Global Review of Islamic Economics and Business, Vol. 5, No.2 (2017) 118-129
Faculty of Islamic Economics and Business-State Islamic University Sunan Kalijaga Yogyakarta
ISSN 2338-7920 (O) / 2338-2619 (P)

Testing The Warrants Mispricing and Their Determinants: The Panel Data Models

Muhammad Rizky Prima Sakti [1] & Abdul Qoyum [2]

[1] Ph.D Candidate, Universiti Teknologi Malaysia
Email: rizky_islamicfinance@yahoo.com.

[2] 2Ph.D Candidate, Universitas Islam Negeri Sunan Kalijaga Yogyakarta
Email: qoyum13@gmail.com

Abstract: This paper empirically studied the impact of several variables such as moneyness, stock return, maturity, and volatility on the warrant mispricing. We selected 4 companies listed in Bursa Malaysia such as MHC Plantations Bhd, MKH Bhd, YFG Bhd, and UNISEM to investigate the mispricing of warrants. Subsequently, panel time series data employed with daily basis from 30 June 2010 until 30 June 2013. The Black-Scholes Option Pricing Model (BSOPM) used to determine the mispricing of warrant. Several panel data techniques employed in this study such as pooled-OLS, fixed effect model (FEM), and random effect model (REM). In turn, we found that FEM is well explained the determinants of warrant mispricing. Thus, empirical results suggest that moneyness, maturity, and volatility are positively and significantly explained the mispricing of warrant, while stock return does not give an impact toward the warrant mispricing. The BSOPM is consistently mispricing the warrant either in-the-money (ITM) or out-the money (OTM) warrants. The market is not efficient on the warrants traded for four companies observed.

Keywords: Warrants, Mispricing, BSOPM, Panel Data Models, P-OLS, FEM, REM.

Introduction

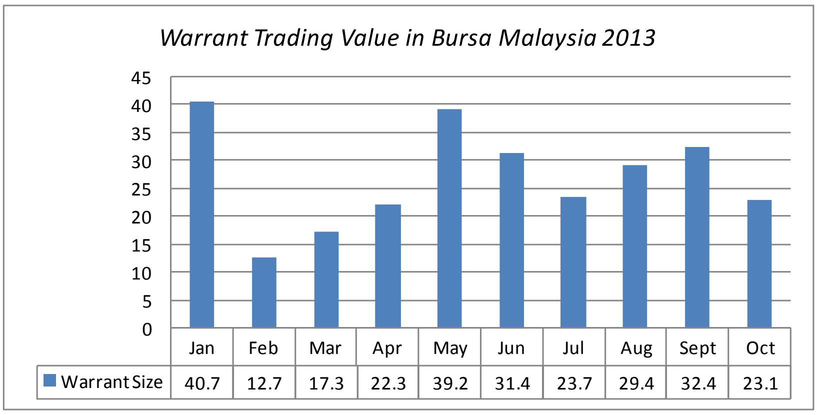
Background of Study

A Warrant can be defined as a type of investment where the issuer offers an option to the buyers the right but not obligation, to buy new ordinary shares at a predetermined price at any particular point within the given time period. Subsequently, the definition of warrant is seems closely related to call option particularly in regards of valuation of its fair price where it is common to pricing warrants used the option pricing models, like Black-Scholes option pricing model (BSOPM). Aside from that, warrant is more volatile relative to its underlying stocks. To some extent, warrants offer better potential increase in its value and tend to rise faster in percentage point, rather than its underlying stocks.

The Malaysian capital market has such various kinds of instruments at which all instruments have their varying degrees of risks and returns as pertaining to different types of investors. One instrument that has gained popularity since it was introduced in the market is warrant. In addition to that, warrants are relatively new relative to others instruments with firstly introduced to the market in 1994. The size of Malaysian warrants are relatively small, thus, warrants might be more volatile.

Apart from that, there are two types of warrants traded on Bursa Malaysia: structured warrant and company warrant. Structured warrant is warrant that issued by third party (usually issued by investment bank) at which generally cash settled and does not dilute the shares being issued when exercised. The investment bank issued the warrants for the purposes of an investment tool in order to manage investment portfolio. While company warrant can be defined as warrant that is issued by companies for the purposes to generate funds (Yip and Hooy, 2012). The value of its warrants is solely dependent on the value of its underlying stocks. Unlike the structured warrant, at settlement period of company warrants, there is physical delivery of shares. Veld (2003) exhibited that when the warrant exercised, the number of outstanding stocks will be inclined. He further noticed that the maturity of warrant basically has least several years with potentially violating the assumption of constant volatility.

