

# Estimating Expected Default Probability and Credit Risk Spread Using the KMV Merton Model: A Case Study of Bank Islam Malaysia Berhad

*Mengestimasi Expected Default Probability dan Credit Risk Spread Menggunakan Model KMV Merton: Studi Kasus Bank Islam Malaysia Berhad*

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## ABSTRACT

The objective of the paper is to estimate the expected default probability and credit risk spread of Bank Islam Malaysia using the KMV Merton Model and analyse the strengths of the KMV model. The data used in this research are short term and long-term liabilities data of Bank Islam Malaysia Berhad that we obtained from the financial statements, stock prices and number of stocks traded of BIMB and Islamic Bank-relevant interest rates data that we obtained from the Overnight Policy Rate Decision (OPR) by Bank Negara Malaysia. The data is then prepared and interpolated to match weekly period before applying the KMV Model using Microsoft Excel to calculate the default probability and credit risk spread of BIMB. The result shows that the Probability of Default for BIMB is nearly 0.0001 for the first 3 years of its debt maturity period and nearly 0.0007 and 0.002 for the maturity period of 4 and 5 years respectively. Credit risk spread for BIMB is nearly null for the first 2 years maturity period then gradually increases each year to 0.01, 0.05 and 0.14. BIMB's distance to default ranges between 9.17-10.01. The research indicates that the BIMB's calculated PD is reliable and that the KMV Merton Model provides high accuracy and reliability of credit risk measurements. The KMV Model can be applied to different types of companies including Islamic Bank.

**Keywords:** Islamic bank, expected default probability, credit risk spread

## ABSTRAK

Penelitian ini bertujuan untuk mengestimasi expected default probability dan credit risk spread menggunakan Model KMV Merton dan menganalisis kekuatan dari model tersebut. Data yang digunakan dalam penelitian ini adalah data sekunder yang bersumber dari laporan keuangan BIMB yaitu kewajiban jangka pendek, kewajiban jangka panjang, harga saham dan jumlah saham BIMB yang di perdagangan dan juga Islamic Bank-relevant interest rates data yang bersumber dari Kebijakan Overnight Policy Rate Decision (OPR) Bank Negara Malaysia. Data tersebut kemudian diinterpolasi untuk disesuaikan dengan periode mingguan sebelum di analisis dengan menggunakan model KMV Merton menggunakan microsoft excel untuk menghitung default probability dan credit risk spread dari BIMB.



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Hasilnya menunjukkan bahwa Probability of Default untuk Bank Islam Malaysia Berhad (BIMB) hampir 0,0001 selama 3 tahun pertama periode jatuh tempo utangnya, kemudian meningkat menjadi hampir 0,0007 pada tahun ke-4 dan 0,002 pada tahun ke-5. Penyebaran risiko kredit (credit risk spread) untuk BIMB hampir nol selama 2 tahun pertama periode jatuh tempo, lalu secara bertahap meningkat setiap tahun menjadi 0,01, 0,05, dan 0,14. Jarak BIMB terhadap gagal bayar (distance to default) berkisar antara 9,17 hingga 10,01. Penelitian ini menunjukkan bahwa PD yang dihitung untuk BIMB dapat diandalkan dan Model KMV-Merton memberikan tingkat akurasi dan keandalan yang tinggi dalam pengukuran risiko kredit dan Model ini dapat diterapkan pada berbagai jenis perusahaan, termasuk Bank Islam.

**Kata Kunci:** bank syariah, expected default probability, credit risk spread

|          |   |                  |
|----------|---|------------------|
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## 1. Introduction

The KMV-Merton model is a default forecasting model developed by the KMV corporation, which applies the framework of Merton's bond pricing model. Default is the failure to pay a debt (Oxford Learners Dictionaries, n.d.-a). Probability to Default (PD) is the estimated likelihood that a firm's value will fall below its debt obligations based on its market value, volatility, and debt characteristics. Risk is a situation that could have a bad result (in the future) affecting the achievement of objectives (Oxford Learners Dictionaries, n.d.-b). Risk factors affecting banks to remain competitive include credit, liquidity, operational and market risks (Rosle et al., 2017). Credit spreads are the difference between yields of various debt instruments. Credit Spread Risk reflects the perceived risk of default by comparing interest rates to a benchmark. The lower the default risk, the lower the required interest rate; higher default risks come with higher interest rates. The opportunity cost of accepting lower default risk, therefore, is higher interest income. Credit spread risk is an important but often ignored component of income investing.

