# Determining Credit Risk Using Contingent Claim Model Approach (Merton Model); A Case Study of Indonesian Digital Banks

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**Abstract.** The Covid-19 pandemic in Indonesia has an unfavorable influence on the banking sector; not only economic and financial policies in adjusting conditions significantly affect companies, but people are also currently turning to the digital era with a relatively high number of customer increases. Thus, this study aims to measure credit risk at digital banks in Indonesia using the 1974 Merton model to assess the company's bankruptcy and see the influence between BOPO, NIM, and LDR in it. The sample used was the five best digital banks according to the Bank Indonesia report in 2021, using the 1974 Merton model measurement method, standard deviation, calculating the distance to the default of each company, calculating the default probability using the distance to default, and empirical tests (influence). The results obtained are default withdrawals on digital banks in Indonesia, in general, it can be in say it is not good enough in terms of the effect of the empirical test results that have been carried out regarding the relationship between BOPO, NIM, and LDR on the default probability, the results of the BOPO variable coefficient are negative, the NIM variable coefficient is positive, and the LDR variable coefficient is negative.

**Keywords:** Merton Model · Credit Risk · BOPO · NIM · LDR

## 1 Introduction

The spread of the Corona Virus disease 2019 (COVID-19) pandemic negatively affected the economy. Pressure on financial markets and the economy results in an aggressive response from monetary authorities. Steps taken by the government include lowering interest rates. In macroeconomics, interest rates are one of the factors that can affect the level of bank profitability. During the COVID-19 pandemic, the banking sector was not free to channel its credit; this was due to the high risk of default from creditors because some private citizens and companies experienced a decreased income. The high credit risk can potentially create liquidity risk for the banking sector. The probability of bankruptcy is a crucial indicator of bank stability. The insta-bility of the banking sector can spread to other sectors through various forms, namely the disruption of the payment


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system, the decrease in the amount of credit, and the freezing of bank customer deposits. Due to its severe and widespread impact on the economy, regulators generally issue regulations that aim to maintain the banking sector's stability by regulating the level of competition between banks and bank efficiency. More efficient banks are expected to be more stable and resilient to economic and business cycle shocks [1].

Banks with a high percentage of non-interest income tend to have a high probability of default compared to banks that focus on the conventional bank business of lending. The bank's entry into non-traditional activities involving complex derivative transactions is an entry point to increase the bank's exposure to market risk. Diversification initially has a good impact on bank income, where the volatility of bank income can be reduced. Revenue diversification at this early stage generally occurs naturally due to customer demand for more complete bank services. However, suppose the proportion of non-traditional income begins to be dominated by bank income from securities trading activities, derivative securities transactions, and other high-risk activities. In that case, diversification will cause bank stability to decline drastically, and the probability of bankruptcy soars [2].

The relationship between diversification and the probability of bank failure can have a U shape. Hovakimian et al. [3] show that high loan interest rates will increase the risk of bank loan portfolios due to adverse selection in the bank loan process, where projects financed by banks are classified as poor-quality projects. The high costs that the company must pay will encourage low-risk debtors to avoid bank funding and seek other funding sources through the capital market with a much lower cost of funds.

The relationship between income diversification and bank stability is influenced by three factors that characterize a bank: the BOPO Ratio (Operating Expenses divided by Operating Income), NIM (Net Interest Margin), and LDR (Loan to Deposit Ratio). LDR shows the bank's ability to manage lending activities and supervision of its customers as well as the level of aggressiveness of the bank (risk-taking behavior) in lending. This study will measure the default probability of banks whose shares are listed on the Indonesia Stock Exchange by applying the Merton Model and test the significance of the relationship between default probability, which is a measure of bank stability, and the BOPO, NIM, and LDR variables respectively on digital banks.

## 2 Research Method

The population selected by researchers in this study was the banking sector and had completed financial reports for the period 2020–2021; the research sample selected was based on the 2021 Bank Indonesia report, which showed the five largest digital bank companies in Indonesia, as shown in Table 1.

This study uses the contingent claim framework from Merton [4] to measure a bank's default risk. Merton's model positions the value of bank equity as a call option on the bank's own assets. The probability of default is measured using the distance to default, which is the difference between the value of the firm's assets and the face value of its debt. As Merton [4] points out, the market value of bank equity can be modeled as a call option on the bank.

**Table 1.** The five largest digital bank companies in Indonesia.

| Bank Code | Bank |
|---|---|
| BTPN | Bank Jenius |
| ARTO | Bank Jago |
| BBYB | Neo Bank |
| BNLI | Permata Me |
| BABP | Motion |

Calculate the standard deviation value of the company's total asset return [5]. In this equation, we will use the results of the calculation of asset re-turns from the first equation. The following formula can calculate the standard deviation:

$$\sigma = \sqrt{\left(\left(\sum_{t}^{n=1}[(\mathrm{xi} - \mathrm{x})]^2\right) \Big/ \mathrm{n} - 1\right)}$$

Description:
$\sigma$ = Standard Deviation
n = Number of Data = i-th data (i = 1,2,3,… N)
x = Sample average

Calculate the distance to the default of each company with the following formula,

$$\mathrm{DD} = \left(\ln\ \mathrm{Vo/B} + \left(\mathrm{r} - 1/2\,\sigma^2\right)\mathrm{T}\right)\left(\sigma\sqrt{\mathrm{T}}\right)$$

Where,
DD = Distance to Default = total asset
B = total liability
r = risk-free interest rate / BI Rate
$\sigma$ = standard deviation of total asset return in the previous equation calculation.

