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# Measuring dynamic market risk charge for market risks

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**Abstract:** An insurance company is significantly affected by market risks. In many current risk-based capital models, the market risk capital charge is determined by applying the fixed pre-determined percentage to the annual statement values regardless of market conditions. Many questions have been raised as to whether the fixed pre-determined percentage is the accurate measure of market risks. In response to this problem, this paper undertakes to determine a suitable percentage for the market risks faced by life insurers in Malaysia. The data involved in this paper are Kuala Lumpur Composite Index (KLCI), Malaysia Bond Index, foreign exchange rates and Housing Price Index (HPI) for year 2004 to 2009. The volatility model is used as proxy to measure the market risk charges. Then, a simulation is run to calculate the dynamic risk charges of market risks by adopting a dynamic financial analysis. Based on the analysis, the dynamic market risk charges are found to be higher for most of the assets classes during the crisis period compared to the normal period. As the ups and downs of the market conditions significantly affect the percentage of risk charge for market risks, it can be concluded that the fixed pre-determined percentage is not a practical measure.

**Keywords:** Risk-Based Capital, Market Risk, Pre-Determined Percentage, Percentage Return, Dynamic Risk Charge

## 1. Introduction

Capital is a firm's cushion against insolvency. Regulation on capital adequacy requirement for insurance companies has a long history, from "one-size-fits-all" to individual insurer risk profile. Over the years, insurance regulators have developed various rules and guidelines for determining capital requirement of insurance companies. The purpose is to ensure that insurers have sufficient capital to be able to face losses that might arise from risks taken by insurers in order to remain solvent and provide safety for policyholders. The main cause of insurance company failure is the inability of insurance companies to provide necessary capital amount to settle a large loss [1]. Therefore, capital is the heart of an insurer's health. The question of how much capital is sufficient still remains unclear. Traditionally, insurers are only required to have a fixed minimum amount of capital as specified by their insurance regulators. However, this historical regulatory fixed minimum capital requirement provides no help for regulators to act in the case of insolvency. This is because regulator has no rights to intervene until a company's capital falls below the minimum capital amount [2]. Due to the insolvency problems, the insurance regulation has evolved since then in an attempt to provide security for the policyholders. Therefore, the insurance regulation has changed from fixed minimum capital requirements to the capital that takes into account risks faced by the insurance companies. Since the implementation of the risk-based capital model, it has been static in nature. However, insurance regulators around the world are still adopting the same general concept of the risk-based capital model. Thus, the problem still remains unsolved and the model does not truly reflect the risk profile of the insurance companies.

Currently, the risk-based capital amount is determined based on the same general concept even though there are a variety of risk-based capital models around the world. In general, the risk-based capital model is a factor-based formula used to measure the capital needed to absorb the risk of insurer's business. However, the risk-based capital differs from one country to another. The difference lies in the risk charge or sometimes called risk factor applied to each risk in the model. The risk charge or risk factor is defined as a percentage that represents the risk exposure to an invested asset. Currently, there is a pre-determined fixed percentage applied by the insurance regulator of each country. The quantification of the risk charge is quite difficult and also subjective. Therefore, each jurisdiction has different

methods of measuring this risk charge. The methods to determine the risk charge are usually being kept confidential and not revealed to the public. Thus, this paper undertakes to explore the problem of the fixed percentage in risk-based capital model. This study looks into the possibility of risk charge that varies depending on the current economic condition by adopting a dynamic financial analysis. This paper analyzes the dynamic risk charge for the market risk which is the most significant risk for insurance company. The analysis of the risk charge for market risk will consider the ups and downs of economic condition. Hence, a method for determining the dynamic market risk charge of several assets classes that truly reflects insurer's risk profile has been developed.

## 2. Literature Review

Insurance regulation has advanced significantly in recent years. Currently, the insurance regulation highlights on the capital which reflects the risk profiles of insurance companies. Over the years, insurance regulators have developed various rules and guidelines for determining suitable capital for insurance companies. The main aim is to ensure that an insurance company has enough capital to remain solvent and to provide safety for the policyholder. Historically, insurance regulator had set an initial capital standard to be a flat minimum capital amount. However, the catastrophic fire of New York City in 1835 brought some concern about an insurer's insolvency. Following that catastrophic event, regulations were adopted by states requiring minimum initial capital amounts for an insurance company formation. This was started by New York in 1849, followed by New Hampshire two years later and other states followed thereafter such as Massachusetts in 1855 and Rhode Island in 1856. By the end of 19th century, most states in United States had their own regulation regarding the minimum capital requirements [3].