Subsequently, the warrant listed in Bursa Malaysia give a significant impact on the performance of Bursa Malaysia itself. In year 2012, according to CEO of Bursa Malaysia Dato' Tajudin Atan exhibited that the steady performance of Bursa Malaysia because of growth in derivative segments and structured warrant listed. In addition, the number of structured warrants listed has inclined from 363 to 551 warrants in the 2011 until 2012 (source: www.world-exchanges.org). However, Bursa Malaysia still registered a small number of warrant traded and more volatile (with average trading value of US$ 27.2 thousands) from January-October 2013. To some extent, the size of warrant in Bursa Malaysia is far behind the size of warrant traded in Hong Kong Exchanges (with average trading value of US$ 2,926.9 thousands) and Korea Exchanges (with average trading value of US$ 2,311.3 thousands) during same period. Figure 1 below depicts the clear picture about the number of warrant traded in Bursa Malaysia.



Source: World Federation Exchange (2013)

Figure 1

Warrant trading Value in Bursa Malaysia 2013

The volatility of the warrants trading value particularly in Malaysian market and the applicability of the BSOPM to warrant pricing, therefore, is an empirical issue to be addressed. Albeit the BSOPM has been widely studied in developed countries, however, empirical studies of BSOPM in emerging markets have been relatively limited. Thus, it seems interesting to conducting the empirical research on the warrant mispricing and its determinants. In this regard, we employed some companies in Bursa Malaysia as case study to address this issue. Subsequently, the objectives of this paper can be distinguished into two parts, (1) to investigate the pricing efficiency of warrant in the Malaysian derivatives market by employing BSOPM. (2) Testing the impact of variables selected such as moneyness, stock return, maturity, and volatility on the mispricing of warrant. The paper contributes to the literature by investigating the determinants of warrant mispricing since empirical works on this topic are relatively limited particularly in Malaysia derivatives market. Our findings, in turn, perhaps might be further enriching our understanding of warrant market behavior and its relation with underlying. This paper perhaps might give an exposure to the investors in regards with the investment decision on the warrant instrument.

The rest of this paper is organized as follows. The next section provides the literature review on theoretical and empirical studies on the warrant mispricing. The third section describes the data and methodology employed in this study. The fourth section discusses and elaborates the empirical findings and discussion. Finally, the last section exhibit conclusions of study.

Literature Review

Theoretical Framework

Black and Scholes (1973) determine the price for a call option on a non-dividend paying share of common stock, which is commonly known as Black-Scholes option pricing model (BSOPM):

$$C = SN\,(d_1) - K\,e^{-rT}N(d_2)$$

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + [r + (\sigma^2/2)]T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T - t}$$

where C is the call option value, S is the spot price of underlying asset, K is exercise price of call option, T is time to expiration (as % of year), r is risk-free (*rf*) interest rate, e^{-rt} is the exponential function of *rf* and T, N(.) is cumulative standard normal distribution function, σ is volatility of underlying asset as measured by standard deviation of the logarithmic stock return, and ln S/K is the natural logarithm of S/K.

The BSOPM is aimed to determine the call option value. In regards with warrant instrument, in turn, some adjustment required for pricing the warrant. The formula to calculate the warrant pricing given as follows:

$$W = \frac{N}{\frac{N}{Y} + m}\,x\,C$$

where w is the value of warrant, N is total number of shares outstanding, Y as the conversion ratio of warrant, in this particular study, the conversion ration should be equal to 1 whereby 1 warrant has the right to be converted into 1 share. M is total number of warrants outstanding, and C is call value.

Subsequently, there are several assumptions holds under BSOPM:

1) Existence of efficient market and no attrition trading
2) There is no transaction cost
3) The option model follows the European style which basically means that it can be exercised only at its maturity
4) There is no dividend required when the maturity of an option occurred
5) The logarithm of stock returns are normally distributed
6) The risk free rate steady the same upon the maturity of the option
7) There is constant volatility of the underlying stock over the maturity of option.

Subsequently, to find the mispricing of warrant or the warrant efficiency, the formula given as follows:

$$\%\ daily\ mispricing = ln\frac{Ri}{R*}.100$$

where Ri is the actual price of warrant, and R* is the theoretical of warrants.

Moneyness can be determined by taking the differences between current values of stocks with the present value of exercise price of warrant. Thus, the formula for moneyness is given as follows:

$$Moneyness = \frac{Stock\ price - \ Exercise\ Price^{\ -rT}}{Exercise\ Price^{\ -rT}}$$

Previous Study

Some studies such as Rubinstein (1987), and Geske, Roll, and Sastri (1983) are confirmed that the BSOPM generates warrant values fairly close to the actual prices at which warrants traded especially for the short-term maturity warrants. Santoso (2000) studied the pricing efficiency for warrants traded at the Jakarta Stock Exchange, and he found that the BSOPM and dividend-adjusted BSOPM are doing equally well. The BSOPM generates option values fairly close to the actual prices at which options are traded.

