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The Effect of COVID-19 to Credit Risk and Capital Risk of State-Owned Bank in Indonesia:

A System Dynamics Model

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The COVID-19 pandemic has significantly impacted the increasing credit risk of BNI (Bank Negara Indonesia). For instance, in 2020, non-performing loans (NPL) rose by 86.96% compared to the previous year, while loans at risk increased to 28.7%. According to studies, the inability of the economy to grow normally after the termination of the credit restructuring policy of *Otoritas Jasa Keuangan* (OJK/Indonesia Financial Services Authority) tends to create serious problems in banks regarding the risk of credit and capital. Therefore, this study simulates the risk of Capital Adequacy Ratio (CAR) and NPL of BNI after the termination of the credit restructuring policy of OJK in March 2022 using system dynamics methodology. With this methodology, various future assumptions regarding the COVID-19 impact on banking activities and policies are analyzed to improve and understand the banking business process.

The result showed that the inability of BNI to convert 50% of its restructured credit value amounting to IDR 150 trillion into performing loans leads to a serious risk of credit and capital. Furthermore, the policy to handle such risk is usually based on an internal decision, such as interest rate of loan and saving, extended loan restructure, and collection of more third-party funds. It is also based on the collection of an external role of the government as the bank owner that needs to prepare an early rescue policy as a last resort. This study is limited to credit and capital risk modeling, excluding the other impact of the COVID-19 pandemic, such as liquidity risk, operational risk, and market risk.

Keywords: COVID-19, Credit Risk, Bankruptcy Risk, Banking, System Dynamics

1. Introduction

This study simulates the credit and capital risk of state-owned banks in Indonesia due to the COVID-19 pandemic using the system dynamics method. According to Wu (2014), this methodology, has the ability to handle the phenomena that exist in a complex, non-linear, feedback and delay condition. It is also useful for designing management policies to reduce credit and capital risk (Sy, Bernardo, Miguel, San Juan, Mayol, Ching, Culaba, Ubando & Mutuc. 2020). Furthermore, the risk of bank bankruptcy due to the COVID-19 pandemic using historical data was impossible due to the lack of parallel historical data (Baker, Bloom, Davis, & Terry, 2020).

The COVID-19 pandemic has led to the closure of several sectors of the modern economy, thereby making the economic crisis more severe (Adrian, Tobias, & Narain, 2020) and different from the previous global financial crisis (Korzeb & Niedziółka, 2020). The tourism, aviation, and other service industries have stopped operating, thereby leading to unemployment. Barua, Bipasha, and Barua (2020) illustrated the impact of the COVID-19 pandemic on economic destruction by referring to the decline in several macroeconomic indicators, including production aggregate, supply, trade flows, savings, investment, and employment.

Due to the pandemic's impact, BNI, as one of the state-owned banks in Indonesia, experienced a credit growth of 6%, while third-party funds grew by 11% in 2020. NPL increased by 86.96%, return on assets (ROA) decreased by 79.17%, and the capital adequacy ratio (CAR) fell by 12.36%. Total outstanding loans in 2020 amounted to IDR 586 trillion with

a composition of non-performing loans of IDR 24.6 trillion (4.2%) and loans restructured due to the COVID-19 pandemic amounting to IDR 148.94 trillion (25.41%).

When 50% of the restructured credit becomes NPL from OJK No. 11/POJK.03/2020 in March 2022, BNI bank capital is likely to be below the safe limit, leading to an increase in bankruptcy. This study simulates the credit and capital risk of BNI after the end of the credit restructuring policy of OJK in March 2022.

2. Literature Review

Non-Performing Loan (NPL) is a risk that arises due to the implementation of bank intermediary function. Generally, the bank converts customer funds into credit. When the credit is current, it makes a profit in addition to the capital. Meanwhile, bad credits are a write-off, leading to lower capital, which impacts the risk of bankruptcy (Mayes & Stremmel, 2012; Claessens, 2014).

Preliminary studies implemented parametric statistical models with accounting capital ratios and market data used to predict the credit and capital risk (Meyer & Pifer, 1970; Sinkey 1975; Martin, 1977; Estrella, Park, & Peristiani, 2000; Cole & White, 2012; Mayes & Stremmel, 2012; Bouvatier, Brei, & Yang, 2013). These studies generally concluded that the NPL and CAR ratios are good predictors of bank's credit and bankruptcy risk.

However, the relationship between NPL and capital risk is not always linear but complex. NPL risk occurs due to management risk taken when making a loan investment decision to achieve the target return on capital. This action creates an expense on loan impairment which reduces capital.

A loan is associated with positive and negative feedback on capital and NPL expense, respectively. NPL reduces available funds for new loan expansion and capital. It also takes time or delays to recover NPL, either by restructuring credit or collection effectiveness.

Several studies have been carried out on credit risk, capital, and bank bankruptcy risk using system dynamics approach (MacDonald, 1993; Pruyt, 2010; Pruyt & Hamarat, 2010; Anderson, Long, Jansen, Affeldt, Rust, & Seas, 2011; Islam, Vasilopoulos, & Pruyt 2013; Wu & Zhao, 2012; and Istiaq, 2015). This is the first study on modeling NPL and capital risk phenomena for state-owned banks in Indonesia during the COVID-19 pandemic. In order to determine the level of banking risk, the simulation results of credit and capital risk using system dynamics are then compared with the standard bank soundness ratio from OJK.

The maximum standard of credit risk measured by NPL is 5%. Meanwhile, the standard of capital adequacy ratio to absorb bank risk is at least 10% in the CAR ratio. When the NPL ratio is greater than 5% and CAR is less than 10%, the risk level of bank bankruptcy increases.

