Effect of Dividend on Derivative Warrants : Evidence from Stock Exchange of Thailand

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นายนครินทร์ ชนะชัยวรกร

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Accepted by the FACULTY OF COMMERCE AND ACCOUNTANCY, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Science

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วิจัยนี้มีจุดประสงค์เพื่อสำรวจการประเมินราคาที่ผิดพลาดของใบสำคัญแสดงสิทธิอนุพันธ์ในวันจ่ายปันผลโดยการเปรียบเทียบราคาทางตลาดกับราคาทางทฤษฎีของใบสำคัญแสดงสิทธิอนุพันธ์จากตลาดหลักทรัพย์แห่งประเทศไทยระหว่างปี2010-2020จากการปรับสิทธิของราคาใช้สิทธิและอัตราการใช้สิทธิสืบเนื่องจากวันจ่ายปันผลของหลักทรัพย์อ้างอิงที่ตั้งขึ้นโดยตลาดหลักทรัพย์แห่งประเทศไทยและงานวิจัยนี้ศึกษาเพิ่มเติมในขนาดของการประเมินราคาที่ผิดพลาดจากอัตราของอัตราเงินปันผลตอบแทนของหลักทรัพย์อ้างอิง ผลลัพธ์เชิงประจักษ์แสดงหลักฐานของประเมินราคาที่ผิดพลาดของใบสำคัญแสดงสิทธิอนุพันธ์จากหลักทรัพย์จากหลักฐานที่แน่ชัดของราคาที่ต่ำกว่าความเป็นจริงของราคาทฤษฎีในใบสำคัญแสดงสิทธิอนุพันธ์ในการซื้อและหลักฐานที่ไม่ชัดเจนเชิงสถิติในราคาที่สูงกว่าความเป็นจริงของราคาทฤษฎีในใบสำคัญแสดงสิทธิอนุพันธ์ในการขายและอัตราการอัตราเงินปันผลตอบแทนของหลักทรัพย์อ้างอิงนั้นมีความสัมพันธ์และมีส่วนรวมในการส่งผลของขนาดของการประเมินราคาที่ผิดพลาดของใบสำคัญแสดงสิทธิอนุพันธ์ยิ่งอัตราเงินปันผลของหลักทรัพย์อ้างอิงมากยิ่งส่งผลต่อราคาที่ต่ำกว่าความเป็นจริงของราคาทฤษฎีในใบสำคัญแสดงสิทธิอนุพันธ์ในการซื้อและส่งผลต่อราคาที่สูงกว่าความเป็นจริงของใบสำคัญแสดงสิทธิอนุพันธ์ในการขาย

สาขาวิชา การเงิน ลายมือชื่อนิสิต

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ปีการศึกษา 2564 ลายมือชื่อ อ.ที่ปรึกษาหลัก

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The purpose of this paper is to investigate mispricing of derivative warrants on ex-dividend date. Using data from the Stock Exchange of Thailand during 2010 to 2020, this research examines mispricing of derivative warrants by comparing the market price to the theoretical price, which incorporates the adjustment of exercise price and ratio on ex-dividend date according to the rules given by SET. This research also studies further by investigating the magnitude of impact from the dividend yield of underlying asset. The empirical results show strong evidence of mispricing in call derivative warrants, whereas put derivative warrants are found to be weakly statistically overpriced. Furthermore, dividend yield of underlying asset is indeed highly correlated to the magnitude of mispricing, as high dividend yield stocks have more underpriced call derivative warrants and as well more overpriced put derivative warrants.

Field of Study:	Finance	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

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Nakarin Chanachaivorakorn

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

Chapter 1
Introduction

Derivative warrant is one type of derivative securities that used by investors as a tool used for leverage, hedging, or managing their stock positions. It shares the same characteristic with options as it provides the rights to buy or sell of the underlying securities at exercise price and quantity at specific time with the same pricing model. Derivative Warrants are issued by the third parties, which are financial institutions approved by regulators. Derivative warrants are traded in equity market, unlike the derivative products that traded in futures market.

In Thailand, Derivative warrants has been traded the same way equities are traded in Stock Exchange of Thailand (SET). It has been traded in SET since 2009. The number of securities and volume of trading have been increasing over time and have potential growth in the future. The issuers are committed to manage derivative warrants and face the risk of interest rate, implied volatility, time to maturity, price of underlying assets and price of theoretical price of options resulting in putting bid/ask regarding its price. It is also committed to make adjustment on the right of asset and issue the report related to derivative warrants and underlying assets when there is an event of corporate action.

Derivative warrant in Stock Exchange of Thailand (SET) requires the following features.

First one, the underlying assets of derivative warrants can be common shares that listed in Stock Exchange of Thailand, foreign common share that listed in foreign exchange market, exchange index, foreign exchange index, ETF and other assets prescribed by SET. Secondly, there are two types of derivative warrants; call and put derivative warrants. Call derivative warrants gives the holders the right to buy the underlying asset or right to receive payment when the spot price of an underlying asset is higher than the strike price at the predetermined time. Put derivative warrants gives the holders the right to sell the underlying asset or right to receive

payment when the spot price of an underlying asset is lower than the strike price at the predetermined time. Thirdly, Exercise style of Derivative warrants in Stock Exchange of Thailand is European Style, which can be only exercised at expiration date. Fourthly, Expiration date is the predetermined date of expiration of derivative warrants. According to Stock Exchange of Thailand, time to maturity or terms of derivative warrants must not be less than 2 months and not exceed 2 years from issuance date. Fifth one is Settlement, Derivative warrants in Stock Exchange of Thailand are settled in cash settlement. Sixthly, Exercise price or strike price is the predetermined price which the call derivative warrants investors have right to buy underlying assets while put derivative investors has right to sell underlying asset when derivative warrants are exercised. Seventhly, Exercise ratio or conversion ratios is the number of units of underlying asset exchanged per derivative warrants when it is exercised. In addition, Exercise price and Ratio will be fairly adjusted when there is a corporate action of underlying asset due to the rule from SEC causing the theoretical price before and after will be the same. Last one is Derivative warrants pay no dividend during issuance date and expiration date. The determinations of derivative warrants price are spot price, exercise price, exercise ratio, time to maturity, volatility and interest rate which will be discussed in the Methodology part.