On the other hand, Macbeth and Merville (1980) revealed that BSOPM underpriced in-the-money (ITM) options, overpriced at-the-money (OTM) options, and gave an approximate and proper price for options at-the-money when the stochastic process that generating the stock price was a constant elasticity of variance process. Subsequently, Lauterbach and Schultz (1990) argued that BSOPM was outperformed by a model that assumed a constant elasticity of variance (CEV) diffusion process for stock price. BSOPM consistently misprices warrants especially on OTM warrants. Shastri and Sirodom (1995) studied the Thailand warrants and further exhibited that a constant elasticity of variance outperformed BSOPM in pricing the warrants. In addition, they argued that the reason why the BSOPM underprice the ITM warrants and overprice OTM warrants is that because the model did not incorporate the fact that market participants were not allowed to short sell their securities. Lim and Terry (2002) in their study noticed that the highest pricing error for BSOPM occurred when the potential dilution for warrant is high, either when the warrants are OTM or when the warrants are further from expiry.

Another research by Duan and Yan (1999) studied the market efficiency of derivative warrants written on the HSBC common stock traded on Hong Kong Stock Exchange. They found that the BSOPM underpriced the warrants in Hong Kong Stock Exchange market. Similarly, the study done by Huang and Chen (2002) who investigated the market pricing of covered warrants traded on Taiwan stock exchange also revealed that the BSOPM underpriced the covered warrants in Taiwan market. The pricing errors are related to the degree to which the warrants are ITM, and the volatility of the underlying assets. Liu and Rangan (2012) studied the covered warrants in China, thus, they found that covered warrants are significantly overvalued over the period 2005-2008. In addition to that, the warrants are so overvalued that the implied volatility provides no information for the future volatility.

In regard with Malaysian derivatives market, Kyun (2004) performed the empirical testing on the performance of Black-Scholes model that used for warrants traded on KLSE using daily prices of 74 samples warrant in year 1994-2003. He further exhibited that the BSOPM tends to overvalue in-the money (ITM) warrants and overvalue "out-of-the money" (OTM) warrants. In addition, he recommended that the investors that used BSOPM should carefully observe the systematic pattern of deviation when choosing a type of warrants in the KLSE. Subsequently, Qizam, Ardiansyah, and Haron (2013) studied the mispricing in Malaysian derivatives market. Using BSOPM model, they further found that the mispricing of warrant existed either at OTM warrants or ITM warrants. The variables such as stock price, KLIBOR, and maturity are significantly explained the mispricing of Malaysian warrants.

Methodology

Data, Samples, and Model Spesification

In examining the warrants mispricing and its determinants in Malaysia, five key variables; percentage of warrant misprice, stock return, maturity, moneyness, and volatility, are employed. For the purpose of this study, four companies being selected as our samples; MHC Plantations Bhd, MKH Bhd, UNISEM, and YFG Bhd, with 5-day daily basis of both variables. In addition, all variables were retrieved from Bloomberg and Bursa Malaysia, covering period from 30 June 2010 until 30 June 2013 with covered 1,452 total observations.

In order to test the determinants of warrant mispricing, panel data techniques such as pooled-OLS, fixed effect model (FEM), and Random effect model (REM) will be employed. Moreover, we try to find which one is the best model to explain the determinants of warrant mispricing. The model for warrant mispricing is given as follows:

$$\%\, mispricing_{it} = \beta_0 + \beta_1\ Stock\ Return_{it} + \beta_2\, Maturity_{it} + \beta_3\, Moneyness_{it} + \beta_4\ Volatility_{it} + \varepsilon_{it}$$

Pooled OLS

Panel data models initially testing the individual effects, time effects, or both for the purpose to deal with heterogeneity or individual effect (cross sectional or time specific effect) that may or may not be observed. Subsequently, if the individual effect does not exist, ordinary least square (OLS) produces efficient and consistent parameters estimation. The function form for pooled OLS:

$$Y_{it} = \alpha + X_{it}\beta + \mu_{it}$$

where $\mu it = \mu i + \lambda t + \nu it$. In case of Pooled OLS, the summation of individual effect and time effect equal to zero; $\mu i + \lambda t = 0$. In other words, the individual effects do not exist. There are five core assumptions under OLS estimation: (1) Linearity in parameters, (2) Exogeneity, which means that disturbances are not correlated with any regressors, (3) Disturbances have constant variances (homoscedasticity) and are not related to each other's (there is no auto-correlation), (4) The observations on the independent variables are not stochastic but fixed in repeated samples without measurement errors, (5) there is no multicollinerity problems.

