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Research Article

Technical Education Efficiency Analysis with Data Envelopments Analysis approach and its effect using TO BIT Regression

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Abstract

The background of this research is to find technical education efficiency analysis (CRS, VRS, and SE) for eleven conventional commercial banks in Indonesia with data between 2010-2019 and the effect of this efficiency on several bank ratio variables (LNTA, ROA, CAR, LDR, NPF) and macro variables (inflation, real GDP, unemployment, us exchange). The method used for technical education efficiency analysis uses a Data Envelopments Analysis (DEA) approach and the effect of efficiency uses TOBIT Regression, using the statistical computer programming language R, with the dear library for DEA and the VGAM library for TOBIT regression. To obtain fairer efficiency results, conventional commercial bank data is classified into 3 types according to the core capital owned by the bank called BUKU (commercial bank based on business activity). The results of the study conclude that the technical education efficiency analysis of conventional commercial banking in Indonesia between 2010-2019 shows that it is not worth 1 (100% efficient), but close to a value of <1 of 0.97 (CRS 97% efficient), 0.984 (VRS 98.4% efficient), and 0.985 (Efficiency Scale 98.5%). To conclude, efficiency is categorized based on 3 types of core banking capital, for BUKU 3 types of 0.983 (CRS), 0.996 (VRS), and 0.987 (SE), for BUKU 2 types of 0.977 (CRS), 0986 (VRS), and 0.99 (SE), for the type of BUKU 1 of 0.963 (CRS), 0.98 (VRS), and 0.98 (SE). The results of the slack analysis show that the inefficiency of the DMU of excess labor wages is 3.45%, the management of the DMU of deposits is not efficient at 0.82%, and the use of the DMU of assets is inefficient at 0.47%. So that the impact on the DMU financing that should be channeled increases by 0.12% and the DMU income that should be able to get an increase of 1.39%, if efficiency can be obtained 100%. The TOBIT regression results show that only CAR (p-value 0.0052) with a coefficient value of -0.0020915960 and LDR (p-value 0.00155) with a coefficient value of 0.0014212500 which significantly affects the technical education efficiency analysis (CRS used as a dependent) of conventional commercial banks in Indonesia, with R square value is 51.76%.

Keywords

Conventional Commercial Banks, DEA, R Programming, dear library, TOBIT Regression, VGAM library

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Introduction

After the world financial crisis in 2008, many banks were more serious in evaluating their performance, effectiveness, efficiency, and bank supervision (Çelen, 2014), the impact of the 2008 global financial crisis really hit the banking world (Tabash & Dhankar, 2014), several indicators of the cause of the decline were evaluated by various methods (Kumar & Sayani, 2015) (Gunarsih, ., Sayekti, & Novak, 2019), such as banking corporate governance has been effective and efficient(Enny, Wan Razazila, & Ruhaya, 2018), several approaches to evaluate the technical education efficiency analysis of banking including using DEA (data envelopments analysis) (Sufian & Shah Habibullah, 2010), banking efficiency research has been carried out by(Anwar, 2014)with data between 2002-2010 showing the failure of banking efficiency in Indonesia.

Literature review

The study examines and compares the efficiency of conventional banks and Islamic banks in Indonesia for the period 2011-2015. (Mulyany et al., 2019).Bank efficiency is an important thing in assessing the health of a bank. Data Envelopment Analysis is a bank efficiency assessment model(Mulyadi, 2015).

Efficiency as one of the benchmarks for the assessment of the intermediation function and banking performance is the ratio of the ratio between the output and input values used in its operational activities. The difference in the level of achievement of the input and output variables at each bank will provide different efficiency values. Likewise, banking in Indonesia which is divided into several groups according to Law RI N0.10 of 1998 also has various levels of achievement of input and output variables so that the level of efficiency achieved by each bank is also different.(MUHARAM, 2007).

Islamic banks can maintain their efficiency while improving their performance. Using the output-oriented DEA VRS model (Pradiknas & Faturohman, 2015).

When a bank is inefficient in using costs, there will be inputs that are used incorrectly, preventing the bank from realizing its role, function and purpose. Therefore, a bank efficiency analysis is needed(Agustina, Sholihin, & Fithria, 2019). Determinants of efficiency on panel data from 116 banks, including 109 conventional banks and 7 Islamic banksvery important characteristics of a bank to improve bank efficiency.(Anwar, 2016).

Efficiency of banks in theory and practice in Poland. An empirical efficiency analysis was carried out for Polish banks during the period 1997-2007. The ratio analysis between commercial banks and cooperatives uses several financial ratios. Statistical analysis using parametric methods (multiple regression models). The results of the comparative analysis at the EU level show that Poland belongs to countries with relatively high levels of ROA and bank ROE. In Poland, the performance of commercial banks as measured by these indicators is currently better than cooperative banks. Overall, the findings of multiple regression analysis provide evidence that in the years covered by the study, the efficiency of Polish banks, return on assets as well as return on equity, were shaped by internal bank performance factors and the macroeconomic environment. (Siudek, 2008).

The results of the Data Envelopment Analysis (DEA), a non-parametric technique, show a general trend of decreasing technical education efficiency analysis (Gordo, 2013).The level of technical education efficiency analysis and relate it to the specific characteristics of the company and industry (Badunenko, Fritsch, & Stephan, 2006).Mexican banks experienced average inefficiencies, the main determinants are loan intensity, GDP growth (Garza-Garcia, 2012).

Efficiency of sample banks from 11 Central and Eastern European Countries (CEEC) during the period 2005-2008 (Pančurová & Lyócsa, 2013).Bank efficiency has become an important issue in the recovery process of Indonesian banking (Kurnia, 2004).

The technical education efficiency analysis (technical efficiency) of commercial banks in Indonesia took data for the years 2004-2009 using the intermediation approach. Research results indicate that commercial banks in Indonesia have experienced improvements in technical efficiency, an average of 10.5%. Furthermore, the study results also confirm that the national banking system experiences a scale inefficiency that is greater than that of pure technical efficiency. In terms of ownership, state banks showed perfect efficiency during the study period compared to private banks. The latest results obtained from the Tobit regression indicate that the scale of assets and liquidity risk can help increase bank efficiency, while the opposite condition

occurs profitability (Vanina Soetanto & Ricky, 2012).
The performance of banking in Indonesia is still not optimal due to the wasteful use of fees on several input variables used by banks in their economic activities. (Rubeda, Pujiati, & Prasetyo, 2014).Efficiency in the banking industry in Indonesia during the period 2012-2014 using the Data Envelopment Analysis (DEA) method and to determine determinants using the Tobit regression model (Sari & Saraswati, 2017).
In this study the statistical tool used is the R Programming with deaR libraryto do DEA analysis and VGAM library to do TOBIT Regression analysis, the version used in this statistical analysis is R Programming version 3.6.

