

An Analysis of the Probability of Default for Non-Financial Public Companies in Asia's Emerging, Developed and Frontier Countries

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ABSTRACT

This research presents the probability of default profiles of non-financial public companies in Asia's market. Investors may need to monitor the market which they want to invest in. In this case, the probability of default is used to represent the financial condition. Using the Merton model as a structural approach method, financial reports data and market capitalization are employed to provide the probability of default of respective companies. The market was then classified further into three categories: developed market, emerging market, and frontier market. The probability of default profiles between those three categories was compared in this research. This study reveals that countries in the developed market and emerging market do not have significant differences, while the liquidity of those three financial markets are significantly different. It indicates that the Merton model does not capture the liquidity of the financial market properly, which results in a low probability of default in the frontier market. These findings can be considered by investors in their decision making in this globalization era.

Keywords: *probability of default; developed market; emerging market; frontier market; liquidity; Merton model*

1. INTRODUCTION

Default is a condition when one party fails to fulfill the obligation to another party. From a firm's point of view, it includes the failure of meeting financial obligations, bankrupt, and financially driven delisting. For public companies, default happens when the market value of an asset is lower than the company's liabilities. This means, the liabilities cannot be covered by the company's assets. The market value of an asset is calculated based on market stock price multiplied by outstanding shares. The probability of default can be predicted using the recent return on a firm's equity. According to Campbell, et al. [1], financially distressed stocks have delivered anomalously low returns. Beside low returns, these distressed stocks have higher standard deviations and market betas compared to low failure risk. It is known that higher returns should follow higher risk. Investment risk, including the probability of default, varies between markets. The riskier the market, the higher return expected by the investor. In other

words, the higher the probability of default, the higher the return index expected by the investor.

Previous research by Panjaitan [2] has found that developed countries in the Asia Pacific have a lower probability of default, lower asset volatility, and a higher liability-to-asset ratio compared to developing countries. Despite that, the developing market can be classified further into 2 (two): emerging market and frontier market. Consequently, it is possible to know the variation between the probability of default in the emerging market and frontier market and whether the probability of default in both markets can be represented by the probability of default in the developing market or not. There are several approaches to model the probability of default. The Merton model is not advised to be applied to financial companies as there was widespread estimation and actual condition due to finance regulation. This research focuses on the probability of default variation among developed markets, emerging markets, and frontier markets in non-financial public companies.

2. LITERATURE REVIEW

2.1 Default and the Probability of Default

According to Sironi and Resti [3], there is no unique definition of default. The definition is varying significantly depending on the aim of analyses by different researchers. Standard & Poor's has defined default as a failure of a firm to fulfill its financial obligation. Dar, *et al.* [4] stated that a default is a risk when firms neglect to pay money-related obligations, impacted by insufficient funds that they have. In other words, it is indebtedness suggesting that an account holder cannot pay. Probability of default is the essential credit risk in the world of finance [4]. The probability of default provides the likelihood estimation that a borrower will be unable to meet its debt obligation. Using a firm's point of view, the probability of default is the likelihood estimation of a firm's failure to meet its financial obligation. Evaluating the probability of default of a firm is the initial step while surveying the credit exposure and potential misfortunes faced by a firm [4]. The probability of default cannot be zero or very less. On the off chance that it will happen, it causes vast monetary misfortunes [5].

There are several methods to measure the probability of default. The methods are the econometric model, structural model, and the reduced-form model. The structural model is also known as option-theoretic or contingent-claim models. Black-Scholes Model for European Call Option (BSM-CO) can be utilized to quantify the probability of default [4]. Merton [6] has created the model to determine the default of a firm. The firm will be in a default state when its liabilities are lower than its assets or firm's value. Merton applied option theory to the problem of valuing a firm's liabilities in the presence of default and limited liability [7]. [8] stated that Merton is the first basic model that relates default risk and the firm's capital structure.

From the point of view of a firm with limited liabilities, default happens when asset value or firm's value cannot cover its liabilities. The value of the firm is negative when liabilities are higher than the assets. In this case, the claim of creditors will not be fully covered. When it occurs, equity holders exercise the walk-away option that they have because of limited liability and leave the firm to the creditors [7]. According to Loeffler and Posch [7], the walk-away option can be priced with standard approaches from option pricing theory. Option pricing theory can help as it implies a relationship between the unobservable and observable variables. Equity value can be used as an observable variable in a listed company. Equity value is calculated from outstanding shares multiplied with the share price. Asset value is then estimated using the equity value and the book liabilities from a firm's financial report. At a maturity point, the relationship

between equity value and asset value can be established. If the asset value is below the liabilities value, the equity value is zero as all assets are claimed by the bondholders [7].