Dividend is a form of distribution of company profits to shareholders who hold the share of the company, there are two type of dividend cash dividend and stock dividend. Regarding its effect to stock price refers to MM theory, (Miller and Modigliani 1961) proposed that the MM dividend irrelevance theory suggesting that capital gain is equivalent to dividend given the capital market are perfect substitute). The price of stock should drop by the amount of dividend on ex-evidence date, If the market is efficient and frictionless that there is no tax and transaction fee and investors are well-informed (Fama 1970). Contrary to MM theory, several studies such as (Elton and Gruber 1970)showed that the price behavior on ex-dividend is drop by less than the amount of dividend due to the tax clientele effect. The difference in taxation bracket of dividend and capital gain that the preference of

investors for dividend or capital gain depend on tax rate of items as followed dividend price drop ratio (DPR). In addition, (Ngoc and Nguyen 2016) studied further on dividend announcement date and ex-dividend date, found that stock price increases in the cash dividend announcement date and keep increases as approach to ex-dividend date and stock price will decrease afterward ex-dividend date as well as the same case of stock dividend (Kadioglu and Kirbas 2021).

Therefore, when the company of underlying assets firm announces dividend payment, the dividend payment will be paid on ex-dividend date. The price of underlying asset should drop by the amount of dividend. While in the case of derivative warrant, derivative warrants will not pay dividend or perform any underlying asset's corporate. There is imbalance between derivative warrant and underlying asset in term of shareholders 'wealth on ex-dividend date. Without the adjustment to exercise price and ratio, the price of derivative warrant in the market would be affected by dividend. The call derivative warrant holders will not get dividend from call derivative warrants and face the opportunity to make a loss if buying derivative warrant prior ex-dividend date and put derivative warrant holders will have opportunity to make a gain on ex-dividend date by buying put derivative warrants prior ex-dividend date regarding to price drop from dividend payment. To prevent this issue and preserve derivative warrant holders' wealth, Derivative warrant issuers will have the role to make adjustment to derivative warrants correspondingly to dividend.

When the company of underlying assets firm announces dividend payment, derivative warrant issuers will issue an adjustment of exercise ratio and price report which will be effective on ex-dividend date. The theoretical derivative warrants price from Black-Scholes Model before and after ex-dividend date will be equivalent given time to maturity constant. Derivative warrant holders 'wealth will be the same for both before and after ex-dividend date similar to the case of shareholders 'wealth of underlying asset which will be the same for both before and after corporate action

Adjustment of exercise ratio and price of Derivative Warrants in Stock Exchange of Thailand

The events of corporate actions that will make adjustment of underlying assets to derivative warrant during issuance date to last trading date of derivative warrants by issuers are as followed; Stock dividend, Cash dividend, Stock split or reverse stock split, Merger and acquisition, and Rights issue.

The adjustment of exercise price will be rounded to nearest 3 decimal points and exercise ratio will be rounded to nearest 5 decimal points.

In this study, we will investigate in cash dividend event. Derivative warrant issuers will issue the adjustment report correspondingly to dividend amount which will adjust the right of derivative warrants on ex-dividend date. However, the derivative warrants price will not be directly adjusted by the dividend but the adjustment will be applied to right to exercise ratio and price of derivative warrants to prevent arbitrage opportunity among investors, issuers and financial institutions. None of party will gain advantage over another party from the adjustment. This adjustment of derivative warrant price is a fair adjustment to compensate dividend payment. Although derivative warrant will not provide the same action of underlying asset 's corporate action, its price could be indirectly affected through the change in underlying asset price. When shareholders hold underlying assets before ex-dividend date, shareholders will be eligible to earn income from dividend payment from the company. After ex-dividend date, the market will react correspondingly the dividend payment causing the underlying asset decreases by the amount of dividend. So, the shareholder 's wealth will be the same for both before and after-ex dividend date. Nevertheless, derivative warrants investors may perceive the price drop from dividend payment of underlying asset on ex-dividend date as a false signal to buy or sell derivative warrants resulting in deviation between the actual price from theoretical price by using Black-Scholes Model from previous view before dividend payment. The deviation is called mispricing.

The purpose of this study is to find mispricing of derivative warrants from the event study by investigating the difference between actual and theoretical price from Black-Scholes before ex-dividend date and opening price on ex-dividend date of underlying asset of derivative warrants between period of 2010-2020. We study whether derivative warrant investors perceive the adjustment of derivative warrants on exercise price and ratio without taking the change in price of underlying asset according to dividend payment into account by testing the difference between actual and theoretical price by using Black-Scholes model. Furthermore, we attempt to investigate the factors associated with the size of mispricing in derivative warrant. We suspect that the dividend yield of underlying asset of derivative warrants are the main factors responsible for the mispricing. As a final note, readers should keep in mind that the mispricing referred in this study is measured in relative terms from prior the ex-dividend date to on the ex-dividend date. It is a relatively short time window, particularly between market closing and the next day market opening, where the market information can still acceptably be held constant. This study makes no investigation or implication on the longer-term mispricing which could occur from the derivative warrants having been mispriced long before or after the ex-dividend date.

Objectives of Research

- To see whether the formal rule for adjustment of exercise price and ratio from the event of ex-dividend leads to mispricing in derivative warrants or not
- To investigate specific factor, namely dividend yield, whether it is responsible for the mispricing in derivative warrants.

Research Questions

- Do derivative warrant investors perceive of derivative warrant adjustment of dividend payment of underlying asset on ex-dividend date?
- Does the dividend yield of the underlying asset contribute to mispricing of derivative warrants on ex-dividend date?

Hypothesis Development

Mispricing of securities causes divergence between price of securities to be a difference from intrinsic value and market value and violates the Law of One Price in which no opportunity for profitable arbitrage trading since identical assets will have the same price given frictionless market. Lamont and Thaler (2003) stated that if the market send the right signals, investors should take it into their account and price the asset correctly. When the underlying asset firms announce dividend payment to shareholder, derivative warrants issuers will issue adjustment report that will adjust the exercise price and exercise ratio that will be effective on ex-dividend date. The theoretical price by using Black-Scholes model before and after adjustment will be equivalent. (Campbell and Beranek 1955)) noted that usually, the price of underlying assets decreases according to dividend payment on ex-dividend date by amount approximately amount of dividend. In the case of call derivative warrants given a frictionless and efficient market, a decrease in underlying asset from dividend payment on ex-dividend date that will decrease the price of call derivative warrant will be compensated by the adjustment to exercise price and ratio applied to the derivative warrant. The result from adjustment of exercise price and ratio is from the event cash dividend payment on ex-dividend date that will make the theoretical price from Black-Scholes Model before and after ex-dividend date be the same given constant of volatility and time to maturity. As a result, from adjustment, the closing price of call derivative warrants before ex-dividend date and opening price of call derivative warrant at ex-dividend date should be equal theoretically. On ex-dividend date, actual opening price of derivative warrant should be the same as theoretical price. However, If the market is informationally inefficient, Call derivative warrant investors might not acknowledge the adjustment or call derivative warrant investors in the market are irrational in terms of behavioral finance called anchoring bias and ignore the adjustment, Call derivative warrant investors will not take the adjustment in exercise price and ratio into account but perceive a decrease in price of the underlying asset as a false signal to buy/sell call derivative warrant at mispricing price. Mispricing of call derivative warrant is from a decrease of underlying asset

