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# IMPACT OF DERIVATIVE WARRANTS INTRODUCTION ON THAILAND STOCK MARKET VOLATILITY

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## ABSTRACT

The Stock Exchange of Thailand (SET) first launched derivative warrants on SET50 index (SET50 DWs) on April 17, 2014. They are currently the most active DWs on the SET. This research uses the GARCH family models augmented with dummy variable to analyze the effect of SET50 DWs on stock market volatility. The sample data consist of daily returns of SET50 index from the period October 30, 2012 to December 30, 2019. The empirical results indicate that the coming into market of SET50 DWs reduces stock market volatility. The GARCH (1,1) TARCH (1,1), and EGARCH (1,1) models are not radically different from each other in their output. However, the asymmetric TARCH (1,1) model is found to provide the best fit in modelling volatility. The SET50 index shows the existence of leverage effect, where negative shocks have a greater impact on the volatility than positive shocks. Introducing SET50 DWs lowers the price volatility of SET50 index so investor having a portfolio investment with a correlation to the performance of SET50 index should adjust hedge ratio appropriately to manage investment risk. There is also a suggestion for policy makers to support the launch of DWs to lower the volatility in underlying spot market resulting in improved efficiency.

***Keywords***: Derivative Warrants; Volatility; GARCH Family Models; Stock Market; Thailand.

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## 1. INTRODUCTION

The impact of derivative products on the spot market has been widely debated for over a decade. While many studies focus on the impact of futures and options, few studies have examined the impact of derivative warrant introduction on the underlying assets. Previous literature shows the mixed results of the influence of derivative warrants on underlying stock market volatility. The impacts on underlying assets arising from the derivative warrant introduction also differ across markets. While most of the existing research concentrates on developed markets, only a relatively small number of studies is associated with emerging markets. The literature on this issue is not complete.

According to a Bloomberg study of 17 emerging markets gauging their potential for 2021 based on 11 indicators of economic and financial performance, Thailand recently becomes the top emerging market, owing to its solid reserves and high potential for portfolio inflows (Jamrisko & Flint, 2020). Earlier study by Leemakdej et al. (1998) provides evidence that warrant listing

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decreases the volatility of underlying stocks traded on the Stock Exchange of Thailand (SET). Bamrungsap (2018) also shows that the spot volatility falls after the trading of SET50 Index Futures on April 28, 2006, leading to stability in Thai stock market. However, the issuers of derivative warrants are commercial banks and brokerage firms, independent of the issuers of the underlying stocks, and tend to issue derivative warrants on volatile stocks. Therefore, the impact on the underlying assets arising from the introduction of derivative warrants may differ from those of futures, options, and warrants. As said by Duangthipnest (2017), trading of derivative warrants on the SET50 index is very active when the stock market is experiencing high volatility. Investors will shift to invest in derivative warrants on a single stock if the stock market is more stable. It is interesting to see whether the impact derivative warrant introduction on the SET behave differently compared to the results in other markets. The possible impact of derivative warrant introduction on the stability of the SET would be of particular interest to investors, market regulators, and those companies with derivative warrants written upon them.

Under the Securities Exchange of Thailand Act, B.E. 2517 (1974), the Securities Exchange of Thailand officially started trading on April 30, 1975. It was officially named as “the Stock Exchange of Thailand (SET)” on January 1, 1991. The SET currently operates under the Securities and Exchange Act, B.E. 2535 (1992). It is regulated by the Securities and Exchange Commission of Thailand (SEC). The SET is the 2nd largest stock exchange after Singapore in the Association of Southeast Asian Nations (ASEAN), with a market capitalization of 16,107,632.55 million baht in 2020. Looking back over the period 2012 – 2020, the SET’s ranking improved by two places from fourth in 2012 to second in 2017 and remained unchanged during 2017 - 2020. Across Southeast Asia, The SET is crowned as the biggest IPO market with the issue size of 136,043.88 million baht and the most active exchange with the average daily trading turnover of 18,714.73 million shares or 67,334.80 million baht (Table 1). The amount of funds raised and the average daily trading turnover for 2020 were higher than in all years between 2017 and 2019. The number of listed companies reached an all-time high of 568 in 2020, and the number of securities listed on the SET was 2,651. The SET provides a full range of investment products including stocks, warrants, derivatives warrants, ETFs, depositary receipts, and unit trusts.

