

The Effects of Macroeconomics on Probability of Default for the Micro Business Segment

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ABSTRACT

This research explains the influences of macroeconomics on the Probability of Default (PD) for the micro business segment in Indonesia. The model used to measure credit risk indicators is based on Days Past Due (DPD) and collectability to calculate the PD in accordance with the company's internal historical data. Then, multiple linear regression was performed to find out whether changes in macroeconomic variables consisting of Gross Domestic Product (GDP), inflation, the IDR exchange rate against the USD, and unemployment rate can affect the PD for the micro business segment in Indonesia. In the light of the results of statistical tests, it was found that macroeconomic changes, especially macroeconomic variables, such as inflation and the IDR exchange rate against the USD, have significant effects on the PD for the micro business segment for each loan bucket. The results of this research are expected to provide an overview of Indonesian banks in expanding loans, especially for the micro business segment, and be of use as a reference in developing credit risk measurement policies in order to improve the principle of prudence.

Keywords: Credit Risk, Default, Probability of Default, Macroeconomics, Gross Domestic Product, Inflation, Exchange Rate, Unemployment Rate, Micro Business Segment.

1. INTRODUCTION

Banking plays a significant role in a country's economy, and the banking industry is considered to be an industry which is prone to economic conditions. If a country undergoes economic development, the banking industry also develops. Conversely, if a country faces a crisis, the banking industry will be negatively impacted. However, when economic conditions are in crisis, economic actors need an injection of funds or additional capitals from banks to sustain their businesses, so the national economy can run even better. Ginting [1] states that the higher the GDP increases, the lower the non-performing loan (NPL) ratio will be. On the other hand, interest rates and inflation have positive and significant impacts on the increase in the NPL ratio of banks in various economic sectors. Caro [2] explains that macroeconomic indicators which have an influence on the development of a country's economy include GDP, inflation, and the unemployment rate. Meanwhile, according to Bank Indonesia, the main macroeconomic

indicators which affect the development of a country's economy are GDP, inflation, exchange rates, and unemployment rate.

This research was conducted at one of the national banks which has a micro loan market share which was recorded at 51.8% in March 2019 or increased by 0.01% from 51.7% in March 2018. Bank XXX has the largest portion of micro-credit distribution, with a total account micro segment in the range of 1.816.150 – 4.354.427 and a Micro NPL ratio in the range of 1.01% - 1.83% during the period of 2011-2018. Crouhy, Galai [3] mentions that credit risk is the risk of changes in the quality of debtor credit which can affect the value of a bank. The decline in debtor credit quality is reflected in the increasing NPL.

Probability of Default (PD) is the main component in calculating expected credit loss to assess whether there is a significant increase in credit risk and determine the probability of a debtor's default. Quagliariello [4] finds that a downturn in

macroeconomic performance can increase the risk of default. According to Caro [2], macro-economic variables which can affect the performance of the Micro Finance Institution is the growth of GDP, the unemployment rate, inflation, and investment from abroad, considering that credit risk is generally present in all activities of banks as intermediary institutions, such as the performance of borrowers and macroeconomic factors which can affect credit quality. In accordance with IFRS 9, effective in Indonesia January 1, 2020 banks in calculating credit losses not only use arrears information, but also all relevant credit information including macroeconomic information looking for the future, so calculating credit losses more accurately.

The objective of this research is to determine whether changes in macroeconomic variables can affect the PD for the micro business segment. The calculation of PD for the micro business segment is carried out by using the migration analysis method by measuring transition probabilities of relatively homogeneous credit so that the movement of the PD can be seen. Furthermore, the migration rate is calculated based on the presentation of the credit value or the number of accounts which have moved from one period of arrears, in which credit is regarded as not being collectible (default). The testing methodology used to see the effect of macroeconomics as an independent variable, which consists of GDP, inflation, exchange rates, and unemployment rates, to the dependent variable is PD by using multiple linear regression on SPSS 23 computer program. The regression results are used to draw the hypothesis by looking at the significance probability value of each of the variables contained in the output of the regression analysis results.

Hereinafter, this research was complemented by literature review, research methodology, result analysis, discussion which led to a conclusion.