The PD and Credit Spread Risk are important measures of credit risk that are used by investors, lenders, and financial institutions to evaluate the creditworthiness of borrowers and make informed decisions regarding lending, investment, and risk mitigation strategies. A higher PD indicates a higher likelihood of default, similar to a higher Credit Spread Risk, indicating the borrower has a higher credit risk. This can lead to higher borrowing costs, as lenders may require higher interest rates to compensate for the increased risk. A higher PD or a higher Credit Spread Risk can also lead to a lower credit rating, and higher borrowing costs which can make it more difficult for the borrower to obtain financing.

On the other hand, a lower PD indicates a lower likelihood of default, similar to lower Credit Spread Risk which means that the borrower is considered to be a lower credit risk. This can lead to lower borrowing costs, as lenders may require lower interest rates to compensate for the lower risk. A lower PD or lower Credit Spread Risk can also lead to a higher credit rating, and lower borrowing costs which can make it easier for the borrower to obtain financing.

Bank Islam Malaysia Berhad (BIMB) was chosen in this study as it is the first full-fledged Islamic bank in Malaysia, established in 1983. It is governed by the Islamic Bank Act 1983 and subsequently by the Islamic Financial Services Act 2013. Bank Islam is writing a new chapter in

its history, breaking the conventions of Islamic banking and finance, and further driving the growth of the financial industry in Malaysia and the region (BIMB, 2021b). Transitioning into a fully listed banking institution on Bursa Malaysia since October 2021 (BIMB, 2021a) represents a leap into a new era, capitalizing on its resources to serve its stakeholders better (BIMB, 2021b).

The primary objective of this study is to estimate the PD and Credit Risk Spread of BIMB using the KMV Merton Model. The secondary objective is to analyse the strengths and weaknesses of using this model in analysing the PD and the Credit Spread Risk. This paper is divided into several sections, beginning with an introduction and continuing with a literature review of KMV Merton model. Subsequently, the application of the KMV Merton model methodology, followed by a presentation of the analysis and findings, strengths and weaknesses of the model and finally conclusions and recommendations of the study.

## 2. Literature Review and Hypotheses Development

### 2.1 KMV Merton Model Theory

Probability of Default is a crucial tool for credit risk management. It is commonly used to predict default rates as well as future credit risk. The PD is always associated with the KMV model. It is a modified version of the Merton model. The model is widely used for credit risk assessment tools especially in the financial sector. The foundation of this approach in estimating a company's credit risk is the market value of its assets. When estimating a firm's credit limit, it considers a few variables such as the probability of default, the quality of assets, and the volatility of returns on assets. The KMV model has also been used in a number of academic studies to examine the determinants of probability of Default. It has been determined that the model can identify credit risk well and can offer useful information for predicting credit ratings and risk management framework for companies.

### 2.2 Previous Studies in KMV Model

KMV Merton model has completely changed the way credit risk is assessed. Risk management practices have been profoundly impacted by its applications in corporate finance, banking, and portfolio management. Its advantage over conventional credit rating agencies has been shown by empirical validation studies. In order to improve risk assessments, it is critical to recognise the model's limitations and keep improving its techniques by conducting more research.

Numerous studies have used the KMV-Merton model to evaluate credit risk in various situations, including assessing the credit risk of commercial banks as well as other industries. According to (Voloshyn, 2015), KMV-Merton model is a reliable approach to estimate credit limit for a firm. There are few factors that influence this estimation which are the structure of the balance sheet, term to maturity of loan/financing, quality of asset as well as the required level of default probability. This paper has suggested in their finding which are a) the longer the term to maturity, the lower the credit limit, b) the higher the level of confidence, the lower the credit limit, and c) the higher the volatility of return on assets, the lower the credit limit.

