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KMV-Merton Model-Based Forecasting of Default Probabilities: A Case Study of Malaysian Airline System Berhad

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Abstract: Malaysian Airline System Berhad (MAS) is the first airline company in Malaysia. MAS shows a rapid increment in achievement by providing airline services to the entire world with over 111 destinations. However, the available of various factors such as competition among airlines, fuel prices increment, poor management and air crash challenge MAS to do better in strengthening its buffer. To this extent, credit risk management is extremely needed to avoid further loss. There are several methods used to manage credit risk and one part of it is by forecasting the probability of default. In this study, KMV-Merton Model is introduced to forecast the probability of default of MAS starting from the year of 2009-2013. KMV-Merton Model is derived according to the scope of the study. Data is collected over the selected years and then implemented to the KMV-Merton Model. The forecasted default probabilities and its determinants are also analyzed. It is found that there is an increment in the forecasted probabilities of default of MAS from 2009-2013. The highest forecasted probability of default is found in the year of 2013 and it is around 31%. The forecasted probabilities of default are said to be equivalent to the financial loss faced by MAS from 2011-2013. Therefore, the KMV-Merton Model is concluded as a valid model to be used in forecasting the current and future default of MAS. In addition, volatility and leverage are found to be the main determinants in forecasting default probabilities.

Key words: Probability of default, KMV-Merton Model, Malaysian Airline System Berhad, forecast, credit risk, Malaysia

INTRODUCTION

In duration of 131 days in 2014, MAS missed 2 Boeing 777 aircrafts with a total of 510 passengers and 27 crews were lost (MAC, 2014). Due to this circumstance, industrial analysts predict MAS will suffer a loss of market share and face a greater challenging environment to stand out from other competitors (Seatmaestro, 2014). In view of that KMV-Merton Model is introduced in the study to predict the level of default risk of MAS. KMV-Merton Model is a model that is developed by KMV corporation or now known as Moody's KMV corporation based on the Black-Scholes-Merton Model. The purpose of developing the model is to provide assessments of firm's likelihood to default. KMV-Merton Model is said to be accurately and timely information based model since probability of default of firms is predicted based on the market value of equity (Bharath and Shumway, 2004). The ability of KMV-Merton Model in predicting probability of default of firms is highly convincing as the case study done on the bankruptcy of enron corporation is succeeded (Moodys, 2010). The similar approach has been done in this study where KMV-Merton Model is derived according to the scope of the study in forecasting default probabilities of MAS. In addition, the relations of parameters and variables used in the KMV-Merton Model towards the estimation of probability of default are identified.

Mathematical structure of kmv-merton Model: KMV defines probability of default at any time, P_τ as the probability that the market value of firm's asset at any time, V_τ will be less than or equal to the book value of firm's liabilities, X where τ = T-t (Crosbie and Bohn, 2003). Therefore, P_T is derived as follows:

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$$P_\tau = P_r\left[V_\tau \le X \middle| V_0 = V_T\right] \quad (1)$$

The variable V_τ is said to follow the log-normal random walk (Merton, 1974). Thus, the future value of V_τ is:

$$V_\tau = V_T e^{\left(G - \frac{1}{2}\sigma^2\right)\tau + \sigma_V \sqrt{\tau}\xi} \quad (2)$$

Where:

G = The growth rate
σ_V = The asset volatility
ξ = The random component of asset returns

Substituting Eq. 2 into Eq. 1, therefore one have:

$$P_\tau = \Pr\left[V_T e^{\left(G - \frac{1}{2}\sigma^2\right)\tau + \sigma\sqrt{\tau}\xi} \le X\right] \quad (3)$$

After rearranging:

$$P_\tau = \Pr\left[\frac{\ln\left(\frac{V_T}{X}\right) + \left(G - \frac{1}{2}\sigma^2\right)\tau}{\sigma\sqrt{\tau}} \ge \xi\right] \quad (4)$$

Since ξ is assumed to be normally distributed (Merton, 1974) thus:

$$P_\tau = N[-d] = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{-d} e^{-\frac{1}{2}z^2} dz \quad (5)$$

where distance to default, d is defined as:

$$d = \frac{\ln\left(\frac{V_T}{X}\right) + \left(G - \frac{1}{2}\sigma^2\right)\tau}{\sigma\sqrt{\tau}} \quad (6)$$

Based on this derivation, the probability of default of MAS is forecasted using the method explained next.