This research uses system dynamics modeling to simulate the increase in credit and capital risk before and after the OJK credit restructuring policy for banks affected by the pandemic. The model is prepared based on the bank financial statement model, which consists of a balance sheet and a profit and loss statement, such as those developed by Alwani, Mazen Jamil (1980) and Islam, Vasilopoulos, & Pruyt (2013).

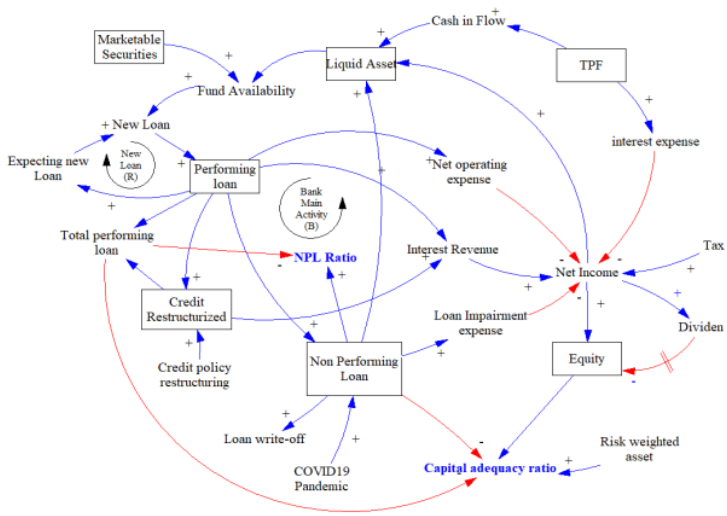
A transaction map is made based on the bank's balance sheet and income statement using the Causal Loop Diagram (CLD) to determine credit and capital risk transactions. CLD bank transactions are developed into stock-flow diagrams to produce baseline projections of NPL and CAR.

3. Modelling Loan, Credit Risk, and Capital Risk

This research analyzes the loan, credit risk, and capital risk by referring to the loan landing and NPL as the credit risk, while equity is the capital risk.

Figure 1 shows the causal loop diagram on the effect of the COVID-19 pandemic on credit and capital risk. The virus has disrupted many activities, especially in the economic sector, where the impact obstructed repayment of loans from borrowers/debtors to the bank.

Figure 1: Causal Loop of Credit Risk and Capital



The main activity of bank's intermediary function is to convert funds from savings to a financial asset, consisting of loan and marketable securities, in order to obtain profits. The number of additional new loans is determined by considering the availability of funds and the expected new loans. Furthermore, the pandemic affected the decision to grant new credit (New Loan) due to an increased risk of bad credit (Non-Performing Loan).

When a credit has a problem with its repayment, it is classified as a non-performing loan (NPL). For this type of loan, the bank should strive to advise borrowers and restructure the credit to run adequately. However, when the opposite occurs, it needs to be written off with bad credit (NPL).

The loan investment generates the risk of NPL, which tends to decrease CAR when not properly controlled. CAR refers for capital adequacy ratio, that assesses a bank's ability to provide assets to mitigate the risk of loss. The higher the CAR number, the better the bank's ability to deal with the risk of insolvency.

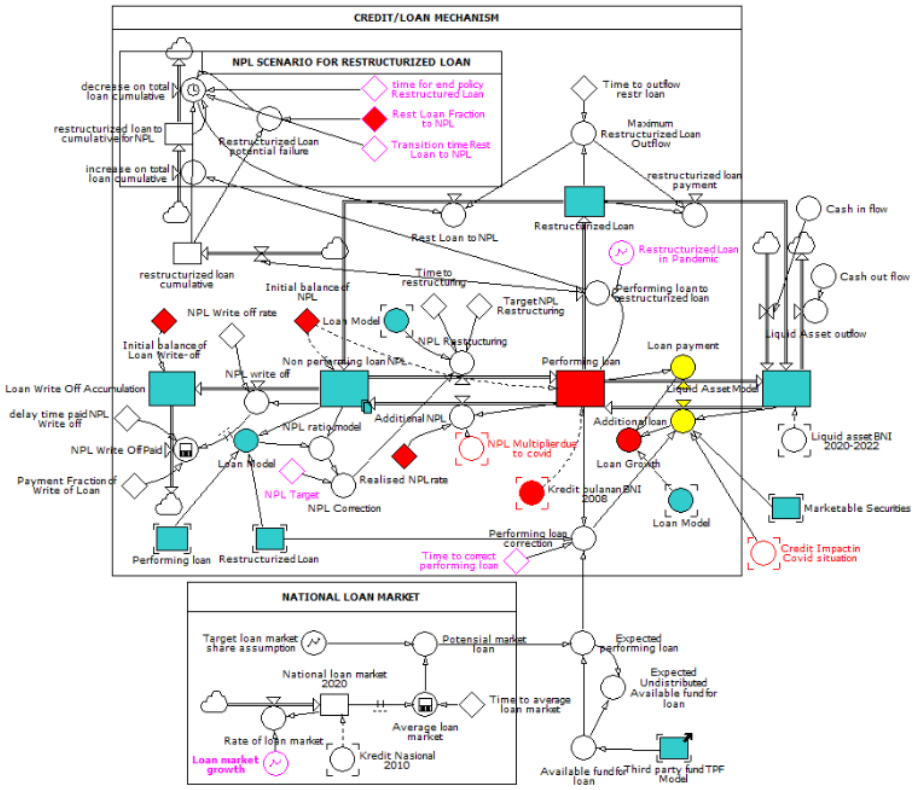
Table 1: Predicted Impact of Variables on CAR and NPL

Variable	CAR	NPL
COVID19 Pandemic	-	+
Restructured Credit policy	+	-

Table 1 shows the relationship between CAR and NPL variables. The pandemic caused a large number of loan impairments. For instance, it leads to an increase in non-performing loans with a decline in performing loans. This causes a decrease in income, resulting in reduced equity, thereby weakening the Capital Adequacy Ratio (CAR). Therefore, to prevent this, it is hoped that the Restructured Credit policy is able to withstand the increase in NPL during the COVID-19 pandemic.