Derivative Warrants (DWs) refer to financial instruments in which the issuer gives the holders the right to buy (Call DW) or to sell (Put DW) the underlying asset at the predetermined time or period of time, under the specified conditions. Sold by securities firms for a set premium, DWs, first launched in Thailand on July 9, 2009, were on PTT Public Company Limited. Besides DWs on common stocks, DWs are issued over the SET50 index on April 17, 2014 and the Hang Seng Index (HSI) on August 14, 2019. The SET50 index, tracking the performance of the top 50 stocks by a ranking based on large market capitalization, is a benchmark of investment in the SET. DWs on the SET50 index (SET50 DWs) are currently the most active DWs on the SET, which contribute 50% of total DW trading volume, followed by common stock DWs at 40% and HSI DWs at 10%. Overall, DWs have been gaining popularity on the SET for over a decade since their average price per unit is only 0.1-2.00 baht. Following common stocks, DWs were ranked second in turnover by type of securities for 2017 - 2020. As shown in Table 1, the trading value of DWs was 1,653,611.74 million baht in 2020, about 10.11% of the SET's total trading value. This recorded an increase from the previous number of 1,509,645.37 million baht for 2019. However, DWs were ranked first in term of number of listed securities, followed by common stocks and warrants, respectively. There are currently 13 DW issuers on the SET with roughly 1,931 DWs issued in 2020, accounted for 72.84% of total number of securities listed on SET. As DW becomes an important trading alternative to small and retail investors in emerging markets, the findings of this paper could help investors to gain a better understanding of volatility of the underlying assets following the DW introduction. There are also some important implications for policy makers highlighting how the issue of DW could have an impact on stock market stability.

I organize the rest of this study in the following way. The next section presents a literature review. Section 3 discusses the source of data and the methods adopted for this study. I discuss the results in the fourth section. Finally, a summary of the paper is provided in section 5.

**Table 1:** Yearly Market Statistics (2017 – 2020)

| Market Statistics | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|
| Total Market Capitalization (M.Baht) | 17,587,433.31 | 15,978,251.87 | 16,747,455.83 | 16,107,632.55 |
| Daily Average Turnover | | | | |
| - Volume (M.Shares) | 9,411.60 | 12,596.38 | 16,202.25 | 18,714.73 |
| - Value (M.Baht) | 47,755.37 | 56,409.06 | 52,467.58 | 67,334.80 |
| Issue Size of IPO (M.Baht) | 106,279.62 | 81,572.53 | 90,838.78 | 136,043.88 |
| Number of Listed Companies | 538 | 545 | 556 | 568 |
| Number of Listed Securities | 2,052 | 2,289 | 2,825 | 2,651 |
| - Common Stocks | 601 | 611 | 624 | 636 |
| - Preferred Stocks | 8 | 9 | 8 | 8 |
| - Warrants | 101 | 92 | 79 | 62 |
| - Derivative Warrants | 1,324 | 1,557 | 2,094 | 1,931 |
| - ETFs | 16 | 17 | 17 | 12 |
| - Depositary Receipts | - | 1 | 1 | 1 |
| - Unit Trusts | 2 | 2 | 2 | 1 |
| - Transferable Subscription Right | - | - | - | - |
| Turnover by Type of Securities (M.Baht) | 11,652,311.48 | 13,820,219.76 | 12,802,090.72 | 16,362,357.26 |
| - Common Stocks | 10,679,263.40 | 12,467,623.24 | 10,947,620.72 | 14,503,476.22 |
| - Common Foreign Stocks | 216,454.31 | 260,813.88 | 221,798.81 | 130,170.03 |
| - Preferred Stocks | 2.07 | 1,313.92 | 409.42 | 212.46 |
| - Preferred Foreign Stocks | - | 288.08 | - | - |
| - Warrants | 180,161.80 | 85,717.75 | 115,236.80 | 67,079.93 |
| - Derivative Warrants | 573,349.47 | 998,720.06 | 1,509,645.37 | 1,653,611.74 |
| - ETFs | 3,079.28 | 5,692.16 | 5,199.72 | 6,212.60 |
| - Depositary Receipts | - | 50.21 | 1,454.53 | 1,594.12 |
| - Unit Trusts | 1.15 | 0.46 | 5.82 | 0.16 |
| - Transferable Subscription Right | - | - | 719.53 | - |

