CHAPTER VI

CONCLUSIONS AND AREAS FOR FUTURE RESEARCH

6.1 Conclusions

This study investigates the warrant pricing abilities of three multiple warrants models which are the Lim-Terry model, the Darsinos-Satchell model and the Dennis-Rendleman model. The Galai-Schneller model as a standard model is included in the study to better understand the dilution effect across the warrants series. The best model is defined as the model that has the theoretical price closest to the market price. An empirical analysis yields several interesting conclusions.

The results from paired t-test in general reveal that the standard model and the multiple warrants models significantly overestimate the market prices. All the pricing errors statistics (MAE, MAPE, and RMSE) yields the same results. For series A warrant, the pricing errors statistics reduce from the Galai-Schneller model to the Darsinos-Satchell model, the Lim-Terry model, and the Dennis-Rendleman model, respectively. For series B warrants, the second and the third ranks are robust. However, the pricing errors statistics of the Galai-Schneller model and of the Lim-Terry model are still largest and lowest, respectively. Apparently, the standard model performs worse than the multiple warrants models. An analysis of MAPE reveals that the Lim-Terry model and the Dennis-Rendleman model show best performance when warrants are in-the-money. The Galai-Schneller model give the best estimate for at-the-money warrants. The Darsinos-Satchell model perform best when series A warrants are at-the-money and series B warrants are out-of-the-money. The results of Wilcoxon Signed Rank-test indicate that the Darsinos-Satchell model ranks the third whereas the Dennis-Rendleman model and the Lim-Terry model result in similar performance. For series B warrants, the Dennis-Rendleman model outperforms the Darsinos-Satchell model. However, the conclusion cannot be drawn whether the Lim-Terry model performs better or worse than the Darsinos-Satchell model and the Dennis-Rendleman model.

Upon closer inspection, the theoretical prices calculated from the Galai-Schneller model and the Darsinos-Satchell model do not differ much due to the same formula in pricing series A warrant and the neglect of the subtle slippage effect. Additionally, because of the same pricing formula, one might expect the theoretical price from the

two models to be the same. Nevertheless, the value of the firm is computed using the series A and series B pricing formula. For series B warrant, the Galai-Schneller model ignores the cross-dilution effect while the Darsinos-Satchell model does. This makes the value of the firm obtained from the Galai-Schneller model a little higher than from the Darsinos-Satchell model and leads to a higher theoretical price of the Galai-Schneller model. Also, the price difference between the Lim-Terry model and the Dennis-Rendleman model is low since the two models take into account the subtle slippage effect. For series B warrants, the theoretical price from the Galai-Schneller model has the highest value whereas the price from the Lim-Terry model, the Darsinos-Satchell model, and the Dennis-Rendleman model are not different in value. This is because the Galai-Schneller model does not take into account the dilution effect of series A warrant (the cross-dilution effect) and therefore estimate the higher price. The similarity in theoretical prices of the other three models suggests that it does not matter how each model takes into account the cross-dilution effect. The important thing is to consider this effect when pricing series B warrants.

In addition, the dilution ratio is also an essential factor in pricing warrants. The pricing errors of each model fall sharply as the dilution ratio decreases. The model that does not account for the dilution effect across warrants series (either the subtle slippage effect or the cross-dilution effect) decreases in a greater degree than the model that does. In other words, the prices from non-dilution model become closer to the prices from dilution model. This is because the dilution effect is much less when the dilution ratio drops. As the dilution effect reduces, each model tends to have a closer value of warrants. In sum, the dilution ratio plays an important role in helping each model to better estimate the value of multiple warrants.

Based on the findings above, several conclusions can be drawn. First of all, for series A warrants, as the Galai-Schneller model and the Darsinos-Satchell model apparently underperforms the Dennis-Rendleman model and the Lim-Terry model, the dilution effect from the later series (the subtle slippage effect) certainly affects the price of the earlier series and should be considered when pricing series A warrants. Additionally, the results of series B warrants show that the cross-dilution effect must be taken into account as well. Overall, it is not appropriate to value the multiple warrants using the standard model which, in this study, is the Galai-Schneller model. The interdependency of each warrant series must be considered when pricing. However, the model that takes into consideration both of the dilution effects, the Lim-Terry

model and the Dennis-Rendleman model shows similar performance. Consequently, this findings leave a decision to practitioners to choose among the multiple warrants pricing models.

Nevertheless, if the value of the firm and the firm volatility are obtained by other methods that make each warrant series be priced seperately, the other aspects apart from the error statistics should be considered. This is due to the similar performances of the models mentioned above. The other selection criterion considered in this study are intuitive reasonableness, simplicity, ease of understanding, ease of implementation, and computation time. The investigation of each criterion is represented in the table 6.1.

Table 6.1: Model Comparison

	L-T	D-S	D-R
Performance			
Series A	1	3	1
Series B	1	1	3
Overall	1	2	2
Intuitive Reasonableness	1	3	1
Back of The Envelope Calculation	3	2	1
Ease of Understanding	3	1	1
Ease of Implementation	2	1	3
Computation Time	1	1	3

1 represents the best model for that crieterion while 3 represents the worst model. The Galai-Schneller model is excluded from the comparison because it underperforms all other models.

Apart from the model performance stated above, it is quite interesting to understand the behavior of each model by performing the regression analysis between the percentage pricing errors and the model inputs.

As a result, for series A and B warrants (except for series A warrants of the Lim-Terry model), the level of overpricing for all the models will increase as the warrants are more in-the-money. The pricing errors of all models for series B decrease as the warrants get closer to expiration. The pricing errors also decrease when the firm volatility increases. The lowest R-Squared of the Dennis-Rendleman model suggests that the model can capture the input parameters better than others.

6.2 Areas for Future Research

This paper employs data from an emerging market (Thai market) to investigate the performance of multiple warrants pricing models. Nevertheless, it is widely known that emerging market has pricing bias more than developed market. Thus, the daily market price used in this study may contain bias as well. Consequently, if the data from developed market is used to examine the model performance, the empirical results may be different from what have been revealed in this paper. Hence, the empirical test of multiple warrants pricing model should be performed on the developed market to see if there is any significant change. Furthermore, as developed market quotes more reasonable warrant prices, the volatility obtained from the market price (implied volatility) can be used. It is interesting to compare the performance of the model using the implied volatility and volatility method used in this study.

To a greater extent, as the regression results reveal that the pricing errors are systematically related with many model inputs, the multiple warrants pricing models might be improved in some ways to better price the warrants. Additionally, recall that the Darsinos-Satchell model is a distribution free model. It can be improved by using underlying process other than the geometric Brownian motion which is used in this study. The other process such as jump process might capture the underlying movement better than geometric Brownian motion and leads to the better estimation of multiple warrants price.