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Merton Models: Mapping Default of Government Bank in Indonesia

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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 study 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. In 2008, the government banks have high probability default because financial crisis of 2008 (probability default >30%).

Key words: Probability default, government banks, Merton Model, financial crisis, sample

INTRODUCTION

Bank Indonesia in 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 (Bastos, 2010) 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 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 Merton (1974) modified Black-Scholes Model. The last model that modified by KMV 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 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.

Literature review and hypothesis development: Studies regarding the estimation of bankruptcy become an attention-grabbing scientists and economists for decades. Manurung 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 Merton (1973) 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 Crosbie and Bohn (2003) with the title "Modeling Default R-Modeling Methodology". Crosbie and Bohn (2003) says that the Black and Scholes (1973) states that the market value of the underlying assets of the company follows the stochastic process. Research Lin *et al.* (2008) 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
A = Asset
X = Book value of debt

$$E_0 = A_0 N(d_1) - X_e^{-rT} N(d_2)$$

Where:

$$d_1 = \frac{\ln\left(\frac{A_0 e^{rT}}{X}\right)}{\sigma_A \sqrt{T}} + 0.5\sigma_A \sqrt{T},\ d_2 = d_1 - \sigma_A \sqrt{T}$$

Where:
d_2 = The volatility (deviation) of the asset value
r = 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 $X^* = Xe^{-rT}$, therefore:

$$E_0 = A_0 N(d_1) - X_e^{-rT} N(d_2)$$

Where:

$$d_1 = \frac{\ln\left(\frac{A_0 e^{rT}}{X}\right)}{\sigma_A\sqrt{T}} + 0.5\sigma_A\sqrt{T},\ d_2 = d_1 - \sigma_A\sqrt{T}$$

Jones *et al.* (1984) and Lin *et al.* (2008) stated that:

$$E_0\sigma_E = \frac{\partial E}{\partial A}A_0\sigma_A$$

and:

$$\sigma_E = \frac{\sigma_A N(d_1)}{N(d_1) - LN(d_2)}$$

Finally, probability of default is formulated as follow $P = N(-d_2)$ where:

$$d_2 = \frac{-\ln(L)}{\sigma_A\sqrt{T}} - 0.5\sigma_A\sqrt{T}$$

MATERIALS AND METHODS

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, Rakyat Indonesia, Tabungan Negara and Mandiri. The period of this study is 2004-2014.

Data and data sources: The data is secondary data. Financial data downloaded from the publications of Bank Indonesia. Volatility of asset measured using Indek Harga Saham Gabungan (IHSG). The proxy of risk-free rate is SBI rate.

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, $P = N(-d_2)$ where:

$$d_2 = \frac{-\ln(L)}{\sigma_A\sqrt{T}} - 0.5\sigma_A\sqrt{T}$$

Data processing: Merton models used in this study is the result of the development that used by Lin *et al.* (2008). He formulated that:

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

Where:
E = Equity
A = Assets
X = Book value of debt

Where:

$$d_1 = \frac{\ln\left(\frac{A_0 e^{rT}}{X}\right)}{\sigma_A\sqrt{T}} + 0.5\sigma_A\sqrt{T},\ d_2 = d_1 - \sigma_A\sqrt{T}$$

Where:
d_2 = The volatility (deviation) of the asset value
r = 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 $X^* = Xe^{-rT}$, therefore:

$$E_0 = A_0 N(d_1) - X_e^{-rT} N(d_2)$$

Where:

$$d_1 = \frac{\ln\left(\frac{A_0 e^{rT}}{X}\right)}{\sigma_A\sqrt{T}} + 0.5\sigma_A\sqrt{T}$$

Finally, the probability of default is formulated as follows, $P = N(-d_2)$ 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 = LN (A/(X×EXP (rf×T))/(SIGMA×SQRT(T)))+0.5×SIGMA×SQRT(T).Furthermore:

$$d_2 = d_1 - \sigma_A\sqrt{T}$$

computed using this formula = LN (V/(K×EXP (rf×T))/(SIGMA×SQRT (T)))-SIGMA×SQRT (T). Then, Normal distribution N (d_1) or delta obtained with excel formulas = NORMSDIST (d_1), Normal distribution N (d_2) or N (d_2) calculated using excel formula = NORMSDIST (d_2). Furthermore, excel formula for the default of probability as follows = 1-ProbaNonBankruptcy.