2. LITERATURE REVIEW

According to Pindyck, Rubinfeld [5], macroeconomics is a branch of economics that deals with economic aggregate variables, such as the rate and average growth of national production, unemployment, interest rates, and inflation. Another study related to the effect of macroeconomic variables on NPL was conducted by Louzis, Vouldis [6], whose results state that a deteriorating economic development of a country could increase banking's bad credit. Similarly, when the economy of a country improves, the level of bad credit decreases.

The results of a study by Laila, Pangestuti [7] point out that GDP has a negative effect on credit risk as measured through NPL. This means that increased economic growth will reduce credit risk. Economic

growth refers to the growth of activities related to the economy that enables the products and services created by a society to increase. However, in contrast to the study, Katsushi, GAIHA [8] states that economic factors, such as GDP, have a positive impact on the performance of Micro Finance Institutions (MFIs). MFIs are financial institutions that are established to give loans or financing for micro-scaled business. This study was performed to find out whether changes of GDP can affect the PD of the borrowers in the micro business segment in Indonesia.

Moreover, Fofack [9] states that high inflation rates hamper people from paying credit to banks, thus raising the bad credits of banks. As a result, many banks have lost their funds for expansion. Conversely, Laila, Pangestuti [7] assert that inflation negatively affects credit risk, meaning that an increase in inflation does not increase the NPL, especially in the state-owned banks.

According to Mankiw [10], foreign exchange, or often called the exchange rate, is the price level agreed upon by residents of the two countries to trade with one another. Laila, Pangestuti [7] state that the exchange rate has a negative impact on NPLs, meaning that the increase in the exchange rate will not be followed by an increase in NPLs.

The study by Caro [2] shows unemployment in a level that represents the percentage of people in productive age who are unemployed compared to the number of people who are part of a country's population. Common causes of unemployment are the lack of employment and of skilled workers. Fundamentally, the higher the economic development achieved by a country is, the more job opportunities will be available to workers. Visconti [11] explains that the bargaining power of productive-age workers decreases when a recession occurs, whereas the risk of unemployment rate will increase.

Furthermore, the research results of Caro [2] reveal that MFIs provide loans to people who do not have access to the financial system to build or develop their businesses. Meanwhile, Blanchard [12] explains that unemployment rate is a ratio of the number of people who do not have a job compared to the number of people in the workforce.

The research results of Zsigraiová [13] show that Probability of Default (PD) is the key to credit risk parameters that can be used to estimate potential credit losses. Based on Basel II, the default criteria include loans which have been in arrears for principal and/or interest held for more than 90 days or loans or exposures which are declared to have collectability of ≥ 3 at the consideration of the bank's management. Credit risk assessment using the Internal Default Experience method can be carried out by employing several

approaches. According to Altman and Saunders [14], migration analysis is a method of measuring credit risk by quantifying transition probabilities of relatively homogeneous credit to be able to see the likelihood of a default. The migration method used to estimate transition probabilities refers to the Markovian model. Meanwhile, the migration rate is calculated based on the presentation of the credit value or the number of accounts which have moved from one period of arrears, in which credit is regarded as not being collectible (default).

3. RESEARCH METHODOLOGY

In this research, risk indicators were assessed based on Days Past Due (DPD), taken from internal historical data which are a source of data used in PD modelling. DPD indicates the number of days by which the payment is delayed. Reflecting on the data held by banks, modelling will consider DPD and collectability data as the main components of calculation. PD calculation was conducted by grouping PD buckets according to DPD into three buckets, referring to the provisions of Basel [15] paragraph 452. The definition of default is based on loans which have been in arrears on principal and/or interest obligations held for more than 90 days, or credit exposures which are declared as default and possess collectability of ≥ 3 .