***Source:*** The Stock Exchange of Thailand (2021)

## 2. LITERATURE REVIEW

The majority group of researchers support the argument that there is a reduction in stock market volatility after the introduction of the futures trading (see for example, Antoniou et al. (1998), Bologna and Cavallo (2002), Singh and Tripathi (2016), Yilgor and Mebounou (2016), and Marcel et al. (2020)). Other researchers argue that futures trading increases spot market volatility (see for example, Pok and Poshakwale (2004), and Xie and Mo (2014)). However, no significant effect of futures trading on the underlying spot market volatility is reported by Chen and Zhang (2015). Although there are inconsistent results in previous studies, it is broadly accepted that option introduction has been associated with significant price increases, liquidity increases, and volatility decreases in the spot market (Aitken & Segara, 2005). However, Robbani and Bhuyan (2016) show a significant increase in market volatility after the launch of futures and options trading on the Dow Jones Industrial Average. This result suggests that higher volatility corresponds to a higher required rate of return on underlying stock investment.

While many studies focus on the impact of options (see for example, Long et al. (1994), Kumar et al. (1995), Chaudhury and Elfakhani (1997), Bollen (1998), and Chevallier et al. (2011)), few studies have examined the impact of derivative warrant introduction on the underlying assets. For the Hong Kong Stock Exchange, Draper et al. (2001) examines the impact of warrant introduction on the price, volatility, and volume of trading in the underlying stocks. The results show a temporary decline in price and an increase in volume of trading as a result of the introduction but little impact on volatility. Chan and Wei (2001), and Chen and Wu (2001) also examine the impact on both price and trading volume of underlying securities, arising from the introduction of derivative warrants on equity in Hong Kong. They find increases in price and volume of underlying securities as a result of derivative warrant issuance. The review by Securities and Futures Commission (2005) indicates that the activities in Hong Kong's derivative warrants market do not currently threaten the stability of stock market. Findings by Aitken and Segara (2005) support Draper et al. (2001). Aitken and Segara (2005) find a negative price effect and a positive volume effect of the introduction of warrants on the underlying stocks listed on the Australian Securities Exchange (ASX). However, their result shows price volatility of underlying stocks is found to be significantly higher following warrant listing. A negative price effect of the derivative warrant introduction is confirmed by Clarke et al. (2011). They find a negative price impact but a decrease in volume and no significant impact on volatility in the ASX. The paper by Mugaloglu (2013) also show that index warrant trading does not lead to a lower in underlying spot market volatility in Istanbul Stock Exchange over the post-crisis period. Chung and Hseu (2006) show the results that are inconsistent with others. The volatility of the underlying stocks decreases in response to the issuance of derivative warrants in Taiwan. There is no evidence of any difference in the changes in trading volumes. They also find a positive price effect on the announcement day, but a negative price effect after the announcement day. By employing the event-study method, Jiming et al. (2010) show that call warrant listing in China has a non-linear impact on average exceed rate and enlarge exceed income fluctuation which supports the theoretical expectation that the listing of call warrants can improve market efficiency. Call warrant listing also increases positive price volatility. When comparing investor preferences between China and Taiwan, Wong et al. (2018) conclude that the Chinese warrant market is volatile for investors. There are more speculative activities in the Chinese warrant market than the Taiwanese warrant market. With a focus on the effect of the announcement of warrant listing on the stock price movement, Nelmida (2020) finds that there are significant differences in the values of abnormal returns and cumulative abnormal returns before and after the announcement date of the warrant listing on the Indonesia Stock Exchange. Findings by Yip and Lai (2009) indicate that warrant listing has no impact on both price and systematic risks but a positive impact on trading volume of underlying stocks on Bursa Malaysia. In addition, Yip and Hooy (2015) show that call warrant listing has no impact on the return, volatility, and bid-ask spread of its underlying stocks on Bursa Malaysia. However, its trading volume tends to be higher in the post event period.