Research Methodology

The method used in this study uses DEA (data envelopments analysis) to measure efficiency, which has indeed been widely used in many banking studies in the world (Khan, Amin, Khokhar, Ul Hassan, & Ahmad, 2018) (Mulyany, Indriani, Fahlevi, & Maidari, 2019) (Shawtari, Abdelnabi Salem, & Bakhit, 2018) (Bank et al., 2019), Some of these studies also compare between different banking systems (Pradiknas & Faturohman, 2015).
The use of DEA (data envelopment analysis) to analyze the efficiency of banking techniques, using several input and output factors (Pančurová & Lyócsa, 2013), to generate efficiency values based on CRS, VRS, and SE (efficiency scale), for DMU which is used for input of labor, savings, and assets. And for DMU used for output: financing and income dan (Mongid & Tahir, 2010) (Anwar, 2016).
To obtain fairer efficiency results, conventional commercial bank data is classified into 3 types according to the core capital owned by the bank called BUKU (commercial bank based on business activities). (OJK, 2016) (Buku, Umum, Usaha, Bank, & Classsification, 2018) (Sari & Saraswati, 2017)
After obtaining the value of banking efficiency, both CRS, VRS, and SE (efficiency scale), a research was conducted on the effect on several bank ratio variables (LNTA, ROA, CAR, LDR, NPF) and macro variables (inflation, real GDP, unemployment, us exchange) (Anwar, 2014) (Anwar, 2016), analytical approach using TOBIT Regression (Sari & Saraswati, 2017) (Sufian & Shah Habibullah, 2010) (Vanina Soetanto & Ricky, 2012) (Muttaqin, Rini, & Alif, 2020).
The statistical device used for this research uses the statistical computer programming language R . (Casella, Fienberg, & Olkin, 2007), with the dear library (Banker, Charnes, & Cooper, 1984) (Ost & Pronk, 2001) (Coll-serrano, Ben, & Jos, n.d.) for DEA (data envelopments analysis) and VGAM library (Analysis, 2013) for TOBIT regression.
In this study, a comparison of Conventional Commercial Banks in Indonesia will be carried out. The increasingly tight competition between banks and the presence of foreign banks in Indonesia, has made national banking in economic theory more efficient and effective in its banking operations.
This research in the early stages will use operational data on 11Conventional Commercial Banks, so that the comparative process of efficiency and economic performance, especially efficiency and operational performance between Conventional commercial banks is fairer, it will use the "BUKU" classification (Commercial Banks for Business Activities) issued by the Financial Services Authority (OJK) of the Republic of Indonesia, so that Conventional commercial banks that will be compared have the same classification closeness.
The research instrument,Analysis of the Technical education efficiency analysis and TOBIT Regression of the eleven Conventional Commercial Banks in Indonesia between 2010 and 2019, as follows:
The method used is DEA (data envelopment analysis) with RTS using a combination of CRS and VRS, with input-output orientation, DEA processing using R Programming with deaR library. The last results of this research are about TOBIT regression, using R Programming with VGAM library.

This study uses data, eleven conventional commercial banks, taken from the banking year report from 2010 to 2019, the total of all decision making units (DMU) is 110 DMU, the data variables used are:

Variables used in reports:
- the bank's annual report
- total capital
- Commercial Bank Business Activities (abbreviation BUKU)

Variables used for the DEA process:
The first input - Deposits, consists of:
- Giro
- Savings
- Time deposits

Second input, consisting of:
- total assets

Third input - Labor load or personnel costs or wages, consisting of:
- labor load

The first output, Financing, consists of:
- Kredit

Second output - Income consists of:
- Interest income
- Income Other Than Interest

Results

Testing Data Envelopments Analysis (DEA) - Conventional Commercial Banks, as follows:

Start Efficiency Analysis - Read Data 3 Inputs and 2 Outputs - Conventional Commercial Banks:

```
>library(deaR)
# View (File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE)
# Analysis EFFICIENCY LEVEL with File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE
# dmus = 2 yaitu Year laporan bank yang bersangkutan
>Dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE <- read_data
(File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE, dmus = 2, inputs = 7:9, outputs = 10:11)
#
# Menjalankan the input-oriented CCR (CRS) & BCR (VRS) DEA model
```

An example of an efficiency analysis of PT Bank Woori Saudara Indonesia 1906, Tbk, is as follows:

```
# BARIS 1 SD 10 - PT BANK WOORI SAUDARA INDONESIA 1906, Tbk
Result_CRS_PT_Bank_Woori_Saudara <- model_basic (Data_File_Kompilasi_Conventional
Bank_2010_2019_FIX_OKE, dmu_eval = 1:10, dmu_ref = 1:10, orientation = "io", rts = "crs")
Result_VRS_PT_Bank_Woori_Saudara <- model_basic (Data_File_Kompilasi_Conventional
Bank_2010_2019_FIX_OKE, dmu_eval = 1:10, dmu_ref = 1:10, orientation = "io", rts = "vrs")
summary (Result_CRS_PT_Bank_Woori_Saudara, exportExcel = TRUE, filename =
"Result_14_PT_Bank_Woori_Saudara_CRS.xlsx")
```

Table 1.
An example output of an efficiency analysis of PT Bank Woori Saudara Indonesia 1906

DMU	Eff
2019	1
2018	1
2017	0,90697
2016	0,94319
2015	0,90888
2014	1
2013	0,96193
2012	0,89814
2011	0,91483
2010	1

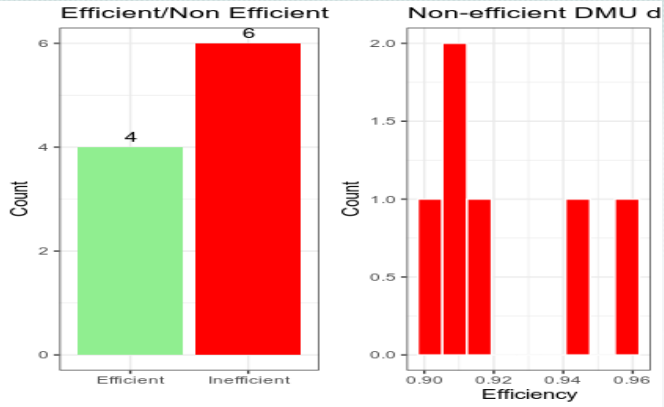


Figure 1. Sample of Chart an efficiency analysis of PT Bank Woori Saudara Indonesia 1906

Discussion on Data Envelopments Analysis (DEA) - Conventional Commercial Banks, Efficiency - Conventional Commercial Banks 2010 – 2019, as follows

