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Modelling Risky Investment by Considering Geometric Brownian Motion using *Musyarakah* Concept

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ABSTRACT

In Islamic investment, the most distinctive element is the prohibition of interest or riba. In order to avoid riba in investment, Islamic banking and finance has developed profit-loss-sharing systems which claim to be primarily based on Islamic concept. One of the Islamic concepts that involve the profit-loss-sharing system is musyarakah concept. In musyarakah, two or more parties which are known as capital provider and entrepreneur will share the profit and loss during the investment. This study develops the new musyarakah investment model by considering the rate of return as a total of a deterministic profit rate and a function of white noise. This model can be used in forecasting the investment in the stock market. Based on the results obtained, this model is useful in forecasting the musyarakah investment and return for two parties since the results show the accurate forecast investment. The profit from the musyarakah investment, then is compared with profit from single investment that uses geometric Brownian motion (GBM) model. The result shows that the difference profit between these investments is small. It can be concluded that the new musyarakah investment model can be used in order to forecast the profit for both parties with two difference profit sharing rates.

Keywords: *Musyarakah investment; single investment; profit sharing rates; geometric Brownian motion (GBM); Islamic finance.*

1. INTRODUCTION

Islam is a religion that promotes equality and fairness, not only to its followers, but also to all mankind. It is totally objected any inequality in all economic activities including investment and prohibits interest or riba. According to Chapra [1], literally, *riba* means addition, increase, growth or expansion. It is however, not every increase or growth has been prohibited by Islam.

In Islamic jurisprudence, two types of financial contracts are offered to substitute *riba* oriented transactions. These are *mudharabah* (profit-sharing) and *musyarakah* (partnership). Muhammad and Muhammad [2] define *musyarakah* as a joint venture formed to conduct some business in which the profit is shared with all partners according to a specific agreed ratio while loss is shared according to the ratio of their contributions. On the other hand, Abdullaah and Hisham [3] define *mudharabah* as a type of investment in which capital is

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contributed by the capital provider (*rabb al-mal*) and labour is from the entrepreneur (*mudarib*). The profit is shared between them. In case of loss in the joint venture, it is borne solely by the capital provider.

According to Maheran, Hamdan, Rashidah, and Abd Aziz [4], *musyarakah* is one of the main basic Islamic concepts of finance in Islamic banking system, but it is not popular and uncontroversial because the concept is hardly used in the Islamic bank's operations. Based on research done by Muhammad and Muhammad [2], one of the reasons for slow growth of the *musyarakah* concept is risk of loss.

Nowadays, investment in the stock market is uncertain and unpredictable, therefore many people prefer to be involved in less or non-risky business investment such as *mudharabah*, *bai bithaman ajil*, *ijarah*, *istisnaa'* and a few more contracts as they want to avoid high loss [5]. Since the *musyarakah* investment involves a higher degree of risk, therefore it is beneficial to model the *musyarakah* investment.

According to Ermogenous [6], geometric Brownian motion is a lognormal, continuous time stochastic process where the movement of a variable, such as stock price is random and continuous. It means that, the stock prices are changing continuously over very small intervals of time and the positions, where the change of state on the assets is being altered by random amounts. In this study, the Brownian motion will be considered as a foundation for the development of the new *musyarakah* investment model in forecasting the stock prices. Thus, this study can help investors reduce the risk on the investment by forecasting the investment and return for two parties with different profit sharing rates using the new mathematical *musyarakah* investment model.

2. METHODOLOGY

2.1 Forecasting The Prices of Syariah Counters using Geometric Brownian Motion (GBM) Model

The objective of this section is to find the best daily data that produces the future prices that are close to the actual values. Three different numbers of daily price data (one week, two weeks and three weeks) was obtained from Kuala Lumpur Stock Exchange (KLSE) online [7] were used to generate initial forecasts. The three different numbers of daily price data were used to forecast the prices of one of the top active *syariah* counters in Bursa Malaysia for four weeks investment by using GBM model. According to Wilmott [8], the GBM model is

$$S(t) = S(0)e^{\left(\mu-\frac{1}{2}\sigma^2\right)t(X(t)-X(0))} \tag{1}$$

where μ represent the drift, σ represent the volatility, $S(0)$ is the initial value and $X(t)-X(0)$ is random value generates from Microsoft Excel. In this research, the high-low-close volatility was used to calculate the volatility. The equation to measure drift μ and volatility σ are

$$\mu = \frac{1}{M\,\delta t}\sum_{i=1}^{M} R_i \tag{2}$$

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where M is number of asset return in the sample, δt is a timestep and R_i is the return at the time i.