MATERIALS AND METHODS

This study introduces the block diagrams of the process of forecasting probability of default as in Fig. 1. The study utilizes several types of data over the period of 2009 until 2013. The data involves the historical daily price of MAS and FTSE Bursa Malaysia (FBM KLCI). In addition, the outstanding share, current liabilities and the long-term liabilities of MAS were extracted from the quarterly report of MAS. The Malaysia treasury bill's obtained from the website of bnm.gov.my is also used in this study. The last data is the market risk premium where the data is based on Fernandez *et al.* (2013).

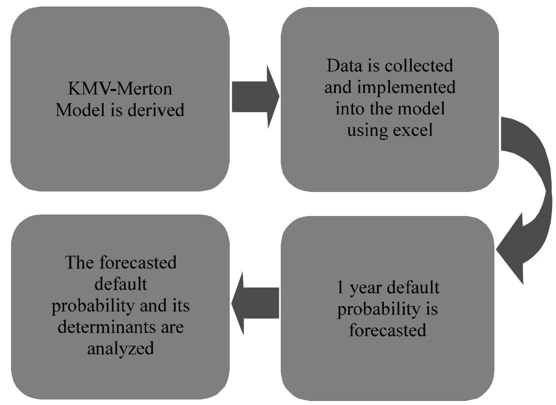

Fig. 1: Block diagram of the processes of forecasting default probability

In order to predict the probability of default of MAS by using the formula given in Eq. 5 and 6, there are five variables that must be estimated first. The approach used to estimate the variables are explained as:

Market value of equity: The market value of equity is calculated by multiplying its historical daily price with the outstanding share.

Book value of liabilities X: The book value of liabilities is calculated by adding the current liabilities with the half of long term liabilities.

Market value of asset V: The market value of asset is calculated by adding the market value of equity with the book value of liabilities.

Growth rate G: The growth rate is calculated by continuously compounding the expected return on asset, μ where μ is defined by capital asset pricing model.

Asset Volatility σ_V: The annual asset volatility is calculated by finding the standard deviation of log return of market value of asset, log V, multiply with the square roots of number of trading days.

RESULTS

Based on the method explained earlier, the probabilities of default of MAS for the years of 2009 until 2003 are forecasted. The details of estimating the probabilities of default of MAS are shown in Table 1. In addition, the relationships of parameters and variables used in the KMV-Merton Model towards the estimation of probability of default are given in Fig. 2 and 3.

Table 1: The spreadsheet of estimating the probability of default of MAS, 2009-2013

Year/Items	2009	2010	2011	2012	2013
Market value of asset, V at 31-Dec (RM mil)	5605.52	8986.43	7869.51	7816.57	11767.33
Book value of liabilities, X at 31-Dec (RM mil)	1060.19	2001.32	3524.70	5443.64	6586.980
Growth rate G (%)	4.04000	3.45000	8.80000	6.53000	4.300000
Asset volatility σ (%)	30.9700	34.5800	24.7200	21.3300	72.99000
Distance to default (d)	5.35360	4.27050	3.48190	1.89590	0.488900
Probability of default P_T (%)	0.00000	0.00100	0.02490	2.89900	31.24610

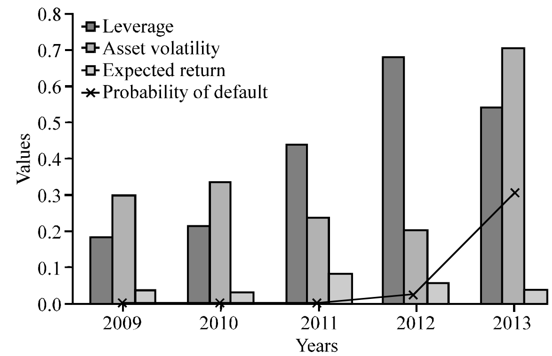

Fig. 2: The graph of leverage, asset volatility, expected return and probability of default of MAS, 2009-2013

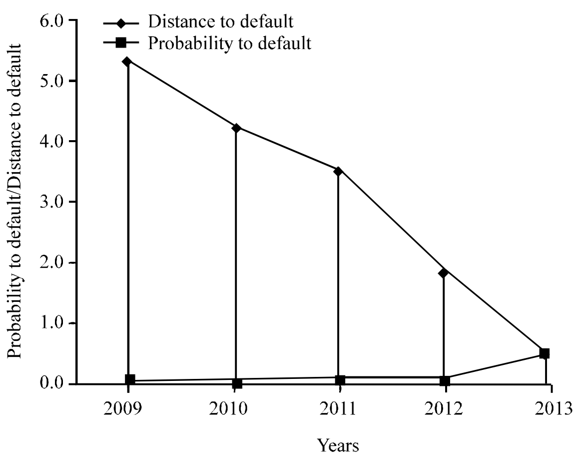

Fig. 3: The line graph of probability to default and distance to default of MAS, 2009-2013