As Thailand recently becomes the top emerging market, research into derivative warrant listing effects in Thailand has been very limited. Previous literature in the area of Thai derivative warrants focuses on pricing (see for example, Junanun and Boonvorachote (2018)) and issuer's profit (see for example, Wongnapakarn et al. (2021)). The objective of this study is therefore to extend the existing literature by analyzing the impact of derivative warrant introduction on the Stock Exchange of Thailand (SET). To our knowledge, this is the first study specifically exploring the impact on Thai stock market volatility arising from the introduction of derivative warrants.

## 3. METHODOLOGY

### *3.1. Data*

To analyze the impact of the introduction of SET50 DW on market volatility, this research employs daily data on the SET50 index prices collected from the website of SETSMART. The daily data are collected for a period starting October 29, 2012 to December 30, 2019, covering the period before and after the introduction of first SET50 DWs on April 17, 2014. Previous literature shows the impact of options introduction on the volatility of the underlying equity. To avoid the possible impact on market volatility, the start date of the study period is the first day new specification of SET50 Index Options contract, an alternative investment choice, has been offered. In addition, this specific time period is chosen due to the stability of Thai stock market prior to the outbreak of COVID-19. Since COVID-19 became a pandemic in 2020, SET50 index went down from 1,081 points on January 2, 2020 to the lowest drop to 680.07 points or decreased by 37.09% on March 23, 2020. To reduce the impact of the COVID-19 pandemic on market volatility, the SET tightened short-selling rule and adjusted ceiling and floor criteria during the period March 18, 2020 to September 30, 2020. Previous literature (see for example, Panyagometh (2020), and Suwannapak and Chancharat (2022)) also shows the relationship between COVID-19 pandemic and Thai stock market volatility.

Then the returns of SET50 ($r_t$), are obtained by taking the difference of natural logarithm of SET50 index prices, $r_t = \ln P_t - \ln P_{t-1}$. The returns ranging from October 30, 2012 to April 16, 2014 refer to the period before the introduction of SET50 DW, and the returns ranging from April 17, 2014 to December 30, 2019 are for the period after the introduction of SET50 DW.

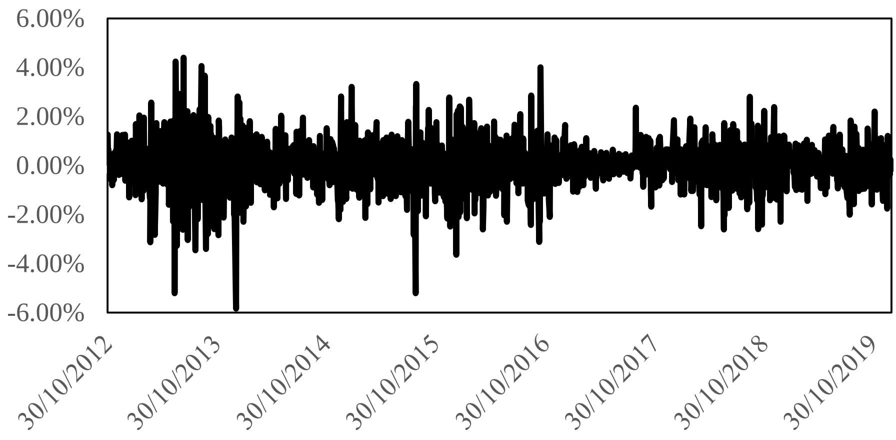
Table 2 presents descriptive statistics for daily return data, namely mean, minimum, maximum, and standard deviation. The results show that the average daily return for the SET50 index is 0.012 percent over the entire period from October 30, 2012 to December 30, 2019. Throughout the entire period, the values for the minimum and maximum returns for the SET50 index are -5.8396 percent and 4.3977 percent respectively. The standard deviation is 0.9351 percent. The whole time period is divided into 2 sub-periods. Before the introduction of SET50 DW (October 30, 2012 to April 16, 2014), the average return for the SET50 index is 0.0267 percent daily. The minimum and maximum values of daily returns are -5.8396 percent and 4.3977 percent respectively. The standard deviation is 1.2667 percent. After the introduction of SET50 DW (April 17, 2014 to December 30, 2019), the daily returns for the SET50 index have the minimum value of -5.2090 percent and the maximum value of 4.0078 percent, with a mean of 0.0082 percent and a standard deviation of 0.8294 percent. A lower in standard deviation indicates lower volatility in stock market after the SET50 DW introduction. Overall, The Augmented Dickey Fuller (ADF) test for unit roots is also conducted for all the time series used for the study. Using the Schwarz Criterion (SC), the zero-lag length is selected due to the lowest SC. The result of the ADF test illustrates that all the data series are stationary at 1 percent level of significance, when the critical value for ADF test with intercept but without trend is -3.43.

