An Analysis of the Covered Warrants Market in the UK

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I certify that all the material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other university.

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Abstract

The covered warrant market in the UK has gained in popularity over time since first launched in 2002. This has opened up an alternative investment choice which offers derivative securities with a life of typically one to two years. It seems to fulfill many of the functions of a traded options market. Since most research has been focused on options trading, the investigation on covered warrants trading is still very limited. This is also largely due to the lack of readily available data for end-traded covered warrants and the existing covered warrants. A unique set of hand-collected data, supplemented by public and private data from main covered warrants issuer and the financial database are employed, making this thesis possible. The sample periods can be divided into two separate sets.

The UK covered warrants trading during the period July 2004 - December 2006 are used to examine the impact of warrant introduction and expiration on the price, volume and volatility of the underlying securities. For the introduction analyses, both the announcement and listing of covered warrants have negative impacts on the price of underlying securities for both call and put features, though the impact of the announcement is more pronounced than that of the listing. These affects are temporary and do not persist much beyond the introduction of the warrants. Negative price impacts of the expiration event are also reported for both call and put covered warrants. However, this study finds no significant impacts on the volume of underlying securities trading from the announcement, listing and expiration of call and put covered warrants. Further evidence indicates an increase in volatility of the underlying securities during the announcement and listing of covered warrants. The results hold true for both call and put warrants cases. On the other hand, a decreasing stock volatility is found as a consequence of the expiration of both call and put covered warrants.

The second data set involves the call covered warrants traded in the UK market between April 2007 and December 2008; this was analysed for evidence of the best appropriate covered warrants pricing model. This study suggests default risk as a major concern for the warrant price which is called the Vulnerable warrant price. The reasons

behind this arise from concern about the issuer's creditworthiness due to traders' fraudulent action and the recent subprime problem, the difficulties of dynamic hedging by issuers because of market imperfections, as well as the no guarantees on covered warrant trading provided by the London Stock Exchange. The most salient findings of the study are the following. The Vulnerable warrant price is generally lower than both the Black-Scholes price and warrant market price throughout the warrant's lifetime. The evidence suggests an overvalued warrant price in the UK market. Moreover, the in-the-money warrants indicate a higher rate of default in comparison to the out-of-the-money warrants. An additional finding shows that the market becomes aware of the default risk only on a short-term basis. The presentation of negative abnormal returns of both market and the Black-Sholes prices support the assumption that default risk is a relevant factor in pricing the UK covered warrants.

These findings add to the literature dealing with the effect of derivatives trading on the underlying securities as well as providing more empirical evidence on a particular covered warrant market. This could be of interest not only for practitioners to widen their investment opportunities but also for regulators to have this as a guideline for their future related policies planning.

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1.1 Background

1.1.1 Covered warrants definition and characteristics

Warrants are transferable options typically issued by companies. They entitle the holder to buy a specific number of shares in a company at a specific price (exercise price) during, or at the end of, a specific time in the future. Warrants are fundamentally option-style instruments although they are securities rather than contracts which mean warrants are generally traded freely on the exchange like common stocks rather than strictly traded depending upon the number of buyers and sellers able to meet and agree on terms of issuance.

Covered warrants are a development of the traditional listed equity (company) warrants. Covered warrants are financial instruments that can be considered as extended options with call and put features. Unlike company warrants, they are generally issued by banks or financial institutions rather than companies. Thus, when they are exercised no new shares are issued and no dilution of existing shareholder wealth is involved. They convey no information about the underlying companies' capital structure or investment policy. Unlike options, covered warrants are non-standardized contracts traded like other securities listed on stock exchanges. They have longer maturity (typically up to 2 years) than traded options. Covered warrants have characteristics closer to options than company warrants and are issued over a wider range of assets compared to options. The underlying assets can be shares, baskets of shares, commodities, international currencies or share price indices. Both covered warrants and option offer leveraged exposure to an underlying and are generally priced using the Black-Scholes pricing models. The covered warrants market is dominated by large players, such as investment banks and major investors.

Covered warrants involve a higher risk than investing directly in shares. The risk for investors investing in covered warrants is that they can rapidly lose their entire initial investment whereas investing in shares brings a very small chance of facing this problem except in the case of bankruptcy or default, which is rare. A large movement in the warrant price could result from a relatively small movement in the underlying asset's price, which can be favourable or unfavourable to the investor. It suggests that covered warrants can be more volatile than normal shares.

1.1.2 Covered warrants compared

A comparison among traditional listed equity warrants, options and covered warrants is provided in Table1.1:

Table 1.1: The characteristics differences among the company warrants, options and covered warrants

Characteristics	Company Warrants	Options	Covered Warrants
Issuer	Corporation itself	Agreement between two parties	Bank or institution
Dilution effect	Yes	No	No
The outstanding issue (after the offer)	Fixed	Unpredictable	Unpredictable
Life time	5-10 years	Typically maximum 9 months	Typically 1 or 2 years
Standardization [a]	Less	More	Less
Feature	Call only	Call and Put	Call and Put
Liquidity	Restricted	Good (in-the-money)	Good (close to issue)
Data and information	Scarce	Readily available	Readily available
Stamp duty	Payable	Not payable if cash-settled	Not payable if cash-settled
Listing Market	London Stock Exchange	LIFFE [b]	London Stock Exchange
Covered [c]	Generally no	Generally no	Yes/no

[a] This is in term of the conditions of the contracts.

[b] LIFFE stands for London International Financial Futures and Options Exchange.

[c] "Covered" means the financial instrument is covered by the underlying security, which the issuer must held in order to satisfy the exercise right upon the expiration of the financial instrument. However, many issuers currently use alternative practices such as dynamic hedging techniques, matching financial transactions via futures, etc.

A covered warrant is just a long term option. However, warrants are generally issued on underlyings which are otherwise difficult and very expensive to access for the average UK investor. They can be held in a Self-Invested personal pension (SIPP). This allows investors to hedge their pensions against market falls and they offer the tightest bid-ask spreads on many UK blue chips for the exchange-traded equivalent, such as options. For example, the spread on 29th September 2009 for a December 09 Vodafone call option, for instance, is 18.18% on LIFFE, on a comparable call covered warrant the spread is 1.53%. Since covered warrants are designed for broader retail investors who often otherwise wouldn't have the access either due to the costs associated or the complexity of trading LIFFE options, the query against covered warrants in term of the more expensive they could become in comparison to identically structured LIFFE options should not be too much of a concern. In addition, the tightness of the bid-ask spreads on covered warrants goes a long way to compensating the fact that investors are buying a product that might be higher priced than other comparative products.

Covered warrants have a higher lot size at issuance in comparison to the traded options as shown in Table 1.2 below. There is no minimum or maximum trading size of covered warrants. Trades of covered warrants that have been put through the LSE were ranging from as low as £1 to as high as £100m worth of covered warrants per transaction. This gives a lot of flexibility in covered warrant trading comparing to the trading of options in LIFFE.

Table 1.2: The Lot size of covered warrants and traded options.

Name of the underlying security	Lot size (in no. of shares)	
	Options	Covered warrants
All	1,000	20,000

Source: LSE and LIFFE

As show in Table 1.4, majority of daily traded options have a higher number of outstanding issues regarding to the daily traded covered warrants on the same underlying securities though few cases do represent the reverse. However, covered warrants are attracting no less trading activities comparing to the options. The daily trading volumes of covered warrants are rather large considering per warrant outstanding issue. For example, the case of 3I Group PLC as the underlying security, the average value of daily trading volume is approximately £145 per option issue whereas approximately £224 per warrant issue. This supports the previous fact that covered warrants are very flexible in terms of trading activities, therefore, leading to a high trading liquidity of the products. This represents a future growth opportunity within this market due to the mentioned trading liquidity which likely to attract and capture more potential investors into the market over time.

Table 1.3 provides the monthly trading value of both individual equity options and covered warrants. This is consistent with the previous information given in the daily data. Even though covered warrants tend to be more liquid in term of trading activities, options still have much larger value of overall trading volume due to much longer existent/more mature of the options market in relation to the covered warrants market.

Table 1.3: The monthly trading value of individual equity options and covered warrants.

Month	Monthly trading value (£'m)	
	Individual equity options	Covered warrants
Jun-09	9644.1	39.4
Jul-09	7966.4	15.5
Aug-09	6985.4	29.5
Sep-09	10199.5	29.9
Oct-09	8916.6	27.3
Nov-09	10644.0	27.5
Dec-09	8471.9	14.5
Jan-10	11155.4	14.8

Source: Euronext-LIFFE (Monthly statistics) and LSE (historical Covered Warrant factsheets)
Notes: Individual equity options: included both call and put equity options traded in LIFFE
Covered warrants: included both call and put covered warrants traded in LSE

Table 1.4: The number of issues and value of daily trading volume of options and covered warrants on the same underlying security

Name of the underlying security	Number of outstanding issues		Value of daily trading volume (£)	
	Individual equity options	Covered warrants	Individual equity options	Covered warrants
3I Group PLC	20	5	2900	1122*
Anglo American PLC	223	19	279205	1000
Antofagasta PLC	5	14	2487.5	3000
AstraZeneca PLC	77	14	54525	3000*
Aviva PLC	26	10	4690	14767*
Barclays PLC	1169	26	140022.5	134480
BG Group PLC	56	7	10205	14917*
BHP Billiton PLC	213	15	236035	2000
British Airways PLC	502	9	2800	16431
British Land Company PLC	3	5	802.5	4000*
British Petroleum (BP) PLC	846	20	67515	17000
British Telecommunications Group PLC	611	9	62472.5	270000
Cable & Wireless PLC	50	5	5875	1108
Cadbury PLC	42	4	3990*	995

Source: Datastream; observed on 11th February 2009

Notes: *value observed on the latest trading day of the derivatives due to the unavailability of the data on 11th February 2009

Individual equity options: included both call and put equity options traded in LIFFE

Covered warrants: included both call and put covered warrants traded in LSE

Table 1.4 (con't) The number of issues and value of daily trading volume of options and covered warrants on the same underlying security

Name of the underlying security	Number of outstanding issues		Value of daily trading volume (£)	
	Individual equity options	Covered warrants	Individual equity options	Covered warrants
Centrica PLC	23	1	2530*	178
Diageo PLC	259	2	77060	4000*
GlaxoSmithKline PLC	237	10	59070	4500*
Home Retail Group PLC	17	3	2550*	3700*
HSBC Holdings PLC	171	13	73810	55000*
Kazakhmys PLC	12	4	5295	20000*
Kingfisher PLC	150	3	5125	1137*
Land Securities PLC	12	8	4355	5000
Legal & General Group PLC	27	8	1167.5	168471*
Lloyds TSB Group PLC	193	15	11595	122901
Lonmin PLC	45	4	10125*	850*
Man Group PLC	215	12	10700	175377
Marks & Spencer PLC	15	4	1162.5	7421*
Next PLC	16	2	6700	40000*

Source: Datastream; observed on 11th February 2009

Notes: *value observed on the latest trading day of the derivatives due to the unavailability of the data on 11th February 2009

Individual equity options: included both call and put equity options traded in LIFFE

Covered warrants: included both call and put covered warrants traded in LSE

Table 1.4 (con't) The number of issues and value of daily trading volume of options and covered warrants on the same underlying security

Name of the underlying security	Number of outstanding issues		Value of daily trading volume (£)	
	Individual equity options	Covered warrants	Individual equity options	Covered warrants
Persimmon PLC	24	4	3180*	483*
Prudential PLC	7	12	472.5	1000*
Rentokil Initial PLC	15	3	2887.5*	1000*
Rio Tinto PLC	854	22	556165	55075
Rolls-Royce Group PLC	72	2	22310	1600*
Royal Bank of Scotland PLC	529	23	9682.5	1470
Royal Dutch Shell PLC	35	6	6935	5000*
Standard Chartered PLC	28	6	31245	24853*
Standard Life PLC	7	4	2432.5*	6000*
Tesco PLC	20	3	5300	5000
Tullow Oil PLC	25	5	9875	20213*
United Utilities PLC	19	3	4675	7500*
Vodafone Group PLC	4748	11	41130	100000*
Xstrata PLC	436	20	171170	81000

Source: Datastream; observed on 11th February 2009

Notes: *value observed on the latest trading day of the derivatives due to the unavailability of the data on 11th February 2009

Individual equity options: included both call and put equity options traded in LIFFE

Covered warrants: included both call and put covered warrants traded in LSE

Covered warrants can also be compared with other listed structured products to see their potential growth and trading trends. Other listed structured products include Knock-out products, Investment products (Capital Protected, Trackers, Yield Enhancement and Participation) and other leveraged products. All of these financial instruments are traded within the LSE. Regarding Table 1.5 and Figure 1.1, the covered warrants have been doing very well over the year as shown from the recent record from the beginning of year 2009 to the beginning year 2010 and likely to continue so in relation to other listed structured products which are traded within the same stock the exchange. Even if there has been a slow down in the trading activities in the January 2010 which probably are affected by the recent sharp drop in the overall UK market following worries about the debt repayments needed by Spain, Portugal and Greece, the covered warrants were traded at £14.8m which is still considerably large in comparison to the Knock-out products of £1.8m and other certificates of £0.1m. Moreover, covered warrants were able to maintain approximately 36% of other combined listed structure products trading value in January 2010. Therefore, the trading of covered warrants has been very active within the UK markets relative to other existing products.

Table 1.5: The monthly trading value of Covered warrants and other Listed structured products within the LSE

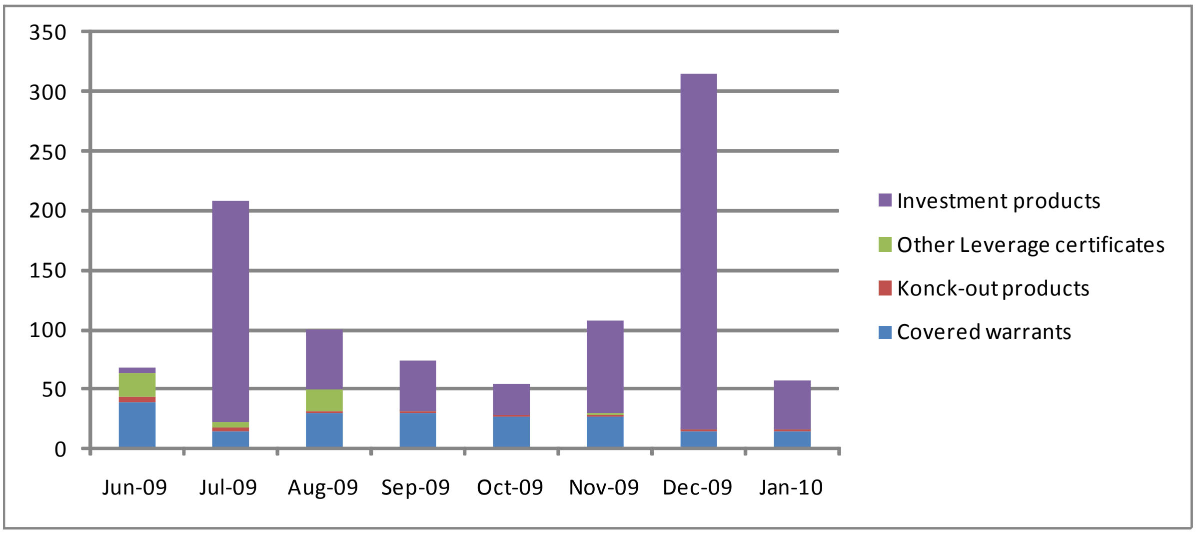
Month	Monthly trading value (£'m)			
	Covered warrants	Knock-out products	Other Leverage certificates	Investment products
Jun-09	39.4	4.3	20.1	3.7
Jul-09	15.5	2.3	5	185.7
Aug-09	29.5	2	17.6	50.8
Sep-09	29.9	1	0.1	43.6
Oct-09	27.3	1.1	0.4	25
Nov-09	27.5	1.6	0.3	78.1
Dec-09	14.5	1.5	0.1	299
Jan-10	14.8	1.8	0.1	40.3

Source: LSE; historical Covered Warrant factsheets

Notes: Other leveraged products mean all leveraged products excluding covered warrants and knock-out products.

Investment products mean all investment products including Capital Protected, Trackers, Yield Enhancement and Participation.

Figure 1.1: The monthly trading value of Covered warrants and other Listed structured products within the LSE (£'m)



Source: LSE; historical Covered Warrant factsheets

Notes: Other leveraged products mean all leveraged products excluding covered warrants and knock-out products.

Investment products mean all investment products including Capital Protected, Trackers, Yield Enhancement and Participation.

1.1.3 History of covered warrants

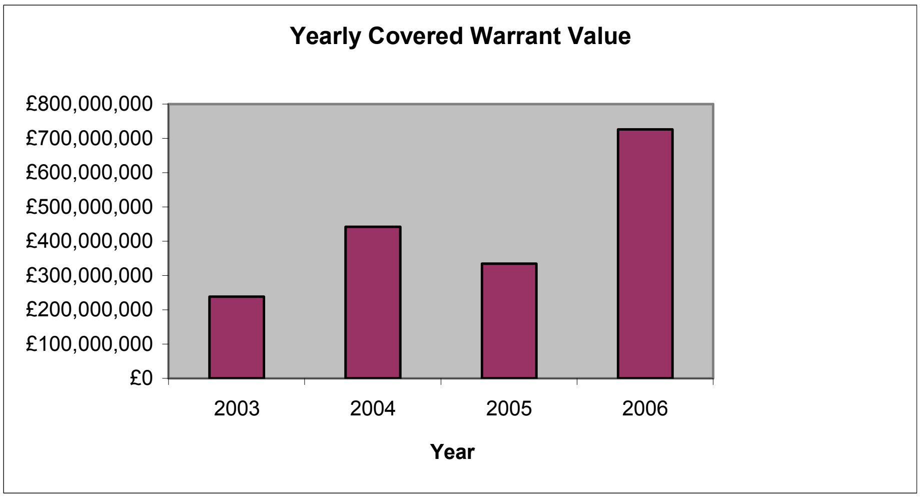
Covered warrant markets are well established in Europe, particularly Germany, Switzerland, Italy and Spain. According to Hildrey (2003), there are more than 50,000 covered warrants listed in Europe, offered by 40 issuers with a total value of €290billion. In 2002, Europe's covered warrants market saw a total turnover of €75billion, with approximately 85,000 trades per day. The world's largest covered warrants market is in Germany. In 2002, Germany's turnover was €17.5billion compared with €16.5billion in Italy and €16billion in Switzerland. Covered warrants have proved to be popular wherever they have been launched. Moreover, there does not seem to have been any widespread problem with investors lacking understanding or appreciation of the risks.