On the other hand, if the individual effects are not zero, heterogeneity will potentially affect the assumption 2 and 3. The violence in assumption 2 renders random-effect estimators tends to biased. Thus, the OLS estimators are no longer best unbiased linear estimators (BLUE). Then, to deal with these problems, panel data models provide a way such as fixed-effect model and random-effect model.

Fixed Effect Model (FEM)

The fixed effect model (FEM) is a model that estimated by least square dummy variables (LSDV) regression; or OLS with a set of dummies, and within effects estimation methods. The intercept are varying across group or time. As individual effects are time invariant and considered as a part of intercept, thus, individual effects are allowed to be correlated with other regressors. In turn, the assumption 2 which is exogeneity; the error terms are not correlated with any regressors, is no longer violated. The functional form for FEM can be defined as follows:

$$Y_{it} = (\alpha + \mu_i + \lambda_t) + X_{it}\beta + V_{it}$$

Subsequently, for the purposes of hypothesis testing, the fixed effect employed the F-test. Basically, the F-test performed to determine which model between Pooled OLS and FEM is the best model. The null hypothesis is that all dummy variables are equal too zero (H0: α1 = α2 = α3 = α4 = 0), while the alternative hypothesis is that at least one dummy parameters in not zero (Ha: at least one αi ≠ 0). In turn, if the null is rejected, we can infer that there is a significant fixed-effect. Therefore, the FEM is better than pooled OLS.

Random Effect Model (REM)

The random effect is also known as error component model. The assumption under REM is that the individual effects are not correlated with other regressors. In turn, the error variances are randomly distributed across group or time. The intercept and slope of regressors are the same across the individuals. The functional form for REM given as follows:

$$Y_{it} = \alpha + X_{it}\beta + (\alpha + \mu_i + \lambda_t + V_{it})$$

Breush and Pagan test provide a test of the Pooled OLS against REM. The null hypothesis is that ${\sigma^2}_\alpha = 0$, which is the case where the individual effect do not exist and Pooled OLS is better. Subsequently, the hausman test initially applied to examine for FEM against REM. In this case, we compare directly the random effect estimators against the fixed effect estimators. The null hypothesis is the REM is preferred, and the alternative is that the FEM is preferred.

Empirical Finding and Discussion

Descriptive Statistics

The table 1 below depicts the average value of several selected variables such as warrant price (adjusted call value), misprice, spot price, warrant price, stock return, volatility, maturity, share outstanding, and warrant outstanding. In this particular study, we can get insight so of four companies listed in Bursa Malaysia (namely: MHC, MKH, YFG, and UNISEM) and their value. For the warrant price, MKH Berhad entitled as the highest price of warrant at RM0.5924, while the lowest price of warrant is YFG at RM0.0903. Subsequently, when the company has the highest warrant price, therefore their stock price will be highest. Its clearly seen that MKH Berhad has RM2.1470 for its stock price, thus, this companies becomes the highest value of all observed companies. The reason behind this is that because the warrant is the right to buy a stock, even with the conversion ratio is equal to one. Thus, the higher stock price of companies, the higher warrant price will be.

Apart from that, since the MKH has the highest value of both stock price and warrant price, in turn, its yield is also high at 0.2930% in average. In contrast, the MHC generates a negative yield for its stock by -0.0740%. Its also true for YFG at which obtained negative yield at -0.0235% during same period. Moreover, the companies that have a highest return, the maturity will be longer as well. It can be seen that the MKH has the longer maturity in average at 1,703 days until expiration period.

Table 1
Descriptive Statistics

Company	**Adj C**	**Misprice**	Spot Price (S0)	Warrant Price	stock return (%)	Volatility	Maturity	Share Outs.	Warrant Outs.
MHC	**0.7330**	**-60.3976**	1.0883	0.2911	-0.0740	1.4600	1631	196540000	56155000
MKH	**1.9283**	**-88.5051**	2.1470	0.2167	0.2930	2.2542	1703	296340000	29104000
YFG	**0.0981**	**178.0546**	0.1472	0.2600	-0.0235	3.4123	1424	609070000	304534000
UNISEM	**0.5660**	**-40.8163**	0.9896	0.3259	0.1086	1.3715	1285	674230000	168540000

Moneyness

Basically, moneyness is the terminologies to define whether the warrant can make money (profitable) or not. According to Bacha (2012), there are two important considerations in describing moneyness; (1) moneyness is always considered as the long position, rather than the seller position, (2) Compare the present value of exercise price of warrant with the current value of underlying stocks. Table 2 below exhibits the warrant moneyness for four selected companies in this particular study. Its clear that out of 4 observed companies, there are 3 companies which is MHC, MKH, and UNISEM are out-the-money (OTM), which means that the value of exercise price is greater than the value of underlying stock price. Therefore, the warrant of MHC, MKH, and UNISEM are no longer profitable for its investors. In contrast, there is only one company which is in-the-money (ITM) at which the company namely YFG is profitable in regards of warrant holders.