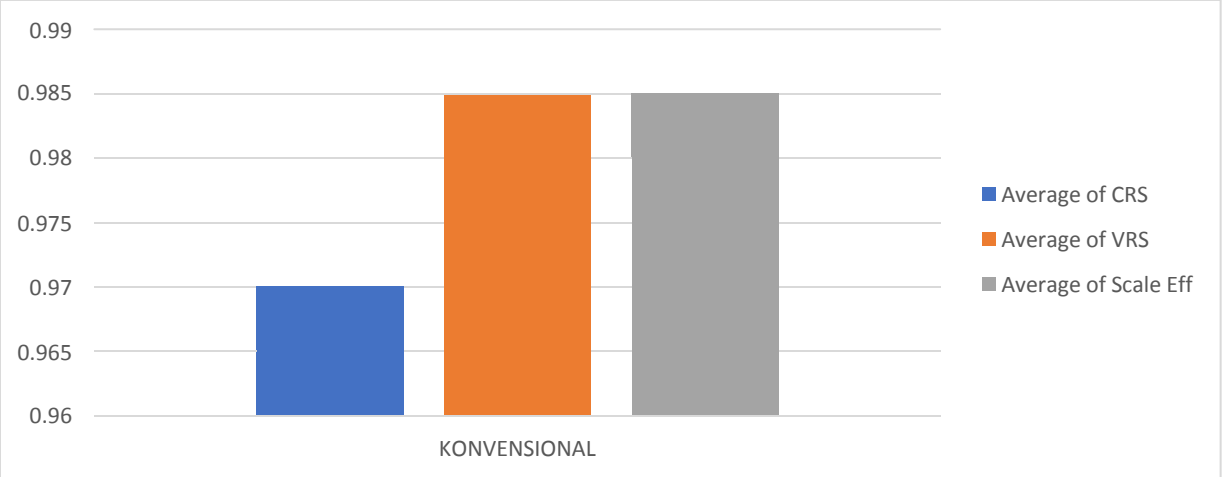


Figure 2. Total Efficiency of Conventional Commercial Banking in Indonesia Between 2010-1019

Table 2.
Total Efficiency of Conventional Commercial Banking in Indonesia Between 2010-1019

Bank Type	Average of CRS	Average of VRS	Average of Scale Eff
Conventional Bank	0,970197364	0,984557091	0,985183813
Grand Total	0,970197364	0,984557091	0,985183813

Efficiency per Buku Type – Conventional Commercial Banks 2010 – 2019, as follows:

Figure 3.
Efficiency per Buku Type

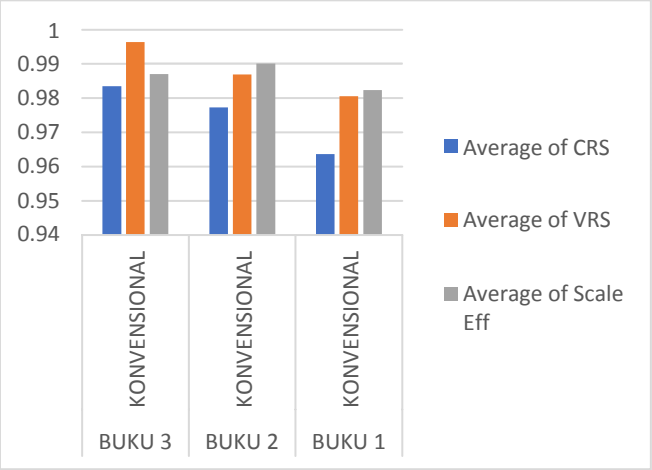


Table 3.
Efficiency per Buku Type

Capital Type	Bank Type	Average of CRS	Average of VRS	Average of Scale Eff
BUKU 3		0,983466	0,996422667	0,987023464
	Conventional Bank	0,983466	0,996422667	0,987023464
BUKU 2		0,97729871	0,986955806	0,990121925
	Conventional Bank	0,97729871	0,986955806	0,990121925
BUKU 1		0,963647813	0,980614219	0,982360746
	Conventional Bank	0,963647813	0,980614219	0,982360746
Grand Total		0,970197364	0,984557091	0,985183813

Efficiency per Buku Type and Year – Conventional Commercial Banks 2010 – 2019, as follows:

Figure 4.
Efficiency per Buku Type and Year

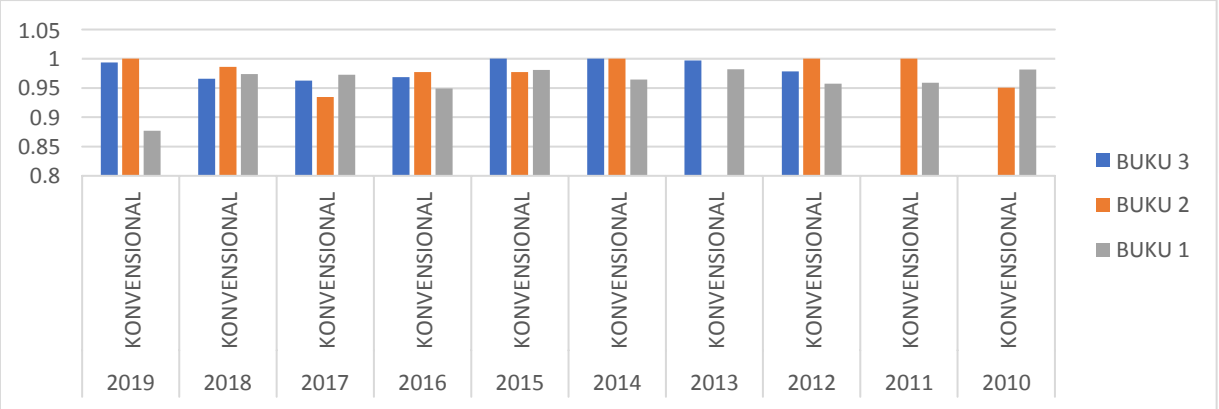


Table 4.
Efficiency per Buku Type and Year

Average of CRS		Capital Type			
Year	Bank Type	BUKU 3	BUKU 2	BUKU 1	Grand Total
2019		0,993305	1	0,87716	0,954113636
2018		0,96595	0,985716	0,9737325	0,977764545
2017	Conventional Bank	0,962535	0,93428	0,972565	0,953339091
2016		0,96831	0,97722	0,949515	0,965525455
2015		1	0,97722	0,980936	0,983050909

2014	1	1	0,964488571	0,977401818
2013	0,99687		0,982182222	0,984852727
2012	0,97805	1	0,95775	0,963436364
2011		1	0,959003333	0,966457273
2010		0,95065	0,981672222	0,976031818
Grand Total	**0,983466**	**0,97729871**	**0,963647813**	**0,970197364**

Efficiency per Buku Type and Bank Name – Conventional Commercial Banks 2010 – 2019, as follows:

Figure 5.
Efficiency per Buku Type and Bank Name

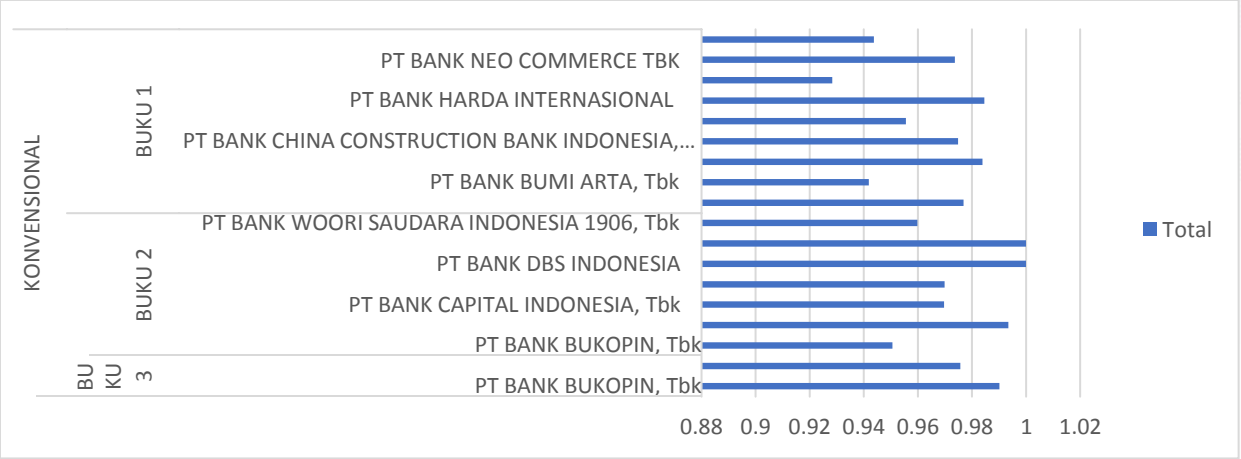


Table 5.
Efficiency per Buku Type and Bank Name

Bank Type	Capital Type	nmbank	Average of CRS
Conventional	Bank		0,970197364
	BUKU 3		0,983466
		PT BANK BUKOPIN, Tbk	0,9902075
		PT BANK DBS INDONESIA	0,975761429
	BUKU 2		0,97729871
		PT BANK BUKOPIN, Tbk	0,95065
		PT BANK BUMI ARTA, Tbk	0,993528
		PT BANK CAPITAL INDONESIA, Tbk	0,969758
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,969915
		PT BANK DBS INDONESIA	1
		PT BANK GANESHA	1
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,95984
	BUKU 1		0,963647813
		PT BANK BISNIS INTERNASIONAL	0,976908
		PT BANK BUMI ARTA, Tbk	0,94193
		PT BANK CAPITAL INDONESIA, Tbk	0,983948
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,9749625
		PT BANK GANESHA	0,955566667
		PT BANK HARDA INTERNASIONAL	0,984571
		PT BANK JAGO INDONESIA, Tbk	0,928338
		PT BANK NEO COMMERCE TBK	0,973775
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,943725
Grand Total			0,970197364

Annual Efficiency and Buku Type 3 – Conventional Commercial Banks, as follows:

Table 6.
Annual Efficiency and Buku Type 3

Year	Bank Type	Capital Type	nmbank	Average of CRS
2019				0,993305
		BUKU 3		0,993305
			PT BANK BUKOPIN, Tbk	0,98661
			PT BANK DBS INDONESIA	1
2018				0,96595
		BUKU 3		0,96595
			PT BANK BUKOPIN, Tbk	0,9981
			PT BANK DBS INDONESIA	0,9338
2017				0,962535
		BUKU 3		0,962535
			PT BANK BUKOPIN, Tbk	0,96516
			PT BANK DBS INDONESIA	0,95991
2016				0,96831
		BUKU 3		0,96831
			PT BANK BUKOPIN, Tbk	1
	Conventional Bank		PT BANK DBS INDONESIA	0,93662
2015				1
		BUKU 3		1
			PT BANK BUKOPIN, Tbk	1
			PT BANK DBS INDONESIA	1
2014				1
		BUKU 3		1
			PT BANK BUKOPIN, Tbk	1
			PT BANK DBS INDONESIA	1
2013				0,99687
		BUKU 3		0,99687
			PT BANK BUKOPIN, Tbk	0,99374
			PT BANK DBS INDONESIA	1
2012				0,97805
		BUKU 3		0,97805
			PT BANK BUKOPIN, Tbk	0,97805
Grand Total				0,983466

Annual Efficiency and Buku Type 2 – Conventional Commercial Banks, as follows:

Table 7.
Annual Efficiency and Buku Type 2

Year	Bank Type	Capital Type	nmbank	Average of CRS
2019				1
		BUKU 2		1
			PT BANK BUMI ARTA, Tbk	1
			PT BANK CAPITAL INDONESIA, Tbk	1
			PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	1
			PT BANK GANESHA	1
			PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	1
2018				0,985716
		BUKU 2		0,985716
			PT BANK BUMI ARTA, Tbk	0,98748
			PT BANK CAPITAL INDONESIA, Tbk	0,95053
			PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,99057
			PT BANK GANESHA	1
			PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	1
2017				0,93428
		BUKU 2		0,93428
	Conventional Bank		PT BANK BUMI ARTA, Tbk	0,98516
			PT BANK CAPITAL INDONESIA, Tbk	0,89826
			PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,88101
			PT BANK GANESHA	1
			PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,90697
2016				0,97722
		BUKU 2		0,97722
			PT BANK BUMI ARTA, Tbk	0,995
			PT BANK CAPITAL INDONESIA, Tbk	1
			PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,94791
			PT BANK GANESHA	1
			PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,94319
2015				0,97722
		BUKU 2		0,97722
			PT BANK BUMI ARTA, Tbk	1
			PT BANK CAPITAL INDONESIA, Tbk	1
			PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	1
			PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,90888

2014			1
	BUKU 2		1
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	1
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	1
2012			1
	BUKU 2		1
		PT BANK DBS INDONESIA	1
2011			1
	BUKU 2		1
		PT BANK BUKOPIN, Tbk	1
		PT BANK DBS INDONESIA	1
2010			0,95065
	BUKU 2		0,95065
		PT BANK BUKOPIN, Tbk	0,9013
		PT BANK DBS INDONESIA	1
Grand Total			0,97729871

Annual Efficiency and Buku Type 1 – Conventional Commercial Banks, as follows:

Table 8.
Annual Efficiency and Buku Type 1

Year	Bank Type	Capital Type	nmbank	Average of CRS
2019				0,87716
		BUKU 1		0,87716
			PT BANK BISNIS INTERNASIONAL	1
			PT BANK HARDA INTERNASIONAL	0,96663
			PT BANK JAGO INDONESIA, Tbk	0,54201
			PT BANK NEO COMMERCE TBK	1
2018				0,9737325
		BUKU 1		0,9737325
			PT BANK BISNIS INTERNASIONAL	1
			PT BANK HARDA INTERNASIONAL	0,97597
			PT BANK JAGO INDONESIA, Tbk	0,91896
			PT BANK NEO COMMERCE TBK	1
2017				0,972565
		BUKU 1		0,972565
			PT BANK BISNIS INTERNASIONAL	1
			PT BANK HARDA INTERNASIONAL	1
	Conventional		PT BANK JAGO INDONESIA, Tbk	0,90769
	Bank		PT BANK NEO COMMERCE TBK	0,98257
2016				0,949515
		BUKU 1		0,949515
			PT BANK BISNIS INTERNASIONAL	0,90476
			PT BANK HARDA INTERNASIONAL	0,94032
			PT BANK JAGO INDONESIA, Tbk	0,95298
			PT BANK NEO COMMERCE TBK	1
2015				0,980936
		BUKU 1		0,980936
			PT BANK BISNIS INTERNASIONAL	0,90468
			PT BANK GANESHA	1
			PT BANK HARDA INTERNASIONAL	1
			PT BANK JAGO INDONESIA, Tbk	1
			PT BANK NEO COMMERCE TBK	1
2014				0,964488571
		BUKU 1		0,964488571
			PT BANK BISNIS INTERNASIONAL	1

