東海大學管理學院財務金融研究所

碩士論文

權證的發行對股價的影響

Introduction of Warrants and Stock Price: Evidence of Taiwan Warrant Markets

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本人 田坂 翔 (學號: G05440003)已完全了解學術倫理之定義。僅此聲明，本人呈交之碩士論文絕無抄襲或由他人代筆之情事。若被揭露具有違背學術倫理之事實或可能，本人願自行擔負所有之法律責任。對於碩士學位因違背學術倫理而被取消之後果，本人也願一併概括承受。

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摘要

本研究主要探討券商權證避險時的買賣股票行為對標的股股價之影響，並以 2012 年至 2014 年台灣證券交易所（TWSE）交易的台灣積體電路製造公司(2330)跟鴻海科技集團(2317)為樣本，探討權證發行日之避險行為對股價造成的影響。權證經紀公司發行認購權證(認售權證)，依法規定，必須買進(賣出)標的資產對價格進行避險，並在期間內依照 delta 變化調整避險部位數量，來維持風險部位的平衡，直至到期日將持有部位全部平倉。

投資者預期認購權證股價將上漲，因為權證發行日認購權證發行商需要購買相關股票。 認售權證的標的物價預期將會下跌。投資者能利用這機會來賺取超額報酬。 結果顯示，當認股權證在公佈日時，股價上漲和交易量增加, 如果投資者在權證發行日之前購買相關股份並在公佈日期後出售，則可能正超額報酬。

關鍵字: Delta 避險、權證、超額報酬

Abstract

We use covered warrants with underlying assets of Taiwan Semiconductor and Hon Hai Precisions traded in the Taiwan Stock Exchange (TWSE) from 2012 to 2014, and examine whether hedging activity of short warrants impacts the underlying stock in the introduction period. Investors expect an increase in stock price in the introduction period of warrants because hedging call warrants need to buy underlying shares. However, a decrease in stock price is expected when hedging put warrants in the same period. If the hedging phenomenon really impacts on underlying asset prices, investors simply can exploit the opportunity to obtain abnormal returns. Results indicate that the stock price and trading volumes increase when warrants are announced. Significant positive abnormal returns can be generated if investors purchase the underlying shares before and sell after the announcement date.

Key Words: Delta hedging; warrants; abnormal return

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1. Introduction

Warrant are financial derivatives traded in stock exchanges that provide opportunities for investors with small amount of funds who seek for leverage trading. Warrants are similar to options that are contingent claims, but differ from two aspects. First, warrant investors always make a long positon, whereas brokerage firms make a short position. Brokerage firms hence face price risk and require buying or selling underlying assets to hedge its risk. Unlike warrants, options investors can make long or short positions. Second, warrants are designed to serve as an investment vehicle for small fund investors, and in contrast, options are traded relative large fund investors. This chapter will address the warrant markets in Taiwan, and the mechanisms of warrants, and the impact on underlying assets from warrant hedging.

1.1. Background of warrant market in Taiwan

Warrants have been traded in the United States, the United Kingdom and other developed markets for a long time. It was until recently that Asian markets such as Hong Kong and Taiwan began to develop their own warrant markets. Early in 1996, foreign capital investors were attracted by the potential market in Taiwan and issued a variety of overseas call warrants based on Taiwanese stocks. Domestic brokers also sought cooperation with foreign agents to issue call warrants, which provided foreign institutional investors and chief shareholders an alternative for speculation, arbitrage, and hedging. As the local financial market opened gradually, new financial commodities were available to the market. Local call warrants appeared in Taiwan in August 1997 under wide public expectations, which accordingly provided domestic investors an option for hedging.

Domestic as well as foreign banks and securities houses are currently allowed to issue call warrants based on listed stocks, stock composites, and portfolios in Taiwan. Ever since the first locally-listed warrant Grand Cathay 01 was issued years ago, there have been 267 call warrants issued based on listed stocks in the market through the end of 2002. Composite call warrants have accounted for 30 in total over the same time. Because call warrants based on a single stock are comparatively convenient for investors to conduct arbitrages and hedging, the trading of such call warrants is more popular than other styles of call warrants. Composite call warrants have faded accordingly. As for targets of investment, electronic stocks have a higher volatility and attract wider attention. Call warrants in Taiwan belong to a kind of call option that gives investors not only hedging but also speculating and arbitraging tools due to their high financial leverage.

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1.2. Mechanisms of warrants

In this section we will talk about what are warrants and how they function. A warrant generally is a contract that gives the holder the right to buy a specified number of shares of stock of a company at a defined price during a specified period of time. Warrants are traded by companies as a way to raise capital. Although a company could sell stock to raise money, the Securities and Exchange Commission regulates the number of shares a company is allowed to issue. There are two types of warrants put warrants and call warrants. A warrant that allows the investor to buy the underlying assets at a specified price is a call warrant. Where put warrant gives the investor a right to sell. The specified price is called the strike price, the expiration date is the expiry, and the initial purchase price is called the premium. Both put and call warrants are classified by their exercise style. American warrants can be exercised anytime on or before the expiration date; European warrants can only be exercised on the day of expiration.

Investors can use call (put) warrants to hedge against rising (falling) share values of stock held in their portfolios. Like stock options, warrants have an exercise price and an expiration date. The time schedules over the whole life of a warrant: the introduction effect around the announcement date, the pervasive effect during the life of the warrant, and the expiration effect around the maturity date. In this paper I will talk about the introduction period, which is the period before the announcement date, the day it is issued, and 10 days after it is issued.

Delta hedging is an important strategy that aims to reduce, or hedge, the risk associated with price movements in the underlying asset, by offsetting the change in warrant values. For example, a short call position may be delta hedged by purchasing the underlying stock. This strategy is based on the change in premium, or price of option, caused by a change in the price of the underlying security. This paper focuses on portfolio consisting of warrants and shares which has the impact on delta hedging strategy. Warrants are chosen to be American call type with shares as underlying assets. Florianová (2015) found out that the average percentage of avoiding risk from delta hedging is 70%, based on the data from Frankfurt Stock Exchange which they build 50 different portfolios. Theoretically, delta hedging is conducted at a very short instant time to maintain delta neutral position, but however in practice a discrete hedging is conducted.