The extent to which derivatives interact with their underlying stocks is an increasingly important issue in the study of financial markets. Black & Scholes (1973) view options as redundant securities. However, Ross (1976) theorizes that stock prices in incomplete markets are generally affected by the introduction of new options. Detemple & Selden (1991) and Detemple (1990) also demonstrate that general equilibrium price effects are possible when non-redundant stock options begin trading in incomplete markets. These theoretical models, however, provide little indication about the direction or magnitude of such price effects. The majority of studies in the area of the effects of derivative issuance and trading have used data from US markets. Much of the research has been conducted using older pre-90's data such as Conrad (1989) and Detemple & Jorion (1990). However, newer research findings suggest that the conclusions of earlier research may not be as robust as first thought. In addition, the phenomenal growth in the derivative markets over the past decade has provoked further interest in this area. Greenspan (1999) shows US outstanding derivatives contracts as having a notional value of $33 trillion at year-end 1998, a measure that has been growing at a compound annual rate of 20% since 1990. He also states the size of the global OTC derivative market as $70 trillion, a figure that follows a rising trend. Recent research has also moved from US data, with research being published on the UK (Gemmill & Thomas (1997)), Hong Kong (Chan & Wei (2001), Chen & Wu (2001)),Taiwan (Lee & Chen (2005)), Australia (Aitken & Segara (2005)), Switzerland (Stucki & Wasserfallen (1994)), Norway (Gjerde & Sattem (1995)), etc.

1.1.4 An overview of the UK covered warrants market

Warrants were issued in the 1970s (and before) in London but it was not until the mid 1980s that significant growth took place. Since then many warrants have been listed on the London Stock exchange. During the initial periods, the warrants were traditional listed equity (company) warrants. Covered warrants were first launched in 1986 but were privately traded and it was not until around 1990 that the market began to attract public attention. They were traded on the London Stock Exchange (LSE) for the first time on 28th October 2002. Even though it is still a small market in comparison with other well established markets in Europe, trading value has been increasing over time. The end of 2006 the annual total value traded on the LSE was £726.74million, more than triple the annual figure of a couple of years ago (Figure 1.2).

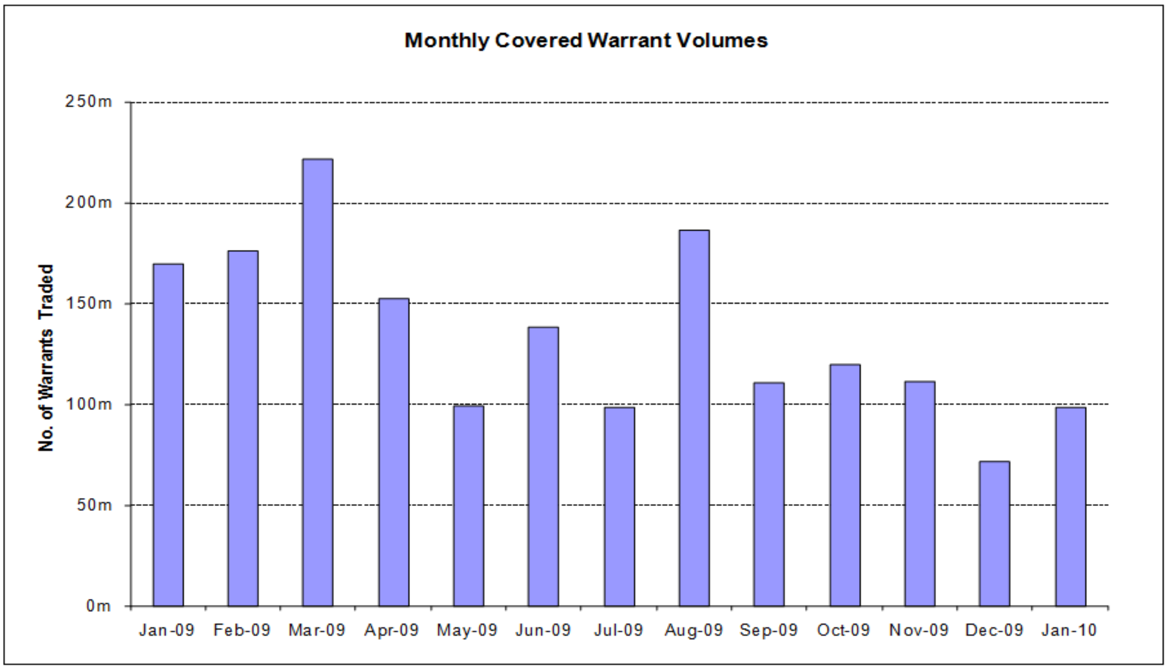
Figure 1.2: Yearly Covered Warrant Value



Data source: The "Covered warrants trading reports" which are publicly reported by the LSE.

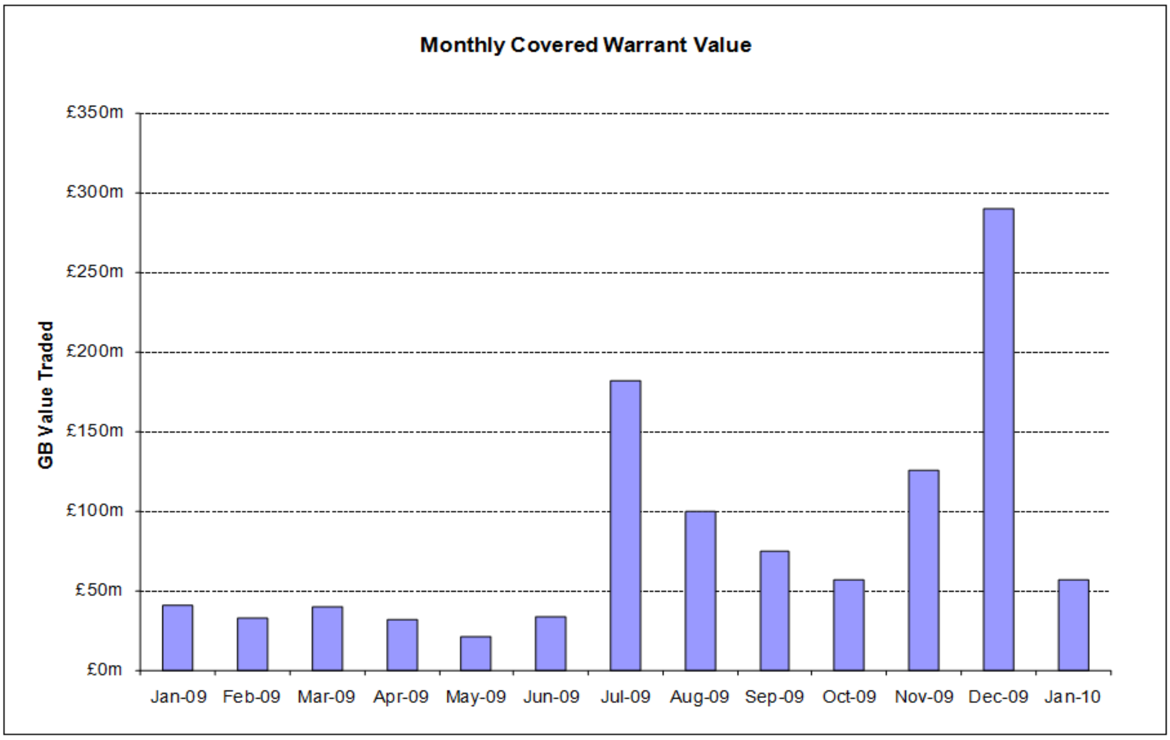
In addition, Figure 1.3 and 1.4 present the recent monthly trading volume and value of the UK covered warrants. Over the years, trading has become more and more popular. Warrants have been at the forefront of financial innovation, providing a wide range of financial instruments for private investors such as equity warrants, currency warrants and index warrants, etc. The popularity of warrants stems from the gearing. It means that price changes in warrants will exaggerate movements in the underlying assets. However, covered warrant trading involves with certain risks and is not suitable for every investor. Since covered warrants are issued by the third party, financial institutions, the holders are exposed to credit risk in respect of the issuers. The holders are unsecure creditors of an issuer and have no preferential claim over any assets an issuer may hold. Moreover, covered warrants have an expiry date and therefore a limited life. They become worthless at the expiration unless they are in-the-money. One should also be aware that the value of covered warrants will decrease over time when other factors being equal. Thus, covered warrants should not be viewed as products that bought and sold as long term investments. In term of volatility, covered warrants are very sensitive to the movement of the underlying assets as well as the demand and supply related to their own trading activities.

Figure 1.3: The monthly trading volume of covered warrants



Source: LSE; historical Covered Warrant trading report 2010

Figure 1.4: The monthly trading value of covered warrants



Source: LSE; historical Covered Warrant trading report 2010

The Financial Services Authority (FSA) introduced new rules to facilitate the listing of covered warrants as part of its objective to "seek to maintain the competitiveness of the UK markets for listed securities". In late June 2002, the FSA published its new rules governing the listing and conduct of business for securitised derivatives which represent a new class of investment that includes covered warrants. Although the launch date for covered warrants was not until 28th October 2002, the new rules officially came into force on 1st August 2002 in order to give the issuers time to set up all of their systems with the new rules and for the Inland Revenue to authorise the waiving of stamp duty. The new rules have two principal elements:

1. The listing rules
   The FSA's intention in drafting the listing rules was to create a regime which achieved a balance between investor protection and facilitating access to listed markets whilst maintaining the integrity and competitiveness of the UK market for listed securities. One such section involves the types of underlying assets that are acceptable. There are no restrictions on the style of the warrants themselves as long as there is full disclosure in the documentation.
2. The conduct of business rules
   These apply obligations to authorised firms selling securitised derivatives to private customers.

In the UK, covered warrants can only be issued by financial institutions. The well-known investment banks who currently issue covered warrants are Goldman Sachs, JP Morgan, Societe General (SG), TradingLab, Dresdner Kleinwort Limited[1], Barclays Capital and Merrill Lynch International & co. Covered warrants can be traded on the LSE through brokers just like ordinary shares. Warrants can be traded on the LSE order book system (the Central Warrants Trading Service, CWTS), during the same hours as for shares. The trading hours are from 8.00am to 4.30pm, Modays thru Fridays except banking holidays. Those traded through the Retail Service Provider (RSP) Gateway can involve trading outside these hours.

[1] Previous name was Dresdner Kleinwort Wasserstein Limited. It changed its name since September 2006.

The sample of current prices data on covered warrants issued by the major issuer in the UK market, Societe General (SG), including bid-ask prices is provided in order to give an indicative picture of the market. The data clearly shown that bid-ask spreads of covered warrants are very small as presented in Table 1.6. Since the bid-offer spreads are tight as previously mentioned, this can help to drastically reduce costs of covered warrants trading which mean lower commission rates of warrants trading.

Covered warrants are listed and traded on the LSE through more than 20 private client stockbrokers such as Abbey National, Charles Stanley & Co Ltd, Barclays Stockbrokers, etc. as well as other UK brokers through a regular share dealing account. Warrants do not have to be held until expiration but can be bought and sold at any time during LSE trading hours. Commission is charged at a similar rate as standard equities at the time of trading. The smallest amount by which the covered warrant price can move is called the "tick size". It has been specified and defined in the following bands:

Price	***Tick Size***
<10p	*0.25p*
≥ 10p<£1	*0.50p*
≥ £1	*1p*

These tick sizes apply to all covered warrants traded on the order book CWTS. However, for warrants traded on alternative services like the RSP Gateway, the tick size is 0.25p for all warrants.

Table 1.6 The sample of current prices data on covered warrants issued by Societe Generale (SG) on 29-Sep-2009

WARRANT TIDM	ISSUER	UNDERLYING	UNDERLYING PRICE	EXPIRY DATE	TYPE	STRIKE PRICE	PARITY	BID	OFFER(ASK)
SR06	SG	ANTOFAGASTA	751.5	18/06/2010	C	8	1/1	1.255	1.27
SR07	SG	ANTOFAGASTA	751.5	17/09/2010	C	9	1/1	1.16	1.17
SR11	SG	AVIVA	418.8	18/12/2009	C	4.5	1/1	0.295	0.306
SR13	SG	AVIVA	418.8	19/03/2010	C	5	1/1	0.325	0.333
SR15	SG	BARCLAYS	365	18/06/2010	C	3.5	1/1	0.691	0.701
SR23	SG	BARCLAYS	365	17/09/2010	P	2.5	1/1	0.342	0.35
SR25	SG	BG GRP.	1090	18/06/2010	C	12	10/1	0.117	0.12
SR26	SG	BG GRP.	1090	17/12/2010	C	14	10/1	0.124	0.129
SR37	SG	BT GROUP	130.85	18/12/2009	C	1.5	1/1	0.0449	0.0489
SR39	SG	BT GROUP	130.85	18/06/2010	C	1.75	1/1	0.053	0.057
SR56	SG	MAN GROUP	303.8	18/12/2009	C	2.5	1/1	0.585	0.595
SR57	SG	MAN GROUP	303.8	18/06/2010	P	2.5	1/1	0.347	0.355
SR29	SG	BHP BILLITON	1738	18/12/2009	C	15	10/1	0.302	0.307
SR30	SG	BHP BILLITON	1738	18/06/2010	C	17	10/1	0.312	0.32
SR32	SG	BP	559	18/12/2009	C	5	1/1	0.646	0.656
SR36	SG	BP	559	18/06/2010	P	4.6	1/1	0.361	0.369
SR41	SG	Glaxosmithkline	1251.5	18/06/2010	C	15	10/1	0.05	0.054
SR43	SG	Glaxosmithkline	1251.5	18/12/2009	P	11	10/1	0.0316	0.0356

Data source: the London Stock Exchange (LSE)

Table 1.6 (con't) The sample of current prices data on covered warrants issued by Societe Generale (SG) on 29-Sep-2009

WARRANT TIDM	ISSUER	UNDERLYING	UNDERLYING PRICE	EXPIRY DATE	TYPE	STRIKE PRICE	PARITY	BID	OFFER(ASK)
SR46	SG	HSBC	723.3	18/12/2009	C	6.5	1/1	0.964	0.974
SR47	SG	HSBC	723.3	18/06/2010	C	8	1/1	0.604	0.614
SR51	SG	LLOYDS	103.75	18/12/2009	C	1	1/1	0.147	0.152
SR52	SG	LLOYDS	103.75	18/06/2010	C	1.25	1/1	0.141	0.146
SR59	SG	PRUDENTIAL	586	18/12/2009	C	5.5	1/1	0.812	0.822
SR60	SG	PRUDENTIAL	586	18/06/2010	C	6.5	1/1	0.764	0.774
SR63	SG	ROYAL BANK SCOT	51.6	18/12/2009	C	0.6	1/1	0.0345	0.0385
SR66	SG	ROYAL BANK SCOT	51.6	19/03/2010	C	0.8	1/1	0.0116	0.0216
SR77	SG	Royal Dutch Shell	1779	18/06/2010	C	18	10/1	0.188	0.193
SR79	SG	Royal Dutch Shell	1779	18/06/2010	P	12	10/1	0.0495	0.0535
SR72	SG	RIO TINTO	2686.5	18/12/2009	C	28	10/1	0.229	0.234
SR75	SG	RIO TINTO	2686.5	18/06/2010	C	30	10/1	0.372	0.38
SR76	SG	RIO TINTO	2686.5	19/03/2010	P	20	10/1	0.156	0.161
SR81	SG	TESCO	392.7	18/06/2010	C	4	1/1	0.408	0.416
SR82	SG	TESCO	392.7	17/12/2010	C	5	1/1	0.251	0.256
SR84	SG	VODAFONE	144.45	18/12/2009	C	1.5	1/1	0.065	0.066
SR85	SG	VODAFONE	144.45	19/03/2010	C	1.7	1/1	0.047	0.049
SR87	SG	XSTRATA	928	18/12/2009	C	9.5	1/1	1.08	1.09
SR89	SG	XSTRATA	928	19/03/2010	C	11	1/1	1.035	1.045

Data source: the London Stock Exchange (LSE)

Market makers (or committed principals as they are known by the LSE) are obliged to provide two-way prices throughout the trading day and for the lifetime of the covered warrant. They are generally, but not necessarily, the issuers. Moreover, both issuers and market makers of the covered warrants in the UK are obliged to comply with LSE animation and spread rules. Therefore, the liquidity for each covered warrant is guaranteed by the issuer and it is regulated by the LSE throughout the trading day. In the past, it was difficult to examine warrants on conventional securities since there were only a small number of such warrants traded in the UK, the majority of them being company warrants and a few traded OTC covered warrants. Pricing of company warrants can also be very complicated.[2] However, covered warrants pricing is more straightforward and calculation against the underlying assets largely automated. Pricing models are based on option pricing theories such as the Black-Scholes (1973) model and the binomial method (Cox, Ross & Rubinstein (1979)). Covered warrant pricing is influenced by the price or level of the underlying asset, the exercise price of the covered warrant, the time left to expiry, volatility of the underlying instrument, interest rates, dividends and exchange rates. These factors affect each particular warrant in various degrees.

1.2 Objectives and Motivations of the Research

There have been arguments that capital markets become more complete with the introduction of derivative securities such as options, etc. Arditti & John (1980) suggest that the availability of options expands capital markets across the possible returns space. The view that the existence of option markets should lead to an increase in investor welfare and expand the returns space is supported by Hakansson (1982). Moreover, a number of studies have been done on the impact of derivatives introduction on the underlying products. Most of the literatures relates to options. Several studies such as Conrad (1989), Detemple & Jorion (1990), Watt, Yadav & Draper (1992), Sahlstrom (2001) examine the effect of option introduction on returns of the underlying security. They find that the listing of

[2] References can be seen in Chapter 2, section 2.5.1: the company warrants pricing model.

options is associated with a positive price effect on the underlying security. Bhattacharya (1987) and Pope & Yadav (1992) indicate that there is a negative price effect on returns of the underlying security around the option expiration date.

The trading volume effect on the underlying securities has also been examined. Hayes & Tennenbaum (1979) reported an increase in underlying trading volume after the listing of options. Bansal, Pruitt & Wei (1989) grouped option listings by time period and reported increases in market-adjusted volume only prior to 1979. Damodaran & Lim (1991) suggest no significant change in market-adjusted volume. Chamberlain, Cheung & Kwan (1993) also show no significant change, even though a gradual increase in trading volume seemed to occur after the listing period on an unadjusted as well as a market –adjusted basis.

A variety of empirical works have reported a decrease in volatility due to options introduction. For examples, Conrad (1989), Skinner (1989), DeTemple & Jorion (1990) and Haddad & Voorheis (1991) seem to support a decrease. In fact, they provide the evidence of no effect on beta risk whereas total risk declines. Since both options and futures are used to reduce the risk that investors face from potential future movements in an underlying market variable, the introduction of the two financial instruments should be reasonably comparable. Edwards (1988a; 1988b) finds no evidence of increased volatility of the underlying over a period up to May 1987 for equity-index futures and interest-rate futures. A totally different result is presented in Damodaran (1990). He shows that stocks underlying the S&P 500 futures had significant but slight increase in both beta and total variance after the futures listing.

There have been other studies on the impact of trading options. However, my attention is on recent trading of covered warrants in the UK market. They fulfil many of the functions of an existing options market. Since covered warrants were first listed, there has not yet been a study of their impact on the market (price, volume and volatility) for the underlying securities in the UK. This thesis therefore aims to analyse covered warrants within the UK market over the period July 2004- December 2006.[3]

[3] The beginning of the testing period was chosen as the earliest time at which historically available data are available for covered warrants. This sample period was employed in Chapter 4 and Chapter 5 of this thesis.