$$\sigma = \sqrt{\frac{1}{(M-1)\delta t}\sum_{i=1}^{M}\left(0.5(\log H(t_i) - \log L(t_i))^2 - 0.39(\log S(t_i) - \log S(t_{i-1}))^2\right)} \tag{3}$$

Then, the forecast was repeated for three different numbers of daily price data. The MAPE was calculated by using the formula

$$MAPE = \frac{1}{M}\sum_{j=1}^{M}\frac{\left|X_A - X_f\right|}{X_A} \tag{4}$$

where X_A represents the actual value and X_f is the forecast value.

Lawrence, Kllimberg, and Lawrence [9] introduce a scale which based on the MAPE measure in order to judge the accuracy of forecast model. The lower value of MAPE means the more accurate the forecast model. The scales are shown in Table 1.

Table 1: A Scale of Judgement of Forecast Accuracy

MAPE	Judgement of forecast accuracy
<10%	Highly accurate
11% to 20%	Good forecast
21% to 50%	Reasonable forecast
>51%	Inaccurate forecast

2.2 The Development of New Musyarakah Investment Model for Two Parties in Managing Risky Investment

The new musyarakah investment model in managing risky investment is derived and modified from the continuous *musyarakah* model (5) that has been discussed by Maheran[5],[10] by considering the rate of return as a total of a deterministic profit rate and a function of white noise. The continuous *musyarakah* model is

$$\begin{pmatrix} E(t) \\ Q(t) \end{pmatrix} = \begin{pmatrix} \dfrac{(1-k)e^{\rho t(k+j-1)} + (1-j)e^{r(t)t}}{(1-k)+(1-j)} & \dfrac{(1-j)(e^{\rho t} - e^{\rho t(k+j-1)})}{(1-k)+(1-j)} \\ \dfrac{(1-k)(e^{\rho t} - e^{\rho t(k+j-1)})}{(1-k)+(1-j)} & \dfrac{(1-k)e^{\rho t} + (1-j)e^{\rho t(k+j-1)}}{(1-k)+(1-j)} \end{pmatrix} \begin{pmatrix} E(0) \\ Q(0) \end{pmatrix} \tag{5}$$

where ρ is profit rate, k and j are the sharing rate of the capital provider and entrepreneur respectively.

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2.3 Forecasting The Musyarakah Investment and Return for Two Parties with Two Different Profit Sharing Rates using Developed Musyarakah Investment Model

In order to forecast the *musyarakah* investment, the best number of daily price data that produced the forecast prices of four weeks investment that were close to the actual prices was used. The forecasting was done by using the new *musyarakah* investment model on one of the top active *syariah* counters.

In this research, the *musyarakah* investment for two parties involving two different profit sharing rates was compared to the single investment which did not involve any profit sharing rate. The forecast profit and MAPE from the *musyarakah* investment and single investment were also compared. The single investment was referred to the forecast investment that has been obtained by using GBM model. In this study, assume the capital of RM12,000 was invested, where RM8000 of the capital was invested by capital provider and RM4000 was invested by entrepreneur. From the capital provider's investment, the profit was shared between the capital provider and entrepreneur with a ratio of 70:30 and from the entrepreneur's investment, the profit was shared between capital provider and entrepreneur with a ratio of 20:80. Then, the average forecast profit difference, $A(n)$ between the *musyarakah* investment and single investment is obtained by using

$$A(n) = \frac{\sum_{t=1}^{n} \left| P_{S(t)} - \left(P_{E(t)} + P_{Q(t)} \right) \right|}{n} \tag{6}$$

where $P_{S(t)}$ is the forecast profit from a single investment at time t, $P_{E(t)} + P_{Q(t)}$ is the total forecast profit from capital provider's and entrepreneur's *musyarakah* investment at time *t*, and *n* is the number of days forecast. The number of days forecasted were 20 days (four weeks investment).