1.3. Warrant hedging and stock price

Simply saying, there are two types of people involved in a warrant transaction, the brokerage firm and the investor/trader/dealer. The brokerage firms wants to raise capital so they short warrants and does hedging (most of the time delta hedging in Taiwan), while the investors who are interested long warrants and buys the share. The hedging transaction usually happens slightly before the introduction period of warrants. Conrad (1989) found that a trader/dealer who anticipates writing calls may purchase the security immediately before warrant introduction to satisfy his or her anticipated hedging demand and facilitate trading. If dealers correctly estimate their hedging demand for warrants, there should be a positive correlation between the price increase caused by the hedging demand and the volume of trading in the warrant. In fact, the price increase in the primary market is positively associated with initial trading volume in the security, although much of the variation in the price increase remains unexplained.

The dealers hedging demand cause a net increase in demand in the underlying security, it must also be the case that the existence of the warrant causes more investors to invest indirectly in the security through the warrant market, perhaps by making some positions less costly. The increase in demand has to be associated with the observed price effects.

1.4. Objective of the research

This paper examines two parts. First, the effect of warrant introduction on the returns of the underlying security is investigated if investors buy stocks before the introduction of warrants. Second, we investigate whether introduction of warrants can affect the price of underlying stock. We use the warrants traded in Taiwan from 2013 to 2015 of two big companies, namely Taiwan Semiconductor and Hon Hai Precisions.

The remainder of this paper is organized as follows. Section two discusses the Literature. Section three describes the data. The methodology and variable explanation are presented in section four. Results are in section five. Finally we conclude the paper in section six.

2. Literature Review

Warrants have been an important issue in the global derivatives markets and many studies investigates the delta hedging impact. There are three areas of literature that deals with the relationship between warrants and their underlying stocks, relating to this study. The first area of research on the impact of option trading on underlying stocks examines whether option introduction generates a one-time change in stock price level. Earlier papers by Conrad (1989) and Detemple and Jorion (1990) indicate that option introduction produces an increase in the level of underlying stock prices. These findings, however, do not appear to be robust. Sorescu (2000) and Ho and Liu (1997) show that in a later time period stock prices decrease upon option introduction, and Mayhew and Mihov (2004) find that the price level effects disappear when benchmarked against the price changes of matched firms that do not have options introduced. Most recently, Lundstrum and Walker (2006) provide evidence that the introductions of LEAPS are associated with small declines in the prices of underlying stocks.

The second area of research investigates whether option activity causes systematic changes in the prices of the underlying stocks at option expiration dates. An early CBOE (1976) report does not find evidence of abnormal underlying stock price behavior leading up to option expiration. Using small samples, Klemkosky (1978) documents negative returns on underlying stocks in the week leading up to expiration and positive returns in the week after expiration while Cinar and Vu (1987) find that the average return and volatility of optioned stocks on the Thursday to Friday of expiration week are largely the same as from the Thursday to Friday of non-expiration weeks. Ni, Pearson, and Poteshman (2005), on the other hand, provide strong evidence that the prices of optioned stocks cluster at strike prices—and therefore are altered—on option expiration dates.

The last area of research on the impact of individual equity options examines whether options produce pervasive changes in underlying stock price movements—changes not limited to the times that options are introduced or expire. Bansal, Pruitt, and Wei (1989), Conrad (1989), and Skinner (1989) all find that being optioned yields a decrease in the volatility of underlying stock prices. However, Lamoureux and Panikkath (1994), Freund, McCann, and Webb (1994), and Bollen (1998) demonstrate that the apparent decrease in volatility is probably rooted in the fact that exchanges tend to introduce options after increases in volatility. In particular, they show that the decrease in volatility that occurs after option introduction is also observed in samples of matched control firms that lack option introduction.

All in all, the literature contains little evidence that option trading has a significant impact on underlying stock prices. We would like to examine the relationship between warrants and underlying stocks in the introduction period. We use covered warrants traded in the Taiwan Stock Exchange (TWSE) and examine whether hedging activity impacts the underlying stock of warrants in the introduction period. Using Taiwan Stock Exchange has advantage such as most warrants are traded by individual investors who don’t have any information or strategy. So we can see a bigger impact to the hedging demands of the warrant issuers.

3. Data

The main source of data is from TEJ (Taiwan Economic Journal) and the data period from January 2012 to December 2014. Due to large samples, we use warrants with underlying assets of Taiwan Semiconductor(2330) and Hon Hai Precisions(2317). Two big Taiwan companies are used because they are one of the largest firms in Taiwan and a more warrants are available than other companies. To find this we collect data from the TEJ for delta, contract size, number of outstanding shares traded on that day, expiration period, warrant type and so on. We take the sample warrants which have more than 170 days until maturity, and find the variables of each company for 10 days after the announcement date and 100 days before the announcement date. We exclude samples that matured before 10 days. We contain 262 put warrants and 779 call warrants for Hon Hai Precisions and 286 put warrants and 474 call warrants for Taiwan Semiconductor with a total sample of 1801 warrants.

Table 1 shows the statistics of the average price, average maturity and average volatility of Taiwan Semiconductor and Hon Hai Precisions. We can see that in both companies out-of-the-money sample are larger than the in-of-the-money and at-of-the-money. Panel A shows a higher price, maturity, and volatility for in-of-the-money call warrants for Taiwan Semiconductor. Panel B shows a higher price and maturity but lower volatility for out-of-the-money samples for put warrants for Taiwan Semiconductor.

Table 1. Summary statistics of the average price, average maturity and average volatility

Panel A: Call Warrants

	2330 Taiwan Semiconductor			2317 Hon Hai Precisions		
	In	Out	At	In	Out	At
Number	90	369	5	126	646	7
Average Maturity	190.23	190.16	183.75	184.08	183.39	183.04
Average Price	106.45	106.31	109.35	88.46	87.91	90.59
Average Volatility	0.312	0.3100	0.306	0.374	0.367	0.347

Panel B: Put Warrants

	2330 Taiwan Semiconductor			2317 Hon Hai Precisions		
	In	Out	At	In	Out	At
Number	36	247	3	29	230	3
Average Maturity	197.53	185.11	187.45	178.24	180.18	179.45
Average Price	108.04	105.61	108.06	87.50	88.67	89.64
Average Volatility	0.301	0.317	0.296	0.374	0.384	0.361

This table reports the descriptive statistics of covered warrants listed on the Taiwan Stock Exchange (TWSE) between January 2012 and December 2014 on Taiwan Semiconductor and Hon Hai Precisions. We obtain the data on warrants from the Taiwan Economic Journal (TEJ) with basket warrants excluded from our analysis. Panel A is the call warrants, and Panel B is the put warrants in the period of time. We divide the warrants in "in", "at" and "out" of the money, which is a reflection of their intrinsic value. A call warrant is in-the-money when the exercise price is lower than the price of the underlying share. A put warrant is in-the-money when the underlying share price is below the exercise price. This table shows the summary statistics of the average day until maturity, average stock price, and average volatility from each warrant in the sample period.