The calculation of PD was based on an account base. The matrix transition was then applied using the DPD obtained from the bank's historical data. The standard specifications to determine the probability of a transition rating were derived from the Markov model, which is based on the probability of migration from one ranking class to another, depending only on the current rating and the probability of changing from one class rating at time t to another class at time $t+n$ irrespective of t . Meanwhile, the time of default applied is the cohort method, in which the default exposure refers to all exposures which have been default for twelve months of performance

The steps taken to calculate PD micro segment credit estimates are as follows: 1) conducting an account selection included in Bucket 3 for data analysis; 2) analyzing account performance (default flag) for the next twelve months based on the predefined default definitions; and, 3) analyzing default rate analysis per each bucket to find out the default percentage of accounts in each bucket to later be used as an estimation for PD in the future. Regression analysis was performed for each bucket with the detailed regressions of Bucket 1, Bucket 2 and Bucket 3. The value of PD with

Table 1. Grouping of Bucket Probability of Default based on DPD:

Bucket	Delay in Days	Description
1	No delay	Collectability 1
2	1- 90 days	Collectability 2
3	> 90 days	Collectability 3, 4, 5 & Write Off

transition matrix can be calculated with the following formula:

$$P_{i,j} = \frac{N_{ij,t}}{N_{i,j}} \tag{1}$$

Validation on the PD calculation model was conducted by comparing between PD in the model and the actual default rate. Model validation for calculating credit risk can be done using the Kupiec Test by using Likelihood Ratio (LR) Test method. LR Test was used to determine whether the actual default rate exceeds PD value during the observation period of January-June 2019. Such LR value was subsequently compared to Chi-Squared value in the distribution table in accordance with the expected confidence level. If LR value = < Chi-Squared value, PD calculation model will be accepted, and backtesting is tested. However, if LR value = > Chi-Squared value, PD calculation model will be rejected, and backtesting is not tested. In validating the model, a Likelihood statistical test was conducted with the following formula:

$$LR = -2\ln[(1 - \alpha)^{T-v} \alpha^v] + 2\ln \left\{ \left[1 - \left(\frac{v}{T} \right) \right]^{T-v} \left(\frac{v}{T} \right)^v \right\}$$

$$LR = -2\ln[(1 - \alpha)^{T-v} \alpha^v] + 2\ln \left\{ \left[1 - \left(\frac{v}{T} \right) \right]^{T-v} \left(\frac{v}{T} \right)^v \right\} \tag{2}$$

PD calculation period was meant to be carried out from January 2011 to December 2018, while backtesting period was supposed to be performed from January 2019 to June 2019. In order to obtain PD value for the period of January 2011-December 2018, account data from January 2009 to December 2018 were needed. The indicator used to see the debtor's default probability in satisfying his/her obligation was PD, while the macroeconomic variables being used were GDP, inflation, exchange rate, and unemployment rate.

This research employed multiple linear regression to see the impact of macroeconomic factors on PD. Santoso [16] says that multiple linear regression is used to predict the magnitude of a dependent variable using two or more independent variables data whose value has been known.

Table 2. Structure of a Transition Matrix:

Bucket at the beginning of the observation period	Bucket	Bucket at the end of the observation period		
		Bucket 1	Bucket 2	Bucket 3
	1	Probability of Bucket 1 remaining in Bucket 1	Probability of Bucket 1 being transferred to Bucket 2	Probability of Bucket 1 being transferred to Bucket 3
	2	Probability of Bucket 2 being transferred to Bucket 1	Probability of Bucket 2 remaining in Bucket 2	Probability of Bucket 2 being transferred to Bucket 3
	3	Probability of Bucket 3 being transferred to Bucket 1	Probability of Bucket 3 being transferred to Bucket 2	Probability of Bucket 3 remaining in Bucket 3

Table 3. Descriptive Statistics on Independent Variables

Bucket	Variabel	N	Min	Max	Mean	Std. Deviation
Bucket 1	GDP	96	-0.0247	0.0651	0.025166	0.0268467
	Inflation	96	0.0279	0.0879	0.050270	0.0169110
	Unemployment rate	96	0.0513	0.0748	0.059750	0.0061454
	IDR/USD Exchange rate	96	8532,00	15178,87	11813,8831	1995,87220
Bucket 2	GDP	96	-0.0247	0.0651	0.025166	0.0268467
	Inflation	96	0.0279	0.0879	0.050270	0.0169110
	Unemployment rate	96	0.0513	0.0748	0.059750	0.0061454
	IDR/USD Exchange rate	96	8532,00	15178,87	11813,8831	1995,87220
Bucket 3	GDP	96	-0.0247	0.0651	0.025166	0.0268467
	Inflation	96	0.0279	0.0879	0.050270	0.0169110
	Unemployment rate	96	0.0513	0.0748	0.059750	0.0061454
	IDR/USD Exchange rate	96	8532,00	15178,87	11813,8831	1995,87220