**Table 2:** Descriptive Statistics of Daily Returns

| | **Before**<br>**30 Oct 12 – 16 Apr. 14** | **After**<br>**17 Apr. 14 – 30 Dec. 19** | **Total**<br>**30 Oct 12 – 30 Dec. 19** |
|---|---|---|---|
| Mean | 0.000267 | 0.000082 | 0.000120 |
| Minimum | -0.058396 | -0.052090 | -0.058396 |
| Maximum | 0.043977 | 0.040078 | 0.043977 |
| Std. Dev. | 0.012667 | 0.008294 | 0.009351 |
| ADF Test Statistic | -18.54698 | -36.80701 | -41.22231 |

Figure 1 plots SET50 daily returns for the period October 30, 2012 to December 30, 2019. The SET50 daily returns tend to be less volatile after SET50 DW introduction in 2014. The return time series of SET50 index also shows the volatility clustering effect, large (small) changes tend to be followed by large (small) changes. Therefore, the Lagrange Multiplier (LM) test for ARCH effects in the residuals is conducted. The LM test statistic is 10.78603 (P-value = 0.00102), which implies that the null hypothesis of no ARCH effects can be rejected at a significance level of 1 percent. The presence of conditional heteroskedasticity leads to models with the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) family models. The goal of such models is to provide a volatility measure. They have become widespread tools for dealing with time series heteroskedastic models (Engle, 2001).

**Figure 1:** SET50 Daily Returns from October 30, 2012 to December 30, 2019




### *3.2. Model*

Financial data typically show the spread and clustering of the volatility of the data. The models of Autoregressive Conditional Heteroskedasticity (ARCH) by Engle (1982) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) by Bollerslev (1986) were designed to capture such properties in financial data (Jongadsayakul, 2020). Moreover, the GARCH (1,1) model is usually considered sufficient enough to capture volatility movement in practice (see for example, Carnot et al. (2011), Javed and Mantalos (2013), Jongadsayakul (2020) and

Jongadsayakul (2021)). However, the GARCH (1,1) model is symmetric and does not capture the asymmetry in financial returns data. It also faces the constraint of non-negativity of the conditional variance. Therefore, asymmetric GARCH models, the TARCH (1,1) model proposed by Zakoian (1990) and Glosten et al. (1993) and the EGARCH (1,1) model proposed by Nelson (1991), are used to capture the leverage effect. The EGARCH (1,1) model also ensures the non-negativity of the conditional variance. In addition, this paper includes a dummy variable in the conditional variance equation to investigate the effect of the SET50 DW introduction on the price volatility of SET50 index. This dummy variable, DW, takes on two values: 1 if data belong to a period of time starting the launch of SET50 DW on April 17, 2014, and 0 otherwise. Both symmetric and asymmetric GARCH models are estimated as follows:

Model 1: GARCH (1,1) Model
The augmented GARCH model with constant mean can be presented as:

$$r_t = c_0 + \varepsilon_t \quad [1]$$

$$\varepsilon_t = \sigma_t Z_t \quad [2]$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + aDW_t \quad [3]$$

where $r$ is the SET50 return, $Z$ is a sequence of iid random variables with zero mean and unit variance, $\sigma^2$ is the conditional variance of returns, $DW$ is the dummy variable, $\alpha_1$ is the ARCH coefficient, and $\beta_1$ is the GARCH coefficient.