Lastly, the percentage of forecast profit difference, $D(n)$ was calculated as follows:

$$D(n) = \frac{A(n)}{S(0)} \times 100\% \tag{7}$$

where the amount of capital investment, $S(0)$ in this research was RM12,000. If the value of $D(n)$ is small, it shows that the forecast profit of the single investment has been divided appropriately between the capital provider and the entrepreneur using the developed *musyarakah* investment model.

3. RESULT AND DISCUSSION

3.1 Forecasting The Prices of Syariah Counters using Geometric Brownian Motion (GBM) Model

One of the *syariah* counter was selected from the top active *syariah* counters in KLSE is George Kent Malaysia Bhd counter. The prices of this *syariah* counter was forecasted for four

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weeks investment (20 days) by using three different number of daily prices data which are one week (23rd June 2016 until 29th June 2016), two weeks (15th June 2016 until 29th June 2016) and three weeks (8th June 2016 until 29th June 2016). In order to determine the best number of daily price data that can be used to forecast the prices of *syariah* counter that are close to the actual values, the MAPE was used to measure the performance of the forecasting model for *syariah* counter prices.

Based on Table 2, it appears that the forecast prices for the *syariah* counter using three different numbers of daily prices data are quite close to the actual prices and the values of MAPE for three different numbers of daily prices data are highly accurate since the error is less than 10%. It means that the different number of daily prices data from one to three weeks daily data can be used to forecast the prices of *syariah* counter, but the most notably is the one week daily prices data which clearly produces the lowest value of MAPE.

Table 2: Values of MAPE for George Kent Malaysia Bhd Counter Sample of Table

Date	Actual Prices, X_A	Forecast Prices, X_f		
		One week	Two weeks	Three weeks
29-Jun-16	1.85			
30-Jun-16	1.86	1.84	1.89	1.86
1-Jul-16	1.93	1.88	1.85	1.85
4-Jul-16	1.98	1.90	1.87	1.87
5-Jul-16	1.99	1.87	1.84	1.86
8-Jul-16	2.03	1.90	1.84	1.87
11-Jul-16	2.05	1.95	1.87	1.86
12-Jul-16	2.03	1.94	1.89	1.87
13-Jul-16	2.01	1.95	1.85	1.86
14-Jul-16	2.06	1.96	1.89	1.88
15-Jul-16	2.03	1.99	1.90	1.88
18-Jul-16	2.03	2.00	1.86	1.87
19-Jul-16	2.01	2.00	1.88	1.88
20-Jul-16	2.06	1.98	1.89	1.87
21-Jul-16	2.02	2.06	1.89	1.90
22-Jul-16	2.06	2.06	1.87	1.89
25-Jul-16	2.07	2.10	1.84	1.88
26-Jul-16	2.05	2.08	1.87	1.91
27-Jul-16	2.03	2.07	1.87	1.90
28-Jul-16	2.00	2.14	1.87	1.90
29-Jul-16	2.00	2.12	1.89	1.91
	MAPE	3.26%	7.23%	6.72%

3.2 The Development of New Musyarakah Investment Model for Two Parties in Managing Risky Investment

The *musyarakah* investment model discussed by Maheran [5], [10] is based on equation (8) and (9) which can be seen from the aspect of equity. The equities that are involved are the equity of the capital provider, E_t and the equity of the entrepreneur, Q_t. In this investment

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research, E_t and Q_t can be defined as the investment of capital provider and entrepreneur respectively. The investment of capital provider E_t is as below

$$E_t = E_{t-1} + r_t kE_{t-1} + r_t(1-j)Q_{t-1} \qquad for\ t = 1,2,3,\mathrm{K} \tag{8}$$

