratio (LDR) and Return on Equity (ROE) have a significant effect on productivity in the long term. The pandemic crisis does not affect productivity. Meanwhile, in the short term, Net Interest Margin has a significant effect on banking productivity in Indonesia.

Keywords: Data Development Analysis (DEA), Indonesian banking, Malmquist Productivity Indices (MPI)

**Abstrak**
Tingkat produktivitas dapat dijadikan sebagai tolak ukur untuk menilai kinerja suatu bank, sehingga kita dapat mengetahui bagaimana efisiensi kinerja suatu bank ataupun produktivitas perbankan untuk tetap bisa mendapatkan kinerja yang maksimal dan efisien ditengah banyaknya pilihan nasabah dalam memilih perbankan. Penelitian ini mengkaji bagaimana perubahan produktivitas perbankan di Indonesia, dengan menggunakan data laporan perbankan di Indonesia periode 2017-2022. Model pemrograman linier Data Envelopment Analysis (DEA), yang digunakan berdasarkan Indeks Malmquist untuk mengukur perubahan Total Factor Productivity (TFP). Model regresi untuk menggambarkan variabel apa saja yang mempunyai pengaruh terhadap perubahan produktivitas perbankan di Indonesia. Dengan Error Correction Model, Loan to Deposit Ratio (LDR) dan Return on Equity (ROE) berpengaruh signifikan terhadap produktivitas dalam jangka panjang. Krisis pandemi tidak berpengaruh pada Produktivitas. Sedangkan dalam jangka pendek, Net Interest Margin berpengaruh signifikan terhadap produktivitas perbankan di Indonesia.

Kata kunci: Data Development Analysis (DEA), Perbankan Indonesia, Malmquist Productivity Index (MPI)

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## 1. Introduction

The banking industry has an important role in stabilizing the financial system through efficient savings for investment at higher growth rates. Not only that, the stability of the

financial system as a whole is important for economic growth and development in a country. Indonesia's central Bank is tasked with stabilizing the monetary system. Of course, it must be followed by a stable financial system (Widjanarko, 2020). Indonesia's central Bank continues to strive to achieve monetary and fiscal economic growth to strengthen integration, competition, and economic performance within the country. Banks are considered the main pillar in achieving economic growth in Indonesia.

Globalization that is happening requires all industrial sectors to change, namely banking digitalization, especially the case of the COVID-19 pandemic changing all aspects of life, various policies carried out by the government to follow up on the Covid Pandemic. Indirectly, banking must have a lot of innovation related to banking digitization. With this digitalization change, banking will be able to increase productivity, be able to improve inclusive and efficient economic and financial recovery (Coryanata et al., 2023).

Bank productivity can be measured as the ratio of the output scale to the input used by the Bank. Thus, banks have varying productivity due to differences in the quality of the inputs used (Gupta et al., 2008). The purpose of this research is to investigate changes in bank productivity in Indonesia during the observation period, namely 2017-2022. Apart from input and output variables, other variables are used to look at factors that influence changes in Productivity, namely Total Assets, Profitability, liquidity, Net Interest Margin, and BOPO, and use a dummy variable, namely the pandemic crisis to see changes in Productivity from internal finance to changes in bank productivity.

The following performance data at Commercial Bank for 2017-2022 are presented in Table 1.

Table 1. Banking Performance for the 2017-2022 period

| Period | Assets (billion IDR) | DPK (billion IDR) | ROA% | NIM% | NIETA% |
|---|---|---|---|---|---|
| 2017 | 7,322,740 | 5,289,377 | 6.73 | 6.44 | 60.31 |
| 2018 | 7,997,067 | 5,630,448 | 7.32 | 7.01 | 63.89 |
| 2019 | 8,562,974 | 5,998,648 | 7.88 | 7.53 | 73.54 |
| 2020 | 9,177,894 | 6,665,390 | 8.44 | 8.13 | 84.99 |
| 2021 | 10,112,304 | 7,479,463 | 9.07 | 8.80 | 85.67 |
| 2022 | 10,180,763 | 7,515,538 | 9.66 | 9.33 | 32.47 |

Source: Banking Statistics (OJK, 2022)