price will deviate the actual price of call derivative warrant to be lower than theoretical price. Thus, our first hypothesis is derivative warrant investors will not fully perceive derivative warrant adjustment of dividend payment of underlying asset on ex-dividend date and buy/sell derivative warrant at mispricing price. We expect that the actual call derivative warrant price will be lower than theoretical call derivative warrant price. The effect will be opposite for put derivative warrants.

Next, the amount of dividend per share or implied dividend price drop ratio, and the in-the-money/out-of-the-money status as a percentage of derivative warrant strike price known as moneyness could be positively associated with the magnitude of mispricing. While the dividend per share obviously associates with the magnitude of price drop in the underlying stock, the moneyness of DW typically associates with the DW's delta which measures how sensitive DW's price is from the change in the underlying stock's price (ITM DW is more sensitive to OTM DW). If the investors' perception change is related to the anchoring bias, then size effect may very well vary across different dividend yields and DW's moneyness. So, the second and third hypotheses are underlying stock's dividend yield and DW's moneyness are responsible for the size of mispricing in DW on the ex-dividend date. Because call and put DWs are expected to be mispriced in different directions, we provide the hypotheses for call DWs and put DWs separately as follow,

Hypothesis for call derivative warrant

H1: There is negative mispricing of call derivative warrants on ex-dividend date

H2: Higher dividend yield of underlying asset affects more (negative) mispricing of derivative warrants on ex-dividend date

Hypothesis for put derivative warrant

H1: There is positive mispricing of put derivative warrants on ex-dividend date

H2: Higher dividend yield of underlying asset affects more (positive) mispricing of derivative warrants on ex-dividend date.

Chapter 2

Literature Review

There are researchers have attempted to study the valuation and pricing of derivative warrants, but there is no research study on effect of dividend on ex-dividend date on derivative warrants that may cause mispricing of derivative warrants due to the decrease in price of underlying asset on ex-dividend date.

(Fama 1970)stated that if the market is efficient, price of security should reflect all information and impossible to generate alpha return. When the company pay dividend, it was referred as signaling to convey the information to investor about positive profit shock to permanent earning because the dividend is slow to adjust stated by (Garrett and Priestley 2000), (Lintner 1956)and (Poterba and Summers 1984). (Miller and Modigliani 1961)said that the MM dividend irrelevance theory suggesting that capital gain is equivalent to dividend given the capital market are perfect. Conversely, (DeAngelo and DeAngelo 2006)argued with MM theory that dividend, payout and investment are not irrelevance and affect shareholder wealth and project choice. Also, (Gordon 1963)argued with MM dividend irrelevance theory that investors may prefer dividend to capital gain because of certainty in source of income which is consistent with the result from (Tangjitprom 2013) studied the demand of dividend In Thailand and found that investors prefer dividend rather than capital gain, even though dividend income is taxable(Elton and Gruber 1970)proposed the tax clientele effect that the difference in taxation bracket of dividend and capital gain that the preference of investors for dividend or capital gain depend on tax rate of items as followed dividend price drop ratio (DPR). Moreover, (Kalay 1982)studied the price of stock behavior on ex-dividend date and tax clientele effect and found that Ex-dividend price drop ratio is less significant than dividend per share and positively related with dividend yield. However, the correlation between the ex-dividend relative price drop and the dividend yield is still positive which is consistent with a tax effect and a tax induced clientele effect. (Ngoc and Nguyen 2016)studied further on dividend announcement date and ex-dividend date, found that stock price increases in the dividend announcement date and keep increases as

approach to ex-dividend date and stock price will decrease afterward ex-dividend date.

Anchoring bias is a cognitive bias occurring when people rely on particular or initial information as a reference point and use this information to make subsequent decision based on reference point.(Cen, Hilary et al. 2013) studied on anchoring bias and found that effect of anchoring bias specialist knowledge and experiment is more consistent and in line than individual-common-sensical beliefs. (Furnham and Boo 2011) studied on anchoring bias on market participants in equity market and found that they were affected by anchoring bias when they estimate future profitability of firm.

(Black and Scholes 1973) developed the Black-Scholes model which assuming that stock price moves with Geometric Brownian motion with constant drift and volatility his model was widely used in pricing the options. (Merton 1973)relaxed the no-dividend assumption of Black-Scholes allowing dividend yield. Meanwhile, (Heston 1993) developed Heston Model which is also followed Geometric Brownian motion with stochastic volatility to price options.

(Shu and Zhang 2003)studied relationship between implied volatility and realized volatility in S&P500 from 1995-1999 by using Black-Scholes and Heston model , They found that Black-Scholes Model has more explanatory power than Heston Model and found another interesting point that implied volatility contains some information and implied volatility computed from Black-Scholes model has more explanatory power than realized volatility .(Fung and Zeng 2012)examine the price efficiency of derivative warrants in Hong Kong Stock Exchange from 2003-2005 and found that derivative warrants are generally more expensive and more liquid than options, meanwhile the implied volatility of derivative warrants is above the average realized volatility during the corresponding period. Consistent with (Li and Zhang 2011), the research was done by investigating the price of derivative warrants relative to options with all the same characteristics; underlying asset exercise price and maturity. The price of derivative warrants was higher than options due to liquidity effects which lead to higher short-term return, while illiquidity of options

has higher long-term return.(Bakshi, Cao et al. 2000)and found that call options monotonically increase and put options monotonically decrease in the underlying asset price, and the market microstructure can explain why price sometimes does not change or change significantly. Furthermore(Guerrero 2020)studied mispricing on option implied by the price drop on ex-dividend date and found that mispricing is high when dividend yield is low, thin trading, and deep in the money and deep out of the money.

(Chen, Gau et al. 2013)studied further on credit rating and warrant price in Taiwan and found negative relationship between pricing error and credit rating of issuers implying that higher quality of credit rating led to lower of pricing error of warrants.