4. Research Design

4.1. Variable Explanation

In this section we first describe the construction of the key variables used in our empirical analyses. We then discuss the empirical methodology for testing the hypotheses.

Investors take a long position and brokerage firms (issuers) take a short position in warrant issuance. Issuers issue warrants face price risk and need to buy underlying assets to hedge its risk. This hedge may lead to stock price rise. As requested by the Taiwan Stock Exchange (TWSE), most warrant issuers in Taiwan conduct a delta-neutral strategy to hedge their risk on short positions of warrants. We can expect that the price impact should be the strongest before the day of issuance, as issuers have to buy or short a sufficient amount of the underlying stocks to hedge their warrant issuance. The impact will be larger when the amount of warrants issued (relative to the number of shares outstanding of the underlying stock) is larger.

We follow Chung et al.(2014) approach to calculate delta hedging position of issuer (DHP) on the announcement date. To avoid any price impact from public investors' reaction (e.g. buying the underlying stock) after they know about the warrant issuance, we conjecture that the hedging position will be established before the announcement day.

$$DHP_j\left(t_a^j, S_{t_a^j}\right) = CS_j * N_{j,t_a^j} * \Delta_j\left(t_a^j, S_{t_a^j}\right) \quad (1)$$

Where CS_j is the contract size, $t^j a$ as the announcement date, N_{j,t_a^j} and $\Delta_j\left(t_a^j, S_{t_a^j}\right)$ are the number and the delta of the warrants issued by issuer *j*, respectively. To investigate the relationship between the issuance amount and hedging impact, we further standardize the delta-hedging position by the number of shares outstanding of the underlying stock, i.e.:

$$SNDHP_j\left(t_a^j, S_{t_a^j}\right) = \left(DHP_j\left(t_a^j, S_{t_a^j}\right)/T_{t_a^j}\right) * 100\% \quad (2)$$

Where $T_{t_a^j}$ is the number of trading volume at time t_a^j.

Note that the standardized hedging positions are positive for call warrants and negative for put warrants. As a result, we expect that the relationship between the standardized hedging position and its price impact is positive for call warrants and negative for put warrants. Thus, we present below the first hypothesis that we want to test about the introduction effect due to the hedging activities of warrant issuers.

Hypothesis 1. There exists a positive (negative) relationship between the standardized delta-hedging position and the price impact before the announcement of a call (put) warrant issuance.

4.2. Calculating abnormal stock returns

To study the introduction effect on stock returns due to delta hedging, we need to calculate abnormal returns and cumulative abnormal returns over the event windows. This study defines abnormal stock returns as the differences between actual returns and expected returns, where the expected returns are obtained the standard market model. Specifically, let $R_{i,t}$ be the stock return of company *i* on day *t* and $R_{m,t}$ be the market return on day *t* or premium. We then define the abnormal return of company *i* on day *t* ($AR_{i,t}$) as follows for the event window (10, -10).

$$\text{AR}_{i,t} = R_{i,t} - (\hat{\alpha} + \hat{\beta}_i * \text{R}_{m,t}) \qquad t = \tau - 10, \dots, \tau + 10 \tag{3}$$

Where τ is the announcement day. $\hat{\alpha}_i$ is the risk free rate. and $\hat{\beta}_i$ is the market risk of the stock. They are estimated from the market model regression using daily returns from days -140 to -41, respectively as the estimation period.

We aggregate the returns across stocks to obtain the cross-sectional means, i.e.

$$\overline{AR}_t = \frac{1}{N_w} \sum_{i=1}^{Nw} AR_{i,t} \qquad t = \tau - 10, \dots, \tau + 10 \tag{4}$$

Where N_W is the number of warranted stocks.

$$\text{CAR}_i(-10,+10) = \sum_{t=-10}^{+10} AR_{i,t} \tag{5}$$

Where $CAR_i(-10,+10)$ is the summation of daily abnormal returns of stock i over the event window (-10 days before the announcement day, +10 after the announcement day). The first day for the announcement day we have used is October 1, 2012. From this we get H2. There is a positive relationship between abnormal return and delta hedge position before the announcement of the warrant. This is because investors expect stock price rise on the date of warrant introduction.

4.3. Methodology

To examine whether a call warrant issuance influences the price of the underlying stock and its trading volumes, we adopt a 21-day event window that consists of 10 trading days before and 10 trading days after the announcement date plus the event day itself. To avoid interference among introduction and/or expiration effects, we exclude call warrants whose event window overlaps with the event windows of other warrants (including call-type and put type) on the same underlying stock.

As Chan and Wei (2001) argue, the positive price effect may be attributed to the fact that warrant issuers want to manipulate the underlying stock price to attract more investors and make the call warrants sell at a more favorable price. To further clarify whether the positive price effect is really due to the hedging activity, we investigate the relationship between the issuance amount (measured by standardized delta-hedging position) and hedging impact (measured by cumulative abnormal return). Specifically, we run the following regression:

$$CAR_{i,t}\left(t_1, t_\alpha^j\right) = \alpha_{i,j} + \beta_{1,j} * SNDHP_{i,j}\left(t_\alpha^j\right) + \beta_{2,j} * \sigma_{i,j} + \beta_{3,j} * M_{i,j} + \varepsilon_{i,j} \quad (6)$$

Where $CAR_{i,t}\left(t_1, t_\alpha^j\right)$ is the cumulative abnormal return of stock *i* from timet_1 to t_α^j (the announcement date of the warrant on stock *i* issued by issuer *j*). $SNDHP_{i,j}\left(t_\alpha^j\right)$ is the standardized net delta hedging position of stock *i* at the announcement period t_α^j as the independent variable. $\sigma_{i,j}$ and $M_{i,j}$ is the dependent variable. Were σ is the volatility of stock *i* issued by issuer *j* for the time period, and *M* is the maturity of stock *i* issued by issuer *j*.

The sample size is different for the cumulative abnormal return and standardized net delta hedging position, volatility, and the maturity of the warrant. So we use the Vector Autoregressive (VAR) model to capture the linear interdependencies among multiple time series. VAR models generalize the univariate autoregressive model (AR model) by allowing for more than one evolving variable. All variables in a VAR enter the model in the same way: each variable has an equation explaining its evolution based on its own lagged values, the lagged values of the other model variables, and an error term. The only prior knowledge required is a list of variables which can be hypothesized to affect each other.