RESULTS AND DISCUSSION

Result of calculation using merton analyzed descriptively to explain probability of failure of State Bank

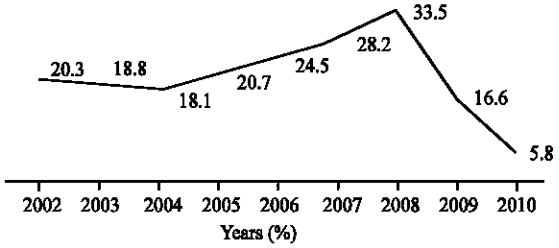

Fig. 1: The probability of default of Bank Negara Indonesia

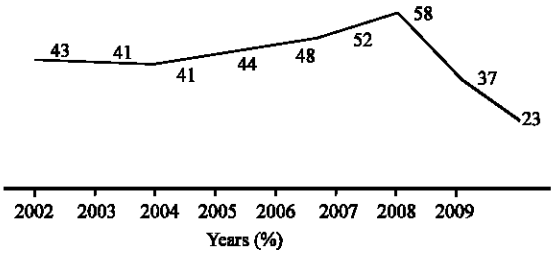

Fig. 2: The volatility of IHSC significantly increase after 2005 of Bank Negara Indonesia

in Indonesia. The probability of default of Bank Negara Indonesia is graphically presented in Fig. 1. Figure 1 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. Beside that the failure probability that started in 2005 is also influenced by the volatility of IHSG that significantly increase after 2005 as Fig. 2.

Based on calculation using Merton Model, the probability of default of Bank Rakyat Indonesia is graphically presented in Fig. 3.

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. In 2008, the government banks have high probability default because financial crisis of 2008 (probability default >30%).

As Fig. 4, 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%.

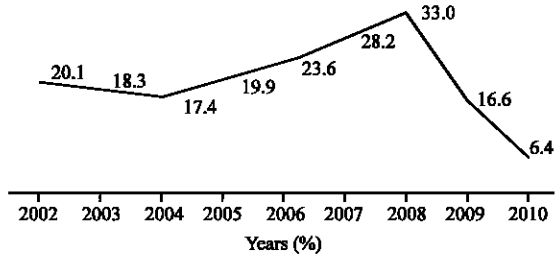

Fig. 3: The probability of default of Bank Rakyat Indonesia

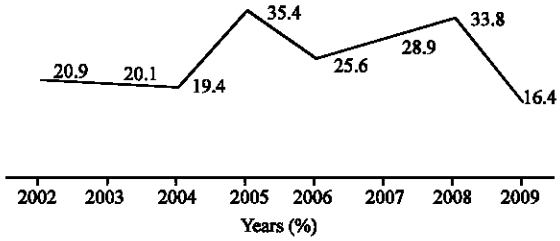

Fig. 4: The probability of default of Bank Tabungan Indonesia

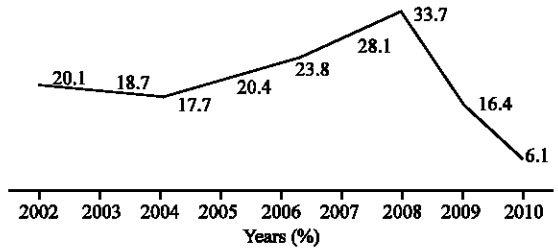

Fig. 5: The probability of default of Bank Mandiri of global crisis

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 Fig. 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. Second, based on calculation result and reliable information, researcher concludes that financial crisis and volatility of IHSG affect probability of default.

LIMITATIONS

Limitation in this research related to the up to date of data. Therefore, the 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.

RECOMMENDATION

Future studies should investigate this effect empirically does not based on mere assumptions. Therefore, the researcher recommends that further research should update the period.

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