Another topic of relevance is how to price covered warrants. The Black-Scholes (1973) model has become the most popular way for options valuation since it was first introduced. Almost all of the derivatives pricing studies are developed from this basic option model. Counterparty, default risk for option trading is minimised through the use of standardised securities traded on an exchange. No such mechanism exists for covered warrants. Prior research which taken default risk into consideration has focused mostly on products such as forward contracts and swaps. For example, Kane (1980), Hull (1989), and Cooper & Mello (1991), etc. The exception can be made by the work of Johnson & Stulz (1987). They assume stochastic processes for both the asset value of the option issuer and the asset value of the underlying. The examination of default risk on option prices can therefore be done and the closed form solutions for the prices of European options in various conditions derived. They also show that option prices which are subject to default risk are different from those with default-free options.

Because of a large number of similarities in characteristics between options and covered warrants, the previous analysis of options pricing can be adapted to price covered warrants. The period of my study is based on the covered warrants traded in the UK market from April 2007 until December 2008.[4] The UK experience can add new evidence to current literature. Moreover, the trading of covered warrants in the UK market is still in the early stage of the development and the result of this early stage studies could also be very useful for other countries considering the introduction of covered warrants trading.

This thesis can therefore be summarized as having three major objectives. Firstly, I aim to conduct an empirical analysis of the effect of the introduction/expiration of covered warrants on the underlying securities in the market, and examine in particular the effect on price and volume of trading. This study compares the listing effect with the announcement effect and further analyses the delisting effect at the end of a warrant life. The persistence and quantity of the effects over time are also taken into consideration. The extant research on covered warrants is still very limited; especially on the UK market. Secondly, I explore further to examine the relationship between the stock return volatility and covered warrants

[4] This sample period of study covers the recent financial distress which associated with the default risk (major factor that influence the pricing model introduced in the study). It was employed in Chapter 6 of this thesis.

trading subject to three cases of announcement, listing and delisting conditions. The expectation of increased speculation during warrants trading makes this topic even more interesting. Thirdly, I am trying to arrive at the best possible pricing model for covered warrants recognising current problems such as financial distress. The covered warrants pricing model associated with the default risk is tested. The trading activity of the covered warrant market has grown rapidly over the years and now amounts to around a 50% market share of all warrants listed on the LSE.[5] There is considerable potential for the covered warrants market to become more and more important in coming years. Furthermore, better availability of recent covered warrant data sets on the LSE as well as unique set of hand-collected data makes research possible.

1.3 Organisation of the Thesis

The organization of the research is as follows.

Chapter 1 provides a general introduction to covered warrants and the evidence on an international basis as well as for the UK. The motivations of the research are outlined and the relevant research objectives are discussed.

Chapter 2 presents the literature review. It is divided into four major areas: underlying price effect on derivatives trading, underlying volume effect on derivatives trading, underlying volatility effect on derivative trading, and the pricing of derivatives. The review provides background knowledge to establish the theoretical framework.

The general theoretical framework is presented in *Chapter 3*. The main methodology of the event study employed throughout the research is explained and justified and the model choice discussed. The benefits and limitations of each model and the tests are explained in detail.

[5] The data taken on 21/04/2006 from the Datastream database shows 1305 covered warrants (about 50%) out of 2604 total warrants.

Chapter 4 discusses the price impact study examining the effect on the underlying securities of covered warrants introduction/expiration. It is followed by an examination of volume effect. The empirical results show that over the sample period, there are significant changes in price of the underlying securities as a result of covered warrants introduction/expiration in the UK market. There is stronger evidence of effects on the announcement than the listing dates of the warrants introduction for both call and put warrants. The negative price effect could be explained by the relaxation of short sales constraints, a transfer of trading from the stock to the warrant markets, or shareholders' belief that warrants act as a destabilizing factor on the underlying stocks. On the delisting of call warrants, the in-the-money warrants reveal a significant price reduction effect whereas the out-of-the-money warrants reveal no price effect in the underlying securities. The price reduction effect of in-the-money call warrants during delisting might be because issuers unwind their position by selling stocks on the delisting of call warrants. The delisting of put warrants results are similar to the call case, even though put warrants cannot be separated into in/out-of-the-money due to the limited samples. With regard to the volume analysis, there is no significant effect on the underlying securities trading volume at the introduction/expiration of covered warrants. A possible explanation for the study is that during the early stage of the introduction of the covered warrants there is insufficient publicity and information to capture the attention of investors. Thus, no effect on trading volume is observed.

Chapter 5 investigates the covered warrants trading effect on stock return volatility. The evidence indicates a significant increasing effect in the underlying securities' volatility from the covered warrant introduction for both call and put cases. Three possible explanations are stock exchanges generally choose to allow the issuance of warrants on stocks where they expect to see an increase in volatility, the profit motive of warrants issuers and their ability to tell when is an appropriate time to issue warrants (because warrant premiums increase when the stock price is expected to be more volatile), and the increased speculation in the derivatives market from informed traders. In contrast, the delisting of warrants is accompanied by a decrease in the volatility of the underlying stocks.

Chapter 6 examines the Vulnerable Warrant model for pricing UK call covered warrants. The model incorporates credit risk into the pricing model. The outcomes suggest warrant prices in the UK market are overvalued. The mean difference between the Vulnerable Warrant price and the market price is large when a warrant is in-the-money because investors seem to face a higher rate of default. There is also little difference between Vulnerable warrant and Black-Scholes prices which is likely to be because of unreliability of some parameters' estimate used in the Vulnerable model. Moreover, the negative effects around financial distress for both market and Black-Scholes cases suggests that credit risk is a significant factor when considering the most suitable model for UK covered warrants valuation.

The conclusion of the study is presented in *Chapter 7*. The research limitations are discussed. Recommendations for future research are also given. The benefits and knowledge that both practitioners and academics could gain from the use of covered warrants as an alternative financial instrument are also discussed.

Chapter 2 : Literature Review

2.1 Introduction

The covered warrants market in the UK that launched on the LSE in 2002 is the main focus of this research. The objective of the research is to enhance existing knowledge in the area of covered warrants as well as give indications as to their impact and trading opportunities.

This chapter is divided into four main sections. The first section focuses on the underlying price impact of having derivatives traded. It covers both the introduction and expiration of derivatives trading. The introduction period examines the listing and announcement periods. The second section is dedicated to documenting prior literature on the volume effect on the underlying securities upon derivatives introduction. The third section looks at how derivatives trading may influence the underlying securities' volatility. The final section presents the variety of warrant pricing methods available and the development of valuation models for covered warrants.

2.2 Pricing effect of derivatives trading

Classic pricing theory (Black & Scholes, 1973) suggests that an option is a redundant security because it can be synthetically replicated by a combination of assets already existing in the market. Under assumed perfect capital market conditions (the concept of the complete market with no trading frictions), options can be replicated by combining the underlying stock and riskless borrowing-lending investments. Under these perfect market assumptions, it is unlikely that options can have any direct effect on the underlying stock. However, it is difficult for the assumptions of the perfect capital market to hold completely true in practice. Thus, when the stock market is incomplete, the introduction of options will generate payoff patterns not previously available, which enhancing market efficiency, and affecting trading patterns and the price behaviour of the underlying stocks. Derivatives' trading expands the opportunity set of investments. It helps information to be more quickly impounded in underlying stock prices and reduces transaction costs, a consequence of greater competition among market makers. Moreover, the pricing argument of the Black & Scholes (1973) model relies upon the ability to continuously adjust one's holding of the underlying asset. In reality, trading frictions prevent this. The trading of derivatives helps make the market more complete and efficient.[6] If this is true, it can be argued that stock prices could be expected to increase with the introduction of derivatives. A positive price effect from the introduction of derivatives is found in numerous studies. Branch & Finnerty (1981) use a sample of options listed between 1973 and 1977. They suggest that initial option listings tend to provide a positive impact on the underlying stock price for the US market and the stocks with fewer shares outstanding seem to experience a proportionately larger increase in marketability associated with an initial option listing. Conrad (1989) demonstrated for US data over the period 1973 to 1980 that option introduction (not announcement) caused a permanent price increase in the underlying security, beginning approximately three days before introduction. The paper claimed that dealers/traders were building inventories for hedging purposes. The examination of the effect of option introductions on stock prices for US sample period 1973-1986 in Detemple & Jorion (1990) shows no announcement effect but positive cumulative abnormal returns of 2.8% in the two weeks around the listing date. They also document that the listing effect considerably lessened in later years (1982 to 1986) in their sample. The absence of positive price effects in later years is attributed to the introduction of options on S&P500 futures in April 1982 that essentially completed the markets. Haddad & Voorheis (1991) reported a positive price impact only on the introduction day for US data from 1973 to 1986, based on a sample of 327 options. Stucki & Wasserfallen (1994) examine the impact of options trading on 11 stocks in Switzerland. Though they observe a positive price reaction, the sample only includes options introduced on one single day. For the Norwegian market, Gjerde & Sattem (1995) employ daily data during 1990-1994. An event study is used and excess returns are calculated from the market model. They found a temporary price increase with a positive average excess return on the introduction day.

[6] See Ross (1976)

Sorescu (2000) paid no attention to announcement data but rather concentrated on the introduction period. He found a positive price effect for US option listing from 1973 to 1980 and a negative price effect for option listing from 1981 to 1995. The reasons for this switch in regime are inconclusive. He suggested that future research could try to concentrate on short sale restrictions as these seem to have the potential to explain the switch. There may be a case to use better proxies than age and size as in his paper. Watt, Yadav & Draper (1992) contribute to the literature by analyzing UK data. The results show that option listing is associated with a temporary price increase, with an increase before the listing date followed by a decrease after. The outcomes also indicate an increase in efficiency of price adjustment to new information after option listing. Draper, Mak & Tang (2001) examine a positive temporary underlying stock price effect of derivative warrants announcement within the Hong Kong market from 1993 to 1996. The excess return rises over the seven days before the announcement event and then falls during the next seven days. A similar result for the Hong Kong market during 1991-1997 is presented in the study of Chan & Wei (2001). They report a significant underlying stock price build up that occurs a few days prior to derivative warrant announcements, followed by a price decline a couple of days after. This suggests net demand for hedging by warrant issuers as they build up inventory a few days prior to warrant issuance.

Studies also exist that support the converse effect of a reduction in stock price once derivatives are introduced. Rao & Ma (1987) documented a negative excess return on announcement days consistent with the hypothesis that existing shareholders view the initial trading of options as a destabilizing influence on the underlying stocks. Evidence of an increase in information efficiency in the market is presented by Figlewski & Webb (1993). The relaxation of short sales constraints brought about by the introduction of options causes negative information to have a faster impact on the security's market price. Investors with unfavourable information can now buy puts and write calls instead of facing limitations in shorting the underlying stocks. This is evidenced by upward pressure on put prices and downward pressure on calls. The results from options introduction appear to support the predicted decline in stock price. The negative effect on stock price is consistent with the argument of Figlewski (1981) who suggests that buying put options or writing call options allow pessimistic investors to get around short sales constraints more efficiently and permits bearish views to be reflected in stock market prices. A more recent study on the

Australian Stock Exchange by Atiken & Segara (2005) shows significant negative abnormal returns to the underlying stocks on both the announcement and listing date of derivative warrants, followed by a steady decline in price.

Early studies suggest that stock option expiration results in a downward price pressure on the underlying stock just prior to the maturity date and an upward price pressure immediately afterwards. Klemkosky (1978) used US weekly data in 1975 and 1976. He focused on two weeks surrounding the expiration period and found approximately a negative 1% average residual price change in the expiration week followed by a positive 0.4% mean residual return in the subsequent week, though not nearly as significant as for the expiration week. Furthermore, the residual returns of the individual securities over all the periods in which options expire showed that a majority of the 76 companies experienced negative residual returns in the week of expiration and positive residual returns in the subsequent week. Officer & Trennepohl (1981) using US daily data from 1977 to 1978, observe statistically significant negative abnormal mean returns two days preceding the option expiration date and statistically significant positive abnormal mean returns on the second day afterwards. The former downward securities price pressure is possibly attributed to arbitrage activities and position adjustments by market makers and option investors. However, they indicate that it is unlikely that a trading strategy based on this expiration information could generate excess returns (after transactions expenses) due to the small size of the abnormal returns. Bhattacharya (1987) extends the literature of derivatives' expiration effect to cover this subject in the futures area. The study employs US data from 1982 through 1985. It uses a variant of the Comparison Period Approach (CPA) and finds no evidence of abnormal price behaviour in the underlying asset for Treasury bond futures either before or after the date of the option expiration, although evidence of increased price prior to the expiration of the option was detected. Pope & Yadav (1992) examine UK options data from 1982 to 1987. They show downward price pressure immediately prior to option expiration. The average residual return on the option expiry is statistically significant, but only negative 0.5% which is small in terms of economic significance since it can barely cover transaction costs associated with a trading rule based on this result.

As the empirical research on the price effect of covered warrants is still scarce and conflicting views abound, it is an empirical issue as to whether the introduction/expiration of a covered warrant has a price effect on the underlying stock. The issuance market for covered warrants is dominated by a few large financial institutions, with interests different to those prevalent in the option market. Moreover, different trading and regulatory mechanisms from option exchanges may lead to the expectation of significant evidence of price impacts at warrants introduction/expiration. The issuer is more likely to take a long position in the underlying securities both for hedging purposes before the initial trading of covered warrants and in an attempt to drive the price upward in order to gain a better warrant issue price. In addition, due to information leakage, other investors might receive this private information and buy the underlying securities prior to the covered warrant's introduction to capture the profit opportunity. This enhances the stock price rise further. Similar notions apply to the increase in the underlying security's price prior to the covered warrants expiration. On the other hand, there also exist arguments which predict a decrease in stock price during the covered warrants introduction. Firstly, investors could circumvent the short sale constraints by using warrants trading, either writing a call warrant or buying a put warrant. Investors who could not previously take a short position can now trade in warrants and benefit from trading on negative information. Secondly, the diversification of trading from the stocks to the warrants leads to the stock price reduction. Thirdly, the covered warrants trading could possibly be viewed by the existing shareholders as a destabilizing factor for the underlying stock and result in the selling of the stock which would generate a decline in stock price. In truth, the question as to the real underlying price impact created by the introduction of covered warrants is still left unanswered.

2.3 Volume effect of derivatives introduction

The investigation on stock trading volume of the effect of the introduction of derivatives has had mixed results. Gjerde & Sattem (1995) report volume impacts for the Norwegian market, using 1990 to 1994 daily data. The analysis of trading volume was conducted using a time-series regression model. They found a significant increase in optioned stocks trading volume due to option listing. Kumar, Sarin & Shastri (1998) using

US data also report an increase in trading volume of the underlying security after option listing whereas Damodaran & Lim (1991) report a decrease in trading volume after the introduction of options in the US. Kumar, Sarin & Shastri (1995) document a decline in volume for the index option stocks as a result of option listing. The result is consistent with the view that option trading causes a movement of speculative and market-wide information-oriented trading activity from the underlying stock market to the option market. Evidence for Canada of no change in trading volume is presented in Chamberlain, Cheung & Kwan (1993).

Covered warrants may be expected to give investors more investment alternatives and can induce more hedging activities, particularly when there is no other similar contract. Moreover, the existence of warrants could entice trades towards warrants from the underlying stocks. This would result in an expected reduction in trading volume of the underlying stock.

On the other hand, there is empirical evidence suggesting a rise in trading volume during warrant listing. Chan & Wei (2001) examine the volume effect on the underlying stock behaviour around the announcement date of derivative warrants for the period 1991 to 1997 in Hong Kong. They found a high level of trading activity in the underlying stock for five days around the warrant announcement date and also find a sharp increase in volume of the underlying stocks during the last 5 trading minutes on the announcement day. However, they report no significant effects around the listing dates of the warrants. Chen & Wu (2001) base their study on Hong Kong data from 1989 to 1997. There is a strong positive relationship between price impact and trading volume of the underlying securities on both introduction and expiration of derivative warrant. Trading volume increases significantly during the introduction day as measured using the daily turnover rate method to generate the abnormal trading volume. Furthermore, the trading volume drops on the first warrant trading day therefore indicating a temporary volume effect. Draper et al. (2001) analyze the effect of the introduction of derivative warrants on the volume of trading in the underlying security with the Stock Exchange of Hong Kong (SEHK). They report a rise in volume of underlying stock trading because of the warrant introduction. According to the previous literature, it would be very useful to test for further evidence of the underlying volume effect from covered warrants traded in the UK market in order to add supporting results of impact direction to the prior studies.

2.4 Volatility effect of derivatives introduction

Under the assumption of complete markets with no transaction costs, any new security can be synthesized from existing securities within the market. This generates a belief that the introduction of derivatives should not have any effect on underlying assets. Grossman (1988) suggests the possibility that options can have an impact on the underlying due to the existence of incomplete market and transaction costs in the real world. The study employs a theoretical framework to analyze the informational content of a traded option in relation to its synthetic counterpart. The conclusion indicates derivatives may affect the variance of the underlying assets.

The early empirical studies on this aspect of the effect of derivatives suggested that volatility is reduced with the introduction of derivatives. Hayes & Tennenbaum (1979) is the earliest research in this area. They analyse US stocks on which call options were listed during 1972 to 1977. The comparison with a control group of non-options listed stocks during the same period shows a decrease in volatility of 15-20% of the optioned stocks relative to non-optioned stocks. Bansal, Pruitt & Wei (1989) using the square-return volatility tests find a 6.4% decrease in return volatility after option listing over the period 1973-1986 in the US market. Skinner (1989) presents a decline on average of 4.8% of total stock return variance after options introduction. Conrad (1989) estimates that the daily excess return variance drops from 2.29% for 200 days before option listing to1.79% for the 200 days after option listing. The survey by Damodaran & Subrahmanyam (1992) reviews more studies which look at the impact of option listing on the return variance of the underlying securities. A more recent US study by Mayhew & Mihov (2000) find that the volatility of stocks are increased because of the introduction of option trading. There are a number of studies conducted in other markets which provide results that are similar to the early US evidence. By analysing UK data, Watt et al. (1992) report a decrease in variance after the option listing. However, option trading has no significant effect on beta. Supporting evidence for Switzerland is provided by Stucki & Wasserfallen (1994). For Japan, Kumar, Sarin & Shastri (1995) report a decrease in stock volatility as a consequence of options trading. For Sweden, Alkebäck & Hagelin (1998) find a reduction in volatility for both unadjusted and adjusted volatility after stock option introduction. To take account of possible changes in market volatility, the adjusted volatility measure is used. Nevertheless, they report no change in volatility surrounding company warrant introduction. For Finland, Sahlastrom (2001) suggests a lower volatility of the underlying stock is due to option listing. However, there is conflicting evidence employing Canadian data. Elfakhani & Chaudhury (1995) find a reduction in stock variance from option listings. On the other hand, Chamberlain et al. (1993) report no statistically significant change in the volatility of option listings. Earlier research by Whiteside, Dukes & Dunne (1983) also demonstrates no statistically significant change in the volatility instantaneously after options are introduced in the US market for both daily and yearly traded shares. Pierre (1998) uses an EGARCH model to capture changes in unconditional volatility observed in the study sample. He documents an absence of any significant change in underlying stock volatility from an initial option listing during 1973 to 1990, using US daily data.