The minimum capital standards requirement is one of the solvency regulatory requirements. Solvency monitoring is mainly undertaken to ensure that insurance companies meet these regulatory requirements. Therefore, the insolvencies problems are significantly important as study by [4] concluded that the level and variability of capital and surplus were significantly related to the probability of life insurer insolvency. The number and average size of property-liability insolvencies were small before the mid-1980s. Then, the frequency and cost of insurer insolvencies have increased from an average of 10 per year from 1969-1983 to 32 per year afterwards in early 1984 [5]. Later, a study conducted by [6] stated that in 1980s insurers and regulators faced severe economic shocks whereby the number of insurer's insolvencies has increased dramatically and the quality of regulation was questioned. The current regulatory fixed minimum capital requirement provides no help for regulators to act in the case of insolvency. This is because the regulator has no rights to intervene until a company's capital falls below the minimum capital amount [2]. The other study on insolvency problem conducted by [7] stated that in the 1980s, 258 insolvencies of property-liability insurers occurred compared to 108 insolvencies during the 1970s. Due to the insolvency problems, the insurance regulation has evolved since then in attempt to provide security for the policyholders. The insurance regulation has changed from fixed minimum capital requirements for all insurance companies to the capital that takes into account the risks faced by insurance companies.

Risk-based capital is a capital that an insurer should hold against unforeseen events that reflects each company's risk profile in order to provide safety for the policyholders. The risk-based capital was established with the aim of helping the regulators to know the suitable time for intervention in the insurer's business and to reduce the costs of insolvencies. The risk-based capital requirement has its root back in 1953 in Finland. After that, there are several variations of the risk-based capital requirement being developed. In 1985, Canada has started their work on risk-based capital requirement for life insurers known as the Minimum Continuing Capital and Surplus Requirements (MCCSR) [8]. However, the MCCSR only came into effect in 1992. While for non-life insurers in Canada, the risk-based capital requirement started in 2003 and known as the Minimum Capital Test (MCT)[9]. It was then followed by the United States in 1990s. In United States (U.S), National Commissioners of Insurance Commissioners (NAIC) developed the risk-based capital (RBC) for life-health insurers in 1992 and for property-liability insurers in 1993 to partially correct the deficiencies of the previous traditional fixed minimum capital standard [6]. Next, Australia has followed the step in 2002 when they created their own risk-based capital requirement. At the same time in the European Countries, Solvency II has been formed to look into the new capital requirement which was based on the risks taken by the insurance companies [10].

Recently, the RBC requirement begins to evolve in Asian countries such as India, Japan, Indonesia, Thailand, Singapore and Malaysia. In 2004, the Monetary Authority of Singapore (MAS) announced the implementation of the risk-based capital framework for insurance companies in Singapore. Thailand started the implementation of their risk-based capital framework for insurance business in January 2008. A year later, Malaysia began their own risk-based capital framework after the release of two concept paper in 2004 and 2005 accordingly. Besides the regulatory risk-based capital requirement, rating agencies also have their own risk-based capital models such as A.M. Best, Standard & Poor and Moody's capital model. These rating agencies models are still primarily concern about an insurer's insolvency as the regulatory risk-based capital requirements models. However, there is a slightly different in the objective of the models. The objective is to provide a view of an insurer's financial health and its ability to meet ongoing obligations to policyholders [11].

Currently, the risk-based capital requirement has been widely accepted by many countries around the world. However, the risk-based capital requirement still has some room for improvement. The existing risk-based capital models are still being hotly debated by academicians and even insurance regulators. Many studies have shown that the weakness of the risk-based capital model is due to the static nature of the model. Some of the studies that pointed out the weakness are [12] and [5]. Furthermore, resulting from the critical review and analyses of the previous studies, we found that the risk-based capital models have the same general concept. The difference only existed in the risk charge applied for determining capital charge of each risk component in the risk-based capital formula. However, the studies particularly on risk charge are still lacking. One of the studies that analyze the risk charge is [13]. [13] analyzes the risk factor for unaffiliated common stock and verifies that the risk factor correctly indicate the risk of decline in value of assets. This study shows in details the current risk factor or risk charge of various asset classes according to the Bank Negara Malaysia (BNM) framework. The risk charges of BNM framework for exposures to various asset classes are provided in Table 1.