Model 2: TARCH (1,1) Model
The augmented TARCH model has the following conditional variance equation:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma \varepsilon_{t-1}^2 d_{t-1} + \beta_1 \sigma_{t-1}^2 + aDW_t \quad [4]$$

where $d$ is the dummy variable taking on two values: 1 if $\varepsilon_t < 0$, and 0 otherwise. If $\gamma > 0$, the leverage effect is observed as the ARCH effect of $\alpha_1 + \gamma$ for bad news is larger than one of $\alpha_1$ for good news.

Model 3: EGARCH (1,1) Model
Using the standardized residual $(\varepsilon / \sigma)$ instead of square of residual $(\varepsilon^2)$, the augmented EGARCH model has the following conditional variance equation:

$$\ln\left(\sigma_t^2\right) = \alpha_0 + \alpha_1 \left|\varepsilon_{t-1} / \sigma_{t-1}\right| + \gamma \varepsilon_{t-1} / \sigma_{t-1} + \beta_1 \ln\left(\sigma_{t-1}^2\right) + aDW \quad [5]$$

where the $\gamma$ coefficient captures the asymmetric effect of previous shocks. The sign of $\gamma$ is negative indicating the leverage effect. The ARCH effect of $\alpha_1 - \gamma$ for bad news is larger than one of $\alpha_1 + \gamma$ for good news.

## 4. RESULTS AND DISCUSSION

To study the effect of SET50 DW introduction on the price volatility of SET50 index, the symmetric and asymmetric GARCH models are augmented by adding the dummy variable, DW, into conditional variance equation. Equations [1] – [5] are then estimated under the assumption that the residuals are normally distributed.

Table 3 shows the estimated results of the GARCH family models for SET50 returns, displaying the estimated coefficients and their P-values, as well as diagnostics tests. To check the validity of the estimated models, including GARCH (1,1), TARCH (1,1), and EGARCH (1,1), the Ljung–Box Q test statistic is computed for examining the null hypothesis of no serial correlation in the standardized residuals. The Ljung–Box Q test on the squared standardized residuals and the Lagrange Multiplier (LM) test for the null hypothesis of no ARCH effects are also conducted. From the results, the p-value from the Box-Ljung test in Table 3 greater than 0.05 indicates a failure to detect the presence of any serial correlation. Moreover, the p-values from the Box-Ljung test of the squared residuals and the LM test are greater than significance level at 0.05. It means that the null hypothesis of no ARCH effect is not rejected. These tests confirm the appropriateness of the GARCH family models for analysing the SET50 index return series.

**Table 3:** Estimation Results of the GARCH Family Models for SET50 Index

| Model | GARCH (1,1) | | TARCH (1,1) | | EGARCH (1,1) | |
|---|---|---|---|---|---|---|
| **Coefficient/Statistics** | **Estimated value** | **P-value** | **Estimated value** | **P-value** | **Estimated value** | **P-value** |
| *Mean Equation* | | | | | | |
| $c_0$ | 0.000408** | 0.0311 | 0.000149 | 0.4275 | 0.000215 | 0.2117 |
| *Variance Equation* | | | | | | |
| $\alpha_0$ | 1.82E-06*** | 0.0043 | 2.67E-06*** | 0.0000 | -0.359405*** | 0.0000 |
| $\alpha_1$ | 0.081564*** | 0.0000 | 0.004994 | 0.5203 | 0.124142*** | 0.0000 |
| $\gamma$ | | | 0.117802*** | 0.0000 | -0.087281*** | 0.0000 |
| $\beta_1$ | 0.910069*** | 0.0000 | 0.917369*** | 0.0000 | 0.970521*** | 0.0000 |
| $a$ | -9.63E-07* | 0.0976 | -1.37E-06** | 0.0189 | -0.022714*** | 0.0006 |
| *Standardized Residual Diagnostics* | | | | | | |
| Ljung-Box Q (36) | 23.7583 | 0.9415 | 22.3494 | 0.9635 | 20.5155 | 0.9821 |
| Ljung-Box $Q^2$ (36) | 19.6649 | 0.9877 | 22.1691 | 0.9877 | 24.5395 | 0.9261 |
| LM ARCH (1) | 0.0376 | 0.8462 | 0.0268 | 0.8700 | 0.0012 | 0.9719 |
| *Model Selection* | | | | | | |
| AIC value | -6.715229 | | -6.744446 | | -6.744257 | |
| SC value | -6.699623 | | -6.725718 | | -6.725530 | |
| RMSE (In Sample) | 0.0093531 | | 0.0093487 | | 0.0093491 | |
| RMSE (Out of Sample) | 0.0136734 | | 0.0136647 | | 0.0136664 | |