The report in Table 1 shows an increase in banking in Indonesia during the 2017-2022 period, seen from the aspects of total assets, DPK, ROA, NIM, and NIETA. The development of banking in Indonesia does not necessarily explain the level of productivity because productivity does not only look at the productive side or just produce. Rather it is a combination of efficiency and effectiveness. The concepts of efficiency and productivity are often used interchangeably. Effectiveness is the expected output, while efficiency is using minimal resources to provide maximum results (Kumar, Malathy, and Ganesh, 2010). Based on the existing literature shows that Productivity can change for three reasons, namely changes in the level of

efficiency, technical changes, or differences in the rules in which the production process takes place. This indicates that efficiency is only one component of changes in banking productivity (Abhiman Das, 2009).

This research seeks to evaluate the factors that can change the level of productivity in the banking sector during the 2017-2022 period. The non-parametric method that is generally used to measure productivity is Data Envelopment Analysis DEA. Most of the research on effectiveness and productivity looks at the factors that affect the level of productivity. Therefore, based on our study, we apply the Malmquist index (Delis, Molyneux, and Pasiouras 2011) to calculate the growth rate of banking productivity in Indonesia in the 2017-2022 period.

Chen (2013) have discussed how competition among banks, banking supervision, and the global financial crisis have affected banking productivity. The empirical results show that banking competition increases bank productivity significantly. Tighter bank supervision has had a positive impact on bank productivity, and banking productivity has declined since the global financial crisis and has started to increase again after the crisis subsided. Similar research has been conducted by Alsharif et al. (2019) regarding the impact of changes in Islamic and conventional banking productivity after the announcement of Basel III. The study was carried out using DEA with the Malmquist approach to measuring the level of banking productivity. The results of the study show that Islamic banking is less productive than conventional banking after BASEL III. However, there have been improvements in efficiency in recent years that have offset declines in productivity, leading to stagnation in total productivity changes for both banks. So, as a step to determine the level of change in banking productivity in Indonesia, this research examines the factors that influence the rate of change in banking productivity in Indonesia and the effect of the pandemic on bank productivity.

## 2. Literature Review

### Banking Productivity

The first study on the productivity index of banks using the Malmquist Index with DEA was conducted by Desta (2018) in analyzing productive and unproductive banking productivity indexes in Africa. Nineteen commercial banks were selected from the top 30 African banks as identified by Global Finance Magazine. Nartey, Osei, and Sarpong-Kumankoma (2020) analyze banking productivity in Africa and investigate the impact of several internal and external determinants that affect bank productivity in Africa. In measuring the productivity level of 120 banks in 24 countries in Africa from 2007 to 2012, the Malmquist index was used. The results of the study show a decline in banking productivity in Africa, which is largely due to inadequate technology. State-owned banks show a higher level of productivity than foreign and private banks.

Some literature mostly discusses banking assessment with efficiency and productivity approaches. In economics, productivity is the ratio between the results of activities (output) and the sacrifice (input) to produce the product. Quantitatively, productivity analysis is often based on the results of comparisons between inputs and outputs.

**Total Assets**

Total assets themselves consist of productive assets and non-productive assets. Total Asset Turnover is the ratio used to measure the number of sales that will be generated from each Rupiah of funds embedded in total assets (Hery, 2018). The magnitude of the TATO value will show assets that rotate faster in generating sales to earn profits. This can be in the form of credit, investment in securities, or funds deposited in other banks so that the Bank will receive interest income.

Various methodologies have been used with different results and conclusions. Aini and Kristanti (2020) In their research, it was revealed that assets could become a company's value added to create a competitive advantage in competing to increase company profitability and productivity. As Kim and Taylor (2014) and their research revealed that the total assets owned by a company would impact increasing productivity. So H1: Assets have a significant positive effect on changes in banking productivity in Indonesia.

**Relationship of Total Deposit (LDR) to Productivity**

The ability of a bank to repay obligations to customers who have invested the funds they have with credit that has been given to its debtors is a benchmark to see if the Bank is able or not to return its obligations to customers, how much the Bank has liquid funds to pay to customers.

The liquidity ratio is used to analyze a bank's ability to fulfill its obligations. When the Deposit Insurance Corporation (LPS) has high liquidity, it shows that the Bank holds more money and lends less money to the public. This has lowered the probability of getting income from loans. These results support the research Asutay and Othman (2020) which states that the Islamic Commercial Bank in Indonesia has a safe level of liquidity based on FDR mapping. H2: Total Deposit has a significant positive effect on productivity.