Vecor Autoregressions(VAR):

$$\mathrm{CAR}_t = \sum_{i=1}^{n} \alpha_i SNDHP_{t-i} + \sum_{j=1}^{n} \beta_j CAR_{t-j} + \mu_{1t} \tag{7}$$

Vecor Autoregressions(VAR):

$$\mathrm{SNDHP}_t = \sum_{i=1}^{m} \lambda_i SNDHP_{t-i} + \sum_{j=1}^{m} \delta_j CAR_{t-j} + \mu_{2t} \tag{8}$$

Where $CAR_{i,t}\left(t_1, t_\alpha^j\right)$ is the cumulative abnormal return of stock *i* from time $t_1\ to\ t_\alpha^j$ (the announcement date of the warrant on stock *i* issued by issuer *j*). $SNDHP_{i,j}\left(t_\alpha^j\right)$ is the standardized net delta hedging position of stock *i* at the announcement period t_α^j as the independent variable.

Where it is assumed that the disturbances μ_{1t} and μ_{2t} are uncorrelated. Equation (6) represents that variable CAR is decided by lagged variable SNDHP and CAR. So does Equation (7) except the dependent variable is CAR instead of SNDHP.

After using the VAR model we will use the Granger Causality in VAR Model to see the significance. So the Granger Causality in VAR Model are statistical tests of "causality" in the sense of determining whether lagged observations of another variable have incremental forecasting power when added to a univariate autoregressive representation of a variable. If the variables are non-stationary, then the test is done using first (or higher) differences. The number of lags to be included is usually chosen using an information criterion, such as the Akaike information criterion or the Schwarz information criterion. Any particular lagged value of one of the variables is retained in the regression if it is significant according to a t-test, and if the other lagged values of the variable jointly add explanatory power to the model according to a Chi-squared test. Then the null hypothesis of no Granger causality is not rejected if and only if no lagged values of an explanatory variable have been retained in the regression.

5. Results

5.1. Statistic Results

Table 2 shows the descripted statistics of Taiwan Semiconductor warrants and Hon Hai Precisions traded on the TWSE. We obtain the data on warrants from the Taiwan Economic Journal (TEJ) with basket warrants excluded from our analysis. We did this statistic to know if the majority of the issuer of the warrants is always the same and how much percentage there is for call warrants and put warrants.

In Table 2 Panel A, we found out that the average are 75% call warrants and 25 % put warrants of a total sample of 1041 warrants for Hon Hai Precisions at January 2012 to December 2014. The most warrants issued at the time period for Hon Hai Precisions was Yuanta followed by Masterlink and KGI. In Panel B, we found out that the average are 62% call warrants and 38% put warrants of a total sample of 760 warrants for Taiwan Semiconductor at January 2012 to December 2014. The most warrants issued at the time period for Taiwan Semiconductor was Yuanta followed by Fubon and Masterlink.

From Table 2 we can see that TWSE issue more call warrants than put warrants. We contain 262 put warrants and 779 call warrants for Hon Hai Precisions and 286 put warrants and 474 call warrants for Taiwan Semiconductor with a total sample of 1801 warrants. Hon Hai Precisions have more call issuers than Taiwan Semiconductor so they have a higher percentage for call warrants. We can also see that most of the issuers are from Yuanta, and Masterlink for both companies. An interesting thing can be said that some issuers issue more in Hon Hai Precision than Taiwan Semiconductor. For example Jihsun issue 76 warrants in Hon Hai Precision but it Taiwan Semiconductor only 24 warrants issued. Even though the total warrants issued in Hon Hai exceed Taiwan Semiconductor the difference is big. There is a similar pattern in President as well.

Table 2: Summary statistics of Hon Hai Precisions and Taiwan Semiconductor

Panel A: 2012-2014 Hon Hai Precisions warrants in Taiwan

Warrant Issuers	KGI	Masterlink	Yuanta	Jihsun	Capital	Mega	Fubon	President	Grand Cathay	Sino Pac	China Trust	Concord	Hua Nan	Oriental	Water land	IBT	*Other	Total
Number of Call Warrants	80	87	92	62	71	59	58	50	18	35	36	14	14	33	19	14	37	779
Percentage of Call Warrants	73%	73%	71%	82%	75%	72%	81%	77%	75%	78%	67%	70%	88%	75%	76%	61%	90%	75%
Number of Put Warrants	30	33	37	14	24	23	14	15	6	10	18	6	2	11	6	9	4	262
Percentage of Put Warrants	27%	28%	29%	18%	25%	28%	19%	23%	25%	22%	33%	30%	13%	25%	24%	39%	10%	25%
Total Warrant	110	120	129	76	95	82	72	65	24	45	54	20	16	44	25	23	41	1041

This table reports the descriptive statistics of covered warrants listed on the Taiwan Stock Exchange (TWSE) between January 2012 and December 2014 on Hon Hai Precisions. We obtain the data on warrants from the Taiwan Economic Journal (TEJ) with basket warrants excluded from our analysis. Panel A, first line shows the warrant issuers who issue warrant for Hon Hai Precisions. The next line is the number of call warrants each issuer issues in the TWSE. Followed by the percentage of call warrants issued for the period of time. The next line is the number of put warrants each issuer issues in the TWSE. The overall percentage in each year. Followed by the percentage of put warrants issued for the period of time.

*Other includes FSITC, E. Sun, Bank Taiwan, Tachan, E. Sun, Polaris for Hon Hai Precisions

Panel B: 2012-2014 Taiwan Semiconductor warrants in Taiwan																		
Warrant Issuers	KGI	Maste r link	Yuant a	Jihsu n	Capita l	Mega	Fubo n	Presid ent	Grand Catha y	Sino Pac	China Trust	Concor d	Hua Nan	Orien tal	Water land	IBT	*Other	Total
Number of Call Warrants	51	49	53	12	36	45	50	29	11	30	31	5	12	22	13	5	20	474
Percentage of Call Warrants	65%	60%	61%	50%	59%	57%	58%	74%	73%	73%	56%	50%	92%	69%	65%	56%	69%	62%
Number of Put Warrants	27	33	34	12	25	34	36	10	4	11	24	5	1	10	7	4	9	286
Percentage of Put Warrants	35%	40%	39%	50%	41%	43%	42%	26%	27%	27%	44%	50%	8%	31%	35%	44%	31%	38%
Total Warrant	78	82	87	24	61	79	86	39	15	41	55	10	13	32	20	9	29	760

This table reports the descriptive statistics of covered warrants listed on the Taiwan Stock Exchange (TWSE) between January 2012 and December 2014 on Taiwan Semiconductor. We obtain the data on warrants from the Taiwan Economic Journal (TEJ) with basket warrants excluded from our analysis. Panel B, first line shows the warrant issuers who issue warrant for Taiwan Semiconductor. The next line is the number of call warrants each issuer issues in the TWSE. Followed by the percentage of call warrants issued for the period of time. The next line is the number of put warrants each issuer issues in the TWSE. The overall percentage in each year. Followed by the percentage of put warrants issued for the period of time.