The work by Freund, McCann & Webb (1994) and Bollen (1998) show that similar effects occur in both a sample of optioned stocks and a matched control sample of non-optioned stocks. Moreover, the direction of the volatility effect is not consistent over time. For instance, Bollen (1998) documents that after 1987, the residual variance increased during option listing for both options stocks and non-optioned stocks in a matched control sample. This control sample related evidence can be explained in various ways. Firstly, there is no true effect on volatility. Thus, the apparent increase in volatility effect is spurious. Such a result could be expected if a common factor is a driving force of different companies' non-systematic risk. Secondly, as mentioned in the theoretical work by Cao (1999), the volatility effect of the listing of an option on one stock can spill over to other stocks, especially those with returns most strongly correlated with the optioned stock. In other words, the option listing would influence the dynamics of other related stocks. This means stocks in the control sample would not be immune to the effects of option listing in this particular case.

Three possible components of stock return volatility are mentioned in Amihud & Mendelson (1987). The first component is the underlying firm's instability, an intrinsic part of variance. Thus, it would not be affected by option listings. The second and third components are a consequence of an imperfect price adjustment process and noise which results from information noise and the bid-ask spread. Both of these two components occur because of imperfect markets. The imperfect price adjustment process in the market might be due to friction in the trading process which cause autocorrelation in the return series as stock values cannot adjust simultaneously to new information. The noise is related to the problems from the use of information stated in Black (1986). The information may not be understood by all market participants. The misunderstanding and misinterpretation of information could lead to errors creating noise in the trading process. In addition, even if all information is observed, its impact might be too complicated to detect with certainty. Noise trading may provide more liquidity due to an increase in the trading in the market. Nevertheless, it could also increase the volatility of the market. Noise trading has been used as a significant factor affecting volatility such as in the study of French & Roll (1986) and Jones, Kaul & Lipson (1994). If option trading improves the underlying security markets' activity and the efficiency of the market, it would result in a more accurate price adjustment process and a decline in the noise effect and lower bid-ask spreads. Hence, stock return volatility would expect to be lower after the option listing than before. Moreover, the trading intentions of investors may be revealed by derivatives trading. Stocks can become less volatile with the increased incentive to acquire new information. A decrease in stock volatility after derivative introduction could be a consequence of the increase in trading volume of the underlying stock, hedging activities by issuers or market makers, and wider media coverage. Furthermore, researchers also suggest more reasons why a reduction in stock return variance could follow the derivative introduction. The underlying stock must meet certain criteria to be qualified for option listing. The selection criteria may cause a bias in the sample due to an expectation in stock return variance reductions. The Exchange tends to have a criterion of high or increasing variance as a reason to list options. Therefore, mean reverting theory would result in stock reverting back to the mean at some point after option listing which may result in a correlation of option listing and a decline in the underlying stock variance. Another reason for a stock variance reduction is lower bid-ask spreads. Fedenia & Grammatikos (1992) have indicated that bid-ask spreads in the stock markets narrow after option listings, hence reducing the bid-ask fluctuation in stock prices and the variance of stock returns. The option introduction might create more efficient opportunities for hedging risks for market makers therefore allowing them to narrow their spreads.

The underlying stock volatility can be increased by derivatives introduction. Trading in a derivative market may attract more investors which may cause increased volatility in underlying stock prices. The existence of derivatives trading may cause a diversion of trading from the stock market to the derivative market. If the introduction of derivatives lures a significant amount of trading volume away from the underlying stock this could lead to a decrease in stock trading volume. The decline in liquidity may then increase the stock price volatility. Damodaran (1990) tests the effect of the S&P 500 futures contract introduction in April 1982 on the stocks in the index. The data employed included 1250 trading days before and after the introduction of the futures contract. He shows that stocks in the index had significantly but modestly higher betas and total variances after futures listing. The evidence provided in the paper explains that these increases corresponded to a trading activity variable, and suggests much heavier trading and noise after the listing.

There are several theoretical and empirical arguments that derivative introduction might affect the underlying stock return variance: the precise direction of the effect is still debatable. Moreover, the covered warrants evidence is inconclusive. Covered warrant introductions on the Mexican Stock Exchange (MSE) are investigated by Hernandez-Trillo (1999). The investigation uses daily data from 1992 to 1996. He suggests that their introduction did not reduce stock return volatilities even before the Mexican financial crisis of 1994. The distinct feature of the MSE is the absence of a clearinghouse for derivatives trading. Therefore, Mexican warrants can be seen as OTCs. Both an event study methodology and an ARCH/GARCH methodology are used in the study. Draper et al. (2001) report no significant impact on the underlying stock return volatility post-covered warrant introduction in Hong Kong market, whereas Aitken & Segara (2005) find a significant increase in underlying stock volatility after covered warrant listing on the Australian market.

2.5 Valuation of derivatives

2.5.1 The company warrants pricing models

Black and Scholes (1973) claim that their model can be used as an approximation to give an estimate of the warrant value in many cases. However, they warn that over a period of years, which is normal for warrant life, the variance rate of return on the stock may change substantially. This could lead to a problem as Black-Scholes assumes that equity return variance is constant. The empirical evidence of Christie (1982) shows that return volatility is not constant but rather is negatively correlated with stock prices. In other words, stock volatilities decrease as stock price rise and vice versa. A better approach might be based on the Cox (1975) constant elasticity of variance (CEV) model.

Based on the Black-Scholes (1973) model, Lauterbach & Schultz (1990) propose the warrant pricing formula known as the Black-Scholes dilution-adjusted model. They follow an idea suggested by Galai & Schneller (1978) who show a way to take the dilution effect into account. Lauterbach & Schultz also made a comparison of Black-Scholes and CEV model forecasts. They follow the suggestion about potential parameter values discussed in Beckers (1980) in order to overcome the noise associated with estimating an additional parameter for Cox's CEV model. Applying this with the dilution adjustment used for the Black-Scholes warrant model, they obtain a specific form of the CEV model known as the Square-Root CEV model (SRCEV). This model was shown in their paper using US daily data (during 1971-1980) to provide more accurate price forecasts than the Black-Scholes dilution-adjusted model.

Hauser & Lauterbach (1997) suggest the Longstaff extendible-warrant model which is obtained by adopting the dilution adjustment used in the Black-Scholes dilution-adjusted model with the Longstaff (1990) writer-extendible call option model. They assume that the exercise price remains unchanged upon extension and warrants are allowed to be extended only after they expire out of the money. In addition, based on the notion that the callability feature of warrants should not be ignored in determining warrant value, Burney & Moore (1997) derive and test a simple valuation model for callable warrants which results in less error in price prediction in comparison to the simple Black-Scholes model. However, they claim the stock price should already incorporate the potential impacts of dilution. Therefore, a dilution adjustment could be ignored because of the stochastic process followed by the underlying stock.

Referring to Ritchken (1987), Hauser & Lauterbach (1997) suggest that binomial approximation formulas could be used for the CEV case as well as adjusting for dilution in order to overcome the limitation of the parameter assumption underlying the square-root CEV model. This approach has been introduced under the name of the Free-Theta CEV model.

Evidence that supports the CEV-based models over the Black-Scholes-based models is discussed in Hauser & Lauterbach (1997). Alternative version are provided in Noreen & Wolfson (1981) and Ferri, Kremer & Oberhelman (1986).

2.5.2 Covered warrants pricing models

The previous studies on alternative pricing models of options are referred in order to find the best possible pricing model of covered warrants due to several similar characteristics between options and covered warrants. It has traditionally been assumed that Black-Scholes option prices have no default risk. However, many options and financial instruments containing option-like payoffs are issued by financial institutions that have limited assets. Thus, default risk is frequently possible. Johnson & Stulz (1987) has taken this seriously and named options subject to default risk as Vulnerable options. An improved method of pricing Vulnerable Black-Scholes options is presented in Klein (1996). The exposure to potential credit risk arises because the options are not traded and have no marked to market rule. There is the possibility of the counterparty (issuer of option) being unable to make the necessary payments at the exercise date. This paper extends Johnson & Stulz (1987) by allowing the option writer to have other liabilities which rank equally with payments under the option and also extends Hull & White (1995) and Jarrow & Turnbull (1995) by relaxing the assumption of independence between the assets of the counterparty and the asset underlying the option, and by specifying a payout ratio which explicitly relates to the value of the assets of the counterparty (a proportional recovery of nominal claims of option in default). The model calculates the effect of credit risk on Black-Scholes options values as being much less when there is positive correlation between the assets of the counterparty and the asset underlying the option, in contrast to when this correlation is negative. This supports the finding that the price of an option under the model introduced in this paper is higher than in Johnson & Stulz (1987) which understates the real option value especially for the positive correlation case. The results are also compared to Hull & White (1995). The comparison examines reductions in option values due to credit risk. The effect of credit risk calculated using the model is generally less than that reported by Hull & White (1995) for European options, and is similar to their calculations for American options. This difference is due to the relatively higher payout ratio assumed in this paper which allows the possibility of the assets of the counterparty to be recovered subsequent to an event of default before the option maturity date. Hence, this paper presents results suggesting that Hull & White (1995) seem to understate the option value under their assumption of credit risk.

Chen (2003) conducted a study on daily data of 23 Taiwan call covered warrants from August 1997 to December 2000. The study involves investigating the difference in the theoretical value of a Vulnerable warrant, Black-Scholes option price and the market price of warrant. The valuation model for Vulnerable warrants is adapted from a generalized pricing model for Vulnerable option in Klein (1996). There are two main motivations to adapt this model to Taiwan warrant data. Firstly, the Taiwan market provides no margin settlement mechanism for existing covered warrants. Therefore, the credit risk of the warrant issuer should be taken into account when evaluating a covered warrant price. Secondly, perfect hedging is not practical because of market imperfections, thus the warrant issuer cannot perfectly hedge their exposure in the spot market. In addition, warrant issuers not only face underwriting risk, but also other operating and financial risks. Hence, the issuer's credit risk must be considered in warrant pricing. The findings show that after considering the default risk of the warrant issuer, the daily price of the theoretical value of a Vulnerable warrant is consistently lower than the non-Vulnerable warrant value (Black-

Scholes option value). Moreover, except one warrant, the average daily theoretical values of Vulnerable warrants are lower than their market prices. The market prices of Taiwan covered warrants, after allowing for the credit risk of the issuers, are possibly overvalued. The study further divided each warrant lifetime into in-the-money, at-the-money and out-of-the-money, and then examined the difference between the Vulnerable warrant value and Black-Scholes option value. The Vulnerable warrant value is lower than Black-Scholes option value. The magnitude of this is larger for in-the-money warrants than that for out-of-the-money warrants. Investors face the default risk of issuers only when the Vulnerable warrant is in-the-money. When a warrant is out-of-the-money, the exercise value is zero, thus it is not necessary to consider credit risk. Furthermore, the study shows that the Vulnerable warrant price will be close to Black-Scholes option price when the warrant is approaching expiration because the shorter time to maturity, the lower the probability that the asset value of the issuer will drop below its liability (lower probability of issuer's bankruptcy). Consequently, the Vulnerable warrant price and Black-Scholes option price will be equal some days before warrant's maturity.

The recent financial distress makes the matter of default risk a reasonable factor in covered warrants pricing. Thus, further investigation of Vulnerable covered warrants in the UK would be a valuable comparison with the existing literature.

Chapter 3 : Research Methodology

This chapter provides the general background and a theoretical framework for the main methodology, an event study, used throughout this study in order to analyse UK covered warrants. The event study methodology has a long history and is reviewed and summarized in detail by MacKinlay (1997).[7] It is an often used method of measuring security price changes in response to events. The event study process involves several important steps. These will be considered in the following sections 3.1 to 3.5.

3.1 Event and estimation period

The event of interest must be decided. Then, the event period (window) and the estimation period (window) are identified. Typically the event period is not allowed to overlap with the estimation period to prevent the influence of the event affecting the long run estimates. The event period often covers both days before and days after the event in order to capture the whole effect of the event. Following Brown & Warner (1985) the event period should be kept small. They indicate that a decrease in the power of the tests occurs when a long interval for the event period is used.

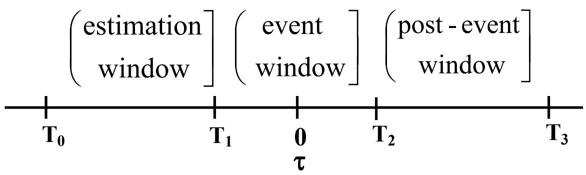


Figure 3.1: Time line for an event study

[7] Other important references are Peterson (1989) ,Henderson (1990), Strong (1992) and Armitage (1995).

3.2 Calculation of returns

There are two choices, discrete or logarithmic returns.

Discrete (simple) return: $R_{it} = \dfrac{P_{it} + D_{it} - P_{it-1}}{P_{it-1}}$

Logarithmic return: $\ln\left(\dfrac{P_{it} + D_{it}}{P_{it-1}}\right)$

Where P_{it} = the price of security *i* at the end of period *t*

D_{it} = the dividend of security *i* during the period *t*

P_{it-1} = the price of security *i* at the end of period *t-1*

Reasons for preferring logarithmic returns over discrete returns are suggested by Strong (1992). Logarithmic returns are analytically more tractable when returns over longer intervals are formed (one can simply sum up the continuously compounded returns of the subperiods).[8] Moreover, logarithmic returns are more likely to be normally distributed and are therefore more compatible with the assumptions of standard statistical techniques. Fama (1977) explains that the general distributions of stock returns are slightly right-skewness relative to normal distributions. The use of continuously compounded returns has the impact of pulling in the right tails of the distributions and stretching out the left tails, thus reducing the degree of right-skewness of the distribution.

3.3 The benchmark for Abnormal returns

There are four main classes of techniques to determine the abnormal return that have been used in previous research. Moreover, there are several variations to choose from choices available within each class:

[8] whereas the discrete return involves a product of the subperiod discrete returns in order to form return over longer interval

3.3.1 Market Models

The ordinary least squares (OLS) model, OLS regression

This is the most common model of adjusting returns for influences that affect all stocks.[9] It is also said by Armitage (1995) to be the most common benchmark employed in event studies.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

where R_{it} = the rate of return on a security i in period t

R_{mt} = the rate of return on a market portfolio in period t

α_i = the intercept of the regression line

β_i = the effect of the market portfolio return on a security i

ε_{it} = the zero mean disturbance term

$\text{var}(\varepsilon_{it}) = \sigma^2_{\varepsilon_t}$

In order to examine the event's impact, the abnormal returns before and after the event must be measured. Using the parameters estimated (α_i and β_i) for the market model, the abnormal returns (AR) can be calculated. They are the difference between the actual and the normal (predicted/market model) returns.

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where } \hat{R}_{it} = \alpha_i + \beta_i R_{mt} \quad (2)$$[10]

[9] The use of OLS parameter can be seen in DeAngelo, DeAngelo, &Rice (1984), Dodd (1980), Mikkleson & Partch (1986) Smith (1977)

[10] The abnormal return is basically the disturbance term, ε_{it}, of the market model computed on an event period outside the estimation period.

$$AR_{it} = R_{it} - \hat{R}_{it} = \varepsilon_{it}$$

However, the β_i calculated using OLS may be biased due to the securities trading delay or trading frequencies different from the market index. This problem is generally known as nonsynchronous trading bias. There are several alternative adjustments for this problem (Scholes & William (1977), Dimson (1979)). However, Brown & Warner (1985) do not find any improvement to the power of tests for abnormal performance from employing either of the Scholes & William (1977) or Dimson (1979) methods.[11] The detail discussions of these two methods are the following.

Scholes and William (1977)[12]

This procedure was developed to support the use of the daily returns data in the case of infrequently traded securities. It involves the estimation of three OLS regressions using the T daily security returns within the estimation period.

$$R_{it} = \alpha_{i1} + \beta_{i1} R_{mt} + \varepsilon_{1t} \qquad \text{for } t = 1, 2, \ldots, T$$

$$R_{it} = \alpha_{i2} + \beta_{i2} R_{m,t+1} + \varepsilon_{2t} \qquad \text{for } t = 1, 2, \ldots, T-1$$

$$R_{it} = \alpha_{i3} + \beta_{i3} R_{m,t-1} + \varepsilon_{3t} \qquad \text{for } t = 2, 3, \ldots, T$$

The Scholes-Williams beta is formed as follows:

$$\beta_{iSW} = \frac{\beta_{i1} + \beta_{i2} + \beta_{i3}}{(1 + 2P)}$$

where β_{ik} = the effect of the market portfolio return on a security i for k = 1, 2, and 3

β_{iSW} = the estimated Scholes-Williams beta

P = the estimated serial correlation of R_{mt} from t = 2 to t = T-1

[11] The power of the test in this context means the ability to detect abnormal security performance (return) under a use of test statistic when abnormal security performance (return) is present. For example, reject the null hypothesis of no abnormal return when it should be rejected which reduces Type 1 error.

[12] The use of the Scholes-Williams methodology can be seen in Rendleman, Jones, & Latane, (1982) and Moore, Peterson, &Peterson (1986)

$R_{m,t-1}$ = the market return in period t-1

$R_{m,t+1}$ = the market return in period t+1

The corresponding Scholes-Williams intercept (α_{iSW}), is calculated as:

$$\alpha_{iSW} = \left(\frac{1}{T-2}\right)\left[\sum_{t=2}^{T-1} R_{it} - \beta_{iSW}\sum_{t=2}^{T-1} R_{mt}\right]$$

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where } \hat{R}_{it} = \alpha_{iSW} + \beta_{iSW} R_{mt}$$

Dimson (1979)[13]

This procedure was developed to avoid biased estimation of parameters using daily returns of infrequently traded securities. The purpose is the same as for the Scholes & William (1977) method.

The procedure involves a multiple regression of lagged, current, and lead values of the return on the market index, and the aggregation of the slope coefficients in the regression:

$$R_{it} = \alpha_i + \beta_{i1} R_{m,t-1} + \beta_{i2} R_{mt} + \beta_{i3} R_{m,t+1} + \varepsilon_t \qquad \text{for} \quad t = 2,3,4,\ldots,T-1$$

The Dimson beta is thus;

$$\beta_{iD} = \beta_{i1} + \beta_{i2} + \beta_{i3}$$

[13] The use of the Dimson methodology can be seen in Basu (1983) and Bhagat (1983). In addition, there have been criticisms of the method relating to properties of the estimator by Cohen, Hawawini, Maier, Schwartz & Whitcomb (1983) and Fowler & Rorke (1983).