In addition, the paper by (Câmara, Ivilina, & Betty, 2012) has mentioned that KMV model theory is used as a main tool to estimate the implied probability of default. It evaluated stock and option

market prices by analysing global financial firms that trade options and focused during the subprime mortgage period. They found that the performance of the KMV model can be improved by adding off-balance-sheet derivatives exposures. KMV model theory also contributed in predicting probability default for SMEs (small and medium sized enterprises). This finding has been discovered by the (Altman and Saunders, 2005) in their paper title Credit risk measurement: Developments over the last 20 years. Another significant research done is by (Bharath, S., & Shumway, T. 2004). The finding of the paper is KMV model has shown effectiveness in assessing credit default risk, particularly for banks, and can be applied in collateral management for financial institutions in the OTC market.

According to study by Merton (1974), he found that the KMV model was able to predict PD accurately for both public and private companies from variety of industries. He also discovered that they were few variables significant factors of probability default which are, leverage: the level of a company's debt relative to its equity, Volatility: the volatility of the company's earnings, asset value: the market value of the company's assets and cost of equity: the interest rate that the company pays on its equity.

## 2.3 KMV Model vs Merton Model

KMV model is modified Merton model. The Merton model, is a theory that Robert E. Merton created in 1974 and it is based on the viewed that a company's equity may be seen as a call option on the value of its assets. It uses the Black-Scholes-Merton option pricing framework to estimate default probability. Below are the main differences between both models:

**Tabel 1 Main Differences between KMV Model and Merton Model**

| Aspect             | KMV Model                                                         | Merton Model                                                        |
|--------------------|-------------------------------------------------------------------|---------------------------------------------------------------------|
| Approach           | Structural model combining accounting data with market-based info | Structural model based on the option pricing framework              |
| Components         | Asset Value, Debt Value, Asset Volatility, Maturity, PD           | Asset Value, Debt Value, Asset Volatility, Risk-Free Rate, Maturity |
| Asset Volatility   | Modelled as a stochastic process                                  | Assumes constant and known volatility                               |
| Use of Market data | Integrates market prices (stock, bond, credit spreads)            | Primarily relies on accounting data                                 |
| Treatment of Debt  | Can handle multiple maturities and structures                     | Assumes a single maturity for debt                                  |
| Recovery Rate      | Incorporates recovery rate                                        | Does not explicitly consider recovery rates                         |
| Flexibility        | More flexible in handling complex debt structures                 | May be less flexible with multiple maturities                       |
| Complexity         | Can be more complex due to integration of market-based data       | Relatively simpler and more straightforward in assumptions          |

## 3. Methodology

### 3.1 Data Collection

There are several data sources used in this research:

1. Accounting data including short term and long-term liabilities of Bank Islam Malaysia, which have been derived from its financial statements. These financial statements have been acquired through Refinitiv database accessible at <https://eikon.refinitiv.com/>.
2. Market data encompassing stock prices and the number of stocks traded, which have also been procured from Refinitiv database.
3. The data on Islamic Bank-relevant interest rates is obtained from the Overnight Policy Rate Decision (OPR) by Bank Negara Malaysia, available at <https://www.bnm.gov.my/monetary-stability/opr-decisions>. This is the standardized rate applicable to all banks operating within Malaysia, including Islamic banks. Furthermore, in this study, we have opted for a time frame encompassing the last five years, starting from 01 January 2018 and concluding at 31 December 2022.

### 3.2 Research Method

The collected data is then analysed using Excel with the following steps:

#### Step 1: Calculate Equity Value, Equity Return and Equity Volatility

The first step involves calculating Equity Value, Equity Return, and Equity Volatility using the following formula:

|                          |                                                                                                                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Equity Value</b>      | $\text{Equity Value, } E = N \times P$ <p>where;<br/> <math>N = \text{Number of Stock}</math><br/> <math>P = \text{Stock Prices}</math></p>                                                                                                             |
| <b>Equity Return</b>     | $\text{Equity Return, } R = \ln \frac{E_{t+1}}{E_t}$                                                                                                                                                                                                    |
| <b>Equity Volatility</b> | $\sigma_R = \sqrt{\left[ \frac{\sum (R_t - \mu_R)^2}{n} \right]}$ <p> <math>R_t = \text{Equity Return at time } t</math><br/> <math>\mu_R = \text{Average Equity Return}</math><br/> <math>n = \text{number of historical data points used}</math> </p> |