		PT BANK BUMI ARTA, Tbk	1
		PT BANK CAPITAL INDONESIA, Tbk	0,99269
		PT BANK GANESHA	0,89278
		PT BANK HARDA INTERNASIONAL	1
		PT BANK JAGO INDONESIA, Tbk	1
		PT BANK NEO COMMERCE TBK	0,86595
2013			0,982182222
	BUKU 1		0,982182222
		PT BANK BISNIS INTERNASIONAL	1
		PT BANK BUMI ARTA, Tbk	1
		PT BANK CAPITAL INDONESIA, Tbk	1
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,95818
		PT BANK GANESHA	0,99107
		PT BANK HARDA INTERNASIONAL	0,98929
		PT BANK JAGO INDONESIA, Tbk	1
		PT BANK NEO COMMERCE TBK	0,93917
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,96193
2012			0,95775
	BUKU 1		0,95775
		PT BANK BISNIS INTERNASIONAL	0,98968
		PT BANK BUMI ARTA, Tbk	0,92823
		PT BANK CAPITAL INDONESIA, Tbk	0,95805
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	1
		PT BANK GANESHA	0,93871
		PT BANK HARDA INTERNASIONAL	0,9735
		PT BANK JAGO INDONESIA, Tbk	0,97012
		PT BANK NEO COMMERCE TBK	0,96332
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,89814
2011			0,959003333
	BUKU 1		0,959003333
		PT BANK BISNIS INTERNASIONAL	0,96996
		PT BANK BUMI ARTA, Tbk	0,88804
		PT BANK CAPITAL INDONESIA, Tbk	0,969
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	1
		PT BANK GANESHA	0,91084
		PT BANK HARDA INTERNASIONAL	1
		PT BANK JAGO INDONESIA, Tbk	0,99162
		PT BANK NEO COMMERCE TBK	0,98674

2010	BUKU 1	PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	0,91483
			0,981672222
			0,981672222
		PT BANK BISNIS INTERNASIONAL	1
		PT BANK BUMI ARTA, Tbk	0,89338
		PT BANK CAPITAL INDONESIA, Tbk	1
		PT BANK CHINA CONSTRUCTION BANK INDONESIA, Tbk	0,94167
		PT BANK GANESHA	1
		PT BANK HARDA INTERNASIONAL	1
		PT BANK JAGO INDONESIA, Tbk	1
		PT BANK NEO COMMERCE TBK	1
		PT BANK WOORI SAUDARA INDONESIA 1906, Tbk	1
Grand Total			0,963647813

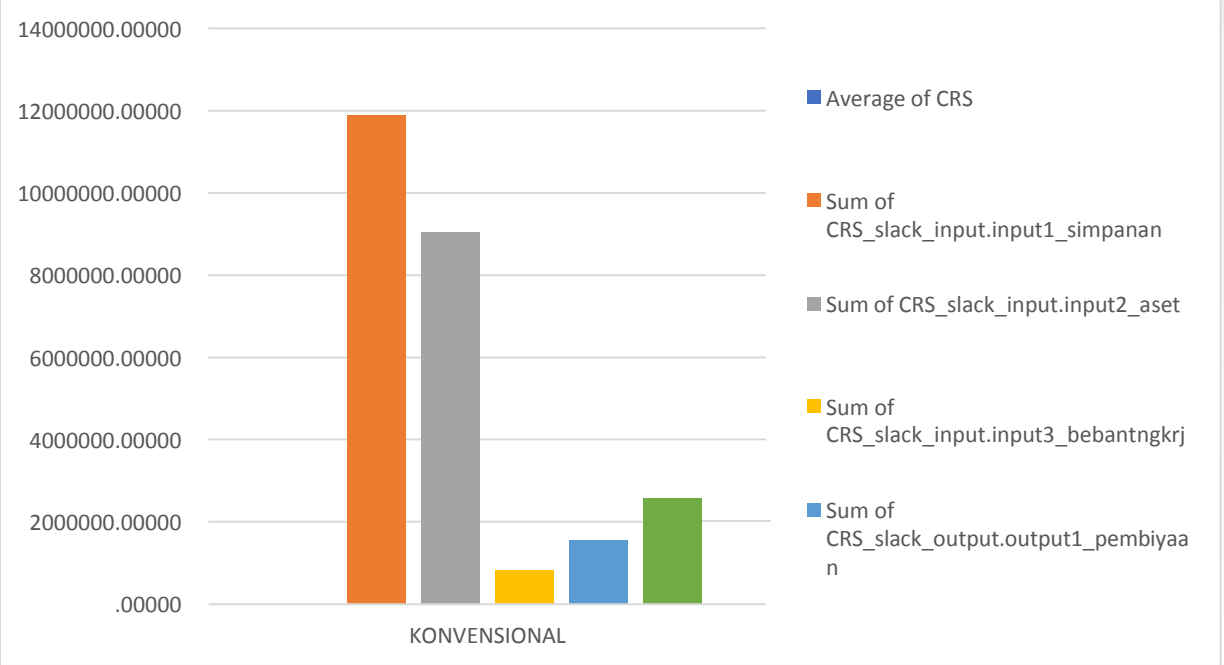
Table 9.
Slack Efficiency Analysis with CRS variable

Bank Type	Average of CRS	Sum of CRS_slack_input. input1_SAVING	Sum of CRS_slack_input. input2_ASSET	Sum of CRS_slack_input. input3_LABOR_WAGES	Sum of CRS_slack_output. output1_FINANCING	Sum of CRS_slack_output. output2_INCOME
Conventional Bank	0,9702	11.885.886,4243	9.036.709,7233	814.363,6882	1.543.830,3421	2.564.346,8203
Grand Total	0,9702	11.885.886,4243	9.036.709,7233	814.363,6882	1.543.830,3421	2.564.346,8203

Table 10.
Real Value versus Slack Efficiency Analysis with CRS variable

In Million (IDR)	Sum of input1_SAVING	Sum of input2_ASSET	Sum of input3_LABOR_WAGES	Sum of output1_FINANCING	Sum of output2_INCOME
Real Value	1.444.342.822,91	1.924.789.958,00	23.598.134,13	1.268.926.904,00	184.153.297,00
Slack Value	11.885.886,42	9.036.709,72	814.363,69	1.543.830,34	2.564.346,82
Persen Slack/Real	0,82%	0,47%	3,45%	0,12%	1,39%