Chapter 3

Data

We collect the data of derivative warrants in Stock Exchange of Thailand from SETSMART, the data includes type of derivative warrants, issuing date, daily closed and opening price, exercise price and, exercise ratio before and after ex-dividend date between 2010-2020.By solving the reverse formula of Black-Scholes model, we will get implied volatility of derivative warrants price. The announcement of dividend, amount and ex-date, closed and opening prices of underlying assets of derivative warrants in Stock exchange of Thailand between 2010-2020 were collected from SETSMART. According to the Black-Scholes model, 1-month of T-Bill from Bank of Thailand was used as a short-term risk-free rate due to liquidity and credibility. Historical credit rating of issuers will be retrieved from Refinitiv Eikon. The credit rating of issuers was rated by TRIS Rating, S&P ‘s global, Fitch Ratings and Moody and converted to number by Altman’s Z-score method. Derivative warrant issuers’ credit rating could change over time according to the financial circumstance. To assign the credit rating of the issuer in our data, the credit rating at ex-dividend date of underlying asset will be used. Derivative warrant issuers’ credit rating will

then be converted from character to numerical value by a mapping which assigns the highest credit rating score to 1 and lowest credit rating score to 20.

Some derivative warrants will be excluded from the data especially those whose misprices are possibly caused by low liquidity rather than the dividend event. Particularly, derivative warrants having remaining expiration less than 1 month, and derivative warrants whose underlying stock has low trading volume will excluded from the data set. In addition, derivative warrants whose underlying asset has other corporate actions on ex-date will also be excluded from data set. Derivative warrants whose has underlying asset as index and foreign equity will be also excluded from data set.

Table 1 ***Derivative Warrant issuer's credit rating converted to number***

Moody's	Fitch	TRIS	Numerical Value
Aaa	AAA	AAA	1
Aa1	AA+	AA+	2
Aa2	AA	AA	3
Aa3	AA-	AA-	4
A1	A+	A+	5
A2	A	A	6
A3	A-	A-	7
Baa1	BBB+	BBB+	8
Baa2	BBB	BBB	9
Baa3	BBB-	BBB-	10
Ba1	BB+	BB+	11
Ba2	BB	BB	12
Ba3	BB-	BB-	13
B1	B+	B+	14
B2	B	B	15
B3	B-	B-	16
Caa	CCC+,CCC,CCC-	CCC+,CCC,CCC-	17
Ca	CC	CC	18
C	C	C	19
D	D	D	20

Chapter 4
Methodology

This study examines the mispricing of derivative warrants from the dividend payment on ex-dividend date. Mispricing of derivative warrant in this study is defined as the price differential between the market trading price and the theoretical price which incorporates the price adjustment rule suggested by SET on ex-dividend date. Because the theoretical price comes from calculation using market information as input variables (see Derivative warrants pricing section for all the input variables), the most recent information up to the ex-dividend event will be used. For instance, the underlying stock price and derivative warrant's time-to-expiration at market opening on the ex-dividend day will be used for the calculation of theoretical price of derivative warrants. Meanwhile, volatility of the underlying stock will be proxied by the implied volatility at the market closed price of derivative warrant on the prior day. Henceforth, the mispricing interpreted in this study is consequently measured for a short time window, particularly a few moments at market opening on ex-dividend day or, at most, from across the market closing on the previous trading day, and also relative to the price at prior day market closing. It could be assumed that the method employed in this study will not detect a mispricing of derivative warrant that occurs a few days before or a few days after the ex-dividend date. The following section illustrates the Black-Scholes model for calculation of derivative warrant price and the adjustment rule that applies to the derivative warrant variables on the same day.

Derivative warrants pricing

The model used for pricing derivative warrants is Black - Scholes model(Black and Scholes 1973)from pricing options under the assumptions as followed

1. Short-term risk-free rate is known and constant through time
2. Underlying assets has log-normal distribution and constant variance

3. Underlying assets pay no dividend and other form of distributions.

4. The options are European options, can be only exercise at maturity date.

5. Frictionless market, no transaction cost and tax

6. It is possible to borrow at risk-free rate to buy underlying assets

7. No penalty of short-selling

We use original Black-Scholes model without relaxing assumption of dividend as proposed by (Merton 1973)due to a set of rules by Derivative warrants that the price will be adjusted by the amount of dividend. There is no need to include dividend to calculate the price of derivative warrants.

The price of European call and put derivative warrants can be calculated by the following equations.

$$C = \text{ER}[\text{S}N(d1) - Ke^{-rT}N(d2)]$$

$$P = \text{ER}[Ke^{-rT}N(-d2) - \text{S}N(-d1)]$$

$$d1 = \frac{\ln(\frac{S}{K}) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{\text{T}}}$$

$$d2 = d1 - \sigma\sqrt{\text{T}}$$

Where ER is exercise ratio of derivative warrants, S is Spot price of underlying asset, K is strike price, T is time to maturity, r is risk-free rate, σ is the annualized standard deviation of underlying asset (volatility), r is risk-free rate C is Call price of derivative warrants, P is put price of derivative warrants, and N() is Cumulative distribution function of the standard normal distribution.

All variables are known except σ or implied volatility, which is from solving equations by reversing Black-Scholes formula from derivative warrants price. Since (Shu and Zhang 2003)mentioned that implied volatility contain information about the stock price and has more explanatory power than Heston model.

Adjustment in exercise price and ratio of derivative warrants

When underlying assets company announces dividend payment to shareholder, derivative warrant issuers will announce adjustment report of

derivative warrants which will be effective on ex-date. The case of adjustment for cash dividend payment of underlying assets in exercise price and ratio of derivative is as followed formula.

$$K_1 = \frac{K_0(S-D)}{S}$$

$$ER_1 = \frac{ER_0 * S}{S-D}$$

Where K_1 is exercise price after adjustment, K_0 is the exercise price before adjustment, S is spot price of underlying asset and D is dividend per share of underlying asset.

Where ER_1 is exercise ratio after adjustment, ER_0 is the exercise ratio before adjustment, S is spot price of underlying asset and D is dividend per share of underlying asset.

Regression Model

We adopt model from (Guerrero 2020), by using observation data of underlying asset, dividend event and derivative warrants, and run ordinary least square (OLS) to test for the t-statistic. We divide the data into two groups; Call derivative warrants and Put derivative warrants, and test each hypothesis separately because the mispricing from call and put derivative warrants may have different direction in term of market reaction to the dividend payment of their underlying asset. Call derivative warrants are expected to decrease in price resulting in an underprice of call derivative warrant, while put derivative warrants are expected to increase in price resulting in overprice of put derivative warrants.

