



Merton Models: Mapping Default of Government Bank in Indonesia

Agus Munandar¹

¹*Faculty of Economics and Business, University of 17 August 1945 Jakarta, Indonesia*

ABSTRACT

The objective of Basel II is to strengthen the financial system security by emphasizing on risk-based calculation of capital. Driven by Basel II, this paper investigates the probability of default of government banks in Indonesia in the period of 2002 – 2010 using annually-published report of central bank (Bank Indonesia) with 4 government banks as the sample of research. The probability of default is measured by using merton model. The findings that measurement results using merton approach are empirically confirmed. In 2004, PT Bank Rakyat Indonesia Tbk which gets the lowest probability of default was announced as “The Best National Bank” in Indonesia by Bisnis Indonesia award (Moeljono, 2006). In 2008, the government banks have high probability default because financial crisis of 2008 (probability default more than 30%).

Keywords: Probability default, Government banks, Merton model

1. Research Background

Bank Indonesia (2010) claims that the financial crisis in Indonesia induced by the fall of the exchange rate of rupiah. As a result, many banks suffered losses, especially banks that have loans in foreign currency and does not hedge the loan. The volatility of the exchange rate becomes more severe when banks have a poor of cash flow (difficulties of liquidity and solvency). Moreover, the case becomes more complex when there are mass withdrawals by customers.

How to solve banking financial problems has always been an actual discussion between economists. The new Basel Capital Accord (Basel Committee on Banking Supervision, 2006, in Bastos, 2009) recommends that the banking sector have to estimates their financial failure (default). In Indonesia, Bank Indonesia has legislate some regulations to achieve effectiveness of the system of banking supervision in accordance with the 25 Basel Core.

The topics of estimation the financial failure has become an attention-grabbing research for some decades. Manurung (2009) states that the measurement of the risk of default (default probability) was started by Beaver (1966) using univariate models, then Altman (1968) using discriminant model (Altman's Z-Score Model).

In 1974, Merton modified Black-Scholes model. The last model that modified by VMR merton (Kealhofer, McQuown and Vasicek) is known as the KMV model. Tudela and Young (2003) have conducted research using merton model for companies in the UK. Hadad et al (2004) have used the model to examine the companies in Indonesia. However, no studies that using merton model to estimate default probability and plot the risk of failure in banking sector in Indonesia. The findings are important and valuable in policy making.

2. Literature Review and Hypothesis Development

Studies regarding the estimation of bankruptcy become an attention-grabbing scientists and economists for decades. Manurung (2009) states that the measurement of the risk of default (default probability) was started by Beaver (1966) that using univariate models. In 1968, Altman using discriminant model (Altman's Z-Score Model) to predict financial default.

In 1973, Merton published the results of his research entitled "On the Pricing of Corporate Debt: The Risk Structure of Interest Pates" which aims to analyze the failure of the company. He defines the risk of failure is the probability that the firm will be unable to satisfy some or all of the indenture require merits.

The study followed by Moody Merton-KMV (2003) with the title "Modeling Default R-Modeling Methodology". Moody-KMV (2003) says that the Black-Scholes (1973) states that the market value of the underlying assets of the company follows the stochastic process. Research SM Lin, et al, entitled "Merton or credit scoring models: modeling the default of a small business" formulate the model as follows

$$E_T = \max [A_T - X, 0]$$

Where E= equity, and A = Asset, while X = Book value of Debt

$$E_0 = A_0 N(d_1) - X e^{-rt} N(d_2) \text{ Where,}$$

$$d_1 = \frac{\ln(A_0 e^{rt} / X)}{\sigma_A \sqrt{T}} + 0.5 \sigma_A \sqrt{T} \quad ; \quad d_2 = d_1 - \sigma_A \sqrt{T}$$

d2 is the volatility (deviation) of the asset value, and r is the risk-free rate of interest, both of which are assumed to be constant. Therefore, N(.) is the accumulation density function of the standard normal distribution.

After that, $L=X^*/A$ be a measure of leverage where $X^* = X e^{-rt}$, therefore,

$$E_0 = A_0 N(d_1) - X e^{-rt} N(d_2)$$

where,

$$d_1 = \frac{\ln(A_0 e^{rt} / X)}{\sigma_A \sqrt{T}} + 0.5 \sigma_A \sqrt{T} \quad ; \quad d_2 = d_1 - \sigma_A \sqrt{T}$$

Jones, Mason and Rosenfeld (1984) in S-M Lin, et al stated that,

$$E_0 \sigma_E = \frac{\partial E}{\partial A} A_0 \sigma_A \text{ and } \sigma_E = \frac{\sigma_A N(d_1)}{N(d_1) - LN(d_2)}$$

Finally, probability of default is formulated as follow,

$$P = N(-d_2) \text{ where } d_2 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} - 0,5 \sigma_A \sqrt{T}$$

3. Research Method

3.1. Population and Sample

The population is all banks in Indonesia. The sample is state banks because these banks supported by government. These bank are assumed have sufficient financial resilience. Finally, the samples are Bank Negara Indonesia, Bank Rakyat Indonesia, Bank Tabungan Negara, and Bank Mandiri. The period of this study is 2004-2014.