* Other includes FSITC, Cathay, E. Sun, Polaris for Taiwan Semiconductor.

Table 3. Summary statistics of the price, average delta hedged position, net delta, average standardized delta hedge position, and standardized net delta.

Panel A. Call Warrants						
	2330 Taiwan Semiconductor			2317 Hon Hai Precisions		
	In	Out	At	In	Out	At
Number	90	369	5	126	646	7
Average DHP	28332.2	16802.2	27847.3	42209.6	25880.2	61285.8
Net Delta (in thousands)	25640.6	62353.0	1475.9	53268.6	167160.4	3432.0
SNDHP (%)	0.59%	0.39%	0.62%	0.14%	0.08%	0.18%

Panel B. Put Warrants						
	2330 Taiwan Semiconductor			2317 Hon Hai Precisions		
	In	Out	At	In	Out	At
Number	36	247	3	29	230	3
Average DHP	-16657.0	-21082.0	-18389.5	-21332.5	-14183.9	-33570.8
Net Delta (in thousands)	-6213.1	-52620.8	-570.1	-7381.1	-32920.8	-705.0
SNDHP(%)	-0.47%	-0.46%	-0.49%	-0.08%	-0.05%	-0.13%

This table reports the descriptive statistics of covered warrants listed on the Taiwan Stock Exchange (TWSE) between January 2012 and December 2014 on Taiwan Semiconductor and Hon Hai Precisions. We obtain the data on warrants from the Taiwan Economic Journal (TEJ) with basket warrants excluded from our analysis. Panel A is the call warrants, and Panel B is the put warrants. We divide the warrants in “in”, “at” and “out” of the money, which is a reflection of their intrinsic value. This table shows the summary statistics of the average delta hedged position, net delta in thousands, and standardized net delta hedging position in percentage. We calculate $DHP_j\left(t_a^j, S_{t_a^j}\right) = CS_j * N_{j,t_a^j} * \Delta_j\left(t_a^j, S_{t_a^j}\right)$, where CS is contract size of 1000 contracts, N is the number of warrants issued, and the $SNDHP_j\left(t_a^j, S_{t_a^j}\right) = \left(DHP_j\left(t_a^j, S_{t_a^j}\right) / T_{t_a^j}\right) * 100\%$ where T is the trading volume for each warrant issued.

Table 3 shows the summary statistics of the average delta hedged position, net delta, and standardized net delta of hedging demands for warrants, which we would use in our regression later. We can see that in both companies out-of-the-money sample are larger than the in-of- the-money and at-of-the-money. Panel A. shows a positive DHP, net delta, and SNDHP because of the call warrant, while Panel B. shows a negative DHP, net delta, and SNDHP because of the put warrants.

We can say that Panel A. shows a higher rate in all variables than Panel B. except for out-of-the-money SNDHP(%). The average number of shares held by all issuers for delta hedging purpose in call warrants is 1.69 million for Taiwan Semiconductor out-of-the-money sample, and 2.59 million in Hon Hai Precisions out-of-the-money samples.

5.2. Results for introduction effect due to hedging

Tables 4 and Figure 1 represent the empirical results for the price effect in the introduction of warrants. We calculate the time series pattern for the cumulative abnormal returns and abnormal returns of the underlying stock for the 21day event window centered around the announcement date which we use 2012 October 1. The cumulative abnormal returns are the addition of the 21day event window. The abnormal return are estimated from the market model regression using daily returns from days -140 to -41, respectively as the estimation period. The event and estimation windows should not overlap because the normal return estimator should not be influenced by unusual price effects that the event period is supposed to capture. Hence, we always leave a buffer of 30 days between the estimation and event period so that the normal return estimation is "uncontaminated" by the event under consideration. In Table 4, the cross-sectional mean excess returns are generally positive (negative) before (after) the announcement date for Taiwan Semiconductor. Hon Hai Precisions are more diverse for the abnormal return and cumulative abnormal return. The positive price effect is especially pronounced from day -6 to day -5, day -3 to day -1, and day +1 to day +4 for Taiwan Semiconductor, and day -6 to day -3 and day +3 to day +5 for Hon Hai Precisions. Investors will expect the price to decline after the announcement date so they buy the warrant before the announcement date. So this means a warrant issuer constructs the hedging portfolio (probably 3–6 days) before the announcement date. Both companies show a similar result in which days are positive and which days are negative.

Figure 1 shows the abnormal return and cumulative abnormal return for Taiwan Semiconductor and Hon Hai Precisions in a graph. We can see that Panel 1 shows a great result for warrant issuer that constructs the hedging portfolio (probably 3–7 days) before the announcement date so they have positive CAR before the announcement date. In both Panel A and B we can see that the CAR is higher before the announcement date and lower after the announcement date. This result is similar to previous studies. We believe this may happen because of the higher out-of-the-money samples and the mixture of call warrants and put warrants. Our sample has an average of 75% call warrants and 25 % put warrants for Hon Hai Precisions and an average of 62% call warrants and 38% put warrants for Taiwan Semiconductor at January 2012 to December 2014. So the put warrants may have made the abnormal returns and cumulative abnormal returns lower than previous literatures.