We investigate further in mispricing of derivative warrants and take moneyness and time to maturity as control variables. However, moneyness and time to maturity do not function as a linear relationship with mispricing. Therefore, we divide each type of group (put and call) into 3x3 matrix subsample groups by

different levels of moneyness and time to maturity. The followings are the criteria for each level of moneyness and time to maturity:

Moneyness:

1.In-The-Money (ITM): The derivative warrants that have moneyness more than 5%

2.At-The-Money (ATM): The derivative warrants that have moneyness between -5% to+5%

3.Out-of-The-Money (OTM): The derivative warrants that have moneyness less than -5%

Time to maturity:

1.Near term of the time to maturity: The derivative warrant that have time to maturity between 20-60 trading days (< 3 months calendar time)

2.Medium term of time to maturity: The derivative warrant that have time to maturity between 61-100 trading days (3-5 months calendar time)

3.Far term of time to maturity: the derivative warrant that have time to maturity more than 101 trading days (>5 months calendar time)

Moneyness of derivative warrants

Moneyness is the status of derivative warrant that describes the current intrinsic value of the derivative warrant. Moneyness is measured by

$$C_{Moneyness} = \left(\frac{S-K}{S}\right)$$

$$P_{Moneyness} = \left(\frac{K-S}{S}\right)$$

where K is strike price, S is spot price of underlying asset, C is call derivative warrants and P is put derivative warrants. We expect that mispricing of derivative warrant will occur at different magnitude for different degree of moneyness, therefore, our sample is divided into several groups so that each the moneyness in each group can be controlled.

Out-of-the-Money (OTM)

Derivative warrant has no intrinsic value. Call derivative warrants are out of the money if the spot price is lower than the strike price, and a put option is in the money if the spot price of the underlying asset is lower than the strike price.

At-the-Money (ATM)

Derivative warrant is at the money, and have no intrinsic value but the time value. Call and put derivative warrants is at the money when the spot price of the underlying asset is equal to the strike price.

In-the-Money (ITM)

Derivative warrant has intrinsic value when there is positive value of spot underlying asset comparing strike price. Call derivative warrants is in the money if the spot price is higher than the strike price, and a put option is in the money if the spot price of the underlying asset is lower than the strike price.

Time to maturity

We treat to maturity as another control variable, where our data is divided into groups according to the remaining time to maturity of the derivative warrant. Time to maturity is quoted in percentage by using remaining trading days of derivative warrants divided by annualized calendar trading day, hence the following formula is applied,

$$\text{TTM} = \frac{t}{T}$$

Where t = remaining trading days to maturity of derivative warrants and T = annualized trading days in a year.

Mispricing in derivative warrants on ex-dividend date(H1)

$$\text{MIS} = \beta + \varepsilon$$

Measurement of mispricing

We measure the percentage in mispricing of derivative warrants by the observed data of actual price of derivative warrants from the market minus with theoretical price of derivative warrants and divided with theoretical price from

Black-Scholes model given the constant of implied volatility before and after ex-dividend date. Implied volatility is from reversing resolution of Black-Scholes model.

$$MISP_i = \frac{Pactual_i - Ptheoretical_i}{Ptheoretical_i}$$

Where P_{actual_i} is the actual price of derivative warrant in the market at ex-dividend date $P_{theoretical_i}$ is the theoretical price of derivative warrant calculated from Black-Scholes Model.

i is the observed data of underlying asset, derivative warrants and dividend event

Mispricing factor

$$MISP_i = \alpha_0 + \beta_1 DY_i + \beta_2 Issuer_i + \varepsilon_i$$

Higher dividend yield of underlying asset effect mispricing of derivative warrants on ex-dividend date(H2)

We study the size effect of mispricing of derivative warrant on ex-dividend date on dividend yield, to find whether the dividend yield of derivative warrant contribute the size effect of mispricing on ex-dividend. The expected dividend has no effect on setting exercise price of derivative warrants due to the adjustment of exercise price and ratio. The issuers have no need to set the exercise price with taking the premium of expected dividend into account. While the dividend yield contributes to decrease in price of underlying asset at ex-dividend day

The higher dividend yield will decrease the price of underlying asset, derivative warrants investors would trade derivative warrants at mispricing. We calculate the dividend yield of derivative warrants at ex-dividend date and we run regression from below equation.

$$DY = \frac{D}{P}$$

Where D is amount of dividend and P is current price before ex-dividend day

Control Variables

Credit rating of issuer effects mispricing of derivative warrant of derivative warrants on ex-dividend date

We take credit rating of issuer of derivative warrant as control variable to study further on size of mispricing of derivative warrant. Credit rating of issuer was rated by credit rating agencies, TRIS, Standard & Poor's, Fitch and Moody. Credit rating is alphabetic character, we use Altman's Z-score Method to convert credit rating of each agency to average number. Since credit rating reflects an evaluation of company in term of qualitative and quantitative information to prospect debtor of issuer, each derivative warrant issuers have different risk associated with, capital structure, ability to pay debt, default risk and represent the trustworthy of issued derivative warrants and effect to its price and volatility.

Chapter 5
Empirical Results

We calculated percentage difference in mispricing between the actual opening price and the theoretical price based on Black-Scholes model. To be precise, the theoretical price is calculated by assuming the implied volatility being carried over from prior to the ex-dividend date, while exercise price and exercise ratio are being adjusted to the derivative warrant price according to the rule by SET.

There are 7,989 total observations in our data, this number is already after the low liquidity derivative warrants are excluded as discussed in the data part. Among the total observations of derivative warrants, 6,276 of them are call derivative warrants, and 1,713 of them are put derivative warrants. The number of observations in the 3x3 subsamples are shown in last row of Table 2 and Table 3.

MISP is the percentage in mispricing of derivative warrant at ex-dividend date calculated by the percentage difference between actual and theoretical price. DY is

dividend yield of underlying asset before ex-dividend date, Moneyness is the status of percentage difference between market and exercise price, and TTM is time to maturity over time to time to expiration. From table 2, the descriptive results of call derivative warrants show that on average, call derivative warrants are underpriced comparing between actual price and theoretical price while result from table 3 shows that on average, put derivative warrants are overpriced comparing between actual price and theoretical price.

These tables show the summary statistics of derivative warrants by categorizing based on status of moneyness and range of time to maturity. There are 6,276 of call derivative warrants and 1,713 of put derivative warrants.