In multiple linear regression analysis, the dependent variable is influenced by two or more independent variables so that there is a functional relationship between the dependent variable (Y) and the independent variables (X1, X2, Xn). The multiple linear regression in this research was conducted using SPSS 23. The multiple linear regression analysis can be formulated in the following equation:

$$Y_t = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + e \quad (3)$$

with information:

- Yt : Probability of Default (PD)
- X1 : GDP
- X2 : Inflation
- X3 : IDR/USD Exchange rate
- X4 : Unemployment rate
- a : Constanta
- b : Regression Coefficient
- e : Error

This research used the actual data of GDP based on the applicable prices, inflation, exchange rate, and unemployment rate for the period of January 2011-

December 2018, and PD values for the micro-segment credit population were in accordance with the nationally collected credit quality for the period of January 2011-December 2018.

4. RESULTS

This research examines the effects of GDP, Inflation, Unemployment Rate and Exchange Rate on the PD. The data were classified into 3 buckets. The dependent variable in this research is PD. PD is used in various credit analysis and risk management frameworks. In the descriptive statistics analysis, the researcher will explain the minimum value, maximum value, mean, and standard deviation of the dependent and independent variables. The descriptive statistics of independent variables are as follows.

Based on Table 3, it can be seen that the sample of research (N) is 96 data. The table also shows the minimum value, maximum value, mean and standard deviation of each variable. That table is used to identify the data deviation on the research variables.

Table 4. The Results of Regression on the Effect of Macroeconomic Variables on Probability of Default based on their Bucket

Model	Variable	Coefficient	Significance	Description
Bucket 1	GDP	0.101	0.007	GDP has a significant positive effect on PD
	Inflation	-0.289	0.000	Inflation has a significant negative effect on PD
	Unemployment rate	1.994	0.000	Unemployment rate has a significant positive effect on PD
	IDR/USD Exchange rate	-0.046	0.000	Exchange rate has a significant negative effect on PD
Bucket 2	GDP	0.106	0.709	GDP has an insignificant positive effect on PD
	Inflation	-1.189	0.009	Inflation has a significant negative effect on PD
	Unemployment rate	1.911	0.370	Unemployment rate has an insignificant positive effect on PD
	IDR/USD Exchange rate	-0.343	0.000	Exchange rate has a significant negative effect on PD
Bucket 3	GDP	-0.029	0.028	GDP has a significant negative effect on PD
	Inflation	0.176	0.000	Inflation has a significant positive effect on PD
	Unemployment rate	-0.062	0.531	Unemployment rate has an insignificant negative effect on PD
	IDR/USD Exchange rate	-0.042	0.000	Exchange rate has a significant negative effect on PD

Table 5. Comparison Actual Default Rate and Calculation Probability of Default

No	Period	Bucket	Actual Default Rate	Probability of Default	Gap	Binary Failure
1	20190131	1	4.63%	4.97%	-0.33%	0
2	20190228	1	4.12%	4.92%	-0.80%	0
3	20190331	1	4.39%	4.90%	-0.52%	0
4	20190430	1	4.41%	4.88%	-0.48%	0
5	20190531	1	4.49%	4.87%	-0.38%	0
6	20190630	1	4.35%	4.84%	-0.48%	0
7	20190131	2	54.16%	54.38%	-0.22%	0
8	20190228	2	47.12%	54.23%	-7.12%	0
9	20190331	2	54.22%	54.50%	-0.29%	0
10	20190430	2	54.16%	54.61%	-0.45%	0
11	20190531	2	56.23%	54.79%	1.44%	1
12	20190630	2	53.85%	54.83%	-0.98%	0
13	20190131	3	97.07%	96.57%	0.51%	1
14	20190228	3	96.44%	96.56%	-0.12%	0
15	20190331	3	96.84%	96.60%	0.24%	1
16	20190430	3	96.11%	96.60%	-0.49%	0
17	20190531	3	96.07%	96.59%	-0.52%	0
18	20190630	3	96.45%	96.61%	-0.16%	0
Amount						3