***Table 1:*** *The BNM risk charges for various asset classes*

| Asset classes: | Risk charge |
|---|---|
| **Equity risks:** | |
| Listed on the main board of Bursa Malaysia or listed on the main board of the recognise stock exchange in G10 country | 20% |
| Listed on recognise stock exchanges other than above | 30% |
| Investments in KLCI index of Bursa Malaysia or indicative index of the recognise stock exchanges in a G10 country | 16% |
| Investments in other stock market indices | 25% |
| Unlisted or private equity instruments (including venture capital investments) | 35% |
| **Property risks:** | |
| Self-occupied properties | 8% |
| Other property and property-related investments | 16% |
| **Interest rate risks:** | |
| For life insurance funds | max[surplus of increasing interest rate scenario, surplus of decreasing interest rate scenario] |
| For general insurance funds and shareholders' funds: | |
| X (residual term to maturity) <= 1 month | 0% |
| 1 < X <= 3 months | 0.20% |
| 3 < X <= 6 months | 0.50% |
| 6 < X <= 12 months | 0.80% |
| 1 < X <= 2 years | 1.30% |
| 2 < X <= 3 years | 1.90% |
| 3 < X <= 4 years | 2.70% |
| 4 < X <= 5 years | 3.20% |
| 5 < X <= 7 years | 4.10% |
| 7 < X <= 10 years | 4.60% |
| 10 < X <= 15 years | 6.00% |
| 15 < X <= 20 years | 7.00% |
| X > 20 years | 8% |
| **Currency risks** | max[net long position, net short position] x 8% |
| **Assets of collective investments schemes:** | |
| Govt. securities | 0% |
| Money market instruments, including cash | 1.60% |
| Shares | 16% |
| Debt securities | 4% |
| Properties | 16% |
| Foreign assets | the above charges plus additional 8% |
| **Concentration risks** | above the limit x 100% |

# 3. Methodology

Market risk is defined as the risk of financial losses arising from the reduction in the market values of assets due to the exposure of several market risk factors. The common market risk factors are equity risk, interest rate risk, property risk, currency risk and commodity risk. The research design for determining the dynamic risk charge of market risks is illustrated in Fig. 1. The volatility model is used as a proxy to measure the market risk charges for several assets classes. Then, the dynamic financial analysis is adopted to determine the dynamic market risk charges.

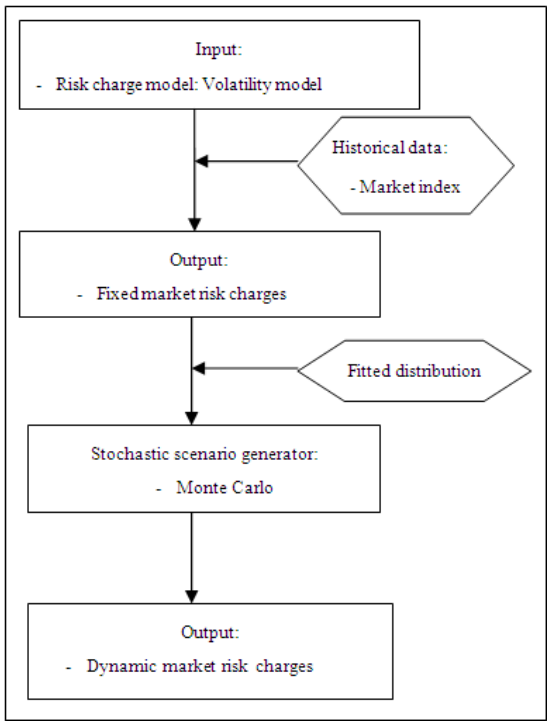


***Fig. 1.*** *Research design for dynamic market risk charge determination*

### *3.1. Data*

The data for 2004 to 2009 have been used in this study to determine the volatility as the risk proxy for dynamic market risk charges. The volatility model used in this study requires several variables namely market indices, foreign exchange rates, Malaysian Bond Index and Housing Price Index. As for foreign exchange rates, the major foreign exchange rates included are United States Dollar (USD), European Euro (EUR), Japanese Yen (JPY100), British Pound (GBP) and Australian Dollar (AUD).