2.2 Factors that Affect the Probability of Default

According to Lina and Ansellb [9], low cap and mid cap companies may have a low probability of default due to low transaction frequency in the market. The accuracy of Merton's probability of default depends on the liquidity of the market. One of the important assumptions that should be used in the Merton model is that the financial market is liquid enough (Pasaribu, 2008). According to Afik, *et al.* [10], asset volatility of non-default companies can be higher than the default companies impacted by the changes in market value.

2.3 Market Classification

The developed market is the strongest and most stable market in the world. The classification is based on the Gross Domestic Product (GDP) of each country. Developing market can be classified further into two: emerging market and frontier market. Morgan Stanley Capital International (MSCI) made Market Classification Framework in December 2018 as table 1.

2.4 Market Capitalization

Market capitalization in a public company is equal to the total number of a company's outstanding shares multiplied by the current market price of one share [11]. Switzer [12] found that low-cap companies in the United States are more vulnerable to default compared to mid-cap and big-cap companies.

2.5 Market liquidity

Market liquidity is important to support the accuracy of probability default calculated using the Merton model. According to Lina and Ansellb [9], the lack of volatility can contribute to an overestimation of distance to default which led to a lower probability of default.

3. RESEARCH METHODOLOGY

3.1 Data

The data used in this research are secondary data, which were obtained from Thomson Reuters Datastream.

The initial plan was to study 375 companies but due to the limitations of available data, it was decreased to 255 companies from a total of 15 countries. Based on MSCI Market Classification Framework, Table 2 is the list of countries from the respective markets in Asia.

Table 1. MSCI Market Classification Framework

Criteria	Frontier	Emerging	Developed
A. Economic Development A.1 Sustainability of economic development	No requirement	No requirement	Country GNI per capita 25% above the World Bank high income threshold* for 3 consecutive years
B. Size and Liquidity Requirements B.1 Number of companies meeting the following Standard Index criteria Company size (full market cap)** Security size (float market cap)** Security Liquidity	2 USD 797 mm USD 71 mm 2.5% ATVR	3 USD 1,594 mm USD 797 mm 15% ATVR	4 USD 3,187 mm USD 1,594 mm 20 % ATVR
C. Market Accessibility Criteria C.1 Openness to foreign ownership C.2 Ease of capital inflows / outflows C.3 Efficiency of operational framework C.4 Competitive landscape C.5 Stability of the institutional framework	At least some At least partial Modest High Modest	Significant Significant Good and tested High Modest	Very high Very high Very high Unrestricted Very high

*High income threshold for 2017: GNI per capita of USD 12,235 (World Bank, Atlas Method)

**Minimum in use for the May 2018 Semi-Annual Index Review, updated on a semi-annual basis

The countries are chosen based on MSCI Framework, while the companies are chosen based on their market capitalization. The timespan of research data is from 2014 up to 2018 year, considering there is no crisis that occurred during the period.

3.2 Research Method

3.2.1 Probability of Default

The Merton model is applied to exercise the probability of default. Clustering is used to analyze the result. The cluster analysis consists of company-wise, country-wise, and market-wise. The result of one cluster was then compared to another to see the correlation and relevance among them. Several parameters used in the Merton model must be taken from the market, while

others must be estimated. Most of the data used in this research has been taken from Thomson Reuters Datastream. These include company book liabilities stated in the financial report and market capitalization.

A company selection criteria has been made to minimize bias. The criteria is the top company sorted by the market capitalization size from each country. The market value of an asset is calculated using market capitalization and book liabilities. The threshold of the tolerance or sum of squared error (SSE) is 10^{-10} . If the SSE is greater than that, the iteration will be repeated consecutively. Iteration is performed for one year, or equal to 260 days which represents active days of the market. The number of the iteration depends entirely on the respective data. The more volatile the data, the more iteration is required. Asset value resulted from iteration then used to calculate asset return as shown in Formula 2.

Table 2. List of Countries

No.	Country	Market Classification	Number of Companies
1	Japan	Developed	23
2	Hong Kong	Developed	18
3	Singapore	Developed	20
4	Taiwan	Emerging	15
5	Malaysia	Emerging	19
6	Indonesia	Emerging	20
7	China	Emerging	14
8	South Korea	Emerging	18
9	India	Emerging	19
10	Pakistan	Emerging	14
11	Philippines	Emerging	13
12	Thailand	Emerging	10
13	Sri Lanka	Frontier	23
14	Vietnam	Frontier	7
15	Bangladesh	Frontier	22

$$A_t = E_t N(d_1) + L_t e^{-r_t \tau} N(d_2)$$

$$A_{t-1} = E_{t-1} N(d_1) + L_{t-1} e^{-r_{t-1}(\tau-1)} N(d_2)$$

$$A_{t-260} = E_{t-260} N(d_1) + L_{t-1} e^{-r_{t-260}(\tau-260)} N(d_2)$$

(1)

$$r_t = \ln \left(\frac{A_t}{A_{t-1}} \right)$$

(2)