Table 4. Abnormal returns and cumulative abnormal returns around the announcement date

2330 Taiwan Semiconductor			2317 Hon Hai Precisions		
Day	$\overline{AR}$	CAR	Day	$\overline{AR}$	CAR
-10	-0.0334	-0.0181	-10	-0.1303	-0.0504
-9	-0.9626	-0.52	-9	0.5644	0.2184
-8	0.316	0.1707	-8	-1.5284	-0.5914
-7	-0.8507	-0.4596	-7	-1.9141	-0.7406
-6	0.4344	0.2346	-6	4.2075	1.628
-5	0.4323	0.2335	-5	0.9028	0.3493
-4	-0.266	-0.1437	-4	6.8257	2.641
-3	0.547	0.2955	-3	1.6879	0.6531
-2	1.3459	0.727	-2	-0.0036	-0.0014
-1	2.447	1.3219	-1	1.6647	0.6441
0	-1.0407	-0.5622	0	1.0278	0.3977
1	0.7509	0.4056	1	-2.0737	-0.8024
2	0.1896	0.1024	2	-1.4817	-0.5733
3	0.8535	0.4611	3	3.5518	1.3743
4	0.4071	0.2199	4	4.3274	1.6744
5	-2.1434	-1.1579	5	2.0527	0.7942
6	-2.3036	-1.2444	6	-1.3585	-0.5257
7	-1.8875	-1.0197	7	0.5904	0.2284
8	0.8979	0.485	8	-1.3728	-0.5312
9	0.0824	0.0445	9	2.5465	0.9853
10	1.2317	0.6654	10	-1.3585	-0.5257

This table shows the abnormal returns and cumulative abnormal returns around the announcement date for Taiwan Semiconductor and Hon Hai Precisions. The table shows time series pattern for the cumulative abnormal returns and abnormal returns of the underlying stock for the 21day event window centered around the announcement date. Where 0 is the announcement date. $\overline{AR}$ is obtained by the average of the 21day event window entered around the announcement date. AR(i,t)= R(i,t)-(αˆ + βῐ * R(m,t)), as *CAR* is obtained by the cumulative return of the 21 day event window. Day 0 is 2012 October 1.

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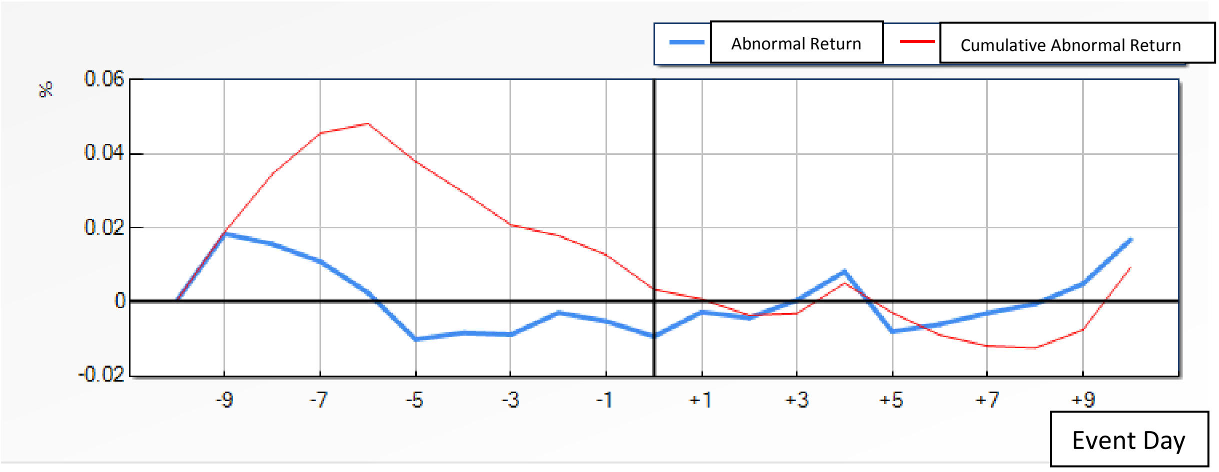
Figure 1. Abnormal return and Cumulative abnormal return

Panel 1: Taiwan Semiconductor



Panel 2: Hon Hai Precisions

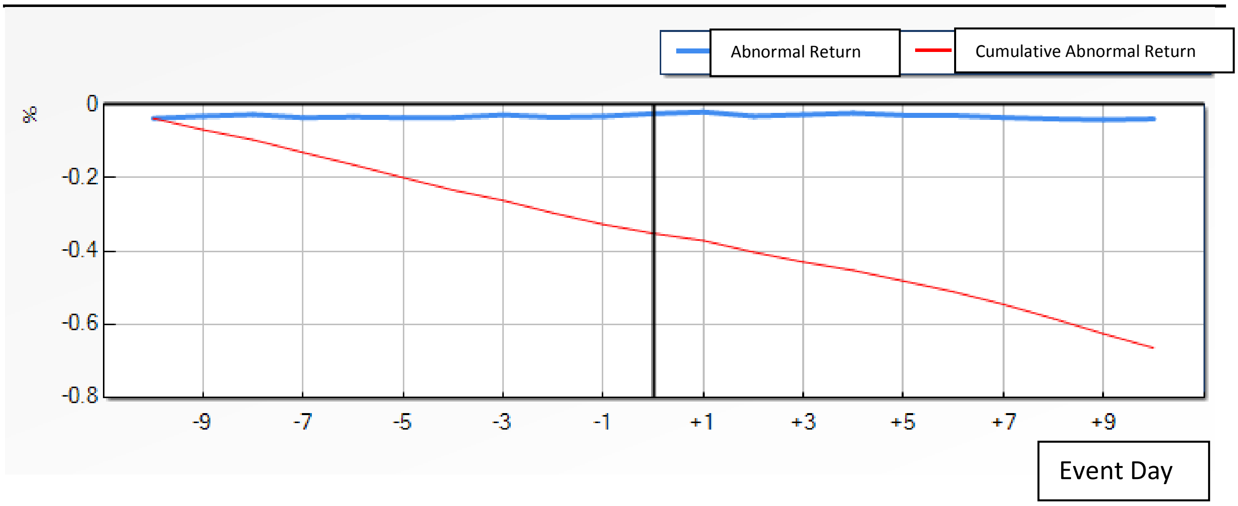


Figure shows time series pattern for the cumulative abnormal returns and abnormal returns of the underlying stock for the 21day event window entered around the announcement date. Panel 1 is the *AR* and *CAR* for Taiwan Semiconductor and Panel 2 is the *AR* and *CAR* for Hon Hai Precisions. We use a market model to estimate the abnormal return for day in the event window. We use call and put warrants for this figure. $\overline{AR}$ is obtained by the average of the 21day event window entered around the announcement date. AR(i,t)= R(i,t)-(αˆ+ βĩ * R(m,t)), as *CAR* is obtained by the cumulative return of the 21 day event window.