### *3.2. Volatility Model*

In the process of determining the risk charges for market risks, we compiled the indices and foreign currency rates and calculated their corresponding volatility. The popular volatility model implemented in the industry by JP Morgan was used. The volatility model is the one-parameter Exponentially Weighted Moving Average (EWMA) model with RiskMetrics as follows:

$$\sigma_t^2 = (1-\lambda) r_{t-1}^2 + \lambda \sigma_{t-1}^2 \quad (1)$$

where $\lambda = 0.95$

$r_{t-1}^2$ = return at time *t*-1

$\sigma_{t-1}^2$ = volatility at time *t*-1

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100\% \quad (2)$$

where $P_t$ is the index (currency rate) at time *t*
$P_{t-1}$ is the index (currency rate) for previous time *t-1*

### *3.3. Dynamic Financial Analysis*

This study adopted the dynamic financial analysis (DFA) in order to transform the static risk charges into a new dynamic risk charge for the capital adequacy model. This is the most significant step in this study which would overcome the main problem of the current risk-based capital approach. In general, [14] defined the dynamic financial analysis as the process of studying profitability and solvency of an insurance company under a realistic and integrated model of key input random variables such as loss frequency and severity, expenses, reinsurance, interest and inflation rates and asset defaults. In this study, DFA can be defined as follows:

- Dynamic – reflects the uncertainty involved in modeling the risk charges of capital adequacy model as opposed to fixed or static risk charges.
- Financial – integration of all risks faced by life insurers
- as well as the integration of insurer's assets and
- liabilities.
- Analysis – process

The DFA is adopted by fitting distribution for the historical market risk charges and then generating the new random or dynamic market risk charges using Monte Carlo simulation. The number of simulation has been limited to 10,000.

The fixed risk charges are calculated as the average of historical volatility and were explained in the previous paper by [15]. This paper extends the analysis by applying the dynamic financial analysis to determine the dynamic market risk charges. The first part of the analysis, the simulated risk charges are observed to confirm that during the crisis period the risk charges are higher compared to the normal period. This is done to validate the DFA model for the dynamic risk charges. Following that, the dynamic risk charges have also been carried out for a five year time horizon. The risk charges data of 2004 to 2008 are used to estimate the distribution, hence to forecast the dynamic risk charges.

## 4. Results and Discussions

The results for the dynamic market risks charges are presented and discussed in this section. The dynamic market risk charges results are divided into two categories. The first category's results are the dynamic market risk charges calculated for two different periods namely crisis and normal period and the second category's results are the forecasted dynamic market risk charges using the 5 years historical data. These dynamic risk charges improvised the existing static or fixed risk charges found in our previous paper [15]. The dynamic financial analysis integrates into the existing static risk charges to produce the new dynamic risk charges. The first analysis is aim to investigate the effect of economic condition on the dynamic market risk charges. Hence, it is validated that the current economic condition do reflects the risk charges and thus the risk-based capital amount of an insurer. Table 2 shows the results of dynamic market risk charges for the normal and crisis period while Table 3 shows the analysis that was conducted to forecast the dynamic market risk charges. For the comparison analysis, three years data have been used which ranges from year 2004 – 2006 (normal period) and 2007 – 2009 (crisis period). The dynamic market risk charge for stocks is the highest at 33.98% during the crisis period compared to only 25.65% during the normal period. The dynamic market risk charges for shares/ warrants are assumed to follow the dynamic market risk charge for stocks. The dynamic market risk charge for properties found to be the second highest after stocks. For normal period, it requires about 16.63% while a during the crisis period it is increased to 19.3%. For crisis period, the MGS bond, Khazanah, Cagamas and corporate conventional bond require a higher dynamic market risk charges as compared to the normal period. The dynamic market risk charges are 1.05%, 0.71%, 0.40% and 0.72% respectively. However, the dynamic market risk charges for corporate Islamic bond is slightly lower during the crisis period compared to the normal period. The dynamic market risk charge for unit trusts is assumed to follow the corporate conventional bond with dynamic market risk charge of 0.68%

for normal period and 0.72% for crisis period. However, the dynamic market risk charge for currency risk is higher for normal period compared to the crisis period on average. For currency risk, the dynamic market risk charge is 0.34% during the normal period and 0.27% during the crisis period.