The corresponding Dimson intercept (α_{iSW}), is calculated as:

$$\alpha_{iD} = \left(\frac{1}{T-2}\right)\left[\sum_{t=3}^{T-3} R_{it} - \beta_{iD}\sum_{t=3}^{T-3} R_{mt}\right]$$

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where } \hat{R}_{it} = \alpha_{iD} + \beta_{iD} R_{mt}$$

3.3.2 Mean-adjusted Models[14]

The mean-adjusted return model (the average return model/the constant mean return model)

Although this is perhaps the simplest model, Brown & Warner (1980; 1985) find it often yields results similar to those of more sophisticated models. It assumes that the expected return of security *i* is a constant R_{it},

$$\overline{R}_i = \left(\frac{1}{T}\right)\sum_{j=1}^{T} R_{ij}$$

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where } \hat{R}_{it} = \overline{R}_i$$

[14] The use of the mean-adjusted return methodology can be seen in Kalay & Loewenstein (1985).

The control portfolio model[15]

This is a modification of the mean-adjusted return methodology for determining expected returns. In this method, returns of a test portfolio are compared with those of a control portfolio designed to have the same risk, measured by beta. It is presumably that the control portfolio should not be affected by the event in the event study.

Then, the excess return calculation becomes:

$$AR_{pt} = R_{pt} - R_{ct}$$

where R_{ct} = the return on the control portfolio c, designed to have the same beta as p.

3.3.3 Market-adjusted Model (Index model)

This model can be viewed as a restricted market model with α_i constrained to be zero and β_i constrained to be 1. It assumes that the best predictor of returns for a given security is the current return on the market R_{mt}. Therefore, no information other than that available in the event period is necessary to assess abnormal/excess returns during the event period.

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where} \quad \hat{R}_{it} = R_{mt}$$

This method is generally very useful when there is limited data availability. For example, the normal model parameters derived from a pre-event estimation period may not

[15] The use of the control portfolio concept is presented in Bradley (1980), Asquith (1983) and Asquith & Mullins (1986).

be feasible. Moreover, using this method to support others should help ensuring the validity of the final outcomes.

3.3.4 Economic Models

The Capital asset pricing model (CAPM)[16]

The CAPM (Sharpe (1964) and Lintner (1965)) is an equilibrium theory which assumes the expected return of a given asset is a linear function of its covariance with the return of the market portfolio. It was commonly used in event studies during the 1970s.[17] However, during the past two decades, the use of the CAPM in event studies has almost ceased due to concerns on the validity of restrictions imposed by CAPM on the market model.

$$R_{ij} = R_{ft} + \beta_i \left(R_{mt} - R_{ft} \right)$$

where R_{mt} = the expected return on the appropriate stock market of period t.

R_{ft} = the risk free rate of interest of period t.

β_i = the covariance of R_{ij} with R_{mt} over some estimation period which is $\left(\text{cov}\left(R_{ij}, R_{mt}\right)\right)$ divided by the variance of R_{mt} over that period $\left(\text{var}\left(R_{mt}\right)\right)$.

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[16] *The CAPM model* collapses to *the mean-adjusted return model* if a security's systematic risk (β_i) is constant and if R_{ft} and R_{mt} are constant over time. Moreover, *the CAPM model* can also collapses to *the Market-adjusted Model (Index model)* if all securities have the same systematic risk as the market which means β_i=1.

[17]For further reference see Campbell, Lo & MacKinlay (1997).

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \text{ where } \hat{R}_{it} = R_{ij}$$

Since the restrictions imposed by CAPM can be relaxed at a small cost by employing the market model, it would not add much benefit to use CAPM in the study.

Arbitrage Pricing Theory (APT)

According to Ross (1976), the APT is an asset pricing theory where the expected return of a given asset is a linear combination of multiple risk factors. A general finding is that with the APT the most important factor behaves like a market factor and additional factors add relatively little explanatory power. Hence, the gains from using the APT motivated model versus the market model are small. Moreover, the complications associated with its implementation in an event study add very little advantage over the unrestricted market model. (see Brown & Weinstein (1985) for an example) The model is:

$$R_{ij} = \lambda_0 + \lambda_1 \beta_{1i} + \ldots + \lambda_k \beta_{ki}$$

where R_{ij} = the rate of return on a security i in period j

λ_0 = the expected return on the security when all factors take the value zero

λ_k = the *k*-th zero mean factor that influence R_{ij}

β_{ki} = the sensitivity of security i to the *k*-th factor

Then, the excess return calculation becomes:

$$AR_{it} = R_{it} - \hat{R}_{it} \text{ where } \hat{R}_{it} = R_{ij}$$

Due to the above drawbacks of the APT model, this economic model is no longer often used in event studies.

The chosen models of measuring normal and abnormal performance

This study employs three models which are the market model (the OLS model), the mean-adjusted model (the average return model) and the market-adjusted model (the index model) in order to analyse the effects of covered warrant trading on both the underlying security price and volume. The advantages for using these three models in comparison to others existing models are discussed previously. It seems that the additional benefits from other more complicated models are not worth the cost that must be involved when actually employed them in practice (Brown & Warner, 1980, 1985). Therefore, this study is designed according to the three simple models to measure the normal and abnormal performance of the underlying securities of the UK covered warrants.

3.4 Aggregation of Abnormal Returns

Two alternative methods are commonly used. This will be discussed below.

3.4.1 Cumulative Abnormal Return, CAR

To accommodate a multiple period window, a cumulative abnormal return (CAR) is employed. The aggregation can be conducted either through time or across securities' dimensions:

Approach I: Time-series aggregation

This approach considers the CAR through time for an individual security;

$$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau} \qquad (5)$$

Where $T_1 < \tau_1 \le \tau_2 \le T_2$

τ = each event period

T_1 = the beginning of the estimation window

T_2 = the end of the post-event window

These are previously discussed in detail in section 3.1

After forming the CARs for each security, aggregate them through time. Then average them across the number of securities in the study sample:

$$\overline{CAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(\tau_1,\tau_2) \tag{6}$$

Where N = numbers of securities

Approach II: Cross-sectional aggregation

This approach aggregates the individual securities' abnormal returns for each event period and averages them across the total number of securities;

$$\overline{AR}_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau} \tag{7}$$

Moreover, the average cumulative abnormal return can next be estimated over the event window via the summation of the average abnormal returns;

$$\overline{CAR}(\tau_1,\tau_2) = \sum_{\tau=\tau_1}^{\tau_2} \overline{AR}_\tau \tag{8}$$

3.4.2 Buy-and-Hold Abnormal Return, BHAR

The BHAR calculates the abnormal return from investing equal amounts in each security and then holding these securities over the cumulation period. The portfolio is not rebalanced at any point. Thus, the BHAR does not implicitly assume rebalancing of a portfolio each period unlike the CAR.

$$BHAR(\tau_1, \tau_2) = \left(\frac{1}{N} \sum_{i=1}^{N} \prod_{t=\tau_1}^{\tau_2} \left(1 + AR_{it}\right) \right) - 1$$

or

$$BHAR(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} \left(\prod_{t=\tau_1}^{\tau_2} \left[1 + r_{it}\right] - \prod_{t=\tau_1}^{\tau_2} \left[1 + E(r_{it})\right] \right)$$

Where $E(r_{it})$ = the expected return on security *i* in period *t* (obtained from the chosen benchmark model)

The comparison between CAR and BHAR

Barber & Lyon (1997) show that cumulative abnormal returns are a biased predictor of long-run buy-and-hold abnormal returns. This means CARs are subject to measurement bias in tests designed to detect long-run abnormal stock returns.[18] However, both CARs and BHARs are subject to the new listing bias. Due to the evidence that the newly listed firms that go public underperform an equally weighted market index (Ritter, 1991), the new listing bias will lead to a positive bias in the population mean over long horizons' abnormal returns. In addition, both CARs and BHARs are positively skewed but the positive skewness is less pronounced in CARs because the cumulative abnormal returns are summed rather than compounded like in BHARs. This reason can also explain why BHARs suffer from rebalancing bias when an equally-weighted market index is used whereas CARs are not. Therefore, the CAR method is usually employed in short-run studies whereas the

[18] The long-run is generally applies to event windows of one year or more.

BHAR method is more appropriate in long-run analyses.[19] Given the short-run event windows employed in this thesis, I have chosen to use CAR approach.

3.5 Choice of estimation procedure and significance test

In the general case, a null hypothesis (H_0) of no abnormal return is tested against an alternative hypothesis (H_1) of significant abnormal return. There are various approaches (dependent on a set of assumptions) which have been used to measure the significance of estimated abnormal returns.[20]

3.5.1 Simple t-tests

Simple t-tests of abnormal returns

It is the simplest procedure to test the significance of abnormal returns. There are two main assumptions of this procedure. Firstly, abnormal returns (AR_{it}) are identically distributed and independent across securities. Secondly, AR_{it} is drawn from a normal distribution (with zero mean under H_0).

The test statistic can be calculated as:

$$\theta_\tau = \frac{\overline{AR}_\tau - \overline{R}}{s_\tau / \sqrt{N}}$$

where $\overline{AR}_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau}$ = average abnormal return at time τ which are time during the event period.

[19] For further reference, see Barber & Lyon (1997), Trojanowski (2006) and Gregory (2007).

[20] These assumptions include independence, normality, lack of skewness, homogeneity of variance, etc.

$\overline{R}$ = mean = 0

$$s_{\tau}^{2} = \frac{1}{N-1}\sum_{i=1}^{N}\left(AR_{i\tau} - \overline{AR}_{\tau}\right)^{2}$$

under H_0, θ_τ has a student-t distribution with ($N-1$) degrees of freedom.

Simple t-tests of cumulative abnormal returns

A similar procedure to the simple t-tests of abnormal returns can be done with some modification to calculate the significance t-test of cumulative abnormal returns.

The test statistic can be calculated as:

$$\theta_{\tau} = \frac{\overline{CAR}(\tau_1, \tau_2) - \overline{R}}{s_{\tau_1,\tau_2} \big/ \sqrt{N}}$$

where $\overline{CAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(\tau_1,\tau_2)$ = average cumulative abnormal return at time during τ_1, τ_2.

$\overline{R}$ = mean = 0

$$s_{\tau_1,\tau_2}^{2} = \frac{1}{N-1}\sum_{i=1}^{N}\left[CAR_i(\tau_1,\tau_2) - \overline{CAR}(\tau_1,\tau_2)\right]^{2}$$

under H_0, θ_τ has a student-t distribution with ($N-1$) degrees of freedom.

In both cases, the distribution of θ_τ converge to a normal distribution, $N(0,1)$, as $N \to \infty$.

Thus, in order to test the null hypothesis that the mean abnormal returns or the mean cumulative abnormal returns are equal to zero for a sample of N securities, the above two parametric test statistics can be employed.

3.5.2 Patell test

Modifications to the basic approach of the Simple t-tests presented previously are possible. To standardize each abnormal return employing an estimator of its standard deviation is one common modification. Patell (1976) demonstrates tests based on standardization. Patell test can be referred to as a standardized abnormal return test or a standardized residual test. The test allows for heteroskedasticity of abnormal returns and assumes cross-secctional independence and normally distributed of returns. The normal returns are generated by market model under the basic procedure.

Under H_0, each AR_{it} has mean zero and variance $\sigma^2_{AR_{it}}$. The maximum likelihood estimate of the variance is:

$$s^2_{AR_{it}} = s^2_{AR_i}\left[1 + \frac{1}{L_i} + \frac{\left(r_{Mt} - \overline{r}_M\right)^2}{\sum_{k=T_0+1}^{T_1}\left(r_{Mk} - \overline{r}_M\right)^2}\right]$$

where $s^2_{AR_i} = \dfrac{\sum_{k=T_0+1}^{T_1} AR^2_{ik}}{L_i - 2}$

L_i = the number of observations for firm i in the estimation period

r_{Mt} = the observed return on the market index on day t

$\overline{r}_M$ = the mean market return over the estimation period

Define the standardized abnormal return (or standardized prediction error) as:

$$SAR_{it} = \frac{AR_{it}}{s_{AR_{it}}}$$

Under H_0, each SAR_{it} follow a Student-t distribution with $L_i - 2$ degrees of freedom. Summing the SAR_{it} across the sample, we obtain:

$$TSAR_{it} = \sum_{i=1}^{N} SAR_{it}$$

The expected value of $TSAR_{it}$ is zero. The variance of $TSAR_{it}$ is $Q_i = \sum_{i=1}^{N} \frac{L_i - 2}{L_i - 4}$.

The test statistic for H_0 that $CAAR_{T_1,T_2} = 0$ is shown below:

$$z_{T_1,T_2} = \frac{1}{N} \sum_{i=1}^{N} \left(\frac{\sum_{t=T_1}^{T_2} SAR_{it}}{\sqrt{\left(T_2 - T_1 + 1\right) \frac{L_i - 2}{L_i - 4}}} \right)$$

The distribution of the test statistic converges to a standard normal distribution for large sample under H_0. A similar procedure can be employed in order to test for significance of AR_{it}.

The comparison between Simple t-tests and Patell test

The Simple t-tests is generally used for a given performance measure such as the AR and CAR. The test assumes distribution under H_0 that mean abnormal performance equals zero as shown previously. However, an alternative would be a Patell test which aggregates standardized abnormal returns into the procedure. A test using standardized abnormal returns like this is in principle superior and more powerful under certain conditions but Brown & Warner (1980; 1985) provide comparison with the basic approach and empirically report that in short-horizon studies it typically makes little difference. Therefore, this thesis focuses on the use of the Simple t-tests.

3.6 Conclusion

The theoretical framework of the event study methodology has been proposed in this chapter. This includes the determination of the event and estimation period, choosing the way to estimate returns, finding the benchmark for normal and abnormal returns, aggregating the abnormal returns and selecting the estimation procedure and significance test. The next chapter follows these steps to test the price and volume effects of the underlying securities from the introduction and expiration of covered warrants traded in the UK market.

Chapter 4 : Price and volume effects of covered warrants trading

4.1 Introduction

4.1.1 Background

It is generally thought that one of the reasons for the 1987 stock market crash was the use of index futures and options as part of computer-based program trading strategies (Lee & Ohk (1992)). Therefore, the growing interest and concern over the derivative markets have introduced many queries about the role and impact they may have on the financial markets or in other words, the underlying markets. There have been a number of debates over how important and useful the trade in derivative products is, and whether the trade is beneficial or detrimental to the existing financial markets.

The introduction of derivatives trading has been argued to make the stock markets more complete. Ross (1976) was the first to suggest that option introduction would have some impact on the underlying security price. He used the complete market theory which states that options introduction expand the opportunity set of risk-return patterns available to investors, contrary to the traditional view (Black & Scholes, 1973) which implicitly assumed that option securities are redundant, and thus should have no impact on the underlying security.[21] The analysis was continued by Breeden & Litzenberger (1978), Hakansson (1978), Arditti & John (1980) and John (1981). They also show that options make the underlying market complete as they allow more desirable positions for investors than is possible in a market without derivatives. Moreover, the improved informational efficiency allows investors easier access to private information and its benefits. Short-sale constraints are also reduced by derivatives trading. Smaller transaction costs are also associated with derivatives in comparison to stock trading.

[21] Black & Scholes (1973) show that, when continuous rebalancing is possible, call and put options may be thought of as equivalent to (time-varying) multiples of the underlying security. The feasibility of continuous rebalancing is a key (and of course unrealistic) assumption of their analysis.

Even though there is no formal evidence relating to the concern that derivative instruments such as options may well be detrimental to the trading activities of the underlying market, contention on this matter still exists. Some believe that derivatives act as a destabilizing factor and this may lead to a reduction in trading volume of the underlying stock. Another argument could be that diversion of trade from the stock market to the option market results in a decrease in stocks' trading volume.

All the debates regarding this area of the effect of the derivatives trading on the underlying securities will never be existed without the inefficient market assumption. Therefore, the development of all research hypotheses through out my thesis in both Chapter 4 and 5 are based on the empirical literature which rejecting the strong efficient market theory. There are number of arguments as to the strength of market efficiency but there is no final agreement whether the efficient markets hypothesis and its mathematical model of random walk is a reasonable explanation of market behaviour. Some people do not believe in the theory at all whereas some do to a certain degree if not all. According to the survey of Fama (1970), majority of studies were unable to reject the efficient market theory of the stock market. However, several later studies have found and recorded some anomalous departures from market efficiency. Keim & Stambaugh (1986) have uncovered empirical evidence which suggested statistically significant predictability in stock prices by using forecasts based on certain predetermined variables. Moreover, the significant negatively serially correlated are discovered in long holding period returns by Fama & French (1988). They show that 25%-40% of the variation of longer-period returns is predictable via past returns. The important implication here is that the forecasting of long-term as well as short-term price movements would become almost useless if markets are efficient, therefore, the efficient market concept tends to be rejected by both fundamentalists and technicians. The fundamentalists who rely heavily on significant information they learn form their analyses could hardly make any profit if the information is quickly reflected in stock prices. This is no better case for the technicians. They would be wasting their time reading news while all these news is reflected quickly in stock prices and these stock prices have no memory. Thus, tables, charts and other technical available tools might turn out to be purposeless. The facts that there are existing investors who make large amounts of money over long periods help provide hope. In addition, the work by Lo &

MacKinlay (1988; 1999) shows some evidence leading to the rejection of the true random walks of stock prices. They find many successive moves in the same direction as well as indicate that short-run serial correlations are not zero. This means short-run stock prices possibly be predictable, therefore, it is consistence with the stock price momentum strategy. Another more recent research by Lo, Mamaysky & Wang (2000), they use nonparametric kernel regression tests in the study to evaluate the effectiveness of technical analysis. The study presents similar finding and stating that technical analysts can be useful with a modest predictive power in recognizing the patterns of the stock price movement. The earlier studies by Pruitt &White (1988), Neftci (1991), Brock, Lakonishok & LeBaron (1992), Neely, Weller & Dittmar (1997), Neely & Weller (1999), Osler & Chang (1995), and Allen & Karjalainen (1999) have also provided relevant support for technical analysis. Moreover, because of the rising popularity in the field of behavioural finance, the idea of short-run momentum is also introduced in consistent with psychological feedback mechanisms. Shiller (2000) provides evidence on the psychological finding of the stock market's movement. Due to the inefficient market, the anomalies resulting from the covered warrant trading may be possible which lead to the full development of all hypotheses employed in Chapter 4 and 5 of this thesis as mentioned earlier.

4.1.2 Motivation

A large number of studies have examined the price effect of option listing on the underlying stocks. Most initial research was conducted on data from the US market, Branch & Finnerty (1981), Conrad (1989), Skinner (1989), and Kim & Young (1991). Later studies expanded to cover other markets. Stucki & Wassserfallen (1994) conducted their analysis on the Swiss market. The Norwegian market has been tested by Gjerde & Sattem (1995). They all report a statistically significant and permanent positive price effect whereas Watt, Yadav & Draper (1992) and Hamill, Opong & McGregor (2002) show a temporary positive price effect prior to the UK option listings followed by a negative price effect after listing. A negative underlying price effect was indicated by Rao & Ma (1987) on option announcement days. The results seem to be inconclusive as to whether the effect is more prevalent at the announcement or listing date, though the majority of US studies seem to suggest that the listing date is more relevant.