**ROE Relationship to Productivity**

For shareholders, ROE has a high value because the higher the ROE number, the higher the rate of return on investment, the better the company will be, and the share price will increase. An increase in stock prices shows that the company's productivity indicators are also increasing.

Junaidi (2021), in his research, revealed that for shareholders, ROE has a high value because if the ROE number is higher, the rate of return on investment will also be higher, and the company will be better off and cause stock prices to increase. An increase in stock prices shows that the company's productivity indicators are also increasing. H3: ROE has a significant positive effect on productivity.

**NIM Relationship to Work Productivity**

For the smooth running of a bank in running its business, good performance and trust from the public are needed to invest some of their money in the Bank by providing interest as a form of return on the willingness and trust of the public to invest some of their money. Likewise, banks need interest as a reward when banks entrust the funds

that have been collected to be channeled back to people who need funds in the form of credit.

Banks will certainly provide lower interest on funds collected from the public than the interest charged to debtors who use bank credit services. This difference in interest is called Net Interest Income. If the difference between interest income and interest costs is large, then the profitability obtained will be even greater. High profitability is an indicator of higher productivity (Ishak et al., 2022). H4: Net Interest Margin has a significant positive effect on productivity.

**Relationship of Operating Expenses (BOPO) to Productivity**

One of the factors that affect profitability is Operating Expenses to Operating Income (BOPO). According to Antika and Novyarni (2020), any increase in the value of the BOPO variable will reduce the value of the ROA variable because any increase in banking operational costs is not matched by an increase in the company's operating income and results in reduced profit before tax.

The existence of payment of operational costs with the income generated, the profit earned will decrease. If the operation is greater, the Bank's operating income will decrease. Thus, it will have an impact on decreasing banking productivity. H5: Operating Expenses have a significant negative effect on productivity.

**The Relationship of Pandemic to Productivity**

The increase in positive confirmed cases of COVID-19 has caused a lot of losses to the economy in Indonesia. One indicator that could worsen the Indonesian economy is the weakening of the Rupiah against the USD and other foreign currencies. In addition, as the number of positively confirmed cases of COVID-19 increases, the weakening of the Rupiah against the USD and other foreign currencies is inevitable. The slowdown in the performance of the manufacturing industry and the slowdown in the global economy have resulted in reduced demand in the market. The decrease in demand also resulted in a decrease in the company's productivity. H6: The Pandemic has a significant negative effect on productivity.

## 3. Research Method

**Malmquist Productivity Index (MPI)**

MPI is a method with a non-parametric approach to measuring productivity. The use of MPI is widely applied in analyzing changes in productivity at the company level. Some of the advantages of this method include being able to measure changes (increases or decreases) in performance over several periods. In addition, this method can decompose changes in productivity into changes in technical efficiency and changes in technology (Cooper et al., 2018). The MPI formula is written as follows:

$$M_0(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_{0^{t+1}}(x^{t+1}, y^{t+1})}{D_{0^t}(x^t, y^t)} X \left[ \left( \frac{D^t{}_0(x^{t+1}, y^{t+1})}{D^{t+1}{}_0(x^{t+1}, y^{t+1})} \right) \left( \frac{D^t{}_0(x^t, y^t)}{D^{t+1}{}_0(x^t, y^t)} \right) \right]$$

Note
Mo : Malmquist Productivity Index (MPI)
Do : distance function
Xt : input from current period technology
Xt+1 : input from the next period technology a
Yt : current period technology output
Yt+1 : output of the next period technology

The use of MPI must have time series data of at least two years. This is indicated by the formulas t and t+1 and$x^{t+1}, y^{t+1}$. The formula for determining Variable Return to Scale (VRS) is assumed to be with an efficiency scale, as follows:

$$D_c(x, y) = D_v(x, y)xSE(x, y)$$

In general, the Malmquist TFP change Index formula for calculating Variable Return to Scale (VRS) is:

$$M_0(x^t, y^t, x^{t+1}, y^{t+1})$$

In this paper, the methodology used by Jreisat, Hassan, and Shankar (2018)uses the input-oriented DEA model to calculate the Malmquist index of changes in Productivity. To find the TFP variable in our study, we use two inputs, labor (x1) and total deposits (x2), to produce two outputs, total loans (y1) and other investments (y2). Labor is measured in full-time terms; total deposits are customer deposits. Total loans are the total credit facilities that appear on the Bank's balance sheet. Other investments consist of investments in bonds and securities, stocks, treasury bills, government bonds, and investments in affiliates and subsidiaries. The data used in this study covers the period 2017-2022 and is taken from banking audit reports registered with the OJK.