The quantity E_t is the investment of the capital provider at time t, $r_t kE_{t-1}$ is the capital provider's profit from the capital provider's investment when the capital provider's profit sharing rate is k while, $r_t(1-j)Q_{t-1}$ is the capital provider's profit from entrepreneur's investment when the capital provider's profit sharing rate is $(1-j)$. The investment of entrepreneur, Q_t is as below:

$$Q_t = Q_{t-1} + r_t(1-k)E_{t-1} + r_t jQ_{t-1} \qquad for\ t = 1,2,3,\mathrm{K} \tag{9}$$

The quantity Q_t is the investment of the entrepreneur at time t, $r_t(1-k)E_{t-1}$ is the entrepreneur's profit from the capital provider's investment when the entrepreneur's profit sharing rate is $1-k$ while $r_t jQ_{t-1}$ is the entrepreneur's profit from the entrepreneur's investment when the entrepreneur's profit sharing rate is j.

The equation (8) and (9) has been solved by Maheran [5], [10] where the solution is in the form of $X(t) - X(0)e^{Nt}$. This solution was used in this research with *r*(*t*) changes at time *t* and *N* is a matrix $\begin{pmatrix} r(t)k & r(t)(1-j) \\ r(t)(1-k) & r(t)j \end{pmatrix}$. In order to solve e^{Nt}, the eigenvalues of matrix *N* were obtained first. The eigenvalues were $\lambda_1 = r(t)$ and $\lambda_2 = r(t)(k+j-1)$. Matrix *N* has different eigenvalues, and hence the solution obtained was as below

$$e^{Nt} = \begin{pmatrix} \dfrac{(1-k)e^{r(t)t(k+j-1)} + (1-j)e^{r(t)t}}{(1-k)+(1-j)} & \dfrac{(1-j)(e^{r(t)t} - e^{r(t)t(k+j-1)})}{(1-k)+(1-j)} \\ \dfrac{(1-k)(e^{r(t)t} - e^{r(t)t(k+j-1)})}{(1-k)+(1-j)} & \dfrac{(1-k)e^{r(t)t} + (1-j)e^{r(t)t(k+j-1)}}{(1-k)+(1-j)} \end{pmatrix} \tag{10}$$

Thus, the solution in the form of matrices is

$$\begin{pmatrix} E(t) \\ Q(t) \end{pmatrix} = \begin{pmatrix} \dfrac{(1-k)e^{r(t)t(k+j-1)} + (1-j)e^{r(t)t}}{(1-k)+(1-j)} & \dfrac{(1-j)(e^{r(t)t} - e^{r(t)t(k+j-1)})}{(1-k)+(1-j)} \\ \dfrac{(1-k)(e^{r(t)t} - e^{r(t)t(k+j-1)})}{(1-k)+(1-j)} & \dfrac{(1-k)e^{r(t)t} + (1-j)e^{r(t)t(k+j-1)}}{(1-k)+(1-j)} \end{pmatrix} \begin{pmatrix} E(0) \\ Q(0) \end{pmatrix} \tag{11}$$

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Comparing the equation (5) and (11), both seems similar and the only difference is, equation (11) is in terms of $r(t)$ where $r(t)$ changes at time, t. The equation (5) solved by Maheran [5], [10] was solved by using MAPLE 9 software, but in this research the equation (11) is solved manually.

The nature of the stock prices development is not fully known, and it depends on the effect of random environment. The effect can be seen in the rate of return or profit. Therefore, the rate of return at time t is

$$\begin{aligned} r(t) &= \alpha(t) + \text{a function of white noise} \\ &= \alpha(t) + f(p) \end{aligned} \tag{12}$$

where *p* is the white noise that represents systematic risk and unsystematic risk which the behavior of the risk is not precisely known, but the probability of the risk is still exist. Systematic risk related to such factors as political, economic and social changes while, unsystematic risk is a type of risk that depends on internal business factors which includes consumer preferences, management capability, labor strikes, and raw material scarcity[11]. Variable $\alpha(t)$ is a deterministic profit rate or profit rate that identified for risk free investment and variable of $f(p)$ can be modeled as