#### Step 2: Calculate Asset Value

To calculate asset value, the KMV model does not use Debt to Equity Ratio (DER). This model utilizes the Black-Scholes model to calculate asset value using the following equation (Crosbie, 2005):

|                                         |                                                                                                                                                                                        |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Call Option Value (Equity Value)</b> | $\text{Call Option Value} = V_0 [N(d_1)] - e^{-r^f T} \bar{D} [N(d_2)]$ <p>where;<br/> <math>V_0 = \text{Asset Value}</math><br/> <math>\bar{D} = \text{Face Value of Debt}</math></p> |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|  |                                                                                                                                                                                                                      |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | $N = \text{Normal distribution function } (0,1)$<br>$r^f = \text{risk free interest rate}$<br>$T = \text{company's maturity term}$<br>$d_1 \text{ and } d_2 = \text{parameters used to calculate call option value}$ |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Where face value of debt is calculated using this formula (Kliestik, 2015):

|                    |                                                                 |
|--------------------|-----------------------------------------------------------------|
| Face Value of Debt | $\bar{D} = \text{Short term debt} + 0.5 \text{ Long term debt}$ |
|--------------------|-----------------------------------------------------------------|

Subsequently,  $d_1$  and  $d_2$  are parameters used to calculate the call option value and can be calculated using the following formula:

|                                                                                                                                   |                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| $d_1 = \frac{\left[ \ln\left(\frac{V_0}{\bar{D}}\right) + \left(r^f + \frac{1}{2}\sigma_A^2\right)T \right]}{(\sigma_A\sqrt{T})}$ | $d_2 = d_1 - \sigma_A\sqrt{T}$<br><i>Where <math>\sigma_A</math> = Asset Volatility</i> |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|

### Step 3: Calculate Asset Volatility

Subsequently, Asset volatility in the KMV Model is a measure of how much the company's asset value can fluctuate over a specific time frame. Asset volatility is calculated using standard deviation with the following formula:

|                  |                                                                                                                                                                                                            |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Asset Volatility | $\sigma_A = \sqrt{\frac{\sum (V_t - \mu_A)^2}{n}}$<br><i>where;</i><br>$V_t = \text{Asset Value at time } t$<br>$\mu_A = \text{Average Asset Value}$<br>$n = \text{number of historical data points used}$ |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Step 4: Calculate the Distance to Default (DD)

Distance to Default is a useful measure for predicting a company's probability of default because DD can provide an indication of how close a company is to default. Companies with low DD have a higher risk of default, while companies with high DD have a lower risk of default. DD can be calculated by the following formula (Pareek, 2021):

|                          |                                                                                                                                                                                                                                                                                                          |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Distance to Default (DD) | $DD = \frac{\left[ \ln\left(\frac{V_0}{\bar{D}}\right) + \left(\mu + \frac{1}{2}\sigma_A^2\right)T \right]}{(\sigma_A\sqrt{T})}$<br><i>where;</i><br>$V_0 = \text{asset value}$<br>$\bar{D} = \text{Face Value of Debt}$<br>$T = \text{company's maturity term}$<br>$\sigma_A = \text{Asset Volatility}$ |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Step 5: Calculate Probability of Default (PD)

Probability of Default (PD) is the probability that the company will default within a specific time frame. PD is calculated using the following equation:

|                               |                                                                                                      |
|-------------------------------|------------------------------------------------------------------------------------------------------|
| <b>Probability of Default</b> | $PD = N(-DD)$ <p>where;<br/> <math>N(-DD) \sim \text{Normal distribution function } (0,1)</math></p> |
|-------------------------------|------------------------------------------------------------------------------------------------------|

### Step 6: Calculate the Credit Risk Spread

Credit Risk Spread is calculated with the following formula:

|                           |                                                                                                                                                                   |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Credit Risk Spread</b> | $S = -\ln \frac{N(d_1)}{L_0} + \frac{N(d_2)}{T}$ <p>where; <math>L = \text{the "quasi leverage ratio" such that:}</math></p> $L_0 = \frac{\bar{D}}{V_0} e^{-rfT}$ |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 4. Result and Discussion

### 4.1 Analysis of Expected Default Probability and Credit Risk Spread of Bank Islam Malaysia Berhad

#### 4.1.1 Equity Volatility, Aset Return and Aset Volatility

When calculating the equity volatility using the weekly 5 years historical data,  $n = 260$  with standard deviation of the equity return, 0.012299, which gives 8.87%. Meaning the equity price fluctuates at the mentioned percentage. Interestingly, the price climbed while recovering from the financial crisis in 2017-2018 then the health crisis hit globally and the share price trend went downward for a while and upward back recovering in 2020.