Since the three observed companies (MHC, MKH, and UNISEM) are out-the-money warrant, thus, the investors are over-expectation on the performance of the stocks in the future. Put in another way, the stock price does not perform well to cater the expectation of the market participants in the future, since the warrant is the right to buy the stocks that reflects on the expectations of investors to its underlying stocks.

Table 2

Warrant Moneyness

Company	Spot Price (S0)	R	Exercise Price (k)	maturity (t)	(-rt)	**moneyness**	Status
MHC	1.0883	0.0322	1.56	1631	-52.5137	**0.16136889**	OTM
MKH	2.1470	0.0322	2.26	1703	-54.8260	**1.42979514**	OTM
YFG	0.1472	0.0322	0.13	1424	-45.8443	**-0.8869898**	ITM
UNISEM	0.9896	0.0322	2.18	1285	-41.3887	**0.07914921**	OTM

Mispricing

Mispricing can be defined as the difference between the current prices and theoretical prices of warrants (adjusted c). The theoretical price can be determined based on BSOPM with some adjustment, because the BSOPM itself utilized in order to find the call option value. Table 3 below shows us the mispricing value for four observed companies. It's clearly seen that there three warrants which are underpriced, namely MHC, MKH, and UNISEM, while YFG entitled as overpriced. In addition, the number of companies which are underpriced is greater than overpriced companies. The logic is that because the investors' expectation toward the companies is lower relative to the real performance of the companies. Thus, in this study, the BSOPM is consistently mispricing the warrant either in-the-money or out-the money warrants. The market is in-efficient on the warrant traded of four observed companies.

Table 3

Warrant Mispricing (%)

Company	Warrant Price	Adj.C (theoretical price)	Shares Outs.	Warrant Outs.	**Mispricing**
MHC	0.2911	0.7330	196540000	56155000	**-60.3976**
MKH	0.2167	1.9283	296340000	29104000	**-88.5051**
YFG	0.2600	0.0981	609070000	304534000	**178.0546**
UNISEM	0.3259	0.5660	674230000	168540000	**-40.8163**

Subsequently, most of warrants are underpriced, means that the actual price of warrants is lower than their theoretical price. In this regards, the investors can take some benefits since the probability of actual value of warrant to drop is very low. Figure 2 below describes the magnitude of mispricing for companies observed and their duration. There are several interesting points that we can infer from the figure 2 below. First, the number of underpriced warrant is greater than overpriced; therefore, the investors can make money or profit in this circumstance. Second, the overpriced warrant is very volatile relative to underpriced warrant which is quite stable. In this regards, the YFG is significantly overpriced. Third, the underpriced warrants entitled as very low magnitude. Lastly, in respect of duration, the underpriced warrants have long duration rather than overpriced warrant.

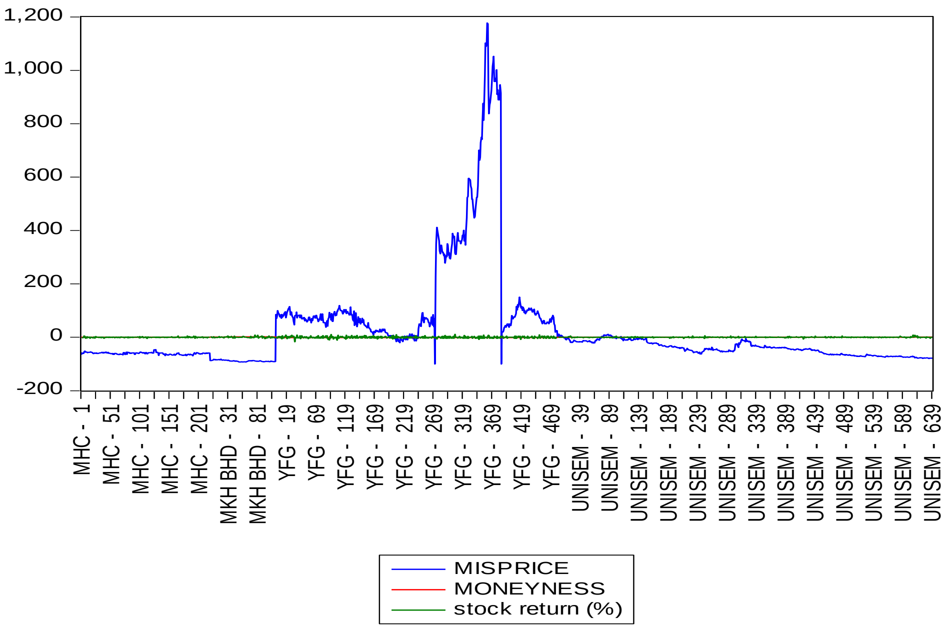


Figure 2
Warrant Mispricing

Furthermore, the overpriced warrant (namely, YFG) is extremely deviate away from the equilibrium. The investors react very slowly, in turn; the mispricing existed and continues until certain period. In addition to that, the overpriced phenomenon can be also explained due to the over-expectation from the investors on the performance of the company issued the warrants. Perhaps, their might expect that the company will perform better and further give an impact on inclining price of underlying stocks. However, the warrant price is still high albeit the theoretical price is low.