The next modeling step is to translate the causal loop diagram of credit and bankruptcy risk into stock and flow (rate) categories of loan mechanism, as shown in Figure 2. The stock category comprises variables that have accumulation or storage characteristics capable of determining the balance at any time. All the accounts are stocks consisting of liquid assets, loan, and equity in the bank balance sheet. The asset stock is an investment portfolio, which generates interest and fee-based income at the expense of a certain risk. The portfolio of investment is funded from third-party and equity.

Figure 2: Stock Flow Diagram of Loan Mechanism



The structure of loan investment is classified into the following four stocks to control risk and return of loan:

- Performing loan, this represents loans that are paid on time and regularly. Additional loan is added to this stock and deducted in accordance with time and regular payment.
- Non-Performing Loan (NPL), representing loans that are delayed for more than 90 days. The inflow of NPL is determined by rate, which is calculated from historical data assumed in a normal condition and affected by COVID-19 as a representation of behavioral change in the borrower's ability to fulfil the payment.
- Restructured Loan is a potential NPL that is classified as a performing loan due to the OJK policy to lighten the borrower's burden during the pandemic.
- NPL Write off Accumulation is associated with non-performing loans that are less likely to be repaid. Bank issue policy to write off these loans, which are booked as NPL Write Off Accumulation, which are not included in banknotes/account, rather they are charged to the borrower.

Performing loans is the main source of interest income and liquidity. During normal business, part of it becomes a credit risk of NPL, therefore, the bank needs to allocate loan impairment expenses.

Figure 3 displays a diagram of COVID-19 impact on loan mechanism in two areas of (1) NPL rate and (2) Credit risk that reduced loan activities. Key points in this structure are (1) COVID-19 time hit (3rd month of 2020), (2) how long NPL rate and credit risk are affected by the pandemic, (3) Adjusting time start for Bank, borrowers starting from when the pandemic was discovered and (4) adjusting time for Bank borrowers, in accordance with when the pandemic will end. The performing loan is restructured with a change in its tenor and interest to comply with OJK regulation as a countercyclical of the COVID-19 pandemic. Based on the regulation, restructuring loan is carried out in an extraordinary manner. Before the pandemic, loan restructuring increases the quality with impairment expense. However, it increased loan quality during the pandemic and, based on OJK regulation, without impairment expenses.

The model shows the bank's compliance with OJK regulation that changes NPL to performing loan, tends to affect all loan status, such as performing loan, NPL, NPL, and write off accumulation. The model illustrates the behavior of loan, NPL, and equity during the pandemic. It is predicted as the end of time and adjustment delay in both situations.

Figure 3: Diagram of COVID-19 Impact on Loan Mechanism

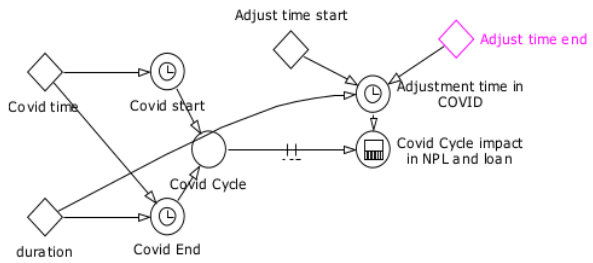
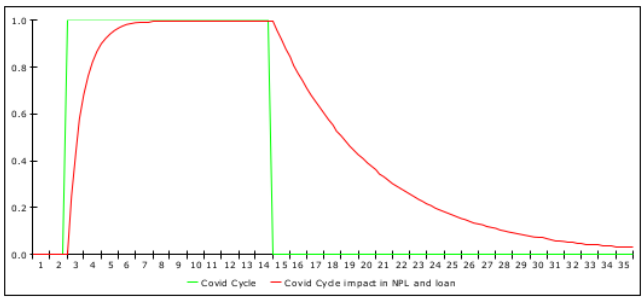


Figure 4 shows that the adjustment time starts for 1 month and ends for 6 months. This is because it is assumed that the pandemic has a duration of 12 months. A value of 1 indicates that the pandemic is still active and reduces the loan activities, while 0 means they are at a normal level. The graph shows loan activities are likely to return to normal level after the 36th month. Duration, start and end adjustment time are potential leverage parameters regarding the loan activities during pandemic situations until the simulation is terminated.

Figure 4 Simulation of COVID-19 Impact on Loan Mechanism



In figure 5, the stock-flow diagram of profit and equity is developed through the components that form the income and expenses, with the addition and reduction of capital/equity. Income is calculated before and after-tax.

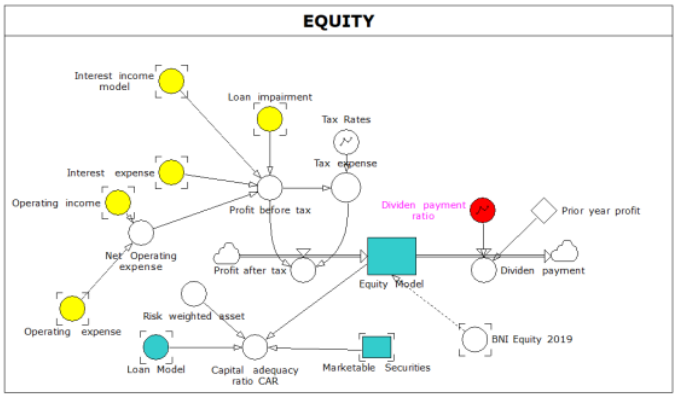
These are auxiliary variables to regular changes in the capital according to the bank's

business model. However, some variables influence changes in equity, including dividend payment prior to the year's profit.

