Hedging Effectiveness of Options on Thailand Futures Exchange

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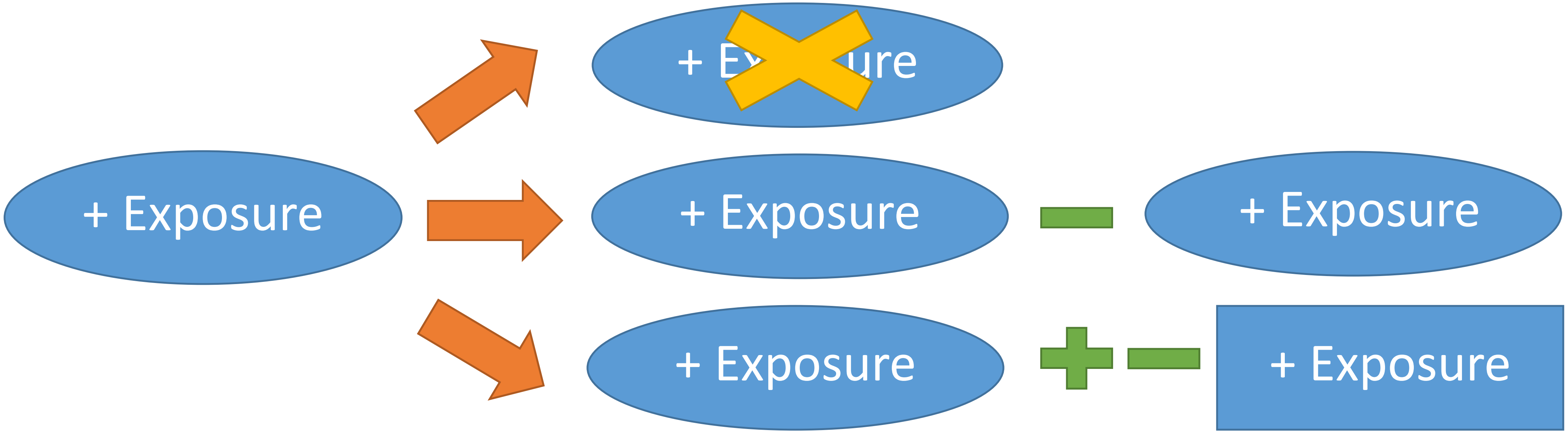
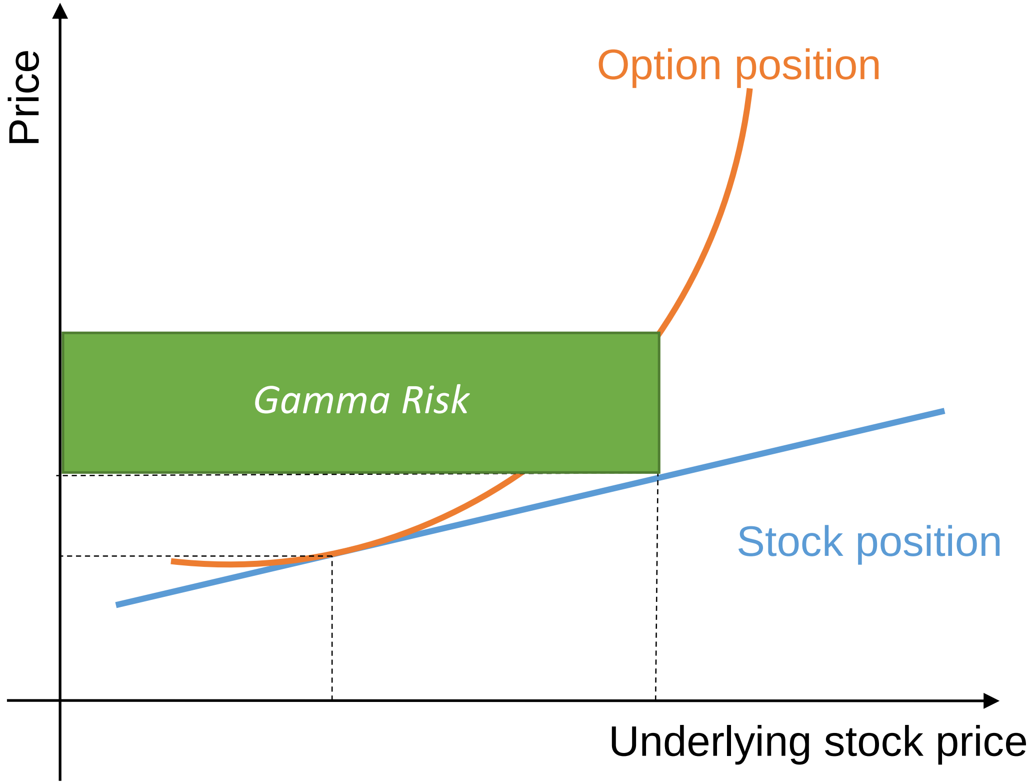
Introduction