3.2. Data and Data Sources

The data is secondary data. Financial data downloaded from the publications of Bank Indonesia. Volatility of asset measured using indeks harga saham gabungan (IHSG). The proxy of risk-free rate is is SBI rate.

3.3. Research Variables

The dependent variable in this study is the probability of financial failure of the banking sector. The financial failure in this research is condition which the firm unable to fulfill obligations to third parties. This variable is measured as follows

$$P = N(-d_2) \text{ where } d_2 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} - 0,5\sigma_A \sqrt{T}$$

3.4. Data Processing

Merton models used in this study is the result of the development that used by SM Lin, et al. He formulated that,

$$ET = \max [AT - X, 0]$$

Where E = equity, and A = Assets, then X = Book value of Debt where,

$$d_1 = \frac{\ln(A_0 e^{rt} / X)}{\sigma_A \sqrt{T}} + 0,5\sigma_A \sqrt{T} \quad d_2 = d_1 - \sigma_A \sqrt{T}$$

d_2 is the volatility (deviation) of the asset value, and r is the risk-free rate of interest, both of which are assumed to be constant. Therefore, $N(\cdot)$ is the accumulation density function of the standard normal distribution.

After that, $L = X^* / A$ be a measure of leverage where $X^* = X e^{-rt}$, therefore,

$$E_0 = A_0 N(d_1) - X e^{-rt} N(d_2)$$

where,

$$d_1 = \frac{\ln(A_0 e^{rt} / X)}{\sigma_A \sqrt{T}} + 0,5\sigma_A \sqrt{T}$$

Finally, the probability of default is formulated as follows,

$$P = N(-d_2) \text{ where } d_2 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} - 0,5\sigma_A \sqrt{T}$$

The data processing using excel software with the following formula,
 $= \text{LN}(A / (X * \text{EXP}(rf * T))) / (\text{SIGMA} * \text{SQRT}(T)) + 0.5 * \text{SIGMA} * \text{SQRT}(T)$

Furthermore, $d_2 = d_1 - \sigma_A \sqrt{T}$ computed using this formula,

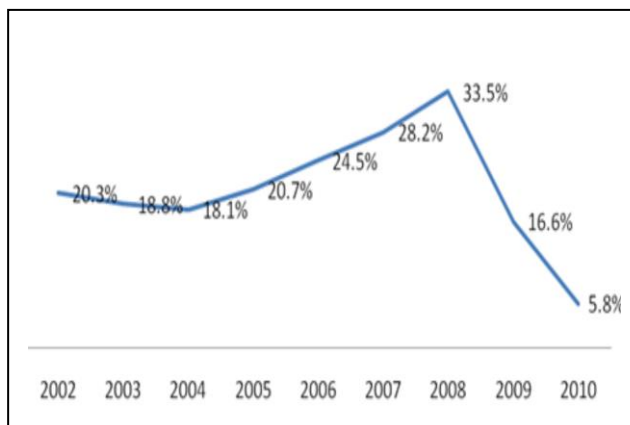
$= \text{LN}(V / (K * \text{EXP}(rf * T))) / (\text{SIGMA} * \text{SQRT}(T)) - \text{SIGMA} * \text{SQRT}(T)$

Then, Normal distribution $N(d_1)$ or delta obtained with excel formulas,
 $= \text{NORMSDIST}(d_1)$, Normal distribution $N(d_2)$ or $N(d_2)$ calculated using excel formula = $\text{NORMSDIST}(d_2)$

Furthermore, excel formula for the default of probability as follows,
 $= 1 - \text{ProbaNonBankruptcy}$

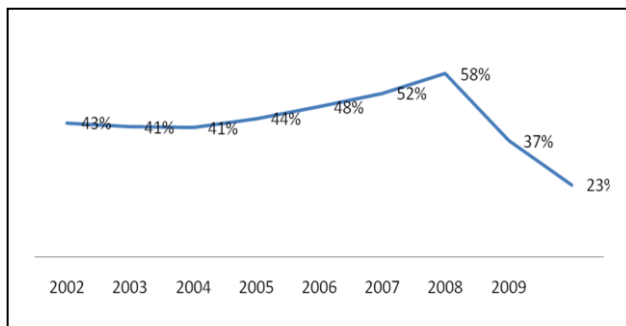
4. Data Analysis and Discussion

Result of calculation using merton analyzed descriptively to explain probability of failure of state bank in Indonesia. The probability of default of Bank Negara Indonesia is graphically presented below,