$$f(p) = \lambda\phi \tag{13}$$

where φ is the random value and λ is a constant. By substituting (12) and (13) into (11) and converting the matrices will produce the capital provider's $E(t)$ and entrepreneur's $Q(t)$ *musyarakah* investment model as below

$$E(t) = \frac{(1-j)e^{(\alpha(t)+\lambda\phi)t}(E(0)+Q(0)) + e^{(\alpha(t)+\lambda\phi)t(k+j-1)}((1-k)E(0)-(1-j)Q(0))}{(1-k)+(1-j)} \tag{14}$$

$$Q(t) = \frac{(1-k)e^{(\alpha(t)+\lambda\phi)t}(E(0)+Q(0)) + e^{(\alpha(t)+\lambda\phi)t(k+j-1)}((1-j)Q(0)-(1-k)E(0))}{(1-k)+(1-j)} \tag{15}$$

where $\alpha(t)$ is the drift of stock prices, λ is the volatility of stock prices and φ is a random value. The equations (14) and (15) are used to forecast the *musyarakah* investment for two parties in risky investments.

3.3 Forecasting The Musyarakah Investment and Return for Two Parties with Two Profit Sharing Rates using The Developed Musyarakah Investment Model

In order to forecast the *musyarakah* investment and return for two parties with two profit sharing rates on one of the top active *syariah* counter, the equation (14) and (15) were used. In order to match the objective of this study, the drift and volatility of one week daily data was used to generate the initial forecast prices of four weeks investment since one week daily prices data produces the lowest value of MAPE among three different number of daily prices data.

The result of the forecast investment and profit for two parties with profit sharing rates and without profit sharing rate for George Kent Malaysia Bhd counter was shown in Table 3.

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Table 3 shows that the capital provider and entrepreneur were getting the maximum profit on 28th July 2016 where the profits are RM1027.44 and RM 917.26 respectively. It means that, if both parties invest their capital on 29th June 2016, they should sell their stock on 28th July 2016 so that they are getting the maximum profit. The maximum profit for single investment is RM 1892.37. It shows that the total profit for capital provider and entrepreneur in *musyarakah* investment on 28th July 2016 is RM 1944.71 which is slightly higher than the profit in a single investment.

The average forecast profit difference, $A(n)$ and the percentage of forecast profit difference, $D(n)$ were calculated by using equation (6) and (7). The small value of $D(n)$ shows that the profit of the single investment has been divided successfully using the developed *musyarakah* model.

Another result is the value of MAPE for the new *musyarakah* investment model of George Kent Malaysia Bhd counter is 3.17% which is less than 10% that signifies the new *musyarakah* investment model has been forecasted accurately.

3. CONCLUSION AND RECOMMENDATION

In conclusion, to forecast the *musyarakah* investment, the forecasts study on the prices of the *syariah* counters using GBM model should been done beforehand. This was done by identifying the best number of daily data that can be used to generate initial forecast prices of four weeks investment. There were three different numbers of daily prices data that were tested in this study. Based on the results obtained, it clearly shows that the one week daily data produces the lowest value of MAPE which is less than 10%. It can be concluded that the one week daily data forecasts the most accurate investment compared to other number of daily data.

The new *musyarakah* investment model was applied to forecast the investment and profit for both capital provider and entrepreneur. The forecast profit of these two parties in *musyarakah* investment was compared to the forecast profit obtained in a single investment. The result shows the forecast profit of *musyarakah* investment is close to the forecast profit obtained in a single investment. The average forecast profit difference, A(n) and the percentage forecast profit difference, D(n) was calculated. The small values of A(n) and D(n) for the *syariah* counter show that the new *musyarakah* investment model can be used to forecast the profit for both parties with two different profit sharing rates. It also verifies that the forecast profit of single investment is divided appropriately by the developed *musyaraka*h model.

It is recommended to determine the optimal profit sharing rates used in capital provider and entrepreneur investment to gain optimal profit. It is also suggested to develop a new model that is more flexible where the model forecasts the investment higher or lower than the initial value of an investment, as well as the same value of initial investment.