***Table2.*** *Dynamic market risk charges for normal and crisis period*

| Asset classes | Dynamic market risk charges | |
|---|---|---|
| | Normal | Crisis |
| **Equity risk:** | | |
| Stocks | 25.65% | 33.98% |
| Investments risk: | | |
| Malaysian Government Bond (MGS) | 0.63% | 1.05% |
| Khazanah | 0.68% | 0.71% |
| Cagamas | 0.33% | 0.40% |
| Corporate conventional bond | 0.68% | 0.72% |
| Corporate Islamic bond | 0.72% | 0.66% |
| Properties | 16.63% | 19.30% |
| Shares/warrants | 25.65% | 33.98% |
| Unit trusts - form of collective investment | 0.68% | 0.72% |
| **Currency risk:** | | |
| USD | 0.03% | 0.42% |
| HKD | 0.24% | 0.09% |
| Indonesian Rupiah | 0.51% | 0.26% |
| Korean Won | 0.74% | 0.40% |
| SGD | 0.30% | 0.20% |
| Thailand Baht | 0.36% | 0.26% |
| Taiwan Dollar | 0.23% | 0.25% |
| **Average** | **0.34%** | **0.27%** |

After the validation process, the 5-years data from the period of 2004 – 2008 is used to predict the dynamic market risk charges. Table 3 shows the forecasted dynamic risk charges according to the assets classes. The dynamic market risk charge for properties is 46.33% which is the highest among the other assets classes. Then, stocks require dynamic risk charge of 26.31%. Shares/ warrants assumed to follow stocks with dynamic market risk charge of 26.31%. Five types of bonds have being considered in this study namely Malaysian Government Bond (MGS), Khazanah, Cagamas, corporate conventional bond and corporate Islamic bond. Among these bonds, corporate conventional bond is found to have the highest dynamic market risk charge at 0.81%. This is followed by Khazanah which has slightly lower dynamic market risk charge of 0.71%. The corporate Islamic bond and Malaysian Government Bond (MGS) have dynamic market risk charges of 0.65% and 0.62% respectively. Cagamas is found to have the lowest dynamic market risk charge of 0.20%. Properties and unit trusts required dynamic market risk charges of 0.40% and 0.81% respectively. Finally, the average dynamic market risk charge for currency risk is 0.40%.

***Table3.*** *Forecasted dynamic market risk charges using five years of data*

| Asset classes | Forecasted dynamic risk charges |
|---|---|
| **Equity risk:** | |
| Stocks | 26.31% |
| **Investments risk:** | |
| Malaysian Government Bond (MGS) | 0.62% |
| Khazanah | 0.71% |
| Cagamas | 0.20% |
| Corporate conventional bond | 0.81% |
| Corporate Islamic bond | 0.65% |
| Properties | 46.33% |
| Shares/warrants | 26.31% |
| Unit trusts - form of collective investment | 0.81% |
| **Currency risk:** | |
| USD | 0.43% |
| HKD | 0.12% |
| Indonesian Rupiah | 1.07% |
| Korean Won | 0.30% |
| SGD | 0.23% |
| Thailand Baht | 0.30% |
| Taiwan Dollar | 0.34% |
| **Average** | **0.40%** |

# 5. Conclusions

The study undertakes to calculate the dynamic market risk charges by adopting a dynamic financial analysis. The dynamic market risks charges have been calculated according to several assets classes. The indices and foreign exchange rates are used as proxies for market risk factors. The study finds that the risk charge during the financial crisis years is the highest across most of the asset classes except for currency risk and corporate Islamic bond. Thus, it can be seen that the capital set aside during the crisis will not be adequate to cover the market risk exposed by an insurer. Furthermore, during the normal period, the results show a low dynamic market risk charges compare to the crisis period. Therefore, we can conclude that the volatile economic condition has significant effect on the determination of the dynamic market risk charges. Hence, the fixed risk charge applied by BNM is not an accurate measure and does not seem to really reflect the current risk profile of insurers. As a result, the determination of capital adequacy will be affected. As a conclusion, this study has produced a dynamic market risk charge formulation that better reflects the risk profile of insurance companies and hence a better measure in determining capital adequacy.

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