***Note:*** ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively.

For the results of the GARCH (1,1) model, the coefficient for the previous shock (the ARCH coefficient: $\alpha_1$) is 0.081564 and that for its lagged conditional variance (the GARCH coefficient: $\beta_1$) is 0.910069. Both ARCH and GARCH coefficients are considered statistically significant at the 0.01 level. Their p-values are less than 0.01. The sum of the ARCH term and GARCH term in the variance equation ($\alpha_1 + \beta_1 = 0.991633$) is less than one shows a mean-reverting process. The coefficient of DW dummy ($a$ = -0.000000963) is negative and significant at the level of 0.10, implying a significant negative relationship between the SET50 DW introduction and the SET50 index volatility.

For the results of the TARCH (1,1) model, the leverage coefficient is 0.117802. It is positive and highly significant at the 0.01 level, indicating the presence of the asymmetric behaviour. The ARCH effect of 0.004994 is for positive residual shocks and one of 0.122796 is for negative residual shocks. For the analysis of the impact of SET50 DW introduction on SET50 index volatility, the negative coefficient of DW dummy ($a$ = -0.00000137) is significant at the level of 0.05, confirming a significant negative impact of the SET50 DW introduction on the price volatility of SET50 index.

For the results of the EGARCH (1,1) model, all estimated coefficients in the conditional variance equation are significant at the level of 0.01. The existence of leverage effect is also observed in the EGARCH (1,1) model. Due to the negative sign of $\gamma$ ($\gamma$ = -0.087281), the reaction to positive shocks (0.036861) is lower than the reaction to negative shocks (0.211423). Moreover, the negative coefficient of DW dummy ($a$ = -0.022714) shows a significant negative relationship between the launch of SET50 DW and the price volatility of SET50 index.

According to Bollerslev et al. (1994), standard model selection criteria such as Akaike Information Criterion (AIC) and Schwarz Criterion (SC) have been widely used in the ARCH literature. As shown in Table 3, the TARCH (1,1) model provides the lowest values of AIC (-6.744446) and SC (-6.725718). The forecasting performance of GARCH family models is also evaluated for in sample (30 October 2012 – 30 December 2019) and out of sample (2 January 2020 - April 28, 2023) using Root Mean Squared Error (RMSE). Comparing the performance of symmetric and asymmetric GARCH models, the TARCH (1,1) model provides the lowest RMSE for both in sample (0.0093487) and out of sample analysis (0.0136647). Therefore, the asymmetric TARCH (1,1) model is found as the best fitting model to capture SET50 index volatility.

To additionally ensure the robustness of the results, this paper conducts the robustness checks on data for extended sample period of January 5, 2010 to April 28, 2023. As shown in Table 4, the estimation results of the GARCH family models for SET50 index provide highly consistent results. The leverage coefficients in the TARCH (1,1) and EGARCH (1,1) models are statistically significant at the 0.01 level in the extended sample. The SET50 index shows the existence of leverage effect, where negative shocks have a greater impact on the volatility than positive shocks. The negative coefficient of DW dummy is statistically significant in all estimated GARCH family models for the extended sample.