Volatility (σ), also called as annualized standard deviation, is determined using asset log return as an input.

$$\sigma(r_{0,T}) = \sqrt{T} \sigma(r_t)$$

(3)

The actual return of the risk-free rate asset is equal to its expected return. Treasury bills are assumed to be risk-free. The drift rate is calculated based on each country's risk premium. The first probability-of-default result will be the probability of default of each company. The analysis is made for company-wise. Then, the result for companies within one country is incorporated using the value-weighted of each company's market cap. By doing this, analysis can be done for the next cluster, country-wise. The last cluster is market-wise.

3.2.2 Market Liquidity

The comparison of transaction volume (in USD) for each company is used to observe the liquidity. Transaction volume for one country is obtained from the average transaction volume of each company within the country. Then the average transaction volume of each country within one market is determined to represent the market liquidity. The transaction volume is very high, then to simplify, normalization was done using the figure of the frontier market transaction volume as the basis.

4. RESULTS

4.1 Result of Asset Volatility

The asset volatility is determined using the market value of an asset resulting from the Merton model. This figure is very essential for the probability of default calculation. In general, Japan is the country with the most volatile asset in the developed market. It is fluctuating significantly in Q3 2015, Q2 2016, Q1 2017, and Q3 2017. It has impacted on the average asset volatility in the developed market as seen in figure 1.

In the emerging market, the Philippines is the country with the most volatile asset. It is fluctuating significantly in Q3 2014, Q3 2015, and Q3 2017. It has impacted the average asset volatility in the emerging market as seen in figure 2.

In general, Bangladesh is the country with the most volatile asset in the frontier market. The fluctuation of the company's market cap and book liabilities in Bangladesh led to the high asset volatility of the country. Figure 3 is the average asset volatility in the frontier market.

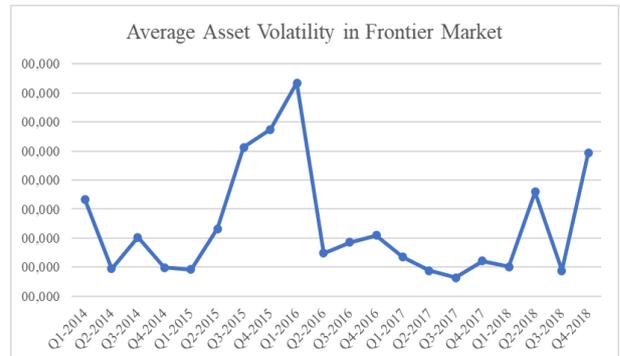
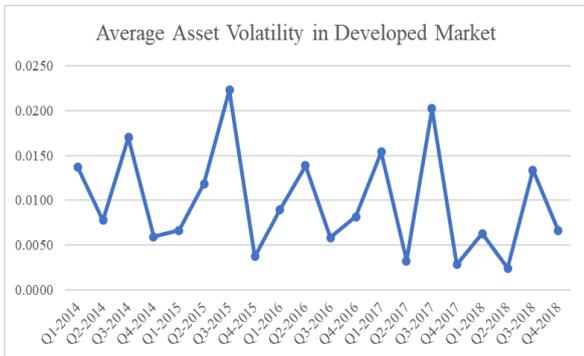