Table 2 Descriptive statistics of Call Derivative Warrant

The table exhibits descriptive statistics of call derivative warrants

		Near term				Medium term				Far term			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ITM	MISP	-0.007	0.056	-0.714	0.254	-0.007	0.039	-0.217	0.16	-0.008	0.061	-0.73	0.23
	DY	0.018	0.01	0	0.056	0.018	0.011	0.001	0.06	0.017	0.01	0	0.07
	Issuer	4.573	1.984	2	8	4.418	1.972	2	10	4.968	1.988	2	10
	N	648				510				650			
ATM	MISP	-0.009	0.063	-0.349	0.208	-0.002	0.043	-0.245	0.21	-0.005	0.042	-0.252	0.18
	DY	0.017	0.01	0	0.057	0.018	0.011	0	0.06	0.018	0.012	0	0.11
	Issuer	5.143	2.038	2	10	5.168	2.035	2	10	4.954	1.938	2	8
	N	385				376				325			
OTM	MISP	-0.02	0.147	-0.75	0.75	-0.005	0.099	-0.714	0.5	-0.002	0.073	-0.871	0.29
	DY	0.017	0.011	0	0.059	0.017	0.011	0	0.06	0.017	0.011	0	0.06
	Issuer	5.374	1.923	2	10	5.239	1.96	2	8	4.919	2.03	2	10
	N	1053				1187				1142			

Table 3 Descriptive statistics of Put Derivative Warrant

The table exhibits descriptive statistics of Put derivative warrants

		Near term				Medium term				Far term			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ITM	MISP	0.003	0.049	-0.183	0.345	0.008	0.035	-0.095	0.2	-0.002	0.047	-0.37	0.2
	DY	0.02	0.011	0	0.059	0.017	0.01	0	0.059	0.018	0.01	0	0.05
	Issuer	3.516	1.337	2	8	3.515	1.358	2	8	3.578	1.447	2	8
	N	217				198				173			
ATM	MISP	0.008	0.065	-0.283	0.37	0.009	0.11	-0.292	1	0.005	0.03	-0.1	0.13
	DY	0.017	0.008	0.002	0.04	0.019	0.012	0.002	0.052	0.019	0.009	0.002	0.04
	Issuer	4.349	1.952	2	8	4.212	1.826	3	8	4.065	1.854	2	8
	N	106				104				107			
OTM	MISP	0.002	0.126	-0.5	1	0.007	0.069	-0.52	0.222	0.005	0.045	-0.24	0.18
	DY	0.017	0.009	0	0.057	0.016	0.01	0	0.057	0.017	0.008	0	0.04
	Issuer	4.848	1.933	2	8	4.65	1.889	2	8	4.778	2.006	2	8
	N	250				274				284			

Multicollinearity Issues

To check multicollinearity issues, we test Pearson Correlation matrix among the variables and found that correlation is low showed in Table 4-5. Moreover, we use the variance inflation factor values in table 6-7 and there is no multilinearity issues on data to concern since VIF is less than 5.

Table 4 Correlation matrix of call derivative warrant

This table exhibits correlation among variables of call derivative warrant

	Near term				Medium term				Far term		
	Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY
ITM	(1) MISP	1			(1) MISP	1			(1) MISP	1	
	(2) DY	-0.102	1		(2) DY	0.121	1		(2) DY	0.179	1
	(3) Issuer	-0.053	-0.06	1	(3) Issuer	0.081	-0.04	1	(3) Issuer	0.009	-0.15

	Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY
	(1) MISP	1			(1) MISP	1			(1) MISP	1	
ATM	(2) DY	0.077	1		(2) DY	0.23	1		(2) DY	-0.1	1
	(3) Issuer	-0.076	0.02	1	(3) Issuer	-0.077	-0.07	1	(3) Issuer	0.114	-0.21

	Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY
	(1) MISP	1			(1) MISP	1			(1) MISP	1	
OTM	(2) DY	0.107	1		(2) DY	0.157	1		(2) DY	0.117	1
	(3) Issuer	-0.036	0.02	1	(3) Issuer	-0.085	-0.04	1	(3) Issuer	0.01	-0

Table 5 VIF of call derivative warrant

This table exhibits Variance inflation factor among variables of call derivative warrant

	Near term **Variance inflation factor**			Medium term **Variance inflation factor**			Far term **Variance inflation factor**		
		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
	DY	1	1	DY	1	1	DY	1	1
ITM	Issuer	1	1	Issuer	1	1	Issuer	1	1
	Mean VIF	1	.	Mean VIF	1	.	Mean VIF	1	.

		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
	DY	1	1	DY	1.007	0.993	DY	1.003	0.997
ATM	Issuer	1	1	Issuer	1.007	0.993	Issuer	1.003	0.997
	Mean VIF	1	.	Mean VIF	1.007	.	Mean VIF	1.003	.

		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
	DY	1	1	DY	1.002	0.998	DY	1.003	0.997
OTM	Issuer	1	1	Issuer	1.002	0.998	Issuer	1.003	0.997
	Mean VIF	1	.	Mean VIF	1.002	.	Mean VIF	1.003	.

Table 6 Correlation matrix of put derivative warrant

This table exhibits correlation matrix among variables of put derivative warrant

	Near term			Medium term			Far term	
Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY
(1) MISP	1			(1) MISP	1			(1) MISP	1	

ITM	(2) DY	-0.102	1		(2) DY	0.121	1		(2) DY	0.179	1	
	(3) Issuer	-0.053	-0.06	1	(3) Issuer	0.081	-0.04	1	(3) Issuer	0.009	-0.145	

	Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY	
	(1) MISP	1			(1) MISP	1			(1) MISP	1		
ATM	(2) DY	0.077	1		(2) DY	0.23	1		(2) DY	-0.1	1	
	(3) Issuer	-0.076	0.023	1	(3) Issuer	-0.077	-0.07	1	(3) Issuer	0.114	-0.209	

	Variables	MISP	DY	Issuer	Variables	MISP	DY	Issuer	Variables	MISP	DY	
	(1) MISP	1			(1) MISP	1			(1) MISP	1		
OTM	(2) DY	0.107	1		(2) DY	0.157	1		(2) DY	0.117	1	
	(3) Issuer	-0.036	0.019	1	(3) Issuer	-0.085	-0.04	1	(3) Issuer	0.01	-0.003	

Table 7 VIF of put derivative warrant

This table exhibits Variance inflation factor among variables of put derivative warrant

	Near term			Medium term			Far term		
	Variance inflation factor			**Variance inflation factor**			**Variance inflation factor**		
		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
ITM	DY	1.004	0.996	DY	1.002	0.998	DY	1.021	0.979
	Issuer	1.004	0.996	Issuer	1.002	0.998	Issuer	1.021	0.979
	Mean VIF	1.004	.	Mean VIF	1.002	.	Mean VIF	1.021	.