The analysis technique used is analysis with the Error Correction Model. The model can accommodate long-term and short-term information in one model. One requirement in ECM is that a group of variables has a cointegration, so the ECM model is considered valid.

**Data Stationarity Test and Integration Degree Test**

An assumption that is needed to produce a reliable estimate, the banking productivity parameter must be stationary. First, you have to do a stationary test at the same degree of test (level or different) to obtain stationary data, namely data whose variance is not too large and has a tendency to approach the average value. Furthermore, if the residue does not have a unit root, then the stationary Variable is not cointegrated(Damodar, 2015). The variables in the research lead to a balance. The equation to see the significance of banking productivity in the long term is as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} \ldots\ldots + \beta_{nt} X_{nt} + \upsilon_t$$

Note:
$Y_t$: Dependent Variable
$\beta_0$: Constant
$\beta_1$: coefficient of the independent variable
$X_1$: Independent Variable
$u_t$: error term
t: shows time series data

The short-term regression equation of the ECM model is:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_{1t} + \beta_2 \Delta X_{2t} + \beta_3 \Delta X_{3t} \ldots\ldots + \beta_{nt} \Delta X_{nt} + \beta_n \upsilon_{t-1} + \varepsilon_t$$

Information:

| | |
|---|---|
| $\Delta Yt$ | : Difference in variable values |
| Yt-1 $\Delta Xt$ | : Difference in the value of variable Xt-1 |
| $\beta_0$ | : ECM model constant |
| $\beta_{1\text{-}3}$ | : coefficient of the independent variable |
| $ut-1$ | : error term white noise |
| $\varepsilon t$ | : the residual value of the ECM model |

## 4. Results and Discussion

### *4.1. Results*

**Test Unit Roots and Degrees of Integration**

All variables are to be tested with the assumption of a critical value of 5%. Unit root test results at the level with ADF.

Table 2. ADF test results at level level

| Variable | ADF t-Statistics | MacKinnon Critical Value 5% | Prob. |
|---|---|---|---|
| Y | -7.442970 | -2.910860 | 0.0000* |
| TA | 0.712502 | -2.909206 | 0.9915 |
| ROE | -1.725007 | -2.907420 | 0.4140 |
| NIM | -1.589920 | -2.907420 | 0.4819 |
| LDR | -0.083068 | -2.908420 | 0.9463 |
| BOPO | -2.861688 | -2.907420 | 0.0556 |
| Dummy | -0.798333 | -2.907420 | 0.8127 |

*Stationary data

Based on Table 2 the ADF test, it is known that the variables Total assets, Return on Equity, Net Interesting Margin, Loan to Deposit Ratio, BOPO, and Dummy have ADF t-statistic values with a probability of over 5% except for bank productivity variables, this shows non-stationary data. The next step is to make a degree test, namely the first difference.

Table 3. ADF test results at the first difference level

| Variable | ADF t-Statistics | MacKinnon Critical Value 5% | Prob |
|---|---|---|---|
| Y | -7.442970 | -2.910860 | 0.0000* |
| TA | -8.976720 | -2.909206 | 0.0000* |
| ROE | -10.014306 | -2.908420 | 0.0000* |
| NIM | -8.995672 | -2.908420 | 0.0000* |
| LDR | -6.056386 | -2.908420 | 0.0000* |
| BOPO | -9.320250 | -2.908420 | 0.0000* |
| Dummy | -7.937254 | -2.908420 | 0.0000* |

*Stationary data

Based on the table above, the data shows that the overall value of the ADF t-statistic is greater than the Mac Kinnon Critical Value % percent. In other words, all variables are stationary at the first difference level.