DISCUSSION

Table 1 describes the spreadsheet of estimating the probability of default of MAS for the years 2009 until 2013. Apparently, KMV-Merton Model forecasts increments in MAS probabilities of default. In 2009 and 2010, the probability of default is forecasted to be 0% and then slightly increased to 0.0249% in 2011. The probability of default continues to increase in 2012 at 2.8990%. In 2013, the probability of default of MAS is getting worse as it drastically increased to 31.2461%. The increments are equivalent to the increment of net loss reported by MAS.

MAS is found fallen starting from 2011 where a net loss of RM 2.52 billion was reported at the end of the year. This is due to the mismanagement and increasing in fuel cost. In the next year of 2012, the net loss of MAS was reported decreased to RM 433 million (MAS, 2011, 2012, 2013). But then, the net loss of MAS increases again in 2013 as much as RM 1.17 billion (WSJM, 2014). MAS has also been expected to loss further market share after the tragedy of flights MH370 and MH17 (NOAW, 2014).

Figure 1 describes the graph of leverage, volatility, expected return and probability of default of MAS from the years 2009 until 2013. The asset volatility is found increased from 2009-2010 and then decreased from 2011-2012. In 2013, the asset volatility is found increased again to the highest value compared to the asset volatility of the other years. Table 1 shows RM 8590.15 million (0.73×RM 11767.33) of V will be added or removed when one unit of standard deviation moves. In contrast, the leverage ratio (X/V) in 2012 is found the highest that is 0.6964 and then followed by 2013 that is 0.5598 and next 2011, 2010 and lastly 2009. This shows that higher asset volatility tends to take lower leverage and vice versa. However, highest probability of default is expected in the year 2013 as the values of both asset volatility and leverage are found high as shown by the line graph in Fig. 1. Meanwhile, growth rate is assumed less significant to forecast probability of default. This can be seen in Fig. 1 where either lower or higher growth rate, both brings to the higher probability of default. Overall, higher asset volatility and higher leverage forecast higher probability of default. This is equivalent to the statement made by Crosbie and Bohn (2003) where asset volatility and leverage are the most important determinants in determining the probability of default of firms.

Figure 2, depicts the line graph of distance to default and probability of default of MAS from 2009 until 2013. It shows that lower distance to default means higher probability of default and vice versa. This can be seen clearly in Table 1 where the distance to default for the year 2013 is found the lowest compared to the distance to default of the other years. Therefore, the highest probability of default is predicted in the year 2013. In other words, the distance to default is said to be inversely proportional to the probability of default. This enhances the statement made by Lu (2008) that distance to default is correlated with the probability of default.

CONCLUSION

After decades, the rate of defaulting firms is still increasing in few sectors. Due to that, effective credit risk management is needed to control the rate of the shutdown. In order to have an effective credit risk management, various instrument and tools are used. In this study, KMV-Merton Model is introduced to forecast the likelihood to default of MAS. In the beginning of the model application, the market value of asset, book value of liabilities, growth rate and asset volatility of MAS are calculated through certain methods. From these calculations, the probabilities of default of MAS from 2009 until 2013 are forecasted by using the KMV-Merton Model. It is found that there is an increment in the forecasted probabilities of default of MAS from 2009-2013. The highest probability of default is forecasted in the year of 2013 and it is around 31%. The forecasts are in line to the financial performance reported in the annual report of MAS. Therefore, KMV-Merton Model is said to be a valid model for MAS to predict current and future default.

In addition, the relationships of asset volatility, leverage, growth rate and distance to default are examined towards the probability of default. It is found that asset volatility and leverage are the main determinants in forecasting the probability of default of MAS. This is contradicted to the growth rate that is assumed to be less significant. Generally, higher asset volatility takes lower leverage. For distance to default, it is said to be inversely proportional to the probability of default. As a conclusion, higher asset volatility and higher leverage forecast lower distance to default and thus, higher probability of default. Application of KMV-Merton Model is actually not limited to MAS but also applicable to be applied to the other firms such as done by other studies (Norliza and Maheran, 2012; Yusof and Jaffar, 2011). The same goes in forecasting probability of default of loans and sukuk where KMV-Merton Model can be applied. Overall, KMV-Merton Model is assumed as a compliment tool to the company managers, investors and researchers in measuring default risk.

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