**Table 2 Equity Volatility**

**Bank Islam Malaysia Bhd | Balance Sheet**

in Millions of Malaysian Ringgit

|                     | 2018     | 2019     | 2020     | 2021     | 2022     |
|---------------------|----------|----------|----------|----------|----------|
|                     | Dec-2018 | Dec-2019 | Dec-2020 | Dec-2021 | Dec-2022 |
| <b>Total Assets</b> | 72,389   | 77,263   | 74,637   | 80,156   | 89,852   |

Source: BIMB's balance sheet

Calculation for asset return turned out at nearly 20% and the asset volatility measured at a little over 5%. Like equity, assets as well experienced reduction in 2020. But keep on improving year after year.

## 4.1.2 Credit Risk Spread

**Tabel 3 Credit Risk Spread**

| Maturity period    | 1 year | 2 years | 3 years | 4 years | 5 years |
|--------------------|--------|---------|---------|---------|---------|
| Credit Risk Spread | 0.00   | 0.00    | 0.01    | 0.05    | 0.14    |

The longer the maturity period, the wider the credit risk spread is. Thus, indicating as compensating for unpredictable risk within the duration beside taking into consideration on the quality of the debt instruments as vouch on its creditworthiness.

## 4.1.3 EDF

**Table 4 EDF**

| Maturity period | 1 year | 2 years | 3 years | 4 years | 5 years |
|-----------------|--------|---------|---------|---------|---------|
| EDF             | 0.0000 | 0.0000  | 0.0001  | 0.0007  | 0.002   |

### Bank Islam Malaysia Bhd | Balance Sheet

in Millions of Malaysian Ringgit

|                             | 2018     | 2019     | 2020     | 2021     | 2022     |
|-----------------------------|----------|----------|----------|----------|----------|
|                             | Dec-2018 | Dec-2019 | Dec-2020 | Dec-2021 | Dec-2022 |
| Total Assets                | 72,389   | 77,263   | 74,637   | 80,156   | 89,852   |
| Total Short Term Borrowings | 5,038    | 9,798    | 12,369   | 10,453   | 14,461   |
| Total Long Term Debt        | 3,604    | 3,969    | 3,527    | 4,320    | 5,523    |
| Total Equity                | 5,026    | 5,894    | 6,286    | 6,400    | 6,796    |

Source: BIMB's balance sheet

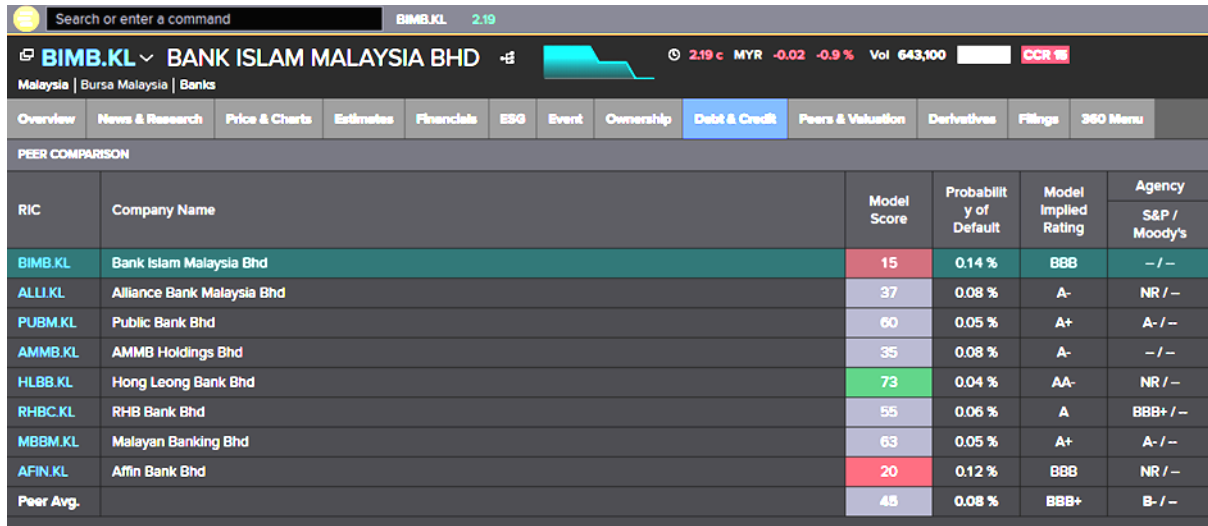
Thankfully for the obvious big amount of assets own that the EDF stays at minimal. This ensures that BIMB can service their debt obligations and far away from being default.