**Cointegration Test**

The cointegration test will provide information on existing long-term relationships using time series data. To see whether or not there is a long-term relationship in each variable used in this study, the variables need to be tested and analyzed. Below are the results of the stationarity test on the residuals of the regression equation.

Table 4. Stationary test results on the residuals of regression equation

| | | t-Statistics | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistics | | -8.386278 | 0.0000 |
| Test critical values: | 1% levels | -3.536587 | |
| | 5% levels | -2.907660 | |
| | 10% levels | -2.591396 | |

Based on the test results, Resid1 is the residual from the conventional banking productivity regression equation. This shows that it has been stationary at levels with a probability level of 0.0000, which is less than 5%. The Engle-Granger cointegration test is used to estimate the long-term relationship in each banking productivity equation, total assets, ROE, NIM, LDR, BOPO, Dummy (pandemic period) in the long term, the results of the Engle-Granger cointegration test are:

Table 5. Engle-Granger cointegration test results ( Long Term Estimation )

| Variables | coefficient | t-Statistics | Prob. |
|---|---|---|---|
| C | -15.71858 | -0.658452 | 0.5128 |
| TA | 1.015296 | 0.831603 | 0.4090 |
| LDR | -4.062585 | -2.071393 | 0.0427*** |
| ROE | 9.002861 | 2.651644 | 0.0103*** |
| NIM | 5.298450 | 0.090740 | 0.9280 |
| BOPO | 1.251785 | 0.419668 | 0.6762 |
| DUMMY | 1.689081 | 0.048699 | 0.9613 |
| R-squared | | 0.267129 | |
| Prob(F-statistic) | | 0.004848 | |

Note: *** = Significant at 1% ** = Significant at 5% * = Significant at 10%

The coefficient of determination $R^2$ in the model used is 0.267129. In the long term, 26.71% of the variables that affect Productivity are explained by the variables Total Assets, LDR, ROE, NIM, BOPO, and pandemic crisis, while the remaining 73.29 are influenced by other variables, apart from the variables used in the model.

Table 6. ECM Estimation Results (Short-Term Estimation)

| Variables | coefficient | t-Statistics | Prob. |
|---|---|---|---|
| C | 0.009476 | 0.935570 | 0.3537 |
| D(TA) | -1.25E-07 | -1.141697 | 0.2587 |
| D(LDR) | -0.008093 | -0.909513 | 0.3672 |
| D(ROE) | 0.098651 | 1.696217 | 0.0957 |
| D(NIM) | 0.284268 | 2.537780 | 0.0141** |
| D(BOPO) | 0.008048 | 1.623210 | 0.1105 |
| D(DUMMY) | 0.014911 | 0.207105 | 0.8367 |
| ECT(-1) | -0.991553 | -7.250260 | 0.0000*** |
| R-squared | | 0.574708 | |
| Prob(F-statistic) | | 0.000000 | |

Note: *** = Significant at 1% ** = Significant at 5% * = Significant at 10%

The ECM equation in this study is:

$$\Delta Y = 0.009476 - 1.25\text{E} - 07(\text{TA}) - 0.008093(\text{LDR}) + 0.098651(\text{ROE}) + 0.284268(\text{NIM}) + 0.008048(\text{BOPO}) + 0.014911(\text{DUMMY})$$

The coefficient of determination R square in the model is 57.47%. In the short term, 57.47% of the productivity variable is explained by variables in the model, while the rest is explained by variables outside the model.

### *4.2. Discussion*

**The long-term**

The Bank's Total Assets do not have a significant effect on banking productivity, so the ups and downs of banking assets will not have a significant change in the total assets owned by banks. Gupta, Doshit, and Chinubhai (2008) revealed the same results, where bank size does not affect bank productivity, asset size has no significant effect. Thus, bank efficiency does not depend on bank size. Hence, a bank appears to have neither benefit nor advantage in economies of scale or the banking industry in India. Likewise, bank size has no significant effect on bank productivity on bank productivity. In contrast to the results of research by Narwal and Pathneja (2015), which stated that small bank assets are more productive than large banks, it is indicated that the market share for small banks is wider.