The Capital Adequacy Ratio (CAR) value is a parameter calculated based on equity, loan, and marketable securities. Risk-weighted assets are parameters that describe the level of risk burden with a value of 80%.

Interest income is the main source of the inflow rate of equity, deducted by loan impairment expense. During the economic crisis and COVID-19 pandemic, loan impairment expense increases significantly, creating bank losses and reducing equity. Reduced capital increases the risk of bank bankruptcy.

Figure 5: Stock Flow Diagram of Bank Profit and Equity



4. Model Configuration and Test

Model configuration comprises the set-up process of the model, namely (1) initial values of parameters, (2) time set-up, and (3) Saving time. The initial values of parameters are shown in Appendix 1. The model is set to run in a 0.25-month timestep, with the 1st month starting on 1 January 2020 and ending on the 37th month, which is on 31st December 2022. Historical data is available from 1 January 2020 until 31st December 2020. Data collected after these dates are determined using prognosis with data trend in 1 year (2020). These data changes are the future of economic growth, the assumption on loan market, and payment ability. The save time of the result is monthly.

Model validation was conducted and used to compare the simulation process with historical data to build confidence with system dynamics (Sterman, 2000). Several results of comparison between model simulation and historical data are shown in Figures 6 and 7. The model comparison has a similar trajectory with historical data from the 1st month till the 13th, while only a few parameters tend to mimic the prognosis behavior in the future.

To examine the model's ability to reproduce further, behaviour reproduction experiments were conducted. Table 2 displays the R^2 (coefficient of determination), mean square error (MSE), root mean square percentage error (RMSPE), and Theil's inequality statistics (Theil, 1966). Furthermore, the RMSPE decomposition, which is bigger U^C in both cases, indicates that the model reasonably represents the data's mean and underlying trends, and the error is related to a difference from point-to-point estimation (Sterman, 2000). Preliminary studies have found that projections from the calibrated model are more trustworthy than forecasts from other methodologies (Suryani et al., 2010).

Figure 6: Comparison Result for Total Loan

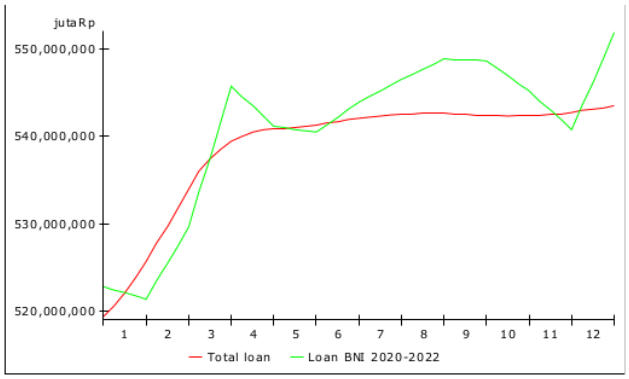


Figure 7: Comparison Result for Equity

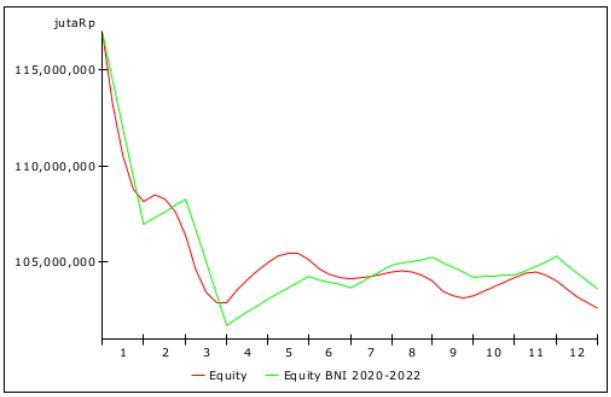


Table 2: Model Fits to Historical Data (error analysis)

Variable	RMSPE	MSE	U^m	U^S	U^C	R^2
Total Loan	0.008902259	7.92502E-05	0.00265	0.02297	0.97431	0.972
Equity	0.014364056	0.000206326	0.07996	0.02683	0.89105	0.9754

The comparison with historical data shows that the simulation result was quite good to mimic the behavior of historical data. Several differences occurred in the comparison due to delay function in the model to replicate the model's behavior and averaging process and smooth the cyclical pattern in the historical data.

5. Model Simulation

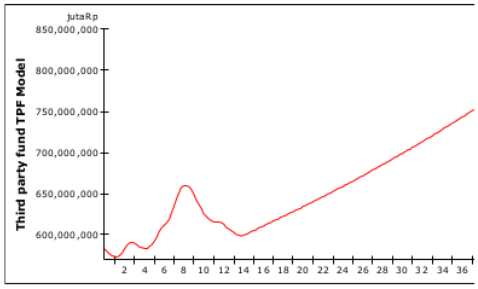
5.1 Baseline Simulation

Baseline simulation is a projected balance sheet, bank profit, and loss for the 2020-2022 periods, usually from 1st to 36th month. The results of this simulation serve as a baseline value that does not take into account credit risk

due to the termination of the credit restructuring policy of OJK in March 2022. The result of the baseline simulation is used to compare the credit risk and capital risk by taking into account the termination of OJK regulations in March 2022.

Figure 8 shows the assumption of the third-party fund until 31 December 2022.