**Table 4:** Robustness Checks for the GARCH Family Models Using Extended Sample Period

| **Model** | **GARCH (1,1)** | | **TARCH (1,1)** | | **EGARCH (1,1)** | |
|---|---|---|---|---|---|---|
| **Coefficient/Statistics** | **Estimated value** | **P-value** | **Estimated value** | **P-value** | **Estimated value** | **P-value** |
| | | | *Mean Equation* | | | |
| $c_0$ | 0.000356** | 0.0212 | 0.000122 | 0.4156 | 0.000161 | 0.2263 |
| | | | *Variance Equation* | | | |
| $\alpha_0$ | 3.11E-06*** | 0.0000 | 3.74E-06*** | 0.0000 | -0.357367*** | 0.0000 |
| $\alpha_1$ | 0.102572*** | 0.0000 | 0.036074*** | 0.0000 | 0.174345*** | 0.0000 |
| $\gamma$ | | | 0.105292*** | 0.0000 | -0.074772*** | 0.0000 |
| $\beta_1$ | 0.882972*** | 0.0000 | 0.892633*** | 0.0000 | 0.974749*** | 0.0000 |
| $a$ | -1.40E-06*** | 0.0086 | -2.02E-06*** | 0.0000 | -0.013273*** | 0.0011 |

***Note:*** ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively.

Overall, the findings of this paper suggest the improvement of stock market stability following the DW introduction. Introducing SET50 DWs lowers the price volatility of SET50 index so investor having a portfolio investment with a correlation to the performance of SET50 index should adjust hedge ratio appropriately to manage investment risk. Moreover, the results provide some important implications for policy makers highlighting the fact that the incentives for the DW market should be strengthened due to a lower in volatility of the underlying spot market resulting in improved efficiency. Authorities should facilitate new DW launch. At present, SET50 DW is the only one choice for trading DW on local index in Thailand. DW issuers should add more underlying assets such as industry group index and sectoral index for DWs. The newly launched DW would be a good trading alternative to DW investors pursuing to manage their portfolio investment more efficiently and effectively.

## 5. CONCLUSION

At present, the SET is the second largest stock exchange by market capitalization in ASEAN but grab the No.1 spot in ASEAN IPO market. Among a full range of investment products available in the SET, DWs are currently ranked second in turnover by type of securities but first in term of number of listed securities. SET50 DWs, launched on April 17, 2014, are the most active DWs on the SET. They currently contribute 50% of total DW trading volume, followed by common stock DWs at 40% and HSI DWs at 10%. The introduction of SET50 DWs may have the impact on the price volatility of SET50 index. Previous literature shows the mixed results of the influence of DW on underlying stock market volatility. The impacts on underlying assets arising from the DW introduction also differ across markets. While most of the existing research concentrates on developed markets, only a relatively small number of studies is associated with emerging markets. The literature on this issue is not complete. As Thailand recently becomes the top emerging market, it is interesting to see whether the impact of the introduction of SET50 DW on the SET behave differently compared to the results in other markets.

This research uses the GARCH family models augmented with dummy variable to analyze the effect of SET50 DWs on the price volatility of SET50 index. Daily returns on the SET50 index are computed for a period starting October 30, 2012 to December 30, 2019. This specific time period is chosen due to the stability of Thai stock market prior to the outbreak of COVID-19. The most commonly used modeling procedure is the GARCH (1,1) model. However, the GARCH (1,1) model is symmetric and does not capture the asymmetry in returns data. The TARCH (1,1) model and the EGARCH (1,1) model are also estimated to capture the leverage effect. The empirical results show that the coming into market of SET50 DWs reduces the price volatility of SET50 index. The estimated volatility of the GARCH (1,1) is very close to the estimated volatility of the TARCH (1,1) model and the EGARCH (1,1) model. However, the asymmetric TARCH (1,1) model is found as the best fit in modelling SET50 index volatility due to the lowest values of AIC and SC. It also provides the most accurate forecast of SET50 index volatility. This study confirms the existence of leverage effect in Thai stock market, where the reaction to negative shocks is higher than the reaction to positive shocks. Since the introduction of SET50 DWs lowers the market volatility, investor having a portfolio investment with a correlation to the performance of SET50 index should adjust hedge ratio appropriately to manage investment risk. The findings of this study also suggest that policy makers should encourage the issue of DW to lower the volatility in underlying spot market, resulting in improved efficiency.

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