Table 5: Vector Autoregressive Model

	Taiwan Semiconductor				Hon Hai Precisions			
	D(CAR)	D(SNDHP)	D(V)	D(M)	D(CAR)	D(SNDHP)	D(V)	D(M)
D(CAR(-1))	0.240	-0.014	0.010	3.371	0.2147	-0.0442	-0.0210	-1.8901
	(-0.691)	(-0.004)	(-0.007)	(-3.138)	(-0.563)	(-0.013)	(-0.011)	(-4.062)
	[0.348]	[-3.593]	[1.439]	[1.074]	[0.381]	[-3.474]	[-1.957]	[-0.465]
D(CAR(-2))	0.096	0.001	0.005	5.372	1.0515	0.0022	-0.0065	-3.7533
	(-0.887)	(-0.005)	(-0.009)	(-4.026)	(-0.326)	(-0.007)	(-0.006)	(-2.348)
	[0.108]	[0.245]	[0.514]	[1.334]	[3.230]*	[0.300]	[-1.042]	[-1.599]
D(CAR(-3))	-0.237	0.005	0.006	3.467	-0.1644	0.0888	0.0243	-0.3359
	(-0.804)	(-0.005)	(-0.008)	(-3.650)	(-0.4673)	(-0.011)	(-0.009)	(-3.370)
	[-0.295]	[1.087]	[0.786]	[0.950]	[-0.352]	[8.417]*	[2.720]*	[-0.100]
D(SNDHP(-1))	5.630	-1.006	0.580	182.861	3.3620	-1.0730	-0.2660	-29.5809
	(-53.237)	(-0.304)	(-0.532)	(-241.535)	(-7.967)	(-0.180)	(-0.151)	(-57.451)
	[0.106]	[-3.308]	[1.090]	[0.757]	[0.422]	[-5.965]	[-1.749]	[-0.515]
D(SNDHP(-2))	79.512	-1.044	0.934	551.333	11.9697	-0.7493	-0.3882	-65.8628
	(-103.05)	(-0.589)	(-1.030)	(-467.546)	(-9.370)	(-0.212)	(-0.179)	(-67.566)
	[0.772]	[-1.773]	[0.908]	[1.179]	[1.277]	[-3.542]	[-2.170]	[-0.975]
D(SNDHP(-3))	3.563	1.819	-0.122	146.238	16.0964	-0.5167	0.3437	27.8683
	(-119.16)	(-0.681)	(-1.191)	(-540.626)	(-6.9727)	(-0.157)	(-0.133)	(-50.273)
	[0.030]	[2.671]*	[-0.103]	[0.270]	[2.309]*	[-3.283]	[2.582]*	[0.554]
D(V(-1))	0.109	-0.002	-0.004	0.201	-81.829	-0.262	0.142	217.495
	(-0.122)	(-0.001)	(-0.001)	(-0.555)	(-21.322)	(-0.481)	(-0.407)	(-153.753)
	[0.894]	[-3.30]	[-3.166]	[0.362]	[-3.837]	[-0.544]	[0.348]	[1.415]
D(V(-2))	-0.176	0.002	-0.004	0.373	-20.0562	-6.3247	-2.2025	76.2463
	(-0.183)	(-0.001)	(-0.002)	(-0.831)	(-41.864)	(-0.945)	(-0.800)	(-301.88)
	[-0.9584]	[2.240]*	[-2.245]	[0.448]	[-0.479]	[-6.692]	[-2.756]	[0.253]
D(V(-3))	-0.093	0.000	-0.001	0.080	6.703	-2.435	-1.440	-87.7226
	-0.221	-0.001	-0.002	-1.003	(-22.750)	(-0.5136)	(-0.4343)	(-164.05)
	[-0.423]	[0.151]	[-0.483]	[0.080]	[0.295]	[-4.742]	[-3.314]	[-0.535]
D(M(-1))	-35.687	0.301	-1.099	-1.735	0.588	-0.007	-0.001	-0.836

	(-25.70)	(-0.147)	(-0.257)	(-116.63)	(-0.199)	(-0.005)	(-0.004)	(-1.434)
	[-1.388]	[2.050]*	[-4.279]	[-0.015]	[2.956]*	[-1.488]	[-0.328]	[-0.583]
D(M(-2))	-33.476	0.120	-0.671	-31.189	-0.302	0.031	0.006	-0.354
	(-37.77)	(-0.216)	(-0.378)	(-171.36)	(-0.254)	(-0.006)	(-0.005)	(-1.836)
	[-0.886]	[0.558]	[-1.777]	[-0.182]	[-1.184]	[5.480]*	[1.215]	[-0.193]
D(M(-3))	-18.624	-0.074	-0.198	29.015	0.228	-0.021	0.000	0.956
	(-23.25)	(-0.133)	(-0.232)	(-105.46)	(-0.1444)	(-0.003)	(-0.003)	(-1.042)
	[-0.801]	[-0.554]	[-0.852]	[0.275]	[1.577]	[-6.461]	[0.176]	[0.918]
C	-0.383	0.003	-0.012	-0.820	0.423	-0.012	0.001	-0.388
	(-0.530)	(-0.003)	(-0.005)	(-2.404)	(-0.216)	(-0.005)	(-0.004)	(-1.556)
	[-0.722]	[0.994]	[-2.263]	[-0.341]	[1.958]	[-2.486]	[0.356]	[-0.250]
R-squared	0.621	0.938	0.926	0.641	0.954	0.991	0.964	0.705
Adj. R-squared	-0.517	0.751	0.702	-0.436	0.816	0.965	0.857	-0.180

This table uses a three lag order selection criteria because the sequential modified LR test statistic (each test at 5% level) and Schwarz information criterion suggests using the 3 lag for both Taiwan Semiconductor and Hon Hai Precisions. Standard errors are in ( ) & t-statistics are in [ ],*is the significance in the t-statistics. Where *CAR* is cumulative abnormal return, *SNDHP* is standard net delta hedging positon, *V* is the volatility, *M* is the maturity of the warrant, and *D* is to use the first difference. This table uses the Vecor Autoregressions(VAR): $\mathrm{CAR}_t = \sum_{i=1}^{n} \alpha_i SNDHP_{t-i} + \sum_{j=1}^{n} \beta_j CAR_{t-j} + \mu_{1t}$ and $\mathrm{SNDHP}_t = \sum_{i=1}^{m} \lambda_i SNDHP_{t-i} + \sum_{j=1}^{m} \delta_j CAR_{t-j} + \mu_{2t}$. This is used because the difference in sample.