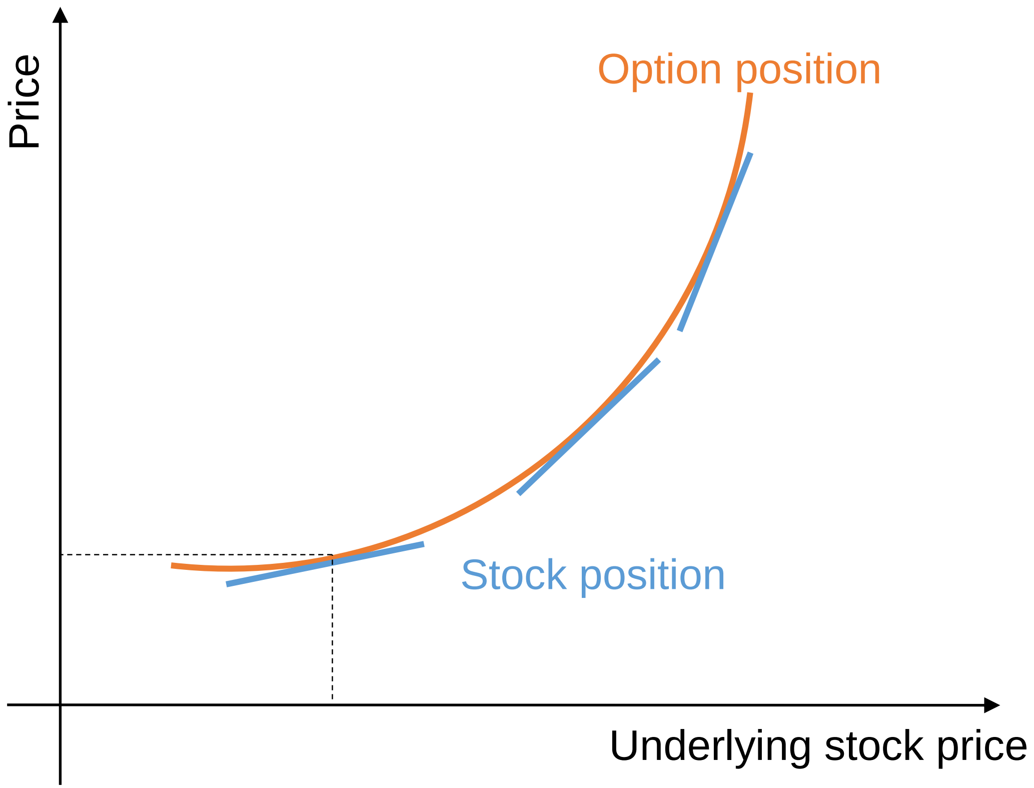
- A hedge is an investment position intended to offset potential losses/gains that may be incurred by a companion investment.

- In case of a European call option, a hedge portfolio is constructed by establishing a long position in the option and a short position in the underlying stock.



- The relative position in the two securities in the hedge portfolio is determined by the first partial derivative of the option pricing formula with respect to the stock price.

- Given Black and Scholes (1973) assumptions, the continual adjustment of the hedge composition the value of the hedge at maturity becomes riskless.



- In practice there are some issues which have to concern. For example,

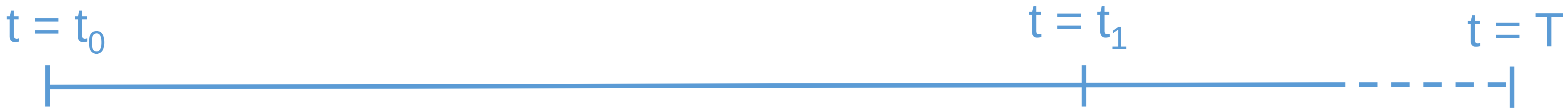
  Discretely rebalanced portfolio,

  Transaction cost,

  and Stock return distribution.

Black and Scholes (1973) Model

- Given Black-Scholes (1973) model, a hedging ratio is $-N(d1)$ for call option and $N(-d1)$ for put option.



$$^{BS}H_C = C_{t0} - N(d_1)S_{t0}$$

$$^{BS}H_C = C_{t1} - N(d_1)S_{t1}$$

$$^{BS}E_C = \Delta C - N(d_1)\Delta S - r\ ^{BS}H_C$$

$$= [\Delta C - N(d1)\Delta S\ /\ ^{BS}H_C] - r\ \%$$

- Given Black and Scholes (1973) assumptions, a hedging error have to equal 0.