		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
ATM	DY	1.001	0.999	DY	1.005	0.995	DY	1.046	0.956
	Issuer	1.001	0.999	Issuer	1.005	0.995	Issuer	1.046	0.956
	Mean VIF	1.001	.	Mean VIF	1.005	.	Mean VIF	1.046	.

		VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
OTM	DY	1	1	DY	1.002	0.998	DY	1	1
	Issuer	1	1	Issuer	1.002	0.998	Issuer	1	1
	Mean VIF	1	.	Mean VIF	1.002	.	Mean VIF	1	.

1.Mispricing of derivative warrant(H1)

This section will investigate the mispricing of derivative warrant by testing the first hypothesis on the data whether derivative warrant is mispriced on ex-dividend date due to the adjustment of exercise price and exercise ratio. We test call and put derivative warrants separately since call and put derivative warrant has different impact in price from stock price decrease according to dividend payment.

1.1Mispricing of call derivative warrant(H1)

We use t-test to test the first hypothesis of call derivative warrant and there are evidences of statistically significant coefficient. There is presence of negative mispricing of call derivative warrant on ex-dividend date. Table8 shows the negative coefficient of derivative warrants and the result of the t-statistic shows 7 out of 9 is significant. 6 out of 7 are strongly statistically significant with 99% confidence level and 1 out of 7 is moderately statistically significant with 95% confidence level. We can conclude that the majority of call derivative warrant is mispriced by being underpriced comparing to the theoretical price.

Table 8 Mispricing of call derivative warrant

This table exhibits call mispricing of call derivative warrant

		Near term	Medium term	Far term
ITM	Coef.	-0.007***	-0.007***	-0.008***
	St.Err.	0.002	0.002	0.002
ATM	Coef.	-0.009***	-0.002	-0.005**
	St.Err.	0.003	0.002	0.002
OTM	Coef.	-0.02***	-0.005***	-0.002
	St.Err.	0.005	0.003	0.002

1.2 Mispricing of put derivative warrant(H1)

We use t-test to test another first hypothesis of put derivative warrant and there is evidence of statistically significant coefficient but the effect is not evident as call derivative warrant. There is presence of positive mispricing of put derivative warrant on ex-dividend date. As empirical results shown in Table9 shows the positive coefficient of derivative warrants and the result of the t-statistic shows 3 out of 9 is significant. 1 out of 7 is strongly statically significant with 99% confidence level and 2 out of 7 moderately statistically significant with 95% confidence level. We can conclude that the minority of put derivative warrant is mispriced by overpriced comparing to theoretical price. Nevertheless, due to low number of observations in put derivative warrant could contribute to limited number of significant of subsample group.

Table 9 Mispricing of put derivative warrant

This table exhibit mispricing of call derivative warrant

		Near term	Medium term	Far term
ITM	Coef.	0.003	0.008***	-0.002
	St.Err.	0.003	0.002	0.004
ATM	Coef.	0.008	0.009	0.005*
	St.Err.	0.006	0.011	0.003
OTM	Coef.	0.002	0.007	0.005*
	St.Err.	0.008	0.004	0.003

2.Size effect of derivative warrants (H2)

In this section, the size of mispricing in derivative warrant at ex-dividend date is investigated. As the price adjustment at ex-dividend date depends on the dividend yield, we regress the mispricing amount on the dividend yield as a dependent variable. Moreover, the credit rating of issuer could also affect the issuer's ability as a market maker for the derivative warrant, therefore, the credit rating of issuer is added as a control variable. We test call and put derivative warrant separately in each of the 3x3 subsample groups.

2.1 Size effect of call derivative warrant(H2)

The model is run by OLS regression to test second hypothesis which is size effect of mispricing in call derivative warrant and empirical result from Table10 shows regression between mispricing and dividend yield and credit rating of issuer. There is negative coefficient and statistically significant in dividend yield with mispricing of call derivative warrants. 7 out of 9 is statistically significant 5 out of 7 is strongly significant, 1 out of 7 is moderately significant and 1 out of 7 is weakly significant. Credit rating of Issuer and constant in almost all of the subsamples are found to be not statistically significant. Results from regressions suggest that the mispricing (underprice) of call derivative warrants found earlier in H1 is indeed related to the dividend yield. The more dividend yield, and consequently the more drop in stock price, the more call derivative warrants are underpriced.

Table 10 Mispricing of call derivative warrant

		Near term	Medium term	Far term
	DY	-0.426**	-0.39**	-0.541**
		(0.214)	(0.158)	(0.231)
	Issuer	-0.001	-0.001	0.001
ITM		(0.001)	(0.001)	(0.001)
	Constant	0.004	0.006	-0.003
		(0.007)	(-0.005)	(0.008)

	Adjusted R-squared	0.0035	0.0123	0.0061
	DY	0.257	0.065	-0.69***
		(0.325)	(0.2)	(0.189)
	Issuer	0.001	-0.003**	-0.002
ATM		(0.002)	(0.001)	(0.001)
	Constant	-0.018*	0.011	0.015**
		(0.01)	(0.007)	(0.007)
	Adjusted R-squared	-0.0029	0.0129	0.0406
	DY	-0.885**	-0.51*	-0.411**
		(0.414)	(0.268)	(0.205)
	Issuer	0.001	-0.002	0
OTM		(0.002)	(0.001)	(0.001)
	Constant	-0.01	0.013	0.007
		(0.015)	(0.01)	(0.007)
	Adjusted R-squared	0.0026	0.0025	0.0018

2.2 Size effect of put derivative warrant(H2)

The model is run by OLS regression to test second hypothesis which is size effect of mispricing in put derivative warrant and empirical result from Table11 shows regression between mispricing and dividend yield and credit rating of issuer. There is positive coefficient and statistically significant in dividend yield and mispricing of put derivative warrants. 6 out of 9 is statistically significant.3 out of 6 is moderately significant, 3 out of 6 is weakly significant. Credit rating of Issuer and constant in almost all of the subsamples are found to be not statistically significant. Results from regressions suggest that the mispricing (overprice) of put derivative

warrants found earlier in H1 is indeed related to the dividend yield. The more dividend yield, and consequently the more drop in stock price, the more put derivative warrants are overpriced.