Figure 8: Assumption for Third-Party Fund



The Third-Party fund, which acts as the main driver of changes, is assumed to grow approximately 13.8% per year until the end of 2021, similar to its prognosis. At the end of the simulation time, the amount of Third-Party fund becomes 726.1 Trillion Rupiah. With this fund, the dynamics of loan also increases and affects other parameters of the model.

Figure 9: Baseline Simulation for Loan

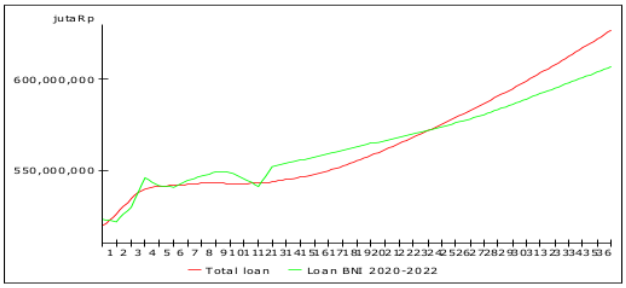


Figure 10: Baseline Simulation for Loan by Category

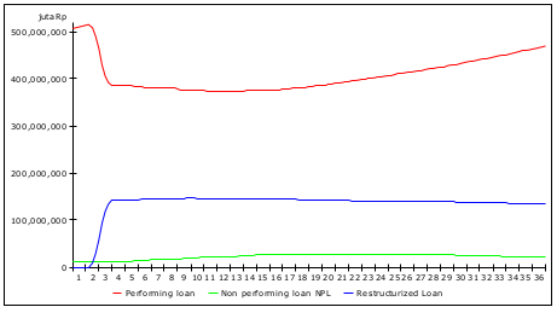


Figure 9 shows that the total loans increase significantly by 627.2 trillion Rupiah or 86% from Third Party fund until the end of 2022. This amount includes the performing, restructured, and non-performing loans. Figure 10 shows that for each category, the performing, restructured, and non-performing loan still dominates the total loan by 71%, 25%, and (4%), respectively.

Figure 11: Baseline Simulation for Non-Performing Loan (NPL) Ratio

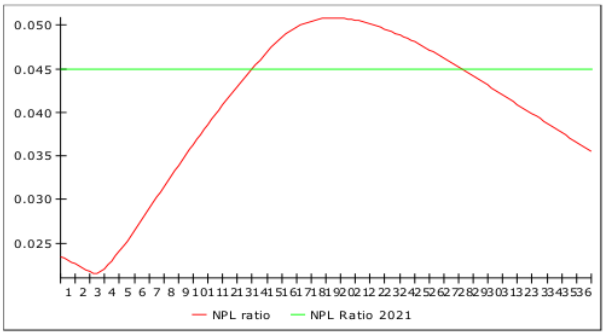
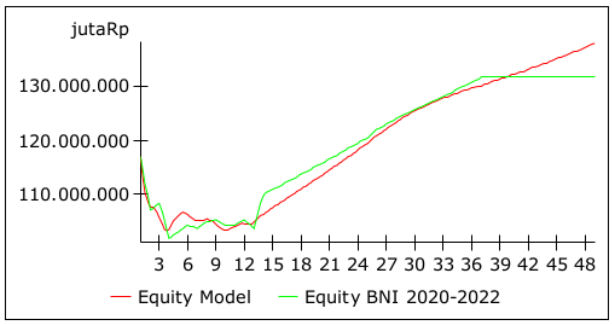


Figure 11 shows that the NPL ratio has good behavior because it is assumed the COVID-19 impact in the ability to pay loan decrease in 2021, and it is getting better until 2022. The impact started to decrease after month 15th and goes to zero in month 36th. For this period, the NPL ratio reached the maximum level of 5%, as stated by Indonesia Financial Services Authority (OJK). This simulation gives early information to management that credit risk increased during the pandemic. Some policies need to be implemented to prevent more losses.

Figure 12 shows the simulation for equity that refers to capital risk. It indicates that in the first twelve months of 2020, the equity decreased from 116, 8 trillion Rupiah to 104,8 trillion Rupiah. The decline was due to the decreasing credit growth and the fact that net interest income had not reached the normal conditions. Furthermore, operating expenses were still high, with missing loan impairment expenses.

The figure also shows that from the 13th month, the equity is expected to increase significantly up to the end of 2022. This is due to the decrease in credit growth by 6-7%, which reduced the impairment loan. The baseline simulation was not considering the growth of NPL at the end time of OJK Credit Restructuring Regulation in March 2022, as the NPL is discussed in the next simulation.

Figure 12: Baseline Simulation for Equity

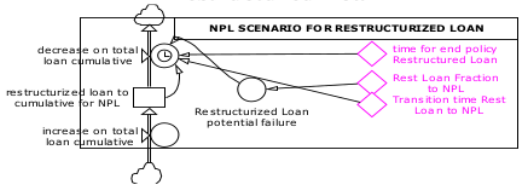


Baseline simulation of equity shows that several performances such as third-party fund and loan growth are expected to get better before 2022. However, other stocks, such as liquid assets, marketable securities, NPL, and equity, are likely to experience decreasing conditions during the till 2022 continuously.

5.2 Scenarios and Policy Simulation

The simulated policy scenario is the revocation of OJK's policy on credit restructuring, which was carried out in March 2022. The policy structure is shown in Figure 13 consists of (1) the rest loan variable assuming 50% of the credit is restructured into NPL, (2) The expiration date of the restructuring policy of the OJK in the 27th month or March 2022, and (3) a two months current credit period of NPL. Scenario simulations are used to estimate the options of policy for credit risk and capital risk that impact NPL and CAR.

Figure 13: Policy Structure of Restructured Loan



The main impact of this credit restructuring policy of OJK was to increase NPL. Of the total outstanding restructured credit of Rp 147 trillion, it is estimated that 50% or approximately 73.5 trillion is converted to NPL in the 28th month.