The empirical evidence concerning the volume effect during derivatives trading is also examined but with mixed results. Hayes & Tennenbaum (1979), Skinner (1989) and Gjerde & Sattem (1995) detected a significant influence from option introduction on the underlying trading volume while the study by Chamberlain, Cheung & Kwan (1993) did not detect any influence.

The variety of studies on price and volume effects on the underlying stocks when options are introduced (and which have many similarities to covered warrants), motivated me to undertake a study of the impacts of covered warrant trading within the UK market.[22] My analysis is based both on call covered warrants and also put covered warrants. The impact of put introduction may be expected to differ substantially from the impact of call introduction. Moreover, some believe that market makers are unlikely to buy, sell or short the stocks as a preparation for the start of put trading. Even though trades are generated because of the introduction of puts, strategies vary and investors may purchase puts rather than short the stock while others may create a long position in stock which they can protect with a put purchase. These activities are unlikely to significantly affect demand for the underlying stock market. We may thus expect not to detect much effect on the underlying stock performance.

The remainder of this chapter is organized as follows. Section 4.2 discusses idea based on the previous literature on price and volume effect of derivatives trading. Section 4.3 gives information on the developments of the research hypotheses. The data sources and constructions are presented in Section 4.4 and the methodology in Section 4.5. Section 4.6 reports the findings, while Section 4.7 concludes.

[22] To the best of my knowledge, Chan & Peretti (2009) is the only recent working paper using the UK data testing on price. They show no lead and lag relationship between covered warrants and the underlying shares traded on the London Stock Exchange.

4.2 Review of Literature

4.2.1 Background on Price effect

As we have noted earlier, an option is a redundant security due to the possibility of replication which means that existing marketable assets could be combined in order to provide a similar payoff as the option. The combination of the underlying security and risk-free borrowing-lending investments can replicate an option under the strong assumptions of a perfect capital market. However, the assumptions of the perfect capital market are unlikely to hold true in practice. Therefore, numerous impacts might be expected from the trading of options. Like any other financial instruments, options make capital markets more complete because they open up more investment opportunities for investors. Information about the underlying can be disseminated faster than before options trading. This results in a more efficient market. If we allow the relaxation of short-sale constraints due to alternative trading in options then a lower transaction cost results because of the increased degree of competition among market makers. According to the research, one might expect an increase in the underlying prices at the time of the options introduction.

The majority of previous research in the area of derivative effects on the underlying security is based upon the introduction of options, with limited studies available on other introductions. The impact of option introduction examined by several studies look at the announcement as well as the listing date. Based on the US market during 1974-1980, Conrad (1989) finds a permanent positive stock price effect after the listing of call options but observes no significant price effect after the announcement of option trading. Detemple & Jorion (1990) report similar findings via US data but also demonstrate a decline in the magnitude of price effect during the post-period of option listing. A later study on the Swiss market by Stucki & Wasserfallen (1994) provides evidence of a positive underlying price effect from options trading on 11 stocks despite a small sample which includes options introduced only on one single day. Many researches conducted in Asian countries seem to recognize the impact of derivatives introduction especially on the announcement day. Chan & Wei (2001) and Draper, Mak & Tang (2001) base their analyses on the Hong Kong market. They observe a positive price effect due to the announcement of derivative warrant.[23] In Taiwan, Chan & Jelic (2005) present a positive price effect on the announcement of covered warrants trading. Nevertheless, there also exist arguments which predict a reduction in underlying prices once options are introduced. Watt et al. (1992) investigate option listing in the UK market. They find a steady price decline after option listing.[24]

4.2.2 Background on Volume effect

There are empirical studies documenting the impact of derivative introductions on the volume of the underlying. The trading volume effects are mixed. According to Anthony (1988), trading volume on options leads trading on stocks with a one-day lag. This suggests that informed investors trade on the option market rather than on the stock market. Moreover, it is widely claimed that derivatives create greater choice for investors and induce more hedging related activities of issuers, especially in the absence of similar contracts. If this is true, we should expect to see a decrease in the volume of trading of the underlying stock market. For the US data, Branch & Finnerty (1981) report an increase in underlying stocks trading volume when call options are listed. In addition, the study of Hong Kong's derivative equity warrants data by Chen & Wu (2001) presents an increase in underlying trading volume after warrants listing. However, Kumar, Sarin & Shastri (1998) examine the Nikkei 225 index options which traded in the Japanese market. They report a decline in trading volume of the stocks contained in the index after the index listing while the US study by Whiteside, Dukes & Dunne (1983) shows no change in trading volume of securities for both announcement and listing days of the options.

[23] Draper et al. (2001) only find a temporary positive price effect pre-announcement day of derivative warrant.
[24] Though, they also find a temporary positive price effect before the option listing.

4.3 Research hypotheses

All of the hypotheses introduced in this chapter are fundamentally based on the literature against the efficient market theory. Please refer back to section 4.1.1 for the detail discussion.

4.3.1 Price effect hypotheses

Numerous empirical researchers support the argument of positive changes in the equilibrium underlying security prices as a consequence of the introduction of derivatives. As previously discussed the incomplete market becomes more complete due to derivatives trading which enhances the investment opportunities. Ross (1976) and Hakansson (1982) support this view. They analyse some conditions under which derivatives like options may have an impact on investors' opportunity sets. Ross actually stated that in a non-perfect world derivatives issued on existing assets could improve efficiency by allowing an expansion of investment opportunities. On the other hand, some researchers indicate that derivatives introduction may create a decline in value of the underlying securities. This view is supported by the studies concerned with short-selling. Miller (1977), Figlewski (1981) and Danielsen & Sorescu (2001) suggest derivatives provide investors with alternative trading choices on the receipt of negative information about the underlying stocks which used to be restricted by short-sale constraints. Pessimistic information moves very quickly into the underlying stock market and leads to a decline in stock prices.

Because of these conflicting views and lack of a conclusive theoretical argument especially in the area of covered warrants, empirical analysis must be employed to seek out the answer. The covered warrants market is generally dominated by a few big financial institutions. These issuers may have much better information about the market and would only issue call covered warrants if they think they can profit from the issue. One possibility of profit is if they anticipate some negative signal affecting the underlying stocks. Hence, the issuance of call covered warrants would be followed by a decline in underlying stock price. The relaxation of short-sale constraints due to derivatives introduction also supports this view. Therefore, the following hypothesis can be introduced:

Hypothesis 4.1: *There should be a significant negative price effect on the underlying securities during both the announcement and listing of call covered warrants.*

The stock price trading impact around the expiration dates of covered warrants is also investigated. Investors usually attempt to close their positions in the derivatives market not long before expiration to avoid physical delivery on the expiration day. Of course, investors may sell stocks after they are acquired from the exercise of call warrants. The issuers of call warrants may liquidate their hedging position by selling out their existing stocks before the call warrants expiration if they are likely to be out-of-the-money. These strategies may lead to a negative effect on stock price around expiration because of the selling pressure. Put covered warrants will be subject to analogous strategies as call covered warrants. This could lead to the opposite effect. In addition, it would be interesting to see whether there are any differences effects during the expiration period between in and out-of-the-money warrants.

Hypothesis 4.2: *There should be a reduction in price of the underlying securities when call covered warrants expire.*

Hypothesis 4.3: *There should be an increase in price of the underlying securities when put covered warrants expire.*

Put covered warrants are also analysed in this study. The impact of put warrant introductions is likely to differ from those for call introductions. However, activities related to put covered warrants trading possibly have less impact on the underlying stock market.[25] Therefore, there should be less expectation of an impact on the underlying stock.

Hypothesis 4.4: *There should be no significant impact on the underling securities price due to both the announcement and listing of put covered warrants.*

[25] Detailed discussion of this is provided in the above section 4.1.2 (Motivation)

4.3.2 Volume effect hypotheses

Campbell, Grossman & Wang (1993) documented that abnormal returns patterns are quite frequently associated with abnormal trading volumes. However, construction of an appropriate hypothesis regarding the expected change in stock volume reactions because of covered warrant introduction and expiration is difficult. The previous literature discussed in this study (section 4.2.2 theoretical background on volume effect) reveals contrasting empirical findings and sometimes directly opposite outcomes.[26] This thesis tests the following general hypothesis:

Hypothesis 4.5: *There are significant changes in the volume of the underlying security traded during the announcement, listing and delisting of both call and put covered warrants.*

[26] More references to the literature are provide in Chapter 2 Literature Review

4.4 Data/Sample construction

4.4.1 Data sources and description

Data on UK covered warrant on the London Stock Exchange (LSE) are provided by Datastream (DS). The data set consists of both call and put covered warrants listed on the Exchange over the period 26th July 2004 – 15th December 2006. The start date was initially chosen to coincide with the first covered equity warrant traded on the Exchange[27] but data difficulties caused me to start some time later in 2004 instead. The sample is selected on the following criteria. Firstly, covered warrants begin trading and expire during the sample period. Secondly, with multiple warrants on the same underlying security, I include only those that have at least a one month-gap between each other. The dataset specifies the announcement date and the expiration date of the warrants but provides no information on the listing date of the warrants. To analyse the effects of the warrants listing on the underlying securities, I assume that the first day availability of the warrant record coincides with the listing date of each particular warrant. My final sample was as follows:

For warrant announcement analysis, I divide the sample into two parts. For call warrants, I use 42 warrants which have only call warrants issued on the underlying stock. For put warrants because of the small sample of put only data, we use 58 warrants which have both call and put warrants issued on the same underlying stock.

For the listing of warrants, I again separate the sample into two parts. Based on the listing dates' data, 39 call only warrants are used for the call investigation and 54 warrants with both call and put features on each underlying securities are used for the put investigation.

For warrant delisting, both call and put warrants are examined. 36 call only warrants are used for the call analysis. I also examine whether moneyness of the warrants would

[27] The first time trading of covered warrants in the LSE was in 28th October 2002.

influence the results. For this the sample is divided into 25 in-the-money and 11 out-of-the-money call warrants. For the put effect, 58 warrants which have both call and put on the same underlying are employed. However, due to the small sample size of put only data, further analysis to separate the moneyness factor influence cannot be done.

4.4.2 Data construction

The underlying security returns data

For dividend paying stocks and stock indices, data is often used in the form of a total return index that reflects both the price of the security and the accumulated dividends that it pays. Datastream DS code of RI (Return Index) provides this.[28] Gross dividends where paid are included in the RI rather than net dividend (net of investor level taxation). Studies suggest that around an ex-dividend date, share price will fall by the net amount of

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[28] From 1988 onwards (and from 1973 for US and Canadian stocks), the availability of detailed dividend payment data enables a more realistic method to be used in which the discrete quantity of dividend paid is added to the price on the ex-date of the payment. Then:

$$RI_t = RI_{t-1} * \frac{P_t}{P_{t-1}}$$

except when t = ex-date of the dividend payment D_t then:

$$RI_t = RI_{t-1} * \frac{P_t + D_t}{P_{t-1}}$$

Where:

P_t = price on ex-date

P_{t-1} = price on previous day

D_t = dividend payment associated with ex-date t

Gross dividends are used where available and the calculation ignores tax and re-investment charges. Adjusted closing prices are used throughout to determine price index and hence return index. At this point the RI is calculated back to the base date.

the dividend (Campbell & Beranek (1955) and Duran & May (1960)). However, using gross dividend rather than net dividend should not alter the results significantly as dividend payments are infrequent relative to the number of observations designed for each firm. Moreover, the discrepancy drop off in prices between gross and net dividends are very small.

For each underlying stock of covered warrant, RI is used to calculate the natural logarithmic return.[29]

$$\text{Rate of Return on stock(i)} = \ln\left(\frac{\text{RI of stock(i) at period t}}{\text{RI of stock(i) at period t-1}}\right)$$

The total stock market return index (FTSE All Share Index) is also obtained (DS code of RI).[30] The return index represents the theoretical aggregate growth in value of the constituents of the index. The index constituents are deemed to return an aggregate daily dividend which is included as an incremental amount to the daily change in the price index. For each daily index value, the obtained total return index is used to calculate natural log return.

$$\text{Rate of Return on the Market Portfolio} = \ln\left(\frac{\text{RI of FTSE index at period t}}{\text{RI of FTSE index at period t-1}}\right)$$

The volume of trading of the underlying securities

The underlying securities volumes come from Datastream (DS code is VO). It provides the number of shares traded of a stock on a particular day/ the total number of constituent shares traded on an exchange on a particular day. The raw trading volume data are not normally distributed. This is supported by the study by Ajinkya & Jain (1989). They claim that the distributions of the prediction errors of raw trading volume data have positive

[29] The reasons for preferring logarithmic returns over the discrete returns are discussed in Chapter 3: Research Methodology; Calculation of returns.
[30] The investigation also uses the FTSE100. However, this does not make much difference. Both FTSE100 and FTSE All Share provide similar results. This study reports only in the results for the FTSE All Share.

sample skewness (right-skewed distribution), left tails are very thin, and right tails are very fat. Since a normally distributed variable is an important requirement of standard parametric statistical tests, they suggest the use of the natural logarithm transformation to solve the problem. The natural log transformed volume can reduce the departure from normality exhibited by the distribution of raw trading volume. The transformed volume becomes more symmetric in prediction error distributions as the skewness problem is solved (the means nearly equal to the medians), and both tails conform reasonably well with the normal distribution. Previous papers such as Morse (1980), Pincus (1983) and Richardson, Sefcik & Thompson (1986) have all suggested taking the natural log transformation in order to 'correct' the volume data. In the event study analysis used here, it requires percentage change in volume. I therefore define the following metrics.[31]

$$V_{it} = \ln\left(\frac{v_{it}}{v_{it-1}}\right)$$

$$V_{mt} = \ln\left(\frac{v_{mt}}{v_{mt-1}}\right)$$

where V_{it} = normalized volume traded for firm *i* in day *t*

V_{mt} = normalized volume traded for the market (FTSE100) in day *t*

v_{it} = securities trading volume of firm *i* in day *t*

v_{it-1} = securities trading volume of firm *i* in day *t-1*

v_{mt} = market trading volume in day *t*

v_{mt-1} = market trading volume in day *t-1*

[31] Even though there are number of studies (such as Cready & Ramanan (1991), Campbell & Wasley (1996), Chen & Wu (2001), etc.) which define the metric as the ratio of the number of securities traded over the number of securities outstanding, this study use the previous day trading volume rather than the outstanding as the denominator due to several reasons as the following. Firstly, the variation of the daily outstanding trading volume is very small or almost constant leading to the invalid over all results when employed. Secondly, the problem of the scale effect because of very large difference between numerator (number of securities traded) and denominator (number of securities outstanding) which consequence in a too small percentage change needed to do the analysis.

4.5 Methodology

4.5.1 Price effect analysis

The impact of the UK call/put covered warrants on underlying stock returns can be divided into three major events: announcement, listing and delisting. The event study methodology is employed to analyse these impacts using daily adjusted closing price returns. A detailed explanation of the event study methodology can be found in Chapter 3: Research Methodology. In this study, a 21-day event window is chosen comprised of 10 trading days before and after the event day (announcement or listing or delisting date of the covered warrants).[32] Day 0 is the event day. The 300 days preceding the event window is the estimation window used in the study.[33]

Three models are chosen to generate normal returns from which abnormal returns are measured. They are widely used in event studies and are seen as providing valid/reasonable results.

- *Market Model*
- *Market-adjusted Model*
- *The mean-adjusted return Model*

Brown & Warner (1980; 1985) conclude that there is no evidence that more complicated methodologies convey any additional benefit.

For the aggregation of abnormal returns, this study uses the cumulative abnormal return (CAR) due to its suitability for short-run studies.

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[32] Event window is the period from day (t) -10 to 10.

[33] Estimation window is the period from day (t) -310 to -11

4.5.2 Volume effect analysis

I study the impact on the trading volume of the underlying securities during the listing, announcement and delisting of covered warrants. A similar event study methodology as for the price effect analysis is used to test for the trading volume effect of the underlying stocks from both call and put covered warrants. 21-day event window and 300-day estimation window are employed using the three general models (market, market-adjusted and mean-adjusted volume models).

4.6 Empirical Results

4.6.1 Pricing/Return effects

The effect of the introduction of covered warrants on the price of the underlying securities is examined using an event study methodology. Both announcement and listing dates are examined to identify any introduction effect. Intuitively, the announcement date should be more reliable because the information released to the market is normally new and fresh. It is used for example in Draper et al. (2001). However, some previous findings (Whiteside, Dukes & Dunne (1981)) suggest that the announcement date of the option/warrant introduction has no impact on the stock (Clarke, Gannon & Vinning (2005)) and the listing date is appropriate. There are various arguments for selecting either of these two event dates. Therefore, this study analyses both of them for comparison. In addition, the results of the effect of the covered warrants delisting on the underlying securities are also presented.

The initial focus is on the call warrant case. The results are reported in Table 4.1 (abnormal returns around the announcement event for call event), the market model suggests a negative 0.29% excess return (statistically significant abnormal return at 10% level) affecting the underlying security on the day of announcement. The market-adjusted model and mean-adjusted model provide supporting evidence of negative abnormal returns of 0.33% (5% significance level) and 0.49% (1% significance level) consecutively.

Although the absolute numbers are not high, the consistency of results between the three models is sufficient to make the interpretation in this study valid and useful. Similar results can be observed throughout Figure 4.1. All three graphs estimated using the market model, market-adjusted model, and mean-adjusted return model show considerable fluctuations in abnormal return. The return rises and remains fairly high before the announcement day. This is clearly illustrated in the third graph (the mean-adjusted return model). This change in underlying securities prices may reflect the securities buying activities (the hedging activities) of the issuing investment banks as they cover their position as sellers of the call warrants. The investment bank will generally try to cover its position before the market becomes aware of the issue, otherwise it risks expensive adverse movement in price as it attempts to cover its position. Other investment banks (its competitors) might also attempt to increase the underlying security prices when they are aware of the issue. Thus, it is safer for the investment bank (issuer) to cover its outstanding position at an early stage in order to avoid buying relatively expensive securities later on. Stock price rises may also be caused by the issuers themselves with the intention of pricing the warrant issue higher (Chen & Wu (2001)). This is driven by the market pricing mechanism where the issuing price of derivatives depends on the difference between the exercise price of the warrant issue and the closing price of the underlying security (known as premium). Prices rise until the investment bank stops buying on announcement of the warrant issue. The rise in price leads to a higher return for existing holders as well as higher abnormal return. Security prices drop when the investment bank terminates its buying activities on the announcement date. Additional explanations for falling security prices (Kabir (1999)) are the relaxation of short sales constraints by warrant introductions, the new investment opportunity as well as low transaction with high leverage lead to shifts of trading from the stock market to the warrants market, and the shareholders selling existing stocks because they see warrants as a destabilizing factor for the underlying stocks. The temporary decline in the price after the day of announcement may be a reflection of what has been described as a price pressure (or distribution effect, or liquidity premium) under the “block trades” theory (Copeland & Weston (1992)). Therefore, the temporary decline of underlying security prices is the summarize impact from the announcement of call covered warrants trading.