## 4.1.4 Distance to Default

**Table 5 Distance to Default**

| Maturity period     | 1 year | 2 years | 3 years | 4 years | 5 years |
|---------------------|--------|---------|---------|---------|---------|
| Distance to default | 9.60   | 9.17    | 9.37    | 9.69    | 10.01   |

The longer the duration, the distance is further away from being default. As data are partially taken from Refinitiv, it is worth comparing the calculation above with the platform, which as shown below, gives the same estimation.



| RIC       | Company Name               | Model Score | Probability of Default | Model Implied Rating | Agency S&P / Moody's |
|-----------|----------------------------|-------------|------------------------|----------------------|----------------------|
| BIMB.KL   | Bank Islam Malaysia Bhd    | 15          | 0.14 %                 | BBB                  | - / -                |
| ALLI.KL   | Alliance Bank Malaysia Bhd | 37          | 0.08 %                 | A-                   | NR / -               |
| PUBM.KL   | Public Bank Bhd            | 60          | 0.05 %                 | A+                   | A- / -               |
| AMMB.KL   | AMMB Holdings Bhd          | 35          | 0.08 %                 | A-                   | - / -                |
| HLBB.KL   | Hong Leong Bank Bhd        | 73          | 0.04 %                 | AA-                  | NR / -               |
| RHBC.KL   | RHB Bank Bhd               | 55          | 0.06 %                 | A                    | BBB+ / -             |
| MBSM.KL   | Malayan Banking Bhd        | 63          | 0.05 %                 | A+                   | A- / -               |
| AFIN.KL   | Affin Bank Bhd             | 20          | 0.12 %                 | BBB                  | NR / -               |
| Peer Avg. |                            | 45          | 0.08 %                 | BBB+                 | B- / -               |

Figure 1 Bank Islam Malaysia Bhd's Probability of Default on Refinitiv Platform

Source: Refinitiv

Here it shows that the probability of default for BIMB calculated is 0.14% and in comparison, to above calculated EDF is 0.002%. Both numbers indicate that BIMB is far away from being default.

## 4.2 The Strengths of the Model

### 4.2.1 The Accuracy and Reliability of the Model

The KMV-Merton model has been the subject of several studies, with mixed outcomes. While some studies have found that the model performs well in predicting default probabilities, others have found that it is less accurate than other models (Vaidya, 2023). The model's strengths include its ability to provide a comprehensive and theoretically sound approach to credit risk assessment, incorporating market-based information and company-specific data, capturing all of the information in traditional agency ratings and well-known accounting variables (Bharath & Shumway, 2011). However, Its weaknesses include the fact that the model's assumptions may not always hold in practice, and that it may be less accurate than other models in certain contexts (Vaidya, 2023).

In this study, the calculated PD using the KMV-Merton model is 0.20% which is very close to the PD stated in the Refinitiv market study, 0.14%. The results showed that the calculated PD was very close to the market PD with a difference of only 0.06%. This suggests that the KMV-Merton model can be a reliable tool for estimating PD.

Despite the mixed outcomes of studies on the KMV-Merton model, it is still widely used in the financial industry and is considered to be a reliable tool for assessing credit risk 1. In fact, Moody's KMV EDF model by Moody Analytics is based on the KMV-Merton model, is widely used by investors, lenders, and financial institutions to evaluate the creditworthiness of borrowers and make informed decisions regarding lending, investment, and risk mitigation strategies. Moody Analytics continued to test the model on nearly 35 years of historical data representing approximately 5,300 defaults in the United States alone, as well as on smaller samples in various countries around the globe, where the model accurately predicted those defaults (Moody

Analytics, 2011). In assessing the likelihood of default, Moody's KMV EDF model performs significantly better than agency ratings and all other statistical scoring models combined (Moody Analytics, 2011).