Wilmott (1994) Model

- Given Wilmott (1994) model, a hedging ratio is $-[N(d1)+(\mu-r+0.5\sigma^2)S\Gamma]$ for call option and $+(N(-d1)-(\mu-r+0.5\sigma^2)S\Gamma)$ for put option.

$t = t_0$

$t = t_1$

$^{WM}H_C = C-(N(d1)+(\mu-r+0.5\sigma^2)S\Gamma)S$

$^{WM}E_C = [\Delta C - (N(d1)+(\mu-r+0.5\sigma^2)S\Gamma)\Delta S \,/\, ^{WM}H_C] - r\ \%$

- The hedging ratio contains μ explicitly. There is no such thing as “perfect hedging” in the real world.

- According to Wilmott’s suggestion, the volatility should be adjusted and the value of volatility adjustment is $\sigma^* = \sigma\,[1 + (0.5\sigma^2)\,(\mu - r)\,(r - \mu - \sigma^2)]$.

The Analysis of Hedging Error

- The analysis of the hedging error have considered the problem of reducing the deviations or spread of the hedging error. Usually the root mean squared error (RMSE) and the mean absolute error (MAE) were considered.

$$RMSE_o^m = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left(E_{o,t}^m(\%)\right)^2} \Rightarrow \Delta RMSE_o^m = RMSE_o^{m=1} - RMSE_o^{m=2}$$

$$MAE_o^m = \frac{1}{N}\sum_{t=1}^{N}\left|E_{o,t}^m(\%)\right| \Rightarrow \Delta MAE_o^m = MAE_o^{m=1} - MAE_o^{m=2}$$

The Data

- In this study, I compare the hedging performance of the Wilmott model against the Black-Scholes model based on the daily data of SET50 index option from January 2014 to December 2014.

Parameters	Source of data
Option prices	
Exercise prices	SETSMART
Expiration dates	
Underlying SET50 index	Thomson Reuter DATASTREAM
Risk-free rate	ThaiBMA (1 Month Treasury Bills)

- I follow Vähämaa (2003) by classified option moneyness into three groups.

Moneyness	Call option	Put option
Out of the money	$S/K < 0.97$	$K/S < 0.97$
At the money	$0.97 < S/K < 1.03$	$0.97 < K/S < 1.03$
In the money	$S/K > 1.03$	$K/S > 1.03$

Table 1 reports number of observations which are classified into three categories.

	Moneyness	Observations
Call option	OTM	220
	ATM	708
	ITM	508
	Total	1,436
Put option	OTM	484
	ATM	695
	ITM	210
	Total	1,389
Total		2,825

$t = 0$ $t = t_1$

$H_C = C_{t0} - [\text{Delta}]S_{t0}$ $H_C = C_{t1} - [\text{Delta}]S_{t1}$

Hedging Error %

$\text{Delta}_{BS} = f\,(\,S_{t0}, K, T, r, \sigma\,)$

- Historical statistic : Standard deviation
- Implied statistic : $\text{Min} \sum (C_{market} - C_{theoretical})^2$

$\text{Delta}_{WM} = f\,(\,S_{t0}, K, T, r, \mu, \sigma^*\,)$

$\sigma^* = f\,(r, \mu, \sigma)$

- Historical statistic : Standard deviation, Average
- Implied statistic : $\text{Min} \sum (C_{market} - C_{theoretical})^2$

Table 2 reports model's parameters.

Descriptive statistic	Implied statistic			Historical statistic			SET50 index Return
	σ	σ*	μ	σ	σ*	μ	
Average	0.8247%	0.8246%	0.0068%	0.0776%	0.0679%	-0.0010%	0.0510%
Median	0.7294%	0.7292%	0.0082%	0.0796%	0.0728%	0.0096%	0.0459%
Max	2.0209%	2.0209%	0.0260%	0.0935%	0.0875%	0.0728%	2.8190%
Min	0.4648%	0.4647%	-0.0178%	0.0552%	0.0314%	-0.0629%	-5.8396%
SD	0.2660%	0.2660%	0.0106%	0.0140%	0.0139%	0.0385%	0.9047%