Other influences may also affect prices. Investors may assume that the issuing bank has additional positive knowledge about the company and warrant announcements may result in a rise in the underlying security price (this is contrary to the finding of this study which is explained earlier). This study also provides results contrary to the confusion hypothesis (Gemmill & Thomas (1997)). They suggest that because of investor confusion securities with warrants are valued more highly by investors (as investors do not understand the concept that the more the warrants are worth, the less the value of the underlying securities.).[34]

[34] They examine the special case of investment trust/company warrants and the effect of company warrants would be different from covered warrants in any event.

Table 4.1: Abnormal returns around the announcement event for *call event*

The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the announcement event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	-0.0025	-0.8924	-0.0025	-0.8924	-0.0019	-0.6849	-0.0019	-0.6849	-0.0015	-0.5162	-0.0015	-0.5162
-9	0.0004	0.2724	-0.0020	-0.6435	0.0004	0.2428	-0.0015	-0.4589	-0.0009	-0.4439	-0.0023	-0.7092
-8	-0.0012	-0.9554	-0.0033	-0.8763	-0.0015	-1.1263	-0.0030	-0.7848	-0.0017	-1.1315	-0.0041	-1.0507
-7	0.0001	0.0287	-0.0032	-0.8013	0.0008	0.4678	-0.0022	-0.5317	0.0044	2.2032**	0.0003	0.0773
-6	-0.0009	-0.7729	-0.0041	-0.9457	-0.0007	-0.5687	-0.0029	-0.6342	0.0029	2.1100**	0.0032	0.6923
-5	0.0019	0.8046	-0.0023	-0.4667	0.0020	0.8899	-0.0009	-0.1739	0.0018	0.7038	0.0050	1.0126
-4	0.0013	0.8114	-0.0010	-0.1977	0.0014	0.8948	0.0006	0.1167	0.0049	2.8659***	0.0099	1.9694**
-3	-0.0019	-1.2093	-0.0029	-0.6135	-0.0021	-1.3046	-0.0015	-0.3172	-0.0014	-0.7737	0.0085	1.8132*
-2	-0.0006	-0.3345	-0.0035	-0.6615	-0.0005	-0.2774	-0.0020	-0.3896	-0.0037	-1.8490*	0.0047	0.8996
-1	0.0005	0.3169	-0.0030	-0.5304	0.0003	0.1826	-0.0017	-0.3111	0.0028	1.4507	0.0075	1.3419
0	-0.0029	-1.8789*	-0.0059	-1.0403	-0.0033	-2.1058**	-0.0050	-0.8920	-0.0049	-2.8823***	0.0026	0.4639
1	0.0000	0.0021	-0.0059	-0.9781	0.0002	0.1455	-0.0048	-0.8137	-0.0020	-1.3000	0.0007	0.1081
2	-0.0044	-1.6848*	-0.0103	-1.5738	-0.0042	-1.5923	-0.0090	-1.3978	-0.0017	-0.6099	-0.0011	-0.1622
3	-0.0005	-0.3600	-0.0107	-1.5952	-0.0010	-0.7567	-0.0100	-1.4809	-0.0038	-2.5577**	-0.0048	-0.7085
4	0.0015	1.0071	-0.0093	-1.3050	0.0017	1.0755	-0.0083	-1.1638	-0.0001	-0.0470	-0.0049	-0.6645
5	-0.0012	-0.5555	-0.0105	-1.4024	-0.0010	-0.4553	-0.0094	-1.2298	-0.0001	-0.0601	-0.0051	-0.6544
6	-0.0006	-0.2820	-0.0110	-1.4701	-0.0009	-0.4560	-0.0103	-1.3484	-0.0005	-0.2115	-0.0055	-0.7259
7	0.0026	1.7930*	-0.0084	-1.0731	0.0031	2.0528**	-0.0071	-0.8950	0.0016	0.9162	-0.0040	-0.4963
8	0.0004	0.2004	-0.0080	-1.0198	0.0001	0.0444	-0.0070	-0.8636	-0.0001	-0.0365	-0.0041	-0.4940
9	0.0021	1.0062	-0.0059	-0.6992	0.0021	0.9966	-0.0049	-0.5538	0.0045	1.7044*	0.0004	0.0469
10	0.0000	0.0152	-0.0059	-0.7256	0.0003	0.1648	-0.0046	-0.5277	0.0019	1.0750	0.0023	0.2777

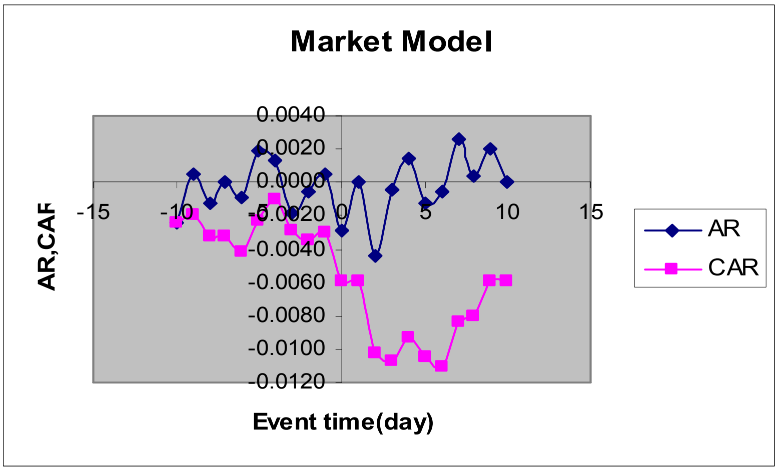
Notes: ***significant at 1% **significant at 5% *significant at 10%

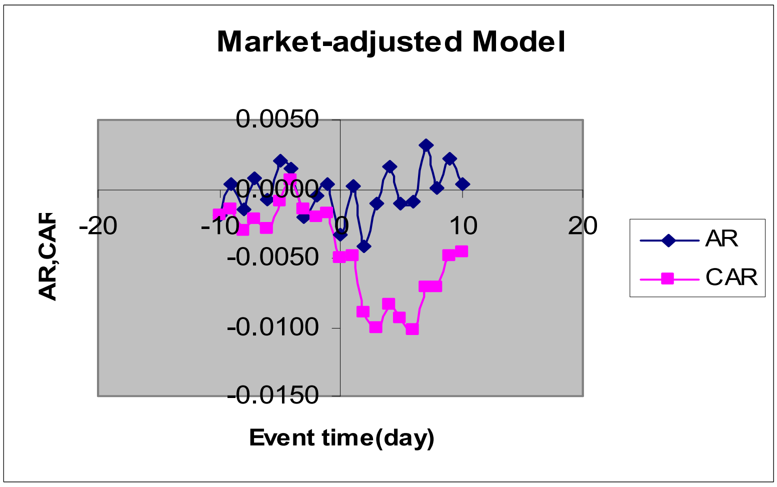
The sample period extends form July 2004 until December 2006.

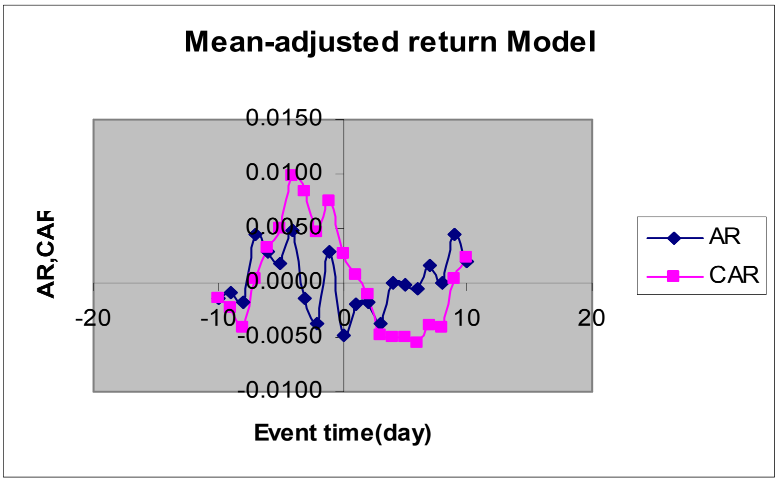
The estimation window consists of 300 days which range from day -310 to -11.

Figure 4.1: Abnormal returns around the announcement event for *call event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the announcement event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.







Notes: The sample period extends form July 2004 until December 2006.

The estimation window consists of 300 days which range from day -310 to -11.

Table 4.2 shows abnormal returns around the listing event for calls. Under the market model and the market-adjusted model, similar negative and statistically significant results for CARs from day -2 to day +3 are evident. Listing dates are on average 7 days after the announcement event of call warrants (Table 4.4). Thus, the analysis of the listing event seems to provide an after effect following the announcement event. Figure 4.2 reveals the behaviour of excess return around the listing event. The figures emphasise the continuous temporary fall in security return after the announcement day. Moreover, returns do not fully recover to their original level before the announcement date. This may be a reflection of a permanent effect or the information effect from the "block trades" theory (Copeland & Weston, 1992). In this case, the market may believe that the issuing investment bank has better information about the stocks prospects compared to others. The issuing of call warrants can be interpreted as the bank's expectation of a decrease in the underlying stock price for the period following warrant listing. In summary, there are evidences of negative prices' effect on underlying securities around the listing event of call covered warrants.

Table 4.2: Abnormal returns around the listing event for *call event*

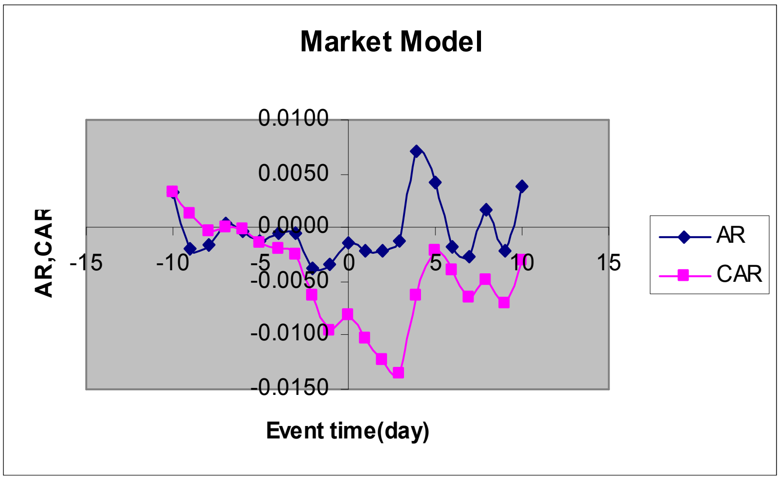
The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the listing event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

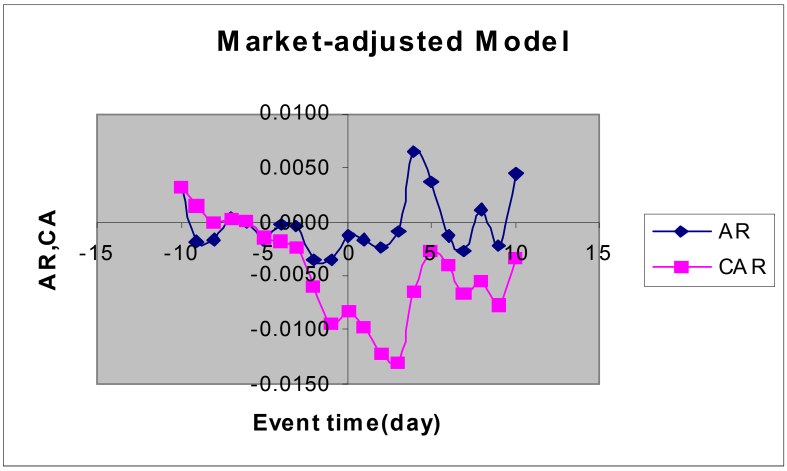
	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0032	2.1294**	0.0032	2.1294**	0.0033	2.1291**	0.0033	2.1291**	0.0029	1.7576*	0.0029	1.7576*
-9	-0.0020	-1.3113	0.0012	0.5354	-0.0018	-1.1483	0.0015	0.5856	-0.0004	-0.2472	0.0025	0.9522
-8	-0.0016	-0.8325	-0.0003	-0.1047	-0.0016	-0.8396	-0.0001	-0.0372	-0.0020	-0.9810	0.0004	0.1442
-7	0.0004	0.2420	0.0001	0.0236	0.0004	0.2621	0.0003	0.1038	-0.0004	-0.2087	0.0001	0.0282
-6	-0.0003	-0.1614	-0.0002	-0.0631	-0.0002	-0.0808	0.0002	0.0455	0.0027	1.2137	0.0028	0.7443
-5	-0.0012	-0.8219	-0.0014	-0.3569	-0.0017	-1.1532	-0.0015	-0.4161	-0.0026	-1.5546	0.0001	0.0364
-4	-0.0005	-0.2657	-0.0019	-0.5081	-0.0003	-0.1641	-0.0018	-0.5288	0.0002	0.0936	0.0003	0.0878
-3	-0.0006	-0.4254	-0.0025	-0.6726	-0.0005	-0.3317	-0.0023	-0.6487	0.0010	0.6630	0.0013	0.3403
-2	-0.0038	-3.2750***	-0.0062	-1.6568*	-0.0036	-3.1520***	-0.0059	-1.6524*	-0.0047	-3.4851***	-0.0034	-0.8311
-1	-0.0034	-1.2061	-0.0096	-1.8254*	-0.0035	-1.2517	-0.0094	-1.8094*	-0.0047	-1.5962	-0.0081	-1.5080
0	-0.0015	-1.0321	-0.0081	-1.7359*	-0.0013	-0.8891	-0.0081	-1.7566*	-0.0014	-0.8771	-0.0067	-1.2456
1	-0.0021	-1.4971	-0.0102	-1.8252*	-0.0017	-1.1732	-0.0099	-1.7080*	-0.0020	-1.2017	-0.0087	-1.5399
2	-0.0020	-1.2041	-0.0123	-2.0300**	-0.0023	-1.3720	-0.0122	-1.9691**	-0.0033	-1.6303	-0.0120	-1.8629*
3	-0.0013	-0.7289	-0.0135	-2.1007**	-0.0009	-0.4597	-0.0131	-1.9278*	-0.0010	-0.4420	-0.0130	-1.8747*
4	0.0072	2.7830***	-0.0063	-0.9680	0.0065	2.4928**	-0.0066	-0.9615	0.0044	1.5037	-0.0086	-1.2765
5	0.0042	1.8906*	-0.0021	-0.3001	0.0038	1.6652*	-0.0027	-0.3703	0.0038	1.4495	-0.0047	-0.6777
6	-0.0018	-1.4103	-0.0039	-0.5368	-0.0013	-0.9789	-0.0040	-0.5249	0.0023	1.6340	-0.0024	-0.3398
7	-0.0026	-1.3470	-0.0065	-1.0131	-0.0026	-1.2551	-0.0066	-0.9498	0.0003	0.1117	-0.0021	-0.3342
8	0.0016	1.2697	-0.0049	-0.7343	0.0011	0.8137	-0.0055	-0.7557	-0.0017	-0.9911	-0.0038	-0.5624
9	-0.0021	-1.4154	-0.0070	-1.0969	-0.0022	-1.3939	-0.0077	-1.0871	0.0003	0.1722	-0.0035	-0.5351
10	0.0039	2.0737**	-0.0031	-0.4646	0.0044	2.2863**	-0.0033	-0.4559	0.0063	3.2387***	0.0028	0.4264

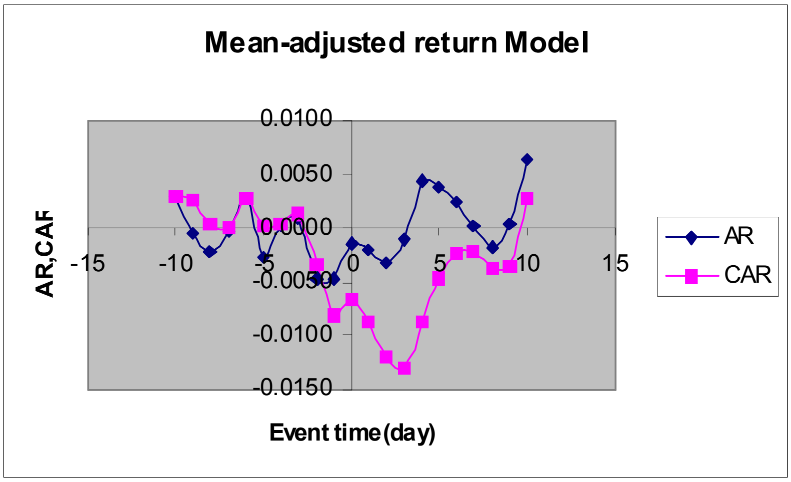
Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Figure 4.2: Abnormal returns around the listing event for *call event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the listing event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.







Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

The effect of put warrant introductions is also of interest. The underlying security price should fall before the warrant issuing date. Issuers want to cover their position from exposure to the risk involved in transactions of this type. By selling the underlying securities in advance (hedging activities), they can protect themselves as sellers of put warrants. Even if they do not own any of the underlying security, they can sell stocks short to cover the outstanding positions. However, issuers are constrained by the costs of employing a short selling strategy as it may be very expensive and/or almost impossible if stock borrowing is difficult. This is likely to be a particular problem for longer dated warrants. This study shows a fall in the underlying securities prices and a fall in returns to existing holders as illustrated by a negative abnormal return. Table 4.3 (abnormal returns around the announcement event for put event) supports these claims. There are negative abnormal returns of 0.34% on day -2 and 0.28% on day -3 (5% significance level) using the market model. The market-adjusted model suggests a negative abnormal return of 0.29% (5% significance level) on day -2 and a negative abnormal return of 0.23% (10% significance level) on day -3. Thus the underlying stock price seems to decrease a few days before announcement day 0 according to the decrease in abnormal returns. A clearer picture can be seen in Figure 4.3 (CARs). The figures demonstrate a similar trend in which the stock returns start to plummet a couple of days before the announcement day. This may be because of the issuing investment banks' hedging activities. To hedge the put warrants, the investment bank (issuer) sell stocks short. Therefore, the price of the stocks falls due to the shorting of stocks. When the investment bank stops selling, the fall in the stock price should also stop. The results in this study provide supporting evidence. It reflects the ending of the selling transactions in the underlying stocks by the investment banks on announcement. The underlying stock prices start to recover and rise back after the announcement day. The slow price recovery is explainable by a temporary decline in price as a reflection of price pressure (Copeland & Weston, 1992). However, the stock price fluctuates a lot over time as can be seen from Figure 4.3 (ARs) and supports the hypothesis that banks attempt to keep high volatility within the market to secure high warrant premiums. This will be discussed in more detail in the analysis of the effect on the return volatility of the underlying stock, Chapter 5 of this research. Anyway, for this section, it can be concluded that the announcement event of put covered warrants creates negative impacts on the underlying stocks. Though the impacts are only temporary and are not persistent beyond the event day.