Table 11 Empirical result of mispricing in put derivative warrant

		Near term	Medium term	Far term
ITM	DY	-0.475	0.421*	0.899**
		(0.305)	(0.239)	(0.371)
	Issuer	-0.002	0.002	0.001
		(0.003)	(0.002)	(0.002)
	Constant	0.02*	-0.007	-0.022*
		(0.012)	(0.008)	(0.012)
	Adjusted R-squared	0.0048	0.0122	0.0221
ATM	DY	0.618	1.999*	-0.267
		(0.766)	(0.858)	(0.335)
	Issuer	-0.003	-0.004	0.002
		(0.003)	(0.006)	(0.002)
	Constant	0.009	-0.014	0.004
		(0.02)	(0.032)	(0.01)
	Adjusted R-squared	-0.0071	0.0378	0.0002
OTM	DY	1.532*	1.103**	0.638**
		(0.895)	(0.429)	(0.324)
	Issuer	-0.002	-0.003	0
		(0.004)	(0.002)	(0.001)
	Constant	-0.012	0.002	-0.007
		(0.026)	(0.013)	(0.009)
	Adjusted R-squared	0.005	0.0237	0.0067

Discussion

When underlying assets pay dividend, the price of underlying asset should drop by equal amount of dividend keeping other factors constant. Derivative warrants are expected to adjust their exercise price and exercise ratio according to the given rules to keep the intrinsic value of the derivative warrants remain the same. By assuming that investors in the market are rational, derivative warrant investors will perceive the decrease in the price of underlying asset regarding to dividend and change in exercise price and ratio into account, Investors should price and trade derivative warrant at theoretical price with the adjustment and opening price of underlying asset at ex-dividend date.

However, our finding of research shows that 7 out of 9 subsample groups of call derivative warrants are statistically significantly underpriced, supporting a possibility of misperception from investors at least at the market opening on ex-dividend date. It could also be that the investors' view of the call derivative warrant prices does not fully align with the adjustment rule given by SET or perhaps some market frictions prevent derivative warrants from reaching appropriate prices. We make this note based on the fact that the mispricing in call derivative warrants happens in the ITM and OTM where liquidity is less than ATM, and likewise for the short-end of the maturity. Unfortunately, results from put derivative warrants do not provide sufficient support to our claims due to the low number of observations. Nevertheless, we found that 3 out of 9 subsample groups of put derivative warrants are at least weakly significantly overpriced in the same direction that was suspected if it is caused by an unawareness of the derivative warrant price adjustment.

We further examine the size effect of mispricing by investigating in dividend yield. The results suggest that the dividend yield does contribute to the size of mispricing of call derivative warrants as 7 out of 9 subsample groups shows statistically significantly negative coefficient between mispricing and dividend yield. It can be implied that higher dividend, which typically causes higher decrease in price of underlying asset, is associated with an excessive decrease in the price of call derivative warrant far more than appropriate amount. Likewise, we found an

evidence that the dividend yield contributed to the size of the overpricing of put derivative warrants in the same logic dividend payment, which again causes an expected drop in price of underlying asset, is associated with an excessive increase in the price of put derivative warrants. Overall, the result supports our claim that the mispricing in derivative warrants occurs through the adjustment rule and is associated with the size of dividend on the ex-dividend date.

In addition, we do not find strong evidence of statistically significant between mispricing and credit rating of derivative warrant issuers. Even the credit rating of issuers associated with the risk and trustworthy of issuer but it is indifferent among credit rating of derivative warrant issuers and does not contribute significant effect to mispricing of derivative warrant.

In conclusion, we found that the mispricing in derivative warrant does exist on ex-dividend date holding relevant parameters from the market closing at a trading day prior. The main responsible factor is the dividend yield, suggesting that the mispricing occurs through the derivative warrant price adjustment rule given by SET. The price adjustment rule was meant to negate the price change caused by dividend event of the underlying, therefore making the derivative warrant price more stable over its lifetime. However, we found mispricing occurs in accordance with the direction of the underlying price drop, perhaps suggesting that the price and ratio adjustment rule does not function to its fullest. For instance, call derivative warrant prices which supposed be kept unchanged as a result of the price adjustment rule, but instead found to be underpriced due to the price drop of the underlying stock. On the other hand, put derivative warrant prices were found to be overpriced relative to the theoretical price, again, rather than being unchanged from the price adjustment rule. We suspect that the mispricing in derivative warrants may be caused by investors lacking sufficient concerns regarding the adjustment rule, and perhaps expect derivative warrants to receive full price change from the underlying price drop on ex-dividend date. The found result of mispricing in this study is contradicted with the Law of one price, in which no opportunity is allowed to gain

arbitrage return, and the signal theory in that if market sends the right signal, the asset must be correctly priced.

Limitations and future research

Derivative warrants price might be overpriced or underpriced based on the actual price in the market, but we only investigate mispricing that happens across closing price a trading day prior to the opening price on the ex-dividend date that has event of adjustment of exercise price and exercise ratio. In other words, the result only implies the mispricing in the short-term while there is no guarantee that the mispricing could last beyond the opening price on the ex-dividend date. In addition, the theoretical price of derivative warrant is based on the implied volatility from reverse calculation of Black-Scholes model from the closed price, meaning that it does not take into account the volatility surface issues where implied volatility could possibly change in value as the strike price and the time to maturity change.

Furthermore, our study has limitation on number of observations of put derivative warrant, since derivative warrants were issued less for the put type comparing to number of call derivative warrants. Future research where a longer period of study is tested may help solving the issue regarding the lack of observations of put derivative warrants.

Chapter 6

Conclusion

In this paper, we examine the effects of dividend on derivative warrants from Stock Exchange of Thailand from 2010-2020. This study finds significant mispricing of derivative warrant on ex-dividend date as dividend yield is contributed to the size of mispricing. This implies that the market is not informationally efficient regarding to delivering information of adjustment of exercise price and exercise ratio to derivative warrant investors. Derivative warrants investors may be irrational or have anchoring bias to previous information, while continuing to use this information to trade at mispricing price. This paper could contribute to policy marker to locate the

current issues regarding the awareness of derivative warrant price adjustment on ex-dividend date. We hope our result could help finding a way to more effectively deliver information regarding the adjustment exercise ratio and price to derivative warrant investors, to ultimately improve the overall efficiency in the derivative warrant market. Also, in short-term, we hope our findings could help derivative warrant investors to form an appropriate trading strategy such as trading put derivative warrant on the ex-dividend date to speculate on extra profit, or avoiding trading overpriced call derivative warrants on the ex-dividend date.

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