Figure 6.
Slack Efficiency Analysis with CRS variable



Tobit Regression Test - Conventional Commercial Bank
Conclusion Statistics Max, Min, Average - Conventional Commercial Banks, as follows:

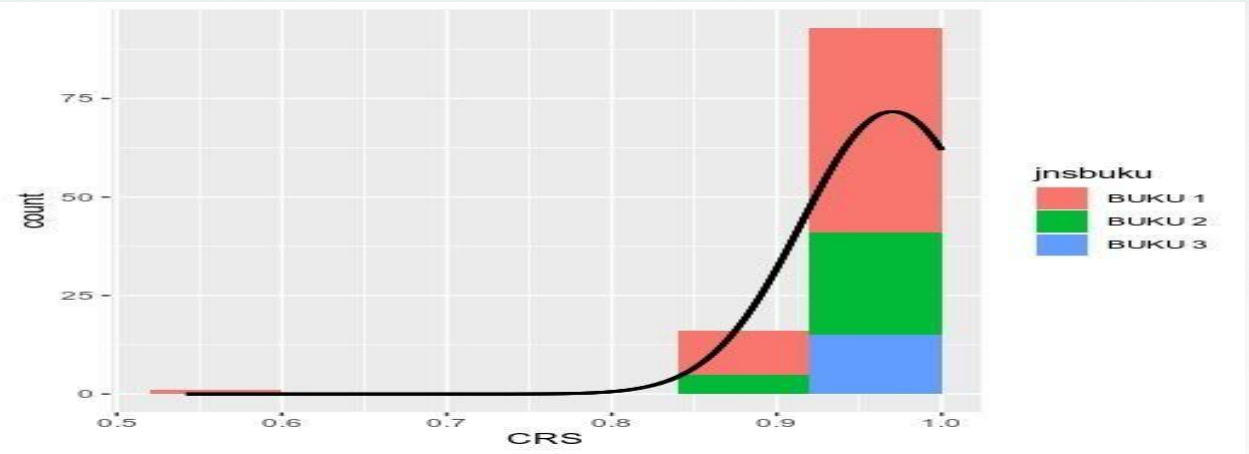
```
> #summary "CRS","LNTA","ROA","CAR","LDR","NPL","inflation","realgdp","unemployment","usdexchange"
> summary (dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE)
```

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.		
$CRS:		0.5420		0.9542	0.9990	0.9702	1.0000	1.0000
$LNTA:	12.54	14.50	15.37	15.54	16.68	18.43		
$ROA:	-15.89	0.5625		1.1350	0.9056	1.8275	3.8400	
$CAR:	10.35	14.83	18.41	22.44	23.42	148.28		
$LDR:	44.24	79.32	85.92	86.95	95.75	145.26		
$NPL:		0.000	1.542	2.300	2.785	3.210	15.750	
$inflation:		2.720	3.130	3.700	4.762	6.960	8.380	
$realgdp:		4.876	5.025	5.120	5.416	6.030	6.224	
$unemployment:		5.230	5.500	6.035	6.064	6.180	7.480	
$usdexchange:			8946	9622	12874	12098	13726	14409

Histogram of CRS Efficiency Value - Conventional Commercial Banks, as follows:

```
> f <- function (x, var, bw = 0.2) {+  dnorm (x, mean = mean(var), sd(var)) * length(var) * bw +}
> library(ggplot2)
> p <- ggplot(dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE, aes(x = CRS, fill=Capital Type))
>   p + stat_bin(binwidth = 0.08) + stat_function(fun = f, size = 1, args = list(var = dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE$CRS, bw = 0.09))
```

Figure 7.
Histogram of CRS Efficiency Value

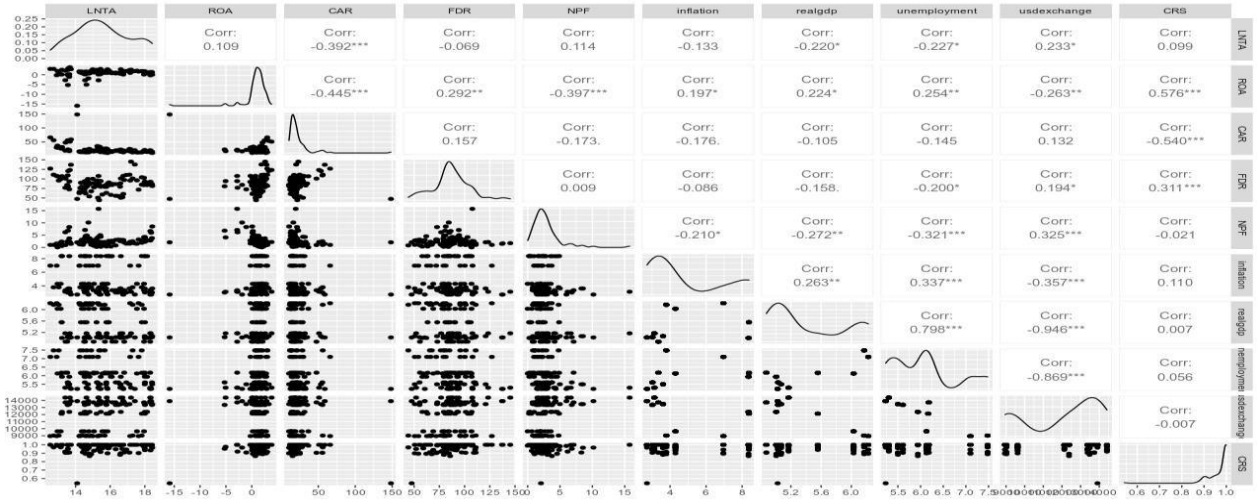


Efficiency Value CRS (Scaled 0.0 -1.0), > # CRS -> Min. : 0.0 # Max. : 1.0
In the histogram below, the pause option generates a histogram that is each unique, the CRS value having its own bar (by setting the pause equal to the vector containing the values, from minimum CRS to maximum CRS). Because the CRS is continuous, most of the CRS values are unique in the data set, even though they are close to the distribution center, there are some CRS values that have two or three cases. The spike at the far right of the histogram is the bar for the case where apt = 1. The height of this bar relative to the others clearly indicates the number of excess cases with this value.