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Table 3: The Forecast Investment and Profit on George Kent Malaysia Bhd

Date	Actual Price	Actual Investment	*Musyarakah* Model						GBM Model			Different Profit |*S*(t)-(E(t)+Q(t))|
			Capital Provider		Entrepreneur					Single Investment		
			Forecasted Investment E(t)	Forecasted Profit E(t)	Forecasted Investment Q(t)	Forecasted Profit Q(t)	Forecasted Investment E(t)+Q(t)	Forecasted Profit E(t)+Q(t)	Forecasted Price	Forecasted Investment S(t)	Forecasted Profit S(t)	
29-Jun-16	1.85	12000	8000		4000		12000			12000		
30-Jun-16	1.86	12064.86	8039.34	39.34	4034.45	34.45	12073.79	73.79	1.84	11934.78	-65.22	139.01
1-Jul-16	1.93	12518.92	8091.27	91.27	4080.01	80.01	12171.28	171.28	1.88	12200.76	200.76	29.48
4-Jul-16	1.98	12843.24	8140.84	140.84	4123.6	123.6	12264.43	264.43	1.9	12319.98	319.98	55.54
5-Jul-16	1.99	12908.11	8151.85	151.85	4133.29	133.29	12285.13	285.13	1.87	12133.29	133.29	151.85
8-Jul-16	2.03	13167.57	8206.46	206.46	4181.43	181.43	12387.89	387.89	1.9	12312.71	312.71	75.18
11-Jul-16	2.05	13297.3	8297.04	297.04	4261.5	261.5	12558.55	558.55	1.95	12640.05	640.05	81.5
12-Jul-16	2.03	13167.57	8321.42	321.42	4283.1	283.1	12604.53	604.53	1.94	12614.37	614.37	9.84
13-Jul-16	2.01	13037.84	8360.45	360.45	4317.72	317.72	12678.17	678.17	1.95	12671.27	671.27	6.9
14-Jul-16	2.06	13362.16	8397.76	397.76	4350.87	350.87	12748.63	748.63	1.96	12728.76	728.76	19.87
15-Jul-16	2.03	13167.57	8477.17	477.17	4421.58	421.58	12898.75	898.75	1.99	12918.33	918.33	19.58
18-Jul-16	2.03	13167.57	8502.3	502.3	4444	444	12946.3	946.3	2	12941.09	941.09	5.21
19-Jul-16	2.01	13037.84	8517.39	517.39	4457.47	457.47	12974.86	974.86	2	12949.64	949.64	25.22
20-Jul-16	2.06	13362.16	8466.45	466.45	4412.03	412.03	12878.48	878.48	1.98	12818.48	818.48	60
21-Jul-16	2.02	13102.7	8713.66	713.66	4633.4	633.4	13347.06	1347.06	2.06	13358.09	1358.09	11.03
22-Jul-16	2.06	13362.16	8739.12	739.12	4656.33	656.33	13395.45	1395.45	2.06	13393.68	1393.68	1.77
25-Jul-16	2.07	13427.03	8859.74	859.74	4765.17	765.17	13624.91	1624.91	2.1	13615.81	1615.81	9.1
26-Jul-16	2.05	13297.3	8789.86	789.86	4702.05	702.05	13491.91	1491.91	2.08	13484.39	1484.39	7.52
27-Jul-16	2.03	13167.57	8745.63	745.63	4662.19	662.19	13407.82	1407.82	2.07	13420.89	1420.89	13.07
28-Jul-16	2	12972.97	9027.44	1027.44	4917.26	917.26	13944.71	1944.71	2.14	13892.37	1892.37	52.34
29-Jul-16	2	12972.97	8917.19	917.19	4817.17	817.17	13734.36	1734.36	2.12	13734.01	1734.01	0.35
										Average of Forecast Profit Difference, *A*(*n*)		RM38.72
					MAPE	3.17%		MAPE	3.26%	Percentage of Forecast Profit Difference, D(n)		0.32%

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