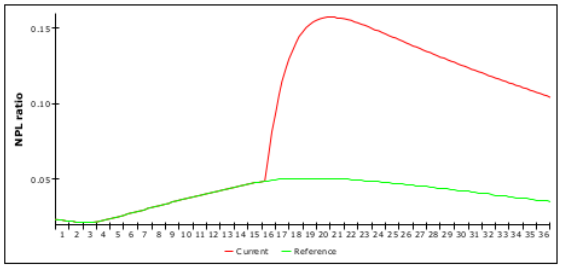
Figure 14 shows that in 2-3 months after the policy stopped, the NPL ratio is likely to increase from 3,33% to a 15% peak in the 20nd month with a decrease to 11% at the end of December 2022 (36nd month).

However, banks are likely to find it difficult to increase new loans during the pandemic and get new or prospective debtors/borrowers. This tends to impact the increasing NPL stock, leading to deficiency in liquid assets and marketable securities. Furthermore, these conditions tend to affect the profitability capacity of the bank based on its intermediation function.

Management changes a portion of liquid assets into an additional new loan. The policy is followed by selling marketable securities to maintain the liquid asset at the desired level. An excise problem of NPL and loan repayment in a long time decreases the bank's capacity to increase liquid assets used in paying the operational cost and interest payment for savers.

The impact of the termination of OJK's credit restructuring policy on the CAR ratio is different from the NPL ratio. The CAR ratio does not show a striking change. In period t0 (January 2020), the bank's CAR ratio was at the level of 23.87% and decreased to 20.6% in December 2020. This is due to an increase in reserves for expenses on credit impairment and a decrease in interest income.

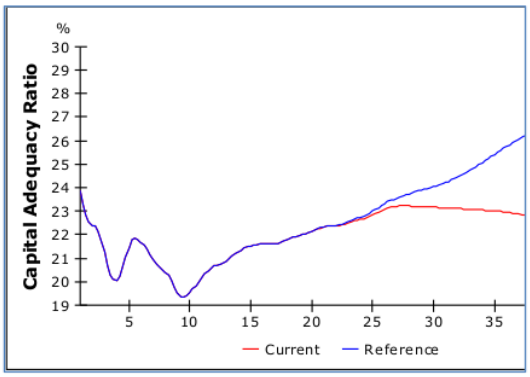
Figure 14: Scenario Simulation for NPL Ratio



The bank increases the reserve to a level above 200% in anticipation of future bad credit risk. Therefore, an increase in bad loans in the 18th month does not immediately decline the level of the CAR ratio. Rather the decline tarts

to occur in the 21st month when banks start adding new reserves.

Figure 15: Scenario Simulation for CAR



Under scenario behavior, there are several policies capable of potentially implementing the decrease in NPL rate while increasing the equity as shown in Table 3.

Table 3: Policy Definition to handle 'NPL Rise Scenario'

Policy	Definition	Parameter changes in model
Extended restructured loan more than the year 2022	Extended restructured loan until the end of 2022 (similar to Baseline scenarios)	• Did not change the end time of the restructured policy
Tight evaluation of restructured loan outstanding and adjusting the tenor to be shorter	Tight evaluation to classify the loan not capable of performing anymore and shorten the tenor for potential restructuring of loans	• Changed the end time of the restructured policy • Put a maximum of potential restructured loan to NPL stock for approximately 20% • Shorter the tenor by 2 - 2.5 times than the previous restructured loan
More Aggressiveness in new loan delivery	Increase new loan to anticipate lower NPL ratio	• Increase market share of loan to 10% under scenario's condition
Raise borrowing to increase fund availability in Bank	Increasing fund with an increase in borrowing combined with the assumption of third party fund.	• Increase borrowing rate to 15% from total asset
Combination of all scenarios	Combination of several or all scenarios	• Changes each scenario above, with various parameter values, except extended restructured policy.

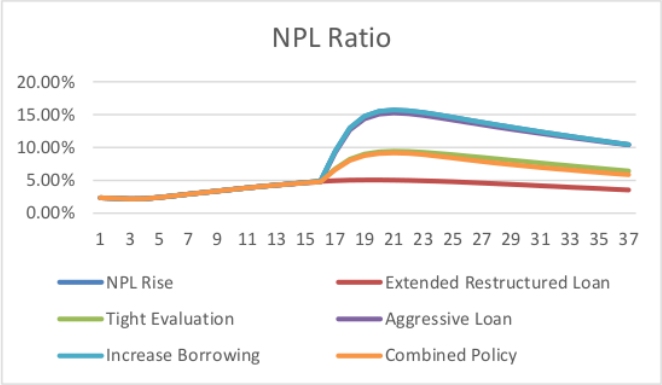
Each scenario correspondences to the graph as follows:

- Scenario simulation stopped the loan restructure in March 2021 and affected the restructured loan to NPL: **NPL Rise Scenario**.
- Extended restructured loan more than the year 2022: **Extended Restructured Loan**.
- Tight evaluation of restructured loan: **Tight Evaluation**.
- More Aggressive Loan: **Aggressive Loan**
- Increase borrowing : **Increase Borrowing**
- Mix Scenarios : **Combined Policy**

Among these 4 scenarios shown in Figure 16, excluding combined policy, **the Aggressive Loan** scenario has NPL ratio similar to **Increase Borrowing Scenario.** However**,** both produced the highest NPL ratio than other scenarios. The increase in loan lending encourages additional NPL due to unstable economic conditions.