5.3. Regression results

Table 5 shows the regression results on the model to investigate the relationship between the issuance amount (measured by standardized delta-hedging position) and hedging impact (measured by cumulative abnormal return). $CAR_{i,t}\left(t_1, t_\alpha^j\right) = \alpha_{i,j} + \beta_{i,j} * SNDHP_{i,j}\left(t_\alpha^j\right) + \sigma_{i,j} + M_{i,j} + \varepsilon_{i,j}$ The standard net delta hedging position is the dependent variable and the volatility and average maturity is the control variable. We have a different sample size for the cumulative abnormal return and standardized net delta hedging position, volatility, and the maturity of the warrant. So we use the Vector Autoregressive (VAR) model to capture the linear interdependencies among multiple time series. Table 5 uses a three lag order selection criteria because the sequential modified LR test statistic (each test at 5% level) and Schwarz information criterion suggests using the three lag for both Taiwan Semiconductor and Hon Hai Precisions. From this table we can see that the first difference in the standard net delta hedging position is significant in the t-statistics in the volume of the second lag for volatility and first lag for maturity for Taiwan Semiconductors. Hon Hai Precisions show better results in significance. For the first difference in cumulative abnormal return, they show significance in t-statistics in the second lag of CAR, third lag of SNDHP and first lag of maturity. For the first difference in standard net delta hedging position they show significance in the third lag in CAR and second lag in maturity. For the first difference in volatility, they show significance in the third lag in CAR, and the third lag in SNDHP. This table shows a high R-squared for SNDHP and volatility for Taiwan Semiconductor and a high R-squared and adjusted R-squared for CAR, SNDHP, volatility for Hon Hai Precisions.

Table 6: Granger Causality in VAR Model

Taiwan Semiconductor				Hon Hai Precisions			
Dependent variable: D(CAR)				Dependent variable: D(CAR)			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
D(SNDHP)	0.960	3	0.811	D(SNDHP)	5.663	3	0.129
D(M)	1.919	3	0.589	D(M)	20.052	3	0.0002***
D(V)	2.269	3	0.519	D(V)	10.077	3	0.0179**
All	4.142	9	0.902	All	57.062	9	0***
Dependent variable: D(SNDHP)				Dependent variable: D(SNDHP)			
D(CAR)	18.525	3	0.0003***	D(CAR)	104.313	3	0***
D(M)	14.770	3	0.002***	D(M)	55.566	3	0***
D(V)	5.476	3	0.140	D(V)	45.984	3	0***
All	22.366	9	0.0078***	All	191.262	9	0***
Dependent variable: D(V)				Dependent variable: D(V)			
D(CAR)	2.324	3	0.508	D(CAR)	8.863	3	0.0312***
D(SNDHP)	2.831	3	0.418	D(SNDHP)	36.445	3	0***
D(M)	17.954	3	0.0004***	D(M)	3.400	3	0.334
All	42.281	9	0***	All	53.819	9	0***

Dependent variable: D(M)				Dependent variable: D(M)			
D(CAR)	2.870	3	0.412	D(CAR)	3.109	3	0.375
D(SNDHP)	2.058	3	0.561	D(SNDHP)	4.411	3	0.220
D(V)	0.540	3	0.910	D(V)	3.071	3	0.381
All	6.758	9	0.662	All	9.133	9	0.425

This table uses a 3 lag order selection criteria because the sequential modified LR test statistic (each test at 5% level) and Schwarz information criterion suggests using the 3 lag for both Taiwan Semiconductor and Hon Hai Precisions which is the degree of freedom (df). * ** 、** 、*is the significance in p-value<1% 、p-value<5% p-value<10%, respectively. Where *CAR* is cumulative abnormal return, *SNDHP* is standard net delta hedging positon, *V* is the volatility, *M* is the maturity of the warrant, and *D* is to use the first difference. All means that all the lagged coefficients of the independent variables taken together cause the dependent variable or not.

Table 6 shows the Granger Causality in VAR Model for Taiwan Semiconductor and Hon Hai Precisions. When the probability is lower than 0.1 we can say that the excluded variable rejects the null hypothesis of the lags taken together do not grantly cause the dependent variable. So for Taiwan Semiconductor we see the that the SNDHP shows a 1% significance in a CAR, maturity, and all the independent variables. Which means that the the lags of CAR and matutity and all the independent variables granger cause the the SNDHP while volume doesn’t. For Hon Hai Precisions each independent variable granger cause the SNDHP. The CAR in Hon Hai Precisions shows a significance in maturity and volatility and all indipendent vaitable.

6. Conclusion

Warrants appeared in Taiwan in August 1997 under wide public expectations, which accordingly provided domestic investors an option for hedging. When the brokerage firm wants to raise capital, they short warrants and do hedging (most of the time delta hedging in Taiwan), while the investors who are interested long warrants and buy the share. The hedging transaction usually happens slightly before the introduction period of warrants. This paper examines two parts. First, the effect of warrant introduction on the returns of the underlying security is investigated if investors buy stocks before the introduction of warrants. Second, we investigate whether introduction of warrants can affect the price of underlying stock.

The main source of data is from TEJ (Taiwan Economic Journal) and the data period from January 2012 to December 2014. Due to large samples, we use warrants with underlying assets of Taiwan Semiconductor and Hon Hai Precisions. We take the sample warrants which have more than 170 days until maturity, and find the variables of each company for 10 days after the announcement date and 100 days before the announcement date. We exclude samples that matured before 10 days. We contain 262 put warrants and 779 call warrants for Hon Hai Precisions and 286 put warrants and 474 call warrants for Taiwan Semiconductor with a total sample of 1801 warrants.

This paper examine whether hedging activity impacts the underlying stock of warrants in the introduction period for Taiwan Semiconductor and Hon Hai Precisions by following Chung et al.(2014) approach to calculate delta hedging position of issuer (DHP) on the announcement date and standardized net delta hedging position (SNDHP). We use the abnormal return and cumulative abnormal return to see the affect in stock price. We also do a Vector Autoregressive Model to see the significance between CAR and SNDHP.

We have found out that Hon Hai Precisions have more call issuers than Taiwan Semiconductor so they have a higher percentage for call warrants. Out-of-the-money sample were bigger in both call and put warrants of Hon Hai Precisions and Taiwan Semiconductor. So we have a lower SNDHP for both companies. Results represent significant positive abnormal returns are found before the announcement of a warrant's issuance of stock price for Taiwan Semiconductor. The results altogether suggests that a warrant issuer constructs the hedging portfolio (probably 3–6 days) before the announcement date. From the VAR model and Granger Causality we see that there is a relationship in CAR and maturity for standardized net delta hedging position.

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