Empirical Results

Table 3 reports model performance comparison: Minimum 1 trading contract

Option	Moneyness	Root Mean Square Error % (RMSE)						Mean Absolute Error % (MAE)					
		Implied Statistic			Historical Statistic			Implied Statistic			Historical Statistic		
		BS	W	BS - W	BS	W	BS - W	BS	W	BS - W	BS	W	BS - W
Call	OTM	24.2700	22.7280	1.5421	3557.9316	68.7825	3489.1492	3.6429	3.5211	0.1218	243.8624	8.4104	235.4520
	ATM	0.4723	0.4721	0.0002	0.4801	0.4794	0.0007	0.3449	0.3448	0.0001	0.3537	0.3535	0.0002
	ITM	0.5499	0.5499	0.0000*	0.5989	0.5989	0.0000	0.4052	0.4051	0.0001*	0.4438	0.4438	0.0000
	Total	9.5110	8.9082	0.6028	1392.6172	26.9267	1365.6904	0.8715	0.8528	0.0187	37.6919	1.6198	36.0721
Put	OTM	14.5725	14.5766	-0.0042	6.0830	6.1146	-0.0317	3.8241	3.8255	-0.0014	1.3248	1.3330	-0.0083
	ATM	0.6034	0.6036	-0.0001	0.5516	0.5522	-0.0005	0.4246	0.4248	-0.0002	0.4000	0.4005	-0.0006
	ITM	0.6017	0.6019	-0.0002*	0.6645	0.6645	0.0000	0.4451	0.4452	-0.0001	0.4961	0.4959	0.0002
	Total	8.6159	8.6183	-0.0025	3.6211	3.6397	-0.0186	1.6123	1.6129	-0.0006	0.7368	0.7399	-0.0031*
Total		9.0819	8.7669	0.3150	992.8901	19.3667	973.5233	1.2357	1.2265	0.0092	19.5218	1.1872	18.3346

*significant at 0.05 level.

Table 4 reports model performance comparison. The out of the money is divided into 2 groups.

Option	Moneyness	Root Mean Square Error % (RMSE)						Mean Absolute Error % (MAE)					
		Implied Statistic			Historical Statistic			Implied Statistic			Historical Statistic		
		BS	W	BS - W	BS	W	BS - W	BS	W	BS - W	BS	W	BS - W
Call	DOTM	48.7796	45.6038	3.1758	7248.8736	139.8307	7109.0430	11.5145	11.0164	0.4981	1007.9105	30.8171	977.0934
	OTM	4.5628	4.5247	0.0381	6.0455	5.2126	0.8330	1.1447	1.1424	0.0023	1.3801	1.2993	0.0808
Put	DOTM	20.0113	20.0194	-0.0081	8.7558	8.7548	0.0010	6.3966	6.3971	-0.0004	2.0097	2.0099	-0.0002
	OTM	9.6916	9.6913	0.0004	3.4685	3.5596	-0.0912	2.2044	2.2064	-0.0020	0.8935	0.9069	-0.0133*

*significant at 0.05 level.

Further Empirical Results : Robustness

Figure 1 reports number of observation given minimum trading contract.