In 'tight evaluation' and 'combined policy' scenarios, when only 20% of restructured loans have difficulties being paid, it is classified as a non-performing loan. Similarly, 80% of the rest are potential to adjust with a shorter tenor, thereby leading to a lower NPL Ratio. In the 'combined policy' scenario, the result is lower than the 'tight evaluation' scenario because it also included an aggressive loan policy. Therefore, it has a lower NPL Rate than the 'tight evaluation' scenario.

Figure 16: Comparison Policy Scenarios for NPL Ratio



Based on the comparison, the 'Extended Restructured Loan' scenario has the best result for NPL Ratio. This is because the restructured loan is extended until after 2022. Therefore, there is no potential or probability of restructured loan that goes to non-performing. However, at the same time, there are hidden concerns on difficulties in paying some of the restructured loans on time. The extended policy is only to maintain 'on paper good performance' without realizing the future impact.

An increase in NPL with a more aggressive loan, influences liquid assets and marketable securities. Liquid assets show that 'NPL rise' and 'Aggressive Loan' scenarios are lowest in liquid assets trajectory. From the 21st to 23rd months (August-October 2021), banks only had approximately 70-71 trillion Rupiah in liquid assets, which increased to more than 80 trillion Rupiah at the end of 2022. The 'tight evaluation' scenario shows better behavior than 'NPL rise' and 'Aggressive Loan' scenarios due to a decrease in NPL rate in those two scenarios. Therefore, adequate funds are needed to convert 'NPL Rise' and 'Aggressive Loan' scenarios into a new loan. Increase borrowing and combined policy scenarios have better results in liquid Assets because of the additional fund. Until the end of the simulation time, liquid assets were 102-103 trillion Rupiah.

Marketable securities as expendable instruments to keep liquid assets secure a broad

range in behavior from only 59.1 trillion Rupiah until 147.5 trillion Rupiah. Based on 'NPL rise' and 'Aggressive Loan' scenarios, the marketable securities have more liquid assets, while 'increase borrowing' and 'tight evaluation' scenarios are more moderate to maintain marketable securities. The 'increase borrowing' scenario showed a better result at the end of the simulation than 'tight evaluation' because of the additional fund from borrowing. Meanwhile, the 'tight evaluation' scenario encourages more in loan management, especially in handling problems associated with performing loan and adjustment.

At the end of the business process, equity is affected by all revenue and cost from bank activities. All scenarios led to the same behavior of equity, with a decrease in trend and various values by the end of 2022 as shown in Figure 17. The most optimistic case is 86.7 trillion Rupiah in 2022 (Extended Restructure loans scenario), while the most pessimistic is 77.53 trillion Rupiah in 2022 (NPL Rise scenario), with a possible decrease in equity between 25.9%-35.8% in 3 years (including the pandemic).

Figure 17: Comparison Policy Scenarios for Equity

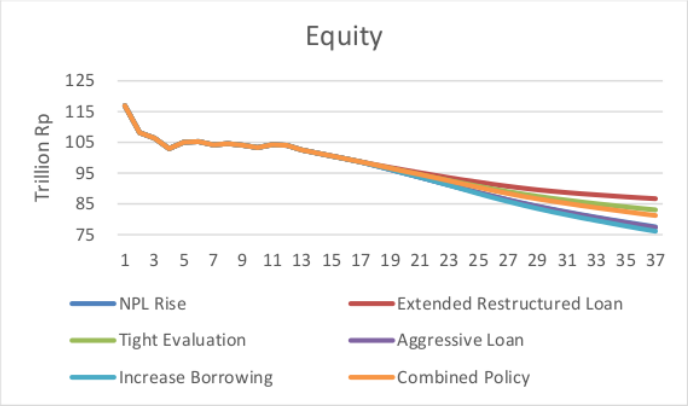
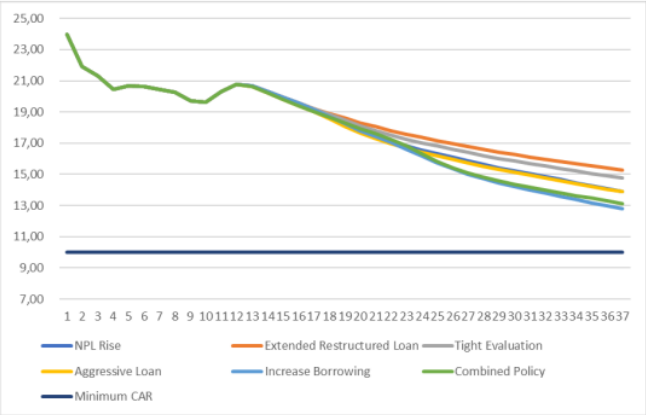


Figure 18:

Comparison Policy Scenarios for Capital Adequacy Ratio (CAR) in %



The downward trend in bank capital with growth in credit and marketable securities led to a decrease in the CAR ratio as a measure of a bank's ability to absorb risk. On December 31, 2020, Bank BNI's CAR reached 22%. However, based on the simulation results, the CAR ratio decreased to between 13% and 16% by the end of 2022, as shown in Figure 18. This condition illustrates the increased risk of bank bankruptcy during the COVID-19 pandemic.

6. Conclusion

The model simulation illustrates that when 50% (IDR 150 trillion) of the restructured credit value in 2020 becomes a non-performing loan, it tends to raise NPL Ratio to 15.7% in the 22nd month and decrease to 10.4% at the end of 2022. High NPL leads to more aggressive loan and, in turn, decreases the fund availability. The impact of this situation decreases equity by approximately 34% from 2020 to 2022 by 765 billion Rupiah with a significant decrease in the CAR ratio. In conclusion, the credit and bank bankruptcy risk increased during the COVID-19 pandemic. Therefore, the success of a bank policy designed to address this simulation depends on economic growth.