Calculate the probability of default by using the distance to default of companies with different distance to default values with the following formula

$$\mathrm{PD} = \mathrm{N}(-\mathrm{DD})$$

Where,
PD = Probability of Default
N = Distribution to N.

## 3 Results and Discussion

The first step is the result of the Black-Scholes-Merton Option formula for call options in Table 2.

**Table 2.** Merton Model (Black-Scholes Option Formula)

| Black-Scholes Option | Value |
|---|---|
| SP | 3981237.969 |
| ST | 3982212.491 |
| Volatility | 3403.60042 |
| Risk Free Interest Indonesia 2022 | 0.035 |
| Dividends | 54.25 |
| Result | |
| Call Price | 0.799201389 |
| Put Price | 2,367,770,23 |

Source: Data results processed using Black-Scholes Calculator

A stock option is the right owned by a party to buy (call option) and or sell (put option) to another party for several shares (underlying stock) at a price (strike price) and within a specific time from the data above shows that the digital bank company at the call price has a value of 0.799 and a put price of 2,367,770.23, to see the default on digital banking is depicted in the graph below.

Table 3 exhibits 5 digital banks, namely Bank Genius, Bank Jago, Neo Bank, Permata me, and Motion Bank, from Distance-to-Default, processed into a statistical description which results in bank genius has a value of 4.70578 with a standard deviation of 2.48746, while Bank Jago value is 6.39229 and a standard deviation of 1.41123, Neo Bank value is 4,81451 while the standard deviation is 5.54643, Permata me value is 4.69792 with a standard deviation of 1.96112, and motion bank 4.67706 with a standard deviation of 3.24874, from these data it can be said that the value of Bank Jago as a digital bank is greater than other banks, but not for the standard deviation as Neo Bank has the highest value; this may be because these two banks in 2020–2021 are trending among young people to provide high-interest rates to customers and marketing strategies. For the lowest default, as for the bank failure of the Merton results can be seen in the following Probability of Default Table 4.

**Table 3.** Merton's Distance-to-Default Calculation Results for 2020 and 2021 Period.

| Bank Code | Bank | Value | Std. Deviation |
|---|---|---|---|
| BTPN | Bank Jenius | 4.70578 | 2.48746 |
| ARTO | Bank Jago | 6.39229 | 1.41123 |
| BBYB | Neo Bank | 4.81451 | 5.54643 |
| BNLI | Permata Me | 4.69792 | 1.96112 |
| BABP | Motion Bank | 4.67706 | 3.24874 |

**Table 4.** Results of Merton's Probability of Default Calculation for the 2020 and 2021 Periods.

| Bank Code | Bank | Value | Std. Deviation |
|---|---|---|---|
| BTPN | Bank Jenius | 2.2942 | 2.48746 |
| ARTO | Bank Jago | 0.6077 | 1.41122 |
| BBYB | Neo Bank | 2.1855 | 5.54642 |
| BNLI | Permata Me | 2.3021 | 1.96111 |
| BABP | Motion Bank | 2.3229 | 3.24874 |

**Table 5.** Empirical Test Results.

| Variable | T Coefficient | Sign |
|---|---|---|
| Constant | 7.566 | 0.084 |
| BOPO | −0.891 | 0.080 |
| NIM | 0.515 | 0.697 |
| LDR | −0.681 | 0.619 |
| R Square | 0.991 | |

From Table 4, it can be seen that the Probability of Default to Bank Jenius, Neo Bank, Permata Me, and Motion Bank is still quite controllable, but Bank Jago has a very high failure vulnerability with a value of 0.6077, with the increase in Distance-to-Default, the risk in probability becomes very vulnerable [6]. As for the Probability of Default data, an empirical test of the influence with BOPO, NIM and LDR is carried out, the following is a table of empirical test results that have been carried out.

Table 5 shows that the regression equation produces a positive constant val-ue of 7.566 with a significance of 0.084; this indicates that the effect data is said to be good and does not need repetition, the coefficient of the BOPO variable obtained a negative value of −0.891 which means that any increase or decrease in BOPO, credit risk with a contingent claim approach (Merton model) does not increase by −0.901.

## 4 Conclusion

The conclusion refers to the research results and discussion above that in the Merton model with the Black-Scholes Option Formula on the optional digital bank company, the call price has a value of 0.799 and a put price of 2,367,770.23, while the withdrawal of default on digital banks in Indonesia, in general, can be said to be not good enough, the next is the result of the calculation of Merton's distance-to-default for the 2020 and 2021 periods where the bank value of Bank Jago as a digital bank is greater than other banks, but not for the standard deviation which has the highest value is neo bank, after determining the Distance-to-Default, the calculation used is Merton's probability of default which has the results of 4 fairly good banks. With a high risk of default on

Bank Jago, the probability of default value is used as an influence variable in empirical tests. The results of empirical tests that have been carried out regarding the relationship between BOPO, NIM, and LDR on the probability of default have results on the BOPO variable coefficient obtained a negative value of −0.891, on the NIM variable coefficient obtained a positive value of 0.515, and the LDR variable coefficient obtained a negative value of −0.681.

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