Loan to Deposit Ratio and Return on Equity have a long-term effect on Bank productivity with coefficients of -4,062,585 and 9,002,861, respectively. That is, the LDR regression coefficient is negative, indicating that an increase in units of LDR causes a decrease in bank productivity. LDR is an illustration of how much the Bank has used Third Party Funds to provide loans to its customers. The higher the LDR, it is indicated to reduce productivity. If more funds from third parties are channeled to borrowers, bad loans in various categories may increase. Therefore, if it is not channeled or screened to customers who will fail to pay, it will reduce productivity levels. Therefore, the Loan to Deposit Ratio must be considered by banks. Screening in channeling funds to customers so that the default rate is minimal. Research conducted by Kamarudin et al. (2017 ) proved that bank liquidity is one of the determinants of the potential productivity of Islamic banks operating in the three countries in the 2006-2014 observation year. However, it is different from the results of research conducted by Jreisat et al. (2018), where the ratio of high loans to deposits is higher so that the return on equity will be high and will affect higher productivity growth. Other findings were made by Otaviya and Rani (2020).

In addition, Return on Equity has a significant positive effect on productivity in the long-term relationship, meaning that the higher the company's ability to generate profits, it will affect the increase in banking productivity. Therefore, banks must maintain ROE at a positive level because it will have a long-term impact on bank productivity. Hasan and Marton (2003), Sufian & Habibullah (2012), and Anggraeni & Rahmayanti (2023) that high profitability will also correlate with high efficiency. In other studies, Chiou (2009), and Sufian and Haron (2008) state that the higher the Bank's profitability, the greater the efficiency and productivity growth. Other research

conducted by However, this is not in line with research conducted by Octrina & Pratidina (2021), where in their research, it was stated that bank profitability has a significant negative effect on bank productivity.

In a long-term relationship, Narwal and Pathneja ( 2015) revealed that the determinants of bank profitability could be measured by Net Interest Margin, where the results diversification and NIM are important contributors to bank profitability because both are found to be significantly related to profitability. If the difference between interest income and interest costs is large, the profitability will be even greater. High profitability is an indicator of higher productivity (Ishak et al., 2022). However, the results of this study, the NIM variable has no significant effect on Productivity. This result is not in line with the assumptions made and previous studies where the Net Interest Margin affects productivity. This indicates that the difference in interest earned by the Bank, whether the size of the income earned, does not affect the Productivity of banks in Indonesia.

Operating Expenses to Operating Income (BOPO), more increasing costs to the Bank, the Bank's operating income will decrease, thereby having an impact on decreasing productivity (Sitompul & Nasution, 2019). In this study, BOPO has no significant effect on productivity in long-term relationships. If you look at the banking BOPO data in the research we conduct every year, there are no significant changes and are at a healthy and good ratio level that does not exceed the BOPO standard set by Bank Indonesia (BI), namely 90%, so that banks are considered efficient in carrying out its operations. Because if the BOPO ratio is too high, it will give a negative signal to the company. In this insignificant result, it is indicated that the Bank has supervised this ratio so that it always makes adjustments to the costs incurred by the Bank. Therefore, it does not have a significant impact on operational costs in our observations of bank productivity.

The dummy variable in this study, namely the case of the COVID-19 Pandemic, hit all sectors, so researchers wanted to see whether the pandemic period had a significant effect on banking productivity. Abbas et al. (2015) show that the level of productivity of Islamic and conventional banks in Pakistan has decreased due to the crisis it faced after 2007, but the Pakistani banking sector was able to minimize this damage. The findings in this study, although the COVID-19 pandemic cases brought down many sectors of the economy, the results of this study did not have a significant influence on bank productivity, so banks continued to carry out their operational activities during the Pandemic, even though by following policies that have been set by the government, namely social restrictions, work from home and other policies to reduce pandemic cases but banks are still able to survive in terms of Productivity and remain stable amidst pandemic cases that have hit all aspects of the economy.

**The short-term**

Kim and Taylor's (2014) in their research revealed that the total assets owned by a company would have an impact on increasing productivity. However, based on the results of research that we have conducted in the short-term ECM test show that bank

assets do not have a significant effect on bank productivity. Big or small company size does not affect productivity. Thus, total assets do not affect productivity either in the long-term relationship or in the short-term relationship.