#### 4.2.2 The Applicability of the Model

The KMV model can be applied to different types of companies including Islamic Bank. However, when we want to adapt it to Islamic Bank, we need to find the debt-like liabilities and Islamic Bank-relevant interest rate. In this study, we analyse the expected default frequency and credit risk spread of Bank Islam Malaysia Berhad. Therefore, we use debt-like liabilities data that we obtained from Refinitiv and use Islamic Bank-relevant interest rates that we obtained from BNM (Overnight Policy Rate Decision).

However, the effectiveness of the KMV model depends on several factors, including company size, industry and market coverage (Vaidya, 2023). This means that the results of assessing the probability of default and credit risk spread using the KMV model vary depending on the quality and availability of the data. For example, financial data for public companies is generally easier to obtain and more reliable than for private companies.

Generally, the KMV model can be applied to various companies because this model integrates financial reports and market prices, making it effective and widely applicable. However, the applicability of the KMV model based on the data of Chinese companies remains controversial. Some Chinese scholars believe that the parameters of the KMV model need to be amended to suit the assessment of credit risk in Chinese companies (Liang, 2012).

According to (Liang, 2012), while the Merton-KMV model is a significant method to predict default in the Chinese market, it is not sufficient on its own. He suggests that the predictive performance of the Merton-KMV model can be improved by incorporating accounting variables and financial ratios measuring profitability, leverage, and liquidity. It also highlights the value of the functional form of the Merton-KMV model. The paper compares the performance of the Merton-KMV model with a pure accounting model and a hybrid model that combines probability of default calculated from the Merton-KMV model with financial ratios. It concludes that the hybrid model outperforms the other two models, indicating that incorporating financial ratios enhances the predictive power of the Merton-KMV model.

#### 4.2.3 The Ease of Use of the Model

The KMV Model is fairly easy applying the corresponding formulas using Microsoft Excel. The compiled data collected varies in terms of the period, some of the data collected are in annual period and some are in quarterly period. However, the model that is developed in Microsoft Excel uses weekly period. Thus, the data had to be interpolated from quarterly or annual to weekly before running the model. The interpolated data includes:

$P$ , the Stock Price,  
 $N$ , the Number of Stocks and  
 $\bar{D}$ , the Face Value of Debt.

## 5. Conclusion and Recommendation

The result shows that the PD for BIMB is nearly 0.0001 for the first 3 years of its debt maturity period and nearly 0.0007 and 0.002 for the maturity period of 4 and 5 years respectively. Credit risk spread for BIMB is nearly null for the first 2 years maturity period then gradually increases each year to 0.01, 0.05 and 0.14. BIMB's distance to default ranges between 9.17-10.01. Furthermore, the KMV-Merton model has the strength of providing a robust and comprehensive theoretical approach to assessing credit risk by integrating market-based information and firm-specific data, and is easy to implement using simple tools such as Microsoft Excel. The model has proven to be reliable in predicting the probability of default (PD), as shown in studies that recorded PD results that were very close to market PDs. However, its effectiveness may vary depending on data quality and availability, as well as contextual factors such as company size, industry, and market scope. Despite challenges in its application, especially in private companies or in specific markets such as China, the model remains widely used in the financial industry, including for companies such as Islamic Banks, with some modifications to the parameters to make it relevant.

Research also shows that the performance of the model can be improved by combining it with accounting variables and financial ratios, making it a flexible and highly predictive tool for assessing credit risk. Future research can build on this work to 1) Explore the factors contributing to the higher credit risk in Islamic banks compared to conventional banks in Malaysia- To identify specific areas that need improvement in risk management strategies for Islamic banks. 2) Investigate the impact of technological advancements, such as blockchain and distributed ledger technology, on credit risk management practices, including collateral management and counterparty risk assessment. 3) Focus and explore on validating and the KMV Merton model by incorporating additional factors such as macroeconomic indicators, industry-specific risks, and qualitative factors to enhance the accuracy and robustness of credit risk assessment.

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