The research results in Bucket 1, Bucket 2 and Bucket 3 models show that the variables of Gross Domestic Product (GDP), Inflation, Unemployment Rate and Exchange Rate collectively affect the Probability of Default (PD). Macroeconomic variables which influence the Probability of Default are shown in p value in the amount of 0.000 (p<5%) In this research, a multiple linear regression analysis was performed to test the impact of GDP, Inflation, Unemployment Rate and Exchange Rate on the dependent variable, which is PD. Based on the results of data processing, the regression equation is as follows:

Bucket 1:

$$Y_t = 0.385 + 0.101X_1 - 0.289X_2 + 1.994X_3 - 0.046X_4 + e \tag{4}$$

Bucket 2:

$$Y_t = 3.711 + 0.106X_1 - 1.189X_2 + 1.911X_3 - 0.343X_4 + e \tag{5}$$

Bucket 3:

$$Y_t = -0.029X_1 + 0.176X_2 - 0.062X_3 - 0.042X_4 + e \tag{6}$$

The validation of the PD calculation model was conducted using LR Test with 5% significance level.

According to the table above it is known that the amount of binary failure is 3, and resulting the value of LR Test is 3.29, which means that the value is lower than the critical value with 95% confidence level at one degree of freedom, or $LR < 3.84$. Based on the LR Test results, it can be concluded that a PD calculation model using migration analysis was reliable to be used in this research.

5. DISCUSSION

Based on the research results, the PD for the micro-segment credit is affected by the changes in macroeconomic factors. In this research, it was found that GDP has a significant positive effect on Bucket 1 and Bucket 2 models. This implies that an increase in GDP of 1 unit will increase PD by 0.101 unit, but Bucket 2 model shows different results, in which GDP has an insignificant positive effect on PD. In contrast, the results in Bucket 3 show that PDB brings about a significant negative effect on PD borrower in micro-segment business, meaning that an increase in GDP of 1 unit will decrease PD by 0.029 unit. The results in Bucket 3 carried out is in line with the results of research from Katsushi, GAIHA [8] which states economic factors such as GDP have a positive impact on the performance of financial institutions that have given loans or financing for micro-scaled business.

Moreover, it was found that inflation has a significant negative effect on PD for Bucket 1 and Bucket 3 models meaning that every increase in inflation of 1 unit will decrease PD by 0.289 unit for Bucket 1 and by 1.189 unit for Bucket 2 loan. The results of the research carried out is in line with the results of research from Zsigraiová [13] found that inflation affected the movement of Probability of default (PD). The results of this study support the results of research by Laila, Pangestuti [7] which states that inflation has a negative effect on credit risk, meaning that an increase in inflation does not increase the NPL, especially in commercial banks. However, Bucket 3 shows the opposite results as inflation has a significant positive effect; an increase in inflation of 1 unit will decrease PD by 0.176 unit.

Unemployment rate exerts a significant positive effect on Bucket 1 model, meaning that an increase in unemployment rate of 1 unit will increase PD by 1.994 unit. On the other hand, unemployment rate has an insignificant effect on PD for Bucket 2 and Bucket 3 models. The results of the research carried out in line with the results of research from Zsigraiová [13] which states that the unemployment rate cannot clearly prove its effect on the movement of PD.

Last but not least, exchange rate produces a significant negative effect on PD for Bucket 1, Bucket 2 and Bucket 3 models. Probability values for all these buckets are lower than 5%, indicating that exchange rate only has an insignificant negative effect on PD. The results of the research carried out in line with the results of research from Zsigraiová [13] which states that exchange rates affect the movement of PD.