Determinants of Warrant Mispricing

In this research, in order to examine the determinants of warrant mispricing, several variables are employed, such as stock return, maturity, moneyness, and volatility. Panel data regression from different jurisdictions, such as Pooled-OLS, fixed-effect model (FEM), and random-effect model (REM) are performed for the purpose of testing the determinants of the warrant mispricing. Panel data models examine individual-specific effects, time effects, or both in order to deal with heterogeneity or individual effect (cross-sectional or time specific effect). The regression tests conducted by using F-statistics and t-statistics, in which the test give a significant result when the significance of α is below the critical value α (we set the critical value 5% or 1%). Table 4 below depicts us clear picture on the panel regressions from several techniques.

Subsequently, from these three techniques, we further testing the models to determine which one is the best model in addressing our objectives. We determine the best model between pooled-OLS and FEM by using poolability test (F-test). For the purpose of testing Pooled-OLS and REM, Breusch-Pagan LM test was performed. Lastly, Hausman test employed to testing which one is the best model between FEM and REM.

Table 4
Panel Data Models

Variables	Pooled-OLS	Fixed Effect Model (FEM)	Random Effect Model (REM)	Fixed Effect Model (FEM) [a]
C	-44.2357	-1893.82	-45.5342	-1893.82
	(-2.0833)**	(-3.5401)***	(-2.1609)**	(-4.9750)***
β_1 (Stock Return)	-1.7465	-2.0114	-1.7675	-2.0114
	(-1.0487)	(-0.9721)	(-1.0856)	(-0.6904)
B_2 (Maturity)	-0.0752	1.2446	-0.0734	1.2446
	(-5.3670)***	(3.2806)***	(-5.2335)***	(4.6676)***
B_3 (Moneyness)	-70.5575	-53.9449	-70.4541	-53.9449
	(-8.9392)***	(-6.1232)***	(-9.2096)***	(-24.7120)***
B_4 (volatility)	78.4940	71.2519	77.9817	71.2519
	(13.9640)***	(12.5990)***	(14.4133)***	(10.6026)***
R-Squared	0.363653	0.673509	0.366221	0.673509
F-statistic	206.1578***	2.586617***	208.4547***	2.586617***
F Test (Poolability Test)		1.1974***		
Breusch-Pagan LM Test	1.2376			
Hausman Test			66.8884***	

Note:, **, *** denotes significant at 10%, 5%, 1% alpha respectively.*
FEM[a] = FEM with robust standard errors

From the pooled-OLS regression, we can infer that the model in overall has significant impact on the warrant mispricing, since the F-statistic (206.1578) is significant at 1% alpha. The R-squared is 0.3636, meaning that the model together can explain the mispricing of warrant by 36.36%, while 63.64% change on the warrant mispricing explained by other variables at which not covered in this research. Subsequently, we notice that there is significant relationship between warrant mispricing and maturity, moneyness, and volatility, respectively. Both maturity and moneyness have negative sign parameters. Thus, we can deduce that when the mispricing is high, the shorter the maturity, the decrease in the moneyness, and the more volatile. However, stock return does not have any significant impact on the warrant mispricing.

Similarly, in regards with FEM, we find enough evidence that the model together can explained the warrant mispricing. Interestingly, according to FEM estimation, this model can predict 67.35% of total determinants on the warrant mispricing, while 32.65% change of mispricing explained by other factors that are not covered in this study. Likewise, maturity, moneyness, and volatility have significant impact on the misprice of warrant, since the p-value for the variables is significant at α 1%. Its also true that stock return does not have any influence on the warrant misprice. However, unlike the pooled-OLS, the FEM estimation gives a different parameters value for maturity which is positive sign coefficient. Therefore, as the mispricing is high, the longer the maturity will be (see figure 3).