LDR variable is a liquidity ratio used to analyze a bank's ability to fulfill its obligations. The results of this test show that LDR does not have a significant effect on banking productivity in the short term. However, in a long-term relationship, the Liquidity Ratio has a significant influence on productivity. Therefore, banks still have to pay attention to and analyze liquidity risk as an indicator of a bank's ability to pay its obligations because of the large influence that the LDR can have on changes in productivity in the long term.

Bank profitability ratios are used to see changes in profits earned by banks and whether they have a significant effect on productivity. In this study, it was found that the profitability ratios have no effect on changes in productivity in the short-term relationship, but in the long-term relationship, the profitability ratios have a significant effect on productivity. With the difference in results on long-term and short-term relationships in this study, banks still have to maintain their profitability ratios at positive numbers because any increase in profits with ROE ratios will increase bank productivity so that Productivity is at a positive level as well.

In the short term, banking productivity is only influenced by the Net Interest Margin variable with a positive coefficient, but at an alpha level of 10%. This shows that the ability of bank management is high in managing its productive assets, which will have an impact on the resulting net interest income. If the difference between interest income and interest costs obtained is large, it will influence the profitability of the banking industry that will be obtained will be even greater. High profitability is an indicator that will increase productivity (Ishak et al., 2022). Therefore, in this study, NIM had a significant positive effect. The higher the income received by the Bank, the higher banking productivity. Meanwhile, short-term Operational Expenses to Operating Income (BOPO) show that the results are insignificant for productivity. BOPO fluctuations do not significantly affect productivity in the short term or long term.

In the short term, the dummy variable in this study is the period of the COVID-19 Pandemic, which hit all corners of the world, including Indonesia. The Dummy variable here is indicated to affect banking conditions, including changes in productivity. It is hoped that with this case, all companies, including banks, will prepare themselves for the threats that will be faced in the future. However, the results of this study show that the existence of the COVID-19 Pandemic has not made any changes to banking productivity. In this case, banks can still maintain their productivity amid a pandemic that has hit the world. The COVID-19 pandemic case itself has contributed to the rapid movement of the Central Bank to take swift steps in terms of extraordinary policies to respond to the dynamics of the economy and the financial system. Some of the things the central Bank has done include lowering interest rates and strengthening the macroprudential policy framework. Accommodative policies and a monetary-fiscal

policy mix support the sustainability of state financial management experiencing a widening fiscal deficit (Isyunanda, 2020).

In short-term estimation, the variables do not have a significant effect on banking productivity. However, Banks need to pay attention to internal and external variables to continue to increase bank productivity. Including pandemic cases that have occurred throughout the world, you still have to be vigilant about events that will affect the financial aspects of banks, even though in this study, there was no significant effect on short-term relationships. This is the result of the government's quick response in monetary policy and innovation for each Bank in maximizing its operational activities by innovating in banking digitization, making it easier for consumers to make transactions.

## 5. Conclusion

This study uses a non-parametric method to measure Indonesian banking productivity, namely DEA, during the 2017-2022 period, taking into account the COVID-19 pandemic period. The results reveal that during the sample period, the banking sector in Indonesia as a whole shows that bank liquidity has a significant negative effect on bank productivity in the long term. Meanwhile, ROE has a significant positive effect in the long run on the Productivity of the banking sector in Indonesia. So, the higher the ROE value, the Productivity of the banking sector will also increase due to an increased rate of return on investment followed by an increase in stock prices which is one indicator of increasing banking productivity. Likewise, the Liquidity ratio, the higher the liquid Bank, meaning that there are still a lot of funds stored in the Bank and not channeled, so bank productivity decreases.

Bank Indonesia has quickly taken actions or innovations carried out by the banking sector in Indonesia, so that with bank digitalization and improvements due to government policies. Banks in Indonesia continue to carry out productivity, but in the results of this study, the Productivity carried out by banks cannot be maximized in carrying out their operational activities.

Various supports from the Ministry of Finance, the Central Bank of Indonesia, OJK, and the Deposit Insurance Corporation continue to encourage economic recovery through several policies, including low interest rates, stabilization of the rupiah exchange rate, and setting a low guarantee interest rate ( https://lps.go .id/, 2022). The national economic recovery policy program can provide confidence to the banking sector to boost business performance through flexibility in lending and continuing to evaluate the internal ratios of the banking itself.

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