6. CONCLUSION

The objective of this research is to observe the impacts of macroeconomic factors on the Probability of Default (PD) for micro-segment credit in Bank XXX for the period of January 2011-December 2018. It can be concluded that PD for the micro-segment credit is, indeed, affected by changes in macroeconomic variables, including GDP, inflation, exchange rate, and unemployment rate. The results for Bucket 1 model indicate that GDP, inflation, exchange rate, and unemployment rate bring about significant effects on PD. Differently, the results for Bucket 2 model reveal that only inflation and exchange rate have significant effects on PD. Meanwhile, concerning the results for Bucket 3, GDP, inflation, and exchange rate exert significant effects on PD. Nevertheless, the impacts of macroeconomic factors on each business sector may vary. By classifying the default based on the business sector, the researcher could have obtained a better and more accurate Probability of Default calculation.

Since businesses in Indonesia predominantly fall into the Micro, Small and Medium Enterprises (MSME) segment, supervision on macroeconomic changes by the government and regulators is very important so that such changes will not bring about significant and adverse effects on businesses, especially those in the micro business segment. It is important to note that the timeframe of this research is limited from January 2011 to December 2018, and the backtesting period is from January 2019 to June 2019. During these periods, Indonesia's economy was not in crisis. By extending the time span, enhancing the backtesting period, and expanding the samples, more accurate results of the measurement of impacts of macroeconomic changes on PD for the micro-segment credit in Bank XXX can be achieved.

REFERENCES

- [1] A. M. Ginting, "Pengaruh Makroekonomi Terhadap Non Performing Loan (NPL) Perbankan", *Jurnal Ekonomi & Kebijakan Publik*, vol. 7, no. 2, pp. 159-170, 2017.
- [2] E. J. Caro, "Effects of Macroeconomic Factors in the Performance of Micro Finance Institutions in Ecuador", *International Journal of Economics and Financial Issues*, vol. 7, no. 5, pp. 547, 2017.

- [3] M. Crouhy, M., D. Galai, and R. Mark, *Risk Management*, New York, NY: McGraw Hill, 2001.
- [4] M. Quagliariello, "Banks' riskiness over the business cycle: a panel analysis on Italian intermediaries", *Applied Financial Economics*, vol. 17, no. 2, pp. 119-138, 2007.
- [5] R. Pindyck et al., *Microeconomics 7Th Edition*. Pearson Education, Inc. 2009.
- [6] D. P. Louzis, A.T. Vouldis, and V.L. Metaxas, "Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios", *Journal of Banking & Finance*, vol. 36, no. 4, pp. 1012-1027, 2012.
- [7] N. Laila, I. D. Pangestuti, and E. D. Arfianto, "Analisis Pengaruh Faktor Ekonomi Makro Terhadap Risiko Kredit di Perbankan Konvensional (Pada Januari 2008-Desember 2015)", Master Thesis, Diponegoro University, Indonesia, 2017.
- [8] S. Katsushi et al., "Performance of Microfinance Institutions-A Macroeconomic and Institutional Perspective", *Journal of Economic Studies*, vol. 35, no. 3, pp. 236-248, 2011.
- [9] H. L. Fofack, "Nonperforming loans in Sub-Saharan Africa: causal analysis and macroeconomic implications", *The World Bank*, 2005.
- [10] N. G. Mankiw, *Principles of Economics*, Cengage Learning, 2016.
- [11] R. M. Visconti, "Global recession and microfinance risk governance in developing countries", *Risk Governance and Control Journal*, vol. 1, no. 3, 2011.
- [12] O. Blanchard, *Blanchard: Macroeconomics*, Pearson Higher Ed, 2017.
- [13] M. Zsigraiová, "Probability of default modelling using macroeconomic factor", Master Thesis, Charles University in Prague, Czech Republic, 2014.
- [14] E. I. Altman and A. Saunders, "Credit risk measurement: Developments over the last 20 years", *Journal of Banking & Finance*, vol. 21, no. 11-12), pp. 1721-1742, 1997.
- [15] I. Basel, "International convergence of capital measurement and capital standards", *Basel Committee on Banking Supervision*, 2006.
- [16] S. Santoso, *Statistik Multivariat*. Jakarta: Elex Media Komputindo. 2010.