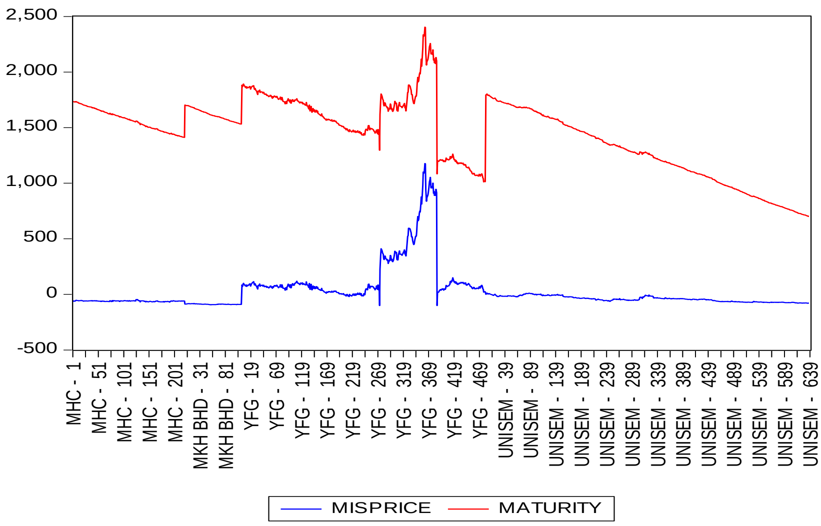


Figure 3
Misprice and Maturity

In regards with random-effect (REM), we noticed that the model together have a significant contribution on the warrant mispricing, as the F-statistic (208.454) is significant at 1% alpha. The R-squared is 0.3662, meaning that 36.62% of the selected variables together can explained the misprice of warrant, while 63.38% explained by other variables at which not covered in the study. Similarly, like the pooled-OLS result, REM confirmed that there is significant relationship between warrant mispricing and maturity, moneyness, and volatility, respectively. Both maturity and moneyness have negative sign coefficient. In turn, we can infer that when the mispricing is high, the shorter the maturity, the decrease value on the moneyness, and the more volatile. However, stock return does not have any significant impact on the warrant mispricing.

Aside from that, for the purpose of comparison between pooled-OLS and FEM, poolabilty test (F-test) depicts that period f-statistic 1.1974 which is significant at 1% α, therefore we can reject the null (H0: α1 = α2 = α3 = α4 ; POLS is better), and accept the alternate hypothesis (Ha: at least one αi ≠ 0 ; FEM is better). Thus, in this regard, we conclude that FEM is the best model. Subsequently, we compare between pooled-OLS and REM. Breusch-Pagan (BP)-LM test showed that the BP statistic 1.2376 which is not significant at 1% α. Thus, we cannot reject the null (H0: σ22 = 0; POLS is better), which means that the pooled-OLS is better model relative to REM. Lastly, hausman test employed to determine which one is the best model between FEM and REM. Based on hausman test, the chi-squared statistic 66.8884 is significant at 1% α. Thus, we can reject the null and accept the alternate hypotheses (FEM is better).

Discussion

After performed model comparisons, we can infer that the fixed-effect (FEM) is the best model for warrant mispricing and its determinants. Therefore, we can postulate the model as follows:

$$\%\,mispricing_{it} = -1893.82 - 2.0114\,Stock\ Return_{it} + 1.2446\,Maturity_{it} - 53.9449\,Moneyness_{it} + 71.2519\,Volatility_{it} + \varepsilon_{it}$$

As mentioned earlier, maturity, moneyness, and volatility that have significant relationship with warrant misprice, while stock return indicates un-significant relationship on the misprice. According to the fixed-effect (FEM) estimation, the intercept value is negative, which basically means that if the value of stock return, maturity, moneyness, and volatility were zero, then the average warrant mispricing would be negative. In the light of maturity, the longer maturity gives a positive impact on the warrant mispricing to increase by 1.2446%. Lim and Terry (2002) argued that the mispricing of the BSOPM appears to increase as the time to expiration increases. Moreover, the negative sign parameter for moneyness indicates that the more discount on the warrant, the mispricing will be slump by 53.94%. There is an inverse relationship between moneyness and mispricing of warrant. Lim and Terry (2002) found that the mispricing for the BSOPM model tends to decrease when the moneyness of the warrants increased, or put in another way, the pricing error for the BSOPM tends to increase as the moneyness of the warrants decreased. Sukhor and Bacha (2010) stated that the greater discount of warrant, the lower the mispricing will be.

Furthermore, volatility has a positive sign with mispricing, indicates that when the volatility is high, the value of warrant mispricing will be also high. The BSOPM assumed that the volatility of the underlying security was constant over the life of derivative, and do not influenced by the changes in the price level of the underlying security. However, there is a critique on this particular assumption. To some extent, the constant volatility for the underlying stocks as the assumption under BSOPM causes the largest empirical biases in the pricing of options (Huang and Chen, 2002). In turn, by assuming the volatility of the underlying stocks is a stochastic volatility, the model of derivatives become more accurate.