Bivariate Correlation (Multicollinearity) - Conventional Commercial Banks, as follows:

```
> cor(dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE[,c("LNTA","ROA","CAR","LDR","NPL","inflation","realgdp","unemployment","usdexchange","CRS")])
> library(ggplot2)
> library(GGally)
> ggpairs(dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE[,c("LNTA","ROA","CAR","LDR","NPL","inflation","realgdp","unemployment","usdexchange","CRS")])
```

Figure 8.
Bivariate Correlation (Multicollinearity)



In the first row of the scatterplot matrix shown above, we see a scatterplot that shows the

relationship between the independent variables (LNTA, ROA, CAR, LDR, NPL, inflation, realgdp, unemployment, and usdexchange) and the dependent variable CRS, the collection above this scatterplot, due to the sensor in the CRS distribution.
The tobit model, the vglm function of the VGAM - Conventional Commercial Bank package, and calculating the P-Values/Signification (Sig) Model - Conventional Commercial Bank as follows:

```
> library(stats4)
> library(splines)
> library(VGAM)
> summary(m <- vglm(CRS ~ LNTA + ROA + CAR + LDR + NPL + inflation + realgdp + unemployment
+ usdexchange + Capital Type , tobit(Upper = 1), data = dat_File_Kompilasi_Conventional
Bank_2010_2019_FIX_OKE))
> pvals <- 2 * pt(abs(ctable[, "z value"]), df.residual(m), lower.tail = FALSE)
> cbind(ctable, pvals)
> n <- cbind(ctable, pvals)
> View(n)
```

Checking Data Model Suitability/Heteroscedasticity Test - Conventional Commercial Banks, as follows:

```
> dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE$yhat <- fitted(m)[,1]
> dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE$rr <- resid(m, type = "response")
> dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE$rp <- resid(m, type = "pearson")[,1]
> View(dat_File_Kompilasi_Conventional  Bank_2010_2019_FIX_OKE)
> par(mfcol = c(2, 3))
> with(dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE, {
+    plot(yhat, rr, main = "Fitted vs Residuals")
+  qqnorm(rr)
+   plot(yhat, rp, main = "Fitted vs Pearson Residuals")
+ qqnorm(rp)
+   plot(CRS, rp, main = "Actual vs Pearson Residuals")
+   plot(CRS, yhat, main = "Actual vs Fitted")
+ })
```

Checking how well the model fits the data, one way to start is to plot the residuals to assess their absolutes, as well as relative (Pearson) values and assumptions as such, as normality and homogeneity of variance.

Table 11.
Results of The TOBIT model and calculating the P-Values/Signification (Sig)

	Estimate	Std. Error	z value	Pr(>|z|)	pvals	pvals (desimal)	The significance value of p-value (t) < 0.05 then the independent variable is significant OR p-value (t) > 0.05 then the independent variable is not significant
(Intercept):1	9,07E-01	4,54E-01	1,9979056	4,57E-02	4,70E-02		
(Intercept):2	-2,81E+00	9,25E-02	-30,387608	8,01E-203	3,02E-78		
LNTA	-1,79E-02	9,54E-03	-1,8805614	6,00E-02	6,14E-02	0,06144	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
ROA	5,85E-03	4,58E-03	1,2788593	2,01E-01	2,02E-01	0,20238	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
CAR	-2,09E-03	5,94E-04	-3,5239016	4,25E-04	5,23E-04	0,00052	The significance value of p-value (sig) <0.05 then the independent variable is significant (Ho is rejected and Ha is accepted)
LDR	1,42E-03	4,43E-04	3,2083313	1,34E-03	1,55E-03	0,00155	The significance value of p-value (sig) <0.05 then the independent variable

NPL	-1,57E-03	4,00E-03	-0,3915608	6,95E-01	6,96E-01	0,69579	is significant (Ho is rejected and Ha is accepted) p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
inflation	3,95E-03	3,69E-03	1,0728353	2,83E-01	2,85E-01	0,28459	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
real GDP	-4,88E-03	4,30E-02	-0,113327	9,10E-01	9,10E-01	0,90988	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
unemployment	2,65E-02	1,88E-02	1,4123423	1,58E-01	1,59E-01	0,15935	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)
us exchange	9,63E-06	1,32E-05	0,729829	4,65E-01	4,66E-01	0,46632	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)

The conclusion of the estimate/regression coefficient is compared to the P-Values/Signification (Sig) Model - Conventional Commercial Banks, as follows:

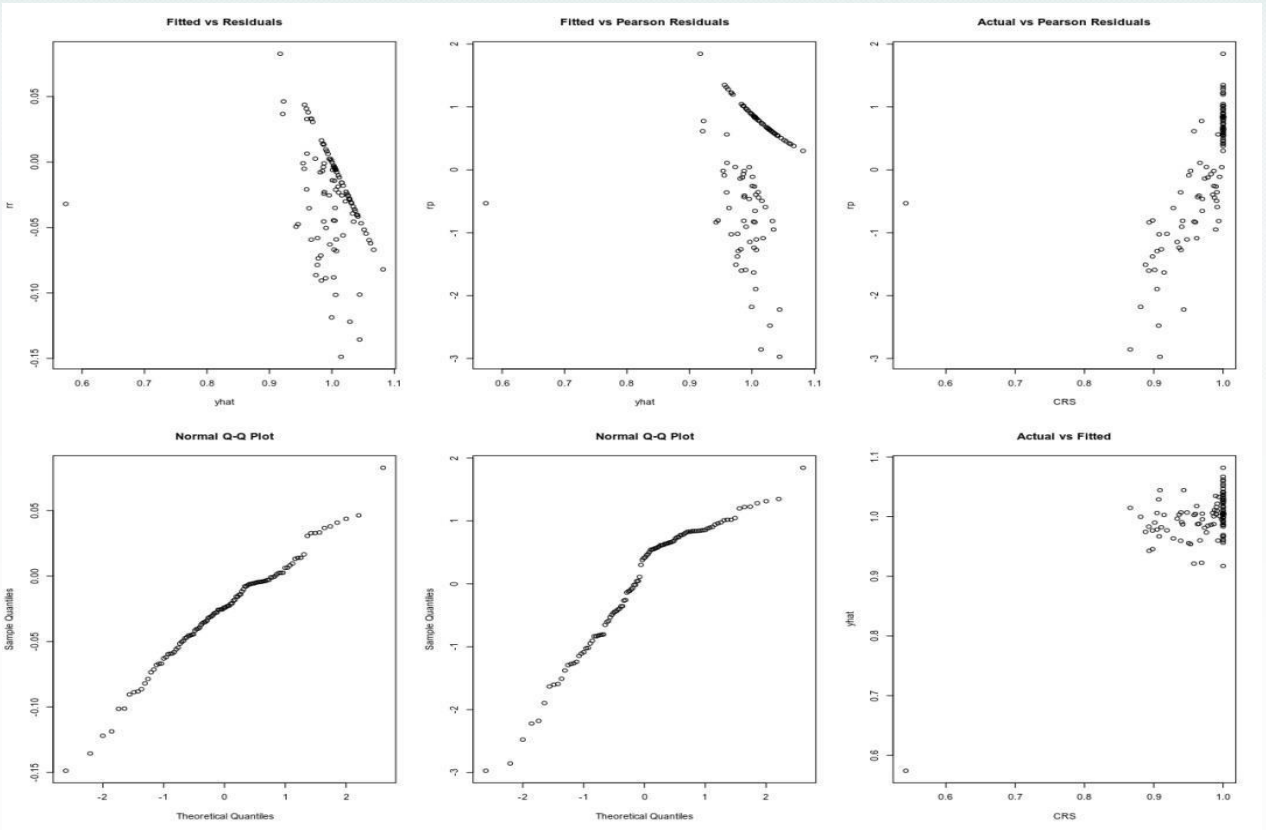
Table 12.
Results of The conclusion of the estimate/regression coefficient is compared to the P-Values/Signification (Sig)