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Appendix. Initial Values and Constant Values of the Baseline Model

Name	Unit	Initial Values	Variable Type
Accumulated depreciation	million Rp	8,682,446	level
Accumulation impairment of loan	million Rp	16,999,405	level
Borrowing	million Rp	80,372,215	level
Borrowing Stock	million Rp	80,372,215	level
Buyback stock cumulative	million Rp	-	level
Dividend payment cumulative	million Rp	-	level
Equity	million Rp	116,898,206	level
equity adjustment cumulative	million Rp	-	level
Fixed Asset	million Rp	69,282,608	level
Impairment losses reserve of MS	million Rp	278,614	level
Liquid Asset	million Rp	105,336,365	level
Marketable Securities MS	million Rp	108,828,780	level
National loan market 2020	million Rp	8,280,811,798	level
Non-performing loan NPL	million Rp	12,172,350	level
NPL Write Off Accumulation	million Rp	-	level
Performing loan	million Rp	507,181,260	level
Restructured Loan	million Rp	-	level
Restructured loan cumulative	million Rp	-	level
Tax Expenses stock	million Rp	-	level
Tax Expenses Stock Delayed	million Rp	-	level
Tax Income Cumulative 2020-2022	million Rp	-	level
Third party fund TPF	million Rp	582,966,966	level
Total profit Before tax	million Rp	-	level
TPF National model 2020	million Rp	6,690,965,987	level
Adjust time end	Month	6	constant
Adjust time end credit	Month	60	constant
Adjust time start	Month	1	constant
Adjust time start for credit	Month	3.5	constant
Adjustment delay impairment rate	Month	3	constant
Capital Adequacy Ratio Standard	%	8%	constant
Central bank reserve rate		5%	constant
Converter month to year	Month/Year	12	constant
Cost to Income Ratio 2021	%	44.20%	constant
COVID time	pada Month to	3.07	constant
Credit Impact in COVID situation assumption		1	constant
Credit Risk Factor in Pandemic		80%	constant
Delay profit before tax	Month	12	constant
Delay time for restriction loan	Month	2	constant
Delay time normalize credit	Month	1	constant
Delay time paid NPL Write off	Month	24	constant
DPK BNI GROWTH 2021	per year	8%	constant
Duration	Month	12	constant

Name	Unit	Initial Values	Variable Type
Elasticity asset to market share		30%	constant
Expected Loan to funding ratio LFR		80%	constant
Expected ratio liquid asset to third party fund		17%	constant
Limit LDR		92%	constant
LOAN GROWTH 2021	per year	6%	constant
Loan maturity	per month	0.20%	constant
Margin Target	%*per year	2	constant
Normal Savings Period	Month	500	constant
Maturity rate borrowing	Month	60	constant
Maximum number of COVID impact to credit		0.8	constant
Multiplier for time step adjustment		1.5	constant
Multiplier for TPF National Growth Rate		1	constant
Multiplier maturity rate in restructured		1.5	constant
Multiplier test interest expense		1	constant
Multiplier test interest income		1	constant
NIM	per year	5.22%	constant
NPL 2020		2.90%	constant
NPL Multiplier due to COVID assumption		2.1	constant
NPL Ratio 2021		4.50%	constant
NPL Target		4.00%	constant
NPL Write off rate	per month	2.40%	constant
Payment Fraction of Write of Loan		20.00%	constant
Prior year profit	million Rp	17602910	constant
Ratio Return Rate MS to Loan Rate		01-Mar	constant
Realized NPL rate	per month	0.22%	constant
Repeat period	Month	12	constant
Reserve rate to central bank		5.0%	constant
Response time to credit	Month	1	constant
Rest Loan Fraction to NPL		0	constant
ROA 2021	per year	0.64%	constant
ROE 2021	per year	5.05%	constant
Month time unit	Month	1	constant
sensitivity to ratio interest rate		5	constant
Target liquid asset to financing ratio		0.14	constant
Target loan impairment rate	per month	0.0055	constant
Target NPL restructuring		0.0025	constant
Time change credit risk	pada Month to	13	constant
Time for end policy restructured Loan	pada Month to	16	constant
Time to average loan market	Month	12	constant
Time to change impairment	pada Month to	13	constant
Time to correct borrowing correction	Month	1	constant
Time to correct performing loan	Month	1	constant
Time to distribute additional loan	Month	1	constant

Name	Unit	Initial Values	Variable Type
Time to liquid asset correction	Month	1.5	constant
Time to outflow restructured loan	Month	1	constant
Time to restructuring	Month	2	constant
Timing to average interest rate	Month	6	constant
Transition time rest loan to NPL	Month	2	constant
Profit and loss period	Month	1	constant
TPF national growth (per month)	Per month	1.15%	Graph
TPF national growth (per year)	per year	13.80%	Graph
BNI market share		13.00%	Graph
Loan market growth	Per month	0.20%	Graph
Loan market growth	per year	2.40%	Graph
BNI loan market share		6.20%	Graph
Liquid asset to financing ratio target		15.00%	Graph
Rate of depreciation (per month)	Per month	0.10%	Graph
Rate of depreciation (per year)	per year	1.20%	Graph
Rate of return financial asset (%/year)	per year	0.94%	Graph
Interest rate saving	per year	2.79%	Graph

Contribution of individual authors to the creation of this scientific article:
Taufiq Hidayat carried out the conception and design of the work, drafting the article.
Dian Masyita reviewed the literatures and final approval of the version to be published.
Sulaeman Rahman Nidar reviewed data analysis and interpretation.
Erie Febrian worked on critical revision of the paper.
Fauzan Ahmad worked on data collection, the modelling and simulation.

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