Subsequently, the appealing finding in our study is that the stock return does not indicate any significant impact on the warrant mispricing. Perhaps, there is a positive auto-correlation among individual stock returns, which is consistent with slow adjustment to the firm specific news (Jegadeesh and Titman, 1993); further make the mispricing does not existed. The opportunity for investors to get more benefits shrinks since the slow adjustment of firm-specific news. Moreover, Asparouhova, Bessembinder, and Kalcheva (2009) argued that the return bias induced by the bid-ask spread cause the pricing errors.

Conclusion

At present, warrants become a well known alternative investment and highly demanded by the market, particularly in Asia-Pacific region, including Malaysia. The warrant listed in Bursa Malaysia give a significant impact on the performance of Bursa Malaysia itself. Moreover, many researchers and investors rely on Black-Scholes model (BSOPM) to find the theoretical price of warrants.

Based on models comparison, the study revealed that the fixed-effect (FEM) is the best model for warrant mispricing and its determinants. We further found that maturity, moneyness, and volatility have significant relationship with the warrant misprice, while stock return indicates un-significant relationship on the misprice. The longer maturity gives a positive impact on the warrant mispricing to increase. Moreover, the mispricing of the BSOPM appears to increase as the time to expiration increase. Subsequently, there is an inverse relationship between moneyness and mispricing of warrant. The mispricing for the BSOPM model tends to decrease when the moneyness of the warrants increased, as otherwise. Furthermore, volatility has a positive sign with mispricing, indicates that when the volatility is high, the value of warrant mispricing will be also high. The BSOPM assumed that the volatility of the underlying security was constant over the life of derivative. On the other hand, stock return does not indicate any significant impact on the warrant misprice. A positive auto-correlation among individual stock returns, which is consistent with slow adjustment to the firm specific news; further make the mispricing does not occurred.

Finally, in this study, the BSOPM is consistently mispricing the warrant either in-the-money (ITM) or out-the money (OTM) warrants. The market is un-efficient on the warrants traded for four companies observed. Evidence of BSOPM model in this study means that most of warrants are underpriced; the actual price of warrants is lower than their theoretical price. In this regards, the investors can take some profits since the probability of actual value of warrant to drop is very low, particularly on the four selected companies.

References

Asparouhova, E., Bessembinder, & Kalcheva. (2009). Liquidity Biases in Asset Pricing Tests. *Journal of Financial Economics* .

Bacha, O. (2012). *Financial Derivatives: Markets and Applications in Malaysia*. Kuala Lumpur: McGraw Hill Education.

Duan, & Yan. (1999). Semi-parametric pricing of Derivative Warrants. *Working Paper, Hong Kong University Science and Technology* .

Geske, Roll, & Shastri. (1983). Over-the-counter Option Market Dividend Protection and Biases in the Black-Scholes Model: A Note. *Journal of Finance, Vol.38* , 1271-1277.

Huang, & Chen. (2002). Warrant Pricing: Stochastic Volatility vs. Black-Scholes. *Pacific-Basin Finance Journal* , 393-409.

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implication for Stock Market Efficiency. *Journal of Finance 48* , 65-91.

Kyun. (2004). Empirical Study of Black-Scholes Warrant Pricing Model on the Stock Exchange of Malaysia. *Working Paper, Univeristi Sains Malaysia* .

Lauterbach, B., & Schultz, P. (1990). On Using the Black-Scholes model to value warrants. *Journal of Finance, 45* , 1181-1209.

Lim, & Terry. (2002). The Valuation of Multiple Stocks Warrants. *Working Paper, Singapore Management University* .

Macbeth, & Merville. (1980). Tests of the Black-Scholes and Cox Call Option Valuation Models. *Journal of Finance, Vol.35* , 285-301.

Qizam, Ardiansyah, & Haron. (2013). Sharia Issue of Warrant Contract: Empirical Evidence of Warrant Mispricing in Malaysia. *Global Review of Islamic Economics and Business, Vol.1, No.1* , 50-68.

Rubinstein. (1987). Derivative Asset Analysis. *The Journal of Economic Perspective,Vol.1,No.2* , 73-93.

Santoso, L. (2000). Warrant Pricing: An Empirical Investigation on the Valuation Models for Warrants Traded at the Jakarta Stock Exchange. *Working Paper, Universitas Gadjah Mada* .

Shastri, & Sirodom. (1995). An Empirical test of the BS and CSR valuation models for warrants listed in Thailand. *Pacific-Basin Finance Journal* , 465-483.

Yip, & Hooy. (2012). Call Warrant Listing and Its Behavior of Its Underlying Spot Market: Some Evidence from Bursa Malaysia. *Journal of Asia Pacific Business* , 287-298.