	Estimate/Coefficient (decimal)	Description Estimate/Coefficient	pvals (decimal)	The significance value of p-value (t) < 0.05 then the independent variable is significant OR p-value (t) > 0.05 then the independent variable is not significant	Description of the effect of independent variables on CRS
(Intercept):1	0,9069065000				
(Intercept):2	-2,8106710000				
LNTA	-0,0179323000	The regression coefficient is -0.0179323, stating that every reduction (because of the - sign) one value in the LNTA variable will give a decrease in score of -0.0179323	0,06144	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The LNTA variable has no significant effect on the CRS. variable
ROA	0,0058509450	The regression coefficient is 0.005850945, stating that each addition (because of the + sign) one value on the ROA variable will give an increase in score of 0.005850945	0,20238	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The ROA variable has no significant effect on the CRS. variable
CAR	-0,0020915960	The regression coefficient is -0.002091596, stating that every reduction (because of the - sign) one value in the CAR variable will give a decrease in the score of -0.002091596	0,00052	The significance value of p-value (sig) <0.05 then the independent variable is significant (Ho is rejected and Ha is accepted)	The CAR variable has a significant effect on the CRS. variable

LDR	0,0014212500	The regression coefficient is 0.00142125, stating that each addition (because of the + sign) one value in the LDR variable will give an increase in score of 0.00142125	0,00155	The significance value of p-value (sig) <0.05 then the independent variable is significant (Ho is rejected and Ha is accepted)	The LDR variable has a significant effect on the CRS . variable
NPL	-0,0015679050	The regression coefficient is -0.001567905, stating that every reduction (because of the - sign) one value on the NPL variable will give a decrease in score of -0.001567905	0,69579	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The NPL variable has no significant effect on the CRS. variable
inflation	0,0039548890	The regression coefficient is 0.003954889, stating that every reduction (because of the - sign) one value on the inflation variable will give a decrease in score of 0.003954889	0,28459	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The inflation variable has no significant effect on the CRS . variable
real GDP	-0,0048786370	The regression coefficient is -0.004878637, stating that every reduction (because of the - sign) one value on the realgdp variable will give a decrease in score of -0.004878637	0,90988	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The realgdp variable has no significant effect on the CRS . variable
unemployment	0,0264826900	The regression coefficient is 0.02648269, stating that each addition (because of the + sign) one value on the unemployment variable will give an increase in the score of 0.02648269	0,15935	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The unemployment variable has no significant effect on the CRS . variable

us exchange	0,0000096289	The regression coefficient is 0.000009628921, stating that each addition (because of the + sign) one value on the us exchange variable will give an increase in score of 0.000009628921	0,46632	p-value (sig) > 0.05 then the independent variable is not significant (Ho is accepted and Ha is rejected)	The us exchange variable has no significant effect on the CRS. variable

Figure 9.
Checking Data Model Suitability/Heteroscedasticity Test



Fitted (tersuai) vs Residual | Fitted vs Pearson Residuals | Actual vs Pearson Residuals | Actual vs Fitted. Regarding the analysis between: Hetersoscedastic vs. homoscedastic, analyzing whether the error variance is fixed/constant (homoscedastic) or variable (heteroscedastic).
Observe the spread of the residuals around line 0, if it appears that the data spreads quite randomly around line 0and there is no visible trend, so it can be concluded that the residual is homoscedastic (the error variance is constant), it can be concluded that the linear model is good enough to model the independent vs. dependent relationship.
The graph on the bottom right is the predicted or mounted, the values are plotted against the actual. This can be very useful when comparing competing models. Can calculate the correlation between the two as well as the quadratic correlation, to find out how accurately the model predicts the data and how much variance in the results the model takes into account.
Normal Q-Q Plot
If it appears that the residuals are around a straight line, it can be concluded that the residuals follow a normal distribution.
Calculating Determination (R Square) - Conventional Commercial Banks, as follows:

```
> (r <- with(dat_File_Kompilasi_Conventional Bank_2010_2019_FIX_OKE, cor(yhat, CRS)))
[1] 0.7194476
> # varians dihitung r square kuadrat
> r^2
[1] 0.5176048
```

R^2 is the magnitude of the coefficient of determination (R Square) is 0.0 - 1.0 or times 100% to get the presentation value, the result of r^2 means that all independent variables simultaneously (together) affect the dependent variable by X%, while the rest (100% - X% = Y%) is influenced by other variables outside this regression equation or variables that are not studied

R^2 = 51.76%

The magnitude of the coefficient of determination (R Square) is 0.5176048 or equal to 51.76%. This figure means that all independent variables simultaneously (together) affect the dependent variable by 51.76%.

While the rest (100% - 51.76% = 48.24%) is influenced by other variables outside this regression equation or variables not examined. For research using cross-sectional data, R2 which is worth 0.2 (20%) or 0.3 (30%) can be said to be good enough.

Conclusion

This study uses data, eleven conventional commercial banks, taken from the banking year report from 2010 to 2019, the total of all decision making units (DMU) is 110 DMU.The results of the study conclude that the technical education efficiency analysis of conventional commercial banking in Indonesia between 2010-2019 shows that it is not worth 1 (100% efficient), but close to a value of <1 of 0.97 (CRS 97% efficient), 0.984 (VRS 98.4% efficient), and 0.985 (Efficiency Scale 98.5%). To conclude, efficiency is categorized based on 3 types of core banking capital, for BUKU 3 types of 0.983 (CRS), 0.996 (VRS), and 0.987 (SE), for BUKU 2 types of 0.977 (CRS), 0986 (VRS), and 0.99 (SE), for the type of BUKU 1 of 0.963 (CRS), 0.98 (VRS), and 0.98 (SE). The results of the slack analysis show that the inefficiency of the DMU of excess labor wages is 3.45%, the management of the DMU of deposits is not efficient at 0.82%, and the use of the DMU of assets is inefficient at 0.47%. So that the impact on the DMU financing that should be channeled increases by 0.12% and the DMU income that should be able to get an increase of 1.39%, if efficiency can be obtained 100%. The TOBIT regression results show that only CAR (p-value 0.0052) with a coefficient value of -0.0020915960 and LDR (p-value 0.00155) with a coefficient value of 0.0014212500 which significantly affects the technical education efficiency analysis (CRS used as a dependent) of conventional commercial banks in Indonesia, with R square value is 51.76%.

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