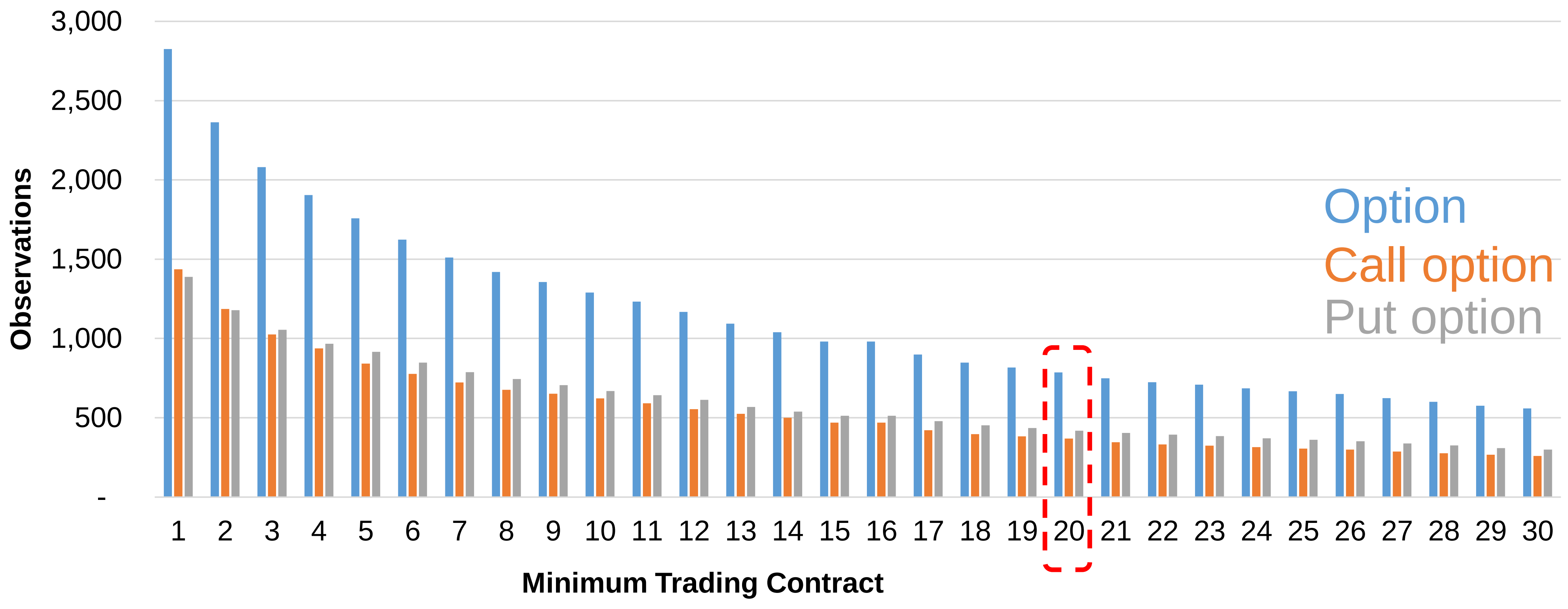


Table 5 reports model performance comparison: Minimum 20 trading contracts.

Option	Moneyness	Root Mean Square Error % (RMSE)						Mean Absolute Error % (MAE)					
		Implied Statistic			Historical Statistic			Implied Statistic			Historical Statistic		
		BS	W	BS - W	BS	W	BS - W	BS	W	BS - W	BS	W	BS - W
Call	OTM	39.5887	39.9038	-0.3151	7866.8618	151.1152	7715.7466	7.7692	7.8188	-0.0496	1184.3305	33.5743	1150.7562
	ATM	0.3944	0.3909	0.0035	0.4212	0.4193	0.0019	0.2844	0.2849	-0.0004	0.2993	0.2988	0.0005
	ITM	0.4855	0.4850	0.0005	0.5123	0.5120	0.0003	0.3969	0.3967	0.0002	0.3959	0.3955	0.0003
	Total	13.8489	13.9590	-0.1101	2750.9575	52.8449	2698.1126	1.2086	1.2150	-0.0064	145.0933	4.3754	140.7179
Put	OTM	2.1938	2.1866	0.0072	3.6152	3.7174	-0.1021	1.0548	1.0533	0.0015	1.1572	1.1814	-0.0242
	ATM	0.5277	0.9922	-0.4645	0.4767	0.4813	-0.0046*	0.3635	0.4123	-0.0488	0.3364	0.3389	-0.0025*
	ITM	0.5953	0.5953	0.0000	0.6354	0.6369	-0.0015	0.4771	0.4773	-0.0002	0.5036	0.5044	-0.0008
	Total	1.0631	1.2830	-0.2199	1.6238	1.6673	-0.0435	0.5009	0.5367	-0.0358	0.5020	0.5084	-0.0064*
Total		9.5077	9.5971	-0.0894	1882.3336	36.1794	1846.1542	0.8322	0.8543	-0.0220	68.1987	2.3189	65.8798

*significant at 0.05 level.

Table 6 reports model performance comparison. The out of the money is divided into 2 groups.

Option	Moneyness	Root Mean Square Error % (RMSE)						Mean Absolute Error % (MAE)					
		Implied Statistic			Historical Statistic			Implied Statistic			Historical Statistic		
		BS	W	BS - W	BS	W	BS - W	BS	W	BS - W	BS	W	BS - W
Call	DOTM	76.6306	77.2410	-0.6104	15234.1081	292.3666	14941.7415	26.4542	26.6401	-0.1859	4435.1864	119.5833	4315.6031
	OTM	1.3484	1.3488	-0.0004	6.9413	7.5343	-0.5930	0.9746	0.9747	0.0000	2.2011	2.2983	-0.0972
Put	DOTM	3.4148	3.4103	0.0045	7.4317	7.5786	-0.1468	1.5253	1.5246	0.0007	2.4068	2.4483	-0.0416
	OTM	1.8888	1.8804	0.0084	2.3247	2.4266	-0.1019	0.9692	0.9676	0.0016	0.9300	0.9511	-0.0211

*significant at 0.05 level.

Conclusion

- Although the Wilmott model is more consistent with hedging procedures of Thai investors, its resulting performance is not better significantly—either statistically or financially, than that of the Black and Scholes model.

- Due to simplicity and familiarity of the model to the investors, the study recommends those investors, who use the Black-and-Scholes model at present, to continue using the model for hedging.

Question and Answer