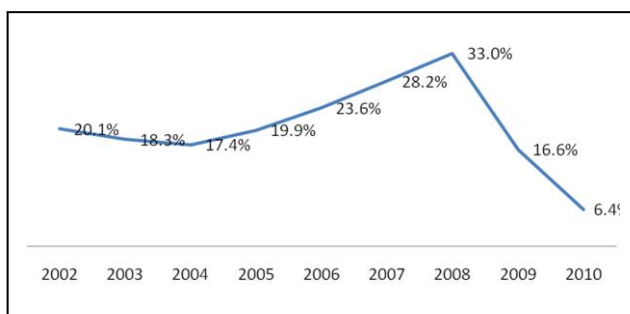
Graphic-1. The probability of default of Bank Negara Indonesia

The graphic describes the fluctuations of probability of failure of Bank Negara Indonesia. Probability of failure in 2008 is 33.5%. This caused by global financial crisis in 2008 that affected the Indonesian banking sector. The probability of default increases since 2005 (17.11%) because increase in world oil prices (Ariwibowo, et al, 2008). Beside that, the failure probability that started in 2005 is also influenced by the volatility of IHSG that significantly increase after 2005 as the graph below,



Graphic-2. The probability of default of Bank Negara Indonesia

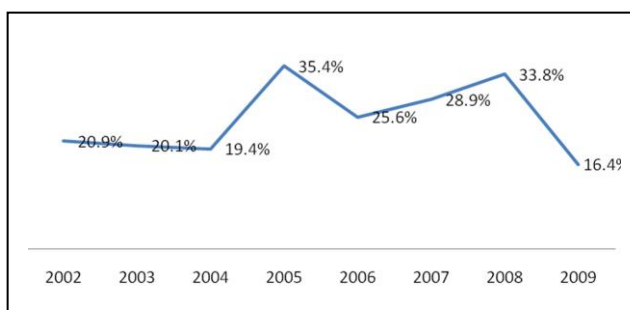
Based on calculation using merton model, The probability of default of Bank Rakyat Indonesia is graphically presented below,



Graphic-3. The probability of default of Bank Rakyat Indonesia

The explanation of increasing of probability default started from 2005 is caused by increase oil price, volatility of IHSG, and global crisis. In 2008, Bank Rakyat Indonesia also affected by global crisis but the probability of default is better than others state bank (33%).

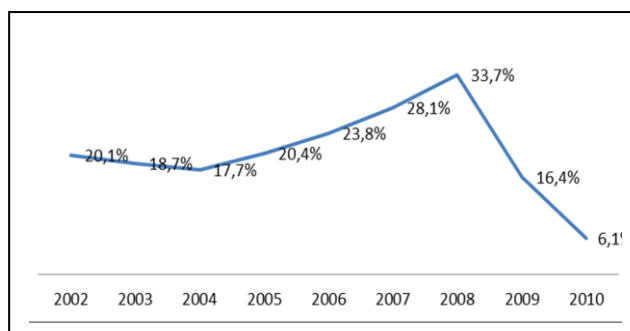
In 2004, the probability of default is also better than others state bank (17, 4). Therefore, In 2004, PT Bank Rakyat Indonesia Tbk that gets the lowest probability of default was announced as “The Best National Bank” in Indonesia by Bisnis Indonesia award (Moeljono, 2006). In 2008, the government banks have high probability default because financial crisis of 2008 (probability default more than 30%).



Graphic-3. The probability of default of Bank Tabungan Indonesia

As graphic 4 below, The probability of default is also increases since 2005 (19.4%). The causes of increase is explained before. In 2008, Bank Tabungan Negara also affected by global crisis so the probability of default is 33,8%.

The last explanation is probability of default of Bank Mandiri. In 2008, this bank also affected by global crisis so the probability of default is 33,7%. The graphic of probability of default of Bank Mandiri below,



Graphic 4: The probability of default of Bank Mandiri

5. Conclusion

Based on research data and results of the analysis can be deduced: First, the probability of default of Bank Rakyat Indonesia is the lowest. In 2004, the finding is empirically confirmed. Based on merton model calculation, the probability of default is better than others state bank (17, 4). In fact, in 2004, PT Bank Rakyat Indonesia Tbk was announced as “The Best National Bank” in Indonesia by Bisnis Indonesia award (Moeljono, 2006). Second, based on calculation result and reliable information, researcher concludes that financial crisis and volatility of IHSG affect probability of default.

6. Limitations and Recommendations

Limitation in this research related to the up to date of data. Therefore, the researcher recommends that further research should update the period. The next limitation is regarding the effects of financial crisis, volatility of IHSG, and oil price affects probability of default. This causal effect is based on assumption that derived from merton model calculation and other supported information such as Ariwibowo, et al (2008). Future studies should investigate this effect empirically does not based on mere assumptions.

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