Figure 1 Average Asset Volatility in Developed Market

Figure 3 Average Asset Volatility in Frontier Market

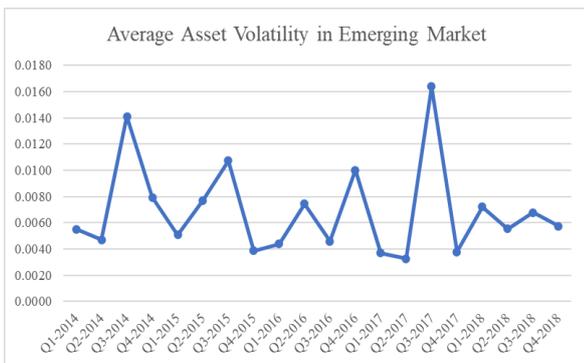


Figure 2 Average Asset Volatility in Emerging Market

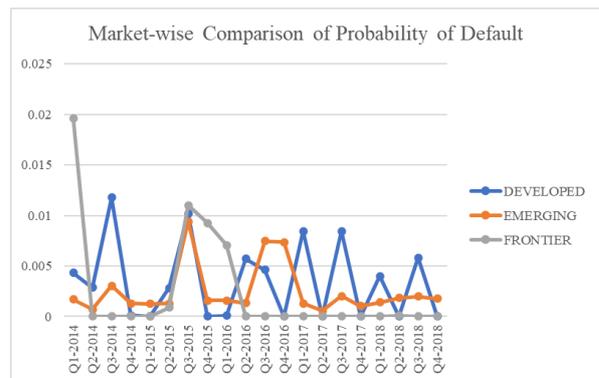


Figure 4 Market-wise Comparison of Probability of Default

Table 3. Transaction Volume comparison

Period	Transaction Value (Ratio)			Basis (USD)
	Developed	Emerging	Frontier	
Q2 2015	309	188	1	13.825
Q3 2015	213	259	1	18.564
Q4 2015	230	147	1	19.374
Q1 2016	239	120	1	14.611
Q2 2016	329	105	1	13.820
Q3 2016	281	89	1	13.942
Q4 2016	362	102	1	14.495
Q1 2017	239	112	1	16.915
Q2 2017	172	72	1	23.917
Q3 2017	358	172	1	12.204
Q4 2017	279	138	1	15.314
Q1 2018	407	205	1	12.792
Q2 2018	532	294	1	11.783
Q3 2018	579	301	1	8.732
Q4 2018	387	179	1	12.761

4.2 Result of Probability of Default

Figure 4 is the comparison of the probability of default in the developed market, emerging market, and frontier market. In general, the frontier is the market with the lowest probability of default except for several periods.

4.3 Comparison of Transaction Volume

The basis is the transaction volume (in USD) of the frontier market in each quarter. The transaction volume in the developed and emerging market is higher compared to the frontier. It indicates that both markets tended to be more liquid than the frontier.

4.4 Significance Test

The t-test is done using the figure of market probability of default and market transaction volume with a 95% degree of confidence. There is a significant difference between the two data sets if the p-value is less than 5%.

5. DISCUSSION

5.1 Analysis of Asset Volatility

In the developed market, the lowest asset volatility is 0.0024, which happened in Q2 2018. Meanwhile, the highest asset volatility is 0.0223, which happened in Q3 2015. The average asset volatility from a total of 20 periods in the developed market is 0.0098. The fluctuation of Japan's asset volatility has a big impact on the developed market's asset volatility. The pattern of asset volatility in the emerging market is quite the same as the pattern in the developed market. However, the asset volatility in the emerging market is lower

Table 4. Significance Test of Market Probability of Default

No.	Market	p-value	Conclusion
1	Developed and Emerging	0.274188	No significant difference
2	Developed and Frontier	0.453869	No significant difference
3	Emerging and Frontier	0.936149	No significant difference

Table 5. Significance Test of Market Liquidity

No.	Market	p-value	Conclusion
1	Developed and Emerging	7.34582E-07	There is a significant difference
2	Developed and Frontier	4.67862E-13	There is a significant difference
3	Emerging and Frontier	1.10319E-07	There is a significant difference

compared to the developed market. It is due to the fluctuation of book liabilities in the developed market's countries. In the frontier market, Bangladesh has different asset volatility values and patterns compared to the other 2 countries. However, this significant difference has impacted the overall frontier market's asset volatility.

5.2 Analysis of Probability of Default

Asset volatility is the key point that influences the probability of default's value. Those two variables have a positive correlation. Besides, market liquidity has impacted the accuracy of the probability of default. For the emerging market, the fluctuation of the probability of default is influenced by the market characteristic. Many companies have just recently listed or conducted initial public offering (IPO) in the research period. However, winsorization was done to mitigate outliers and minimize the deviation.

5.3 Analysis of Market Liquidity

The transaction volume in the frontier market is significantly lower compared to the developed and emerging market. The frontier market is considered as illiquid. Thus, the available data in the developed and emerging market represents the actual market condition and led to a more accurate result of probability of default.

6. CONCLUSION

Based on the calculation conducted, it was found that the probability of default in the frontier market tended to be lower than the probability of default in both developed and emerging markets. Meanwhile, there is no significant difference in the pattern and value of the probability of default between the developed and the emerging market. The fluctuation of asset volatility has led to the fluctuation of the probability of default. Both have a positive but not significant correlation. Asset volatility can be caused by the fluctuation of market cap values and by the changes in book liabilities.

While there is no significant difference among the probability of default of countries in the developed, emerging and frontier markets, the liquidity of those three financial markets are significantly different. It indicates that the Merton model does not capture the liquidity of the financial market properly, which results in a low probability of default in the frontier market.

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