Table 4.3: Abnormal returns around the announcement event for *put event*

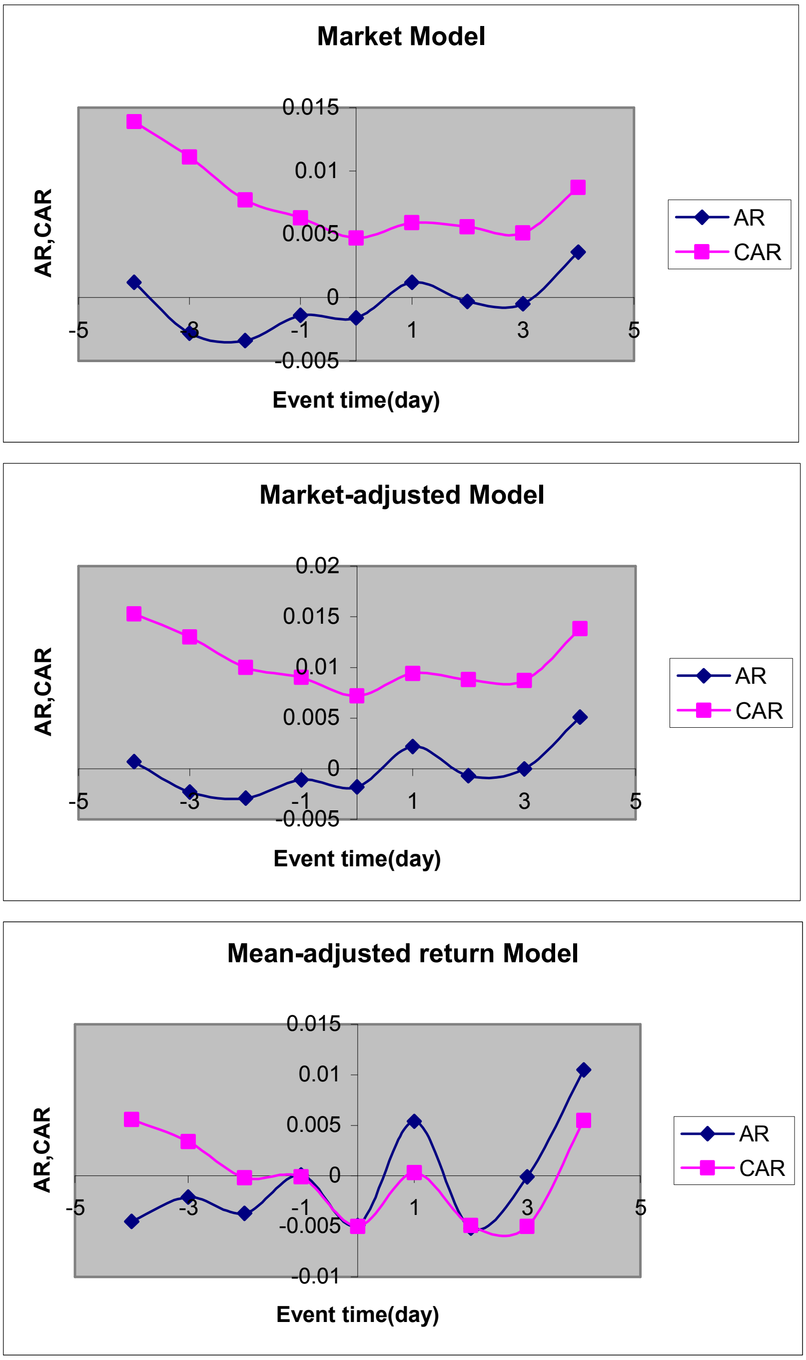
The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the announcement event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0017	1.5145	0.0017	1.5145	0.0021	1.8700*	0.0021	1.8700*	0.0019	1.3739	0.0019	1.3739
-9	0.0042	3.1325***	0.0059	3.5752***	0.0045	3.1568***	0.0067	3.7797***	0.0028	1.5027	0.0047	2.0079**
-8	0.0028	1.2216	0.0087	4.0009***	0.0024	0.9684	0.0091	3.8129***	-0.0008	-0.2459	0.0039	1.1781
-7	0.0011	0.6495	0.0099	3.3233***	0.0017	0.9547	0.0108	3.3415***	0.0024	1.3276	0.0063	1.5761
-6	0.0022	1.2873	0.0121	3.3443***	0.0025	1.4254	0.0133	3.4165***	0.0028	1.6018	0.0092	2.0340**
-5	0.0006	0.3623	0.0126	3.1695***	0.0013	0.7686	0.0146	3.4038***	0.0009	0.4646	0.0101	1.9477*
-4	0.0012	0.8301	0.0139	3.3475***	0.0007	0.4207	0.0153	3.2833***	-0.0045	-2.1899**	0.0056	0.8774
-3	-0.0028	-2.0542**	0.0111	2.8471***	-0.0023	-1.6915*	0.0130	2.9755***	-0.0021	-1.4428	0.0034	0.5616
-2	-0.0034	-2.2646**	0.0077	1.9398*	-0.0029	-1.9636**	0.0100	2.2389**	-0.0037	-2.3541**	-0.0002	-0.0352
-1	-0.0014	-0.6616	0.0063	1.2770	-0.0011	-0.4899	0.0090	1.7005*	0.0001	0.0517	-0.0001	-0.0148
0	-0.0016	-0.4460	0.0047	0.7200	-0.0018	-0.4885	0.0072	1.0718	-0.0049	-1.3284	-0.0050	-0.6727
1	0.0012	0.5302	0.0059	0.9392	0.0022	0.9874	0.0094	1.4756	0.0054	2.1435**	0.0003	0.0479
2	-0.0003	-0.1686	0.0056	0.8022	-0.0007	-0.4494	0.0088	1.2363	-0.0052	-3.3858***	-0.0049	-0.6309
3	-0.0005	-0.3133	0.0051	0.6965	0.0000	-0.0254	0.0087	1.1531	-0.0001	-0.0684	-0.0050	-0.6068
4	0.0036	2.0609**	0.0087	1.1419	0.0051	3.0513***	0.0138	1.7593*	0.0105	6.0398***	0.0055	0.6881
5	0.0023	1.6970	0.0110	1.3822	0.0028	1.9936**	0.0166	2.0108**	0.0024	1.2081	0.0079	0.9428
6	-0.0004	-0.1748	0.0106	1.2951	0.0007	0.2842	0.0173	2.0475**	0.0035	1.5507	0.0114	1.3662
7	-0.0011	-0.5374	0.0095	1.0828	0.0002	0.0925	0.0175	1.9281*	0.0041	1.6537*	0.0155	1.7651*
8	-0.0028	-1.6183	0.0067	0.7857	-0.0029	-1.6845*	0.0146	1.6561*	-0.0053	-3.3568***	0.0102	1.1919
9	0.0002	0.1490	0.0069	0.8127	0.0009	0.6405	0.0155	1.7551*	0.0042	2.2989**	0.0144	1.6713*
10	-0.0011	-0.8264	0.0058	0.6878	-0.0009	-0.6452	0.0146	1.6712*	-0.0026	-1.5730	0.0117	1.3863

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Figure 4.3: Abnormal returns around the announcement event for *put event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the announcement event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.



Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.4 shows there are 17 days on average between the announcement and the listing dates of put warrants. Hence, the listing event analysis provides interesting outcomes in comparison with the announcement effect. Nevertheless, it does not result in a large significant (statistically or economically) effect. Figure 4.4 (Abnormal returns around the listing event for put event: Market model) presents a similar trend as for the announcement event.[35] That is a decline in the underlying stock return before and on the listing day with an increase in return after that. The same reasons as for the announcement event analysis can be used to explain the phenomenon here.

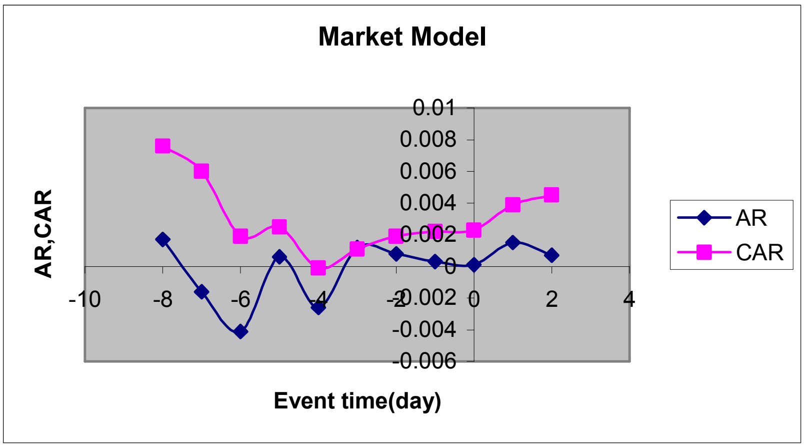
Table 4.4: The difference between Announcement and Listing dates (days)

	The different between Announcement and Listing dates (days)	
	Call event	**Put event**
Average	7	17
Minimum	0	0
Maximum	29	59
Median	7	6

Note: The sample period extends form July 2004 until December 2006.

Figure 4.4: Abnormal returns around the listing event for *put event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the announcement event of the UK put covered warrants where market model is used to generate normal return.



Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

[35] The figures of abnormal returns around the listing event for put event under the market-adjusted model and the mean-adjusted return model are presented in Appendix 4.2. Moreover, the numerical presentation of this information can be seen in Appendix 4.1.

For call covered warrants, the direct results of the effect of the warrants introduction on the underlying securities can be seen from looking at the announcement event. The listing event provides an after affect continuing after the announcement date. However, both the announcement and the listing date employed to test the introduction effect of put covered warrants in this study provide similar results. The announcement event provides a much clearer picture of the effect compared to the listing event, but the results support each other.

The present study also reports evidence of the underlying stock market reaction after covered warrant delisting. One of the motivations to study this effect is to test the hypothesis that the results from option delisting effects should be opposite to those of listing effects (Detemple & Jorion (1990)).

Table 4.5 present the results for the whole delisting sample for the effect of call warrants. Figure 4.5 estimated using the market model, market-adjusted, and mean-adjusted return models show similar trends. The excess returns presented in Table 4.5, rise around 0.7% (though not significant) from day -5 until day -2 for both the market model and the market-adjusted model. These reflect an upward movement in the underlying stock market before the warrant delisting date. The more obvious evidence can be seen in Table 4.5 under the mean-adjusted return model which shows around a 1.7% rise in excess return (from day -5 until day -2), significant at a 1% level. The excess return of the underlying securities might come from activity resulting from approaching the warrant expiry date. This activity refers to the demand from the warrant issuer to adjust its position on the underlying security according to the moneyness of the warrants. In the case of call warrants, if they are about to expire in-the-money, the issuer may have accumulated a large amount of the underlying security (a long security position by hedging activity, delta hedging) (Chen & Wu (2001)).[36]

[36] A "delta hedging" strategy is normally used to hedge the price risk. The delta is a measure of the sensitivity of the price of a derivative (warrant) to small changes in the underlying security price. By undertaking a delta hedging strategy, the issuer has to buy a number, delta shares of the underlying security for every call warrant sold. The issuer must always adjust its position because delta values change through time. The non constant delta value results from the dependency of delta on both security price and time to expiration (as these two factors move through time).

Table 4.5: Abnormal returns around the delisting event for *call event*

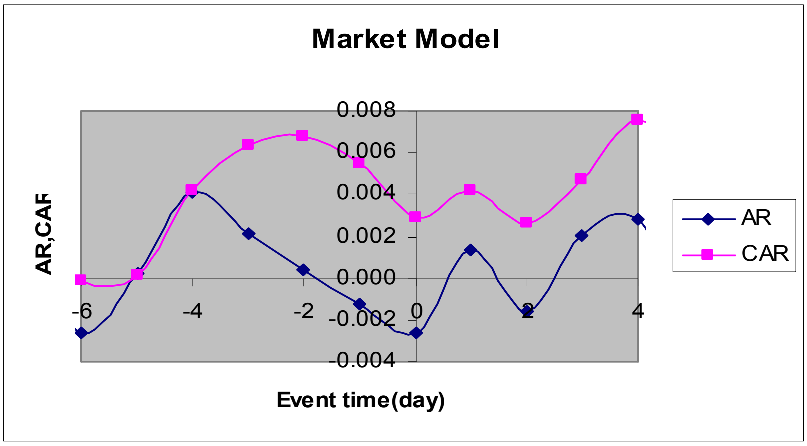
The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

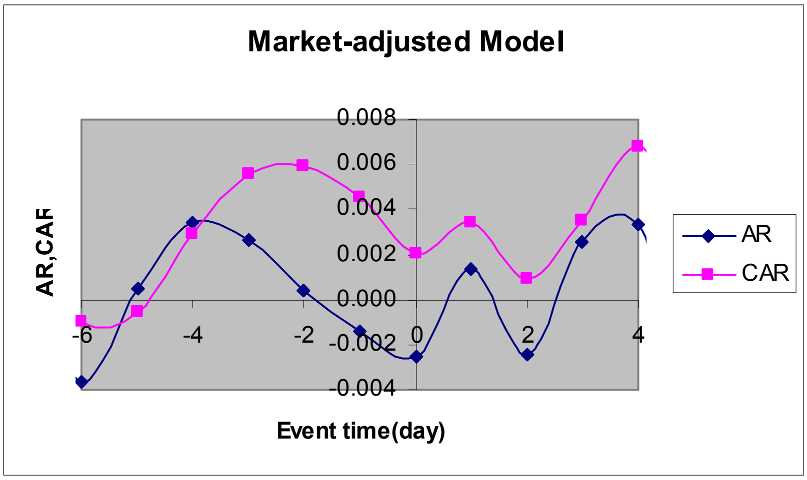
Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0014	1.5023	0.0014	1.5023	0.0020	1.8836*	0.0020	1.8836*	0.0072	5.8109***	0.0072	5.8109***
-9	-0.0005	-0.3953	0.0009	0.5354	0.0000	-0.0228	0.0020	0.9399	0.0051	3.3654***	0.0123	5.7377***
-8	-0.0003	-0.2261	0.0005	0.2748	-0.0005	-0.3110	0.0015	0.6238	-0.0014	-0.8880	0.0108	4.5593***
-7	0.0019	1.8893*	0.0025	1.3432	0.0012	1.0070	0.0027	1.3820	-0.0058	-4.7148***	0.0050	2.6384***
-6	-0.0026	-1.0666	-0.0001	-0.0513	-0.0037	-1.4338	-0.0010	-0.3763	-0.0142	-5.0870***	-0.0091	-3.4338***
-5	0.0003	0.1765	0.0001	0.0381	0.0005	0.3905	-0.0005	-0.1758	0.0034	2.5886***	-0.0058	-1.8454*
-4	0.0041	2.1328**	0.0042	1.1451	0.0034	1.6299	0.0029	0.7497	0.0017	2.6924***	-0.0041	-1.9502*
-3	0.0021	1.3735	0.0064	1.3727	0.0027	1.9673**	0.0056	1.2368	0.0093	6.8921***	0.0052	1.0682
-2	0.0004	0.3115	0.0067	1.4035	0.0004	0.3178	0.0060	1.2935	0.0023	2.7111***	0.0075	1.4324
-1	-0.0012	-0.7618	0.0055	1.3272	-0.0014	-0.8633	0.0046	1.1599	-0.0029	-1.7391*	0.0047	0.9675
0	-0.0026	-0.9306	0.0029	0.4888	-0.0025	-0.8797	0.0021	0.3619	-0.0035	-1.2559	0.0011	0.1737
1	0.0013	0.7326	0.0042	0.8975	0.0013	0.7404	0.0034	0.7900	0.0037	1.9084*	0.0049	0.8859
2	-0.0016	-1.2104	0.0026	0.5411	-0.0025	-1.9857**	0.0010	0.1943	-0.0105	-7.3088***	-0.0057	-0.9020
3	0.0021	1.1703	0.0047	0.7830	0.0026	1.4679	0.0035	0.5929	0.0068	3.8696***	0.0011	0.1611
4	0.0028	1.5983	0.0076	1.2640	0.0033	1.8354*	0.0068	1.2162	0.0055	2.7032***	0.0066	1.0396
5	-0.0024	-2.5144**	0.0051	0.8682	-0.0035	-3.6535***	0.0033	0.5632	-0.0131	-2.2780**	-0.0066	-0.9736
6	-0.0003	-0.1603	0.0049	0.6742	-0.0006	-0.2951	0.0027	0.3843	-0.0070	-3.3136***	-0.0135	-1.6695*
7	0.0005	0.3002	0.0053	0.7181	0.0016	0.8555	0.0043	0.6334	0.0089	3.8475***	-0.0046	-0.5960
8	0.0011	0.8399	0.0065	0.8838	0.0020	1.1026	0.0063	0.9486	0.0081	4.2304***	0.0034	0.4586
9	0.0002	0.1175	0.0067	0.9779	0.0008	0.5297	0.0071	1.2001	0.0050	3.1956***	0.0084	1.2257
10	0.0010	0.5978	0.0076	1.0703	0.0007	0.4211	0.0077	1.2760	0.0023	1.2467	0.0108	1.5194

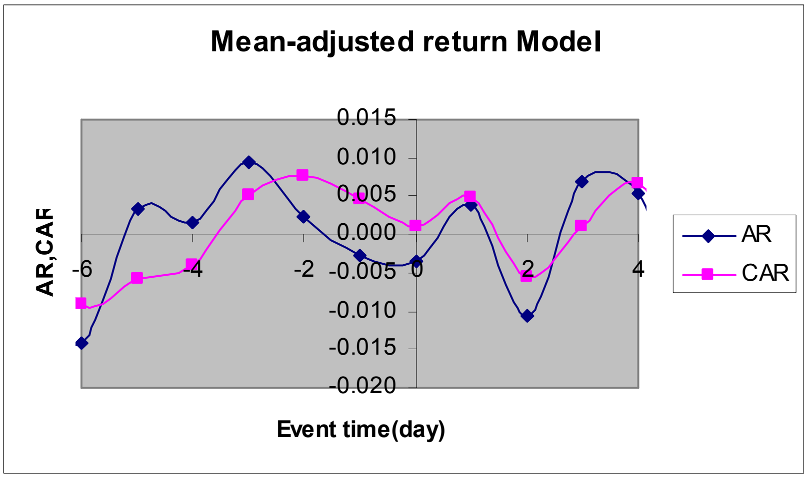
Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Figure 4.5: Abnormal returns around the delisting event for *call event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.







Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Alternatively, the excess return/increase in price of the underlying securities might come from other banks (competitors of the issuing bank) trading pressure as they attempt to push the underlying securities price up in order to make the warrants exercise in-the-money and potentially disadvantage the issuing bank. Thus, for "in-the-money" call warrants, the investment bank keeps its hedge in place and on delisting sells the underlying security to unwind its position. In addition there is an incentive for existing holders to liquidate/exercise the warrants and sell out the underlying securities after acquiring them from exercising the warrants into the market, assuming that delivery has been in securities and not in cash. The negative abnormal returns on day 0 may be the consequence shown in Table 4.5. The negative abnormal returns a day before the event provides similar evidence because of early trading from knowing the delisting dates within the market. However, this can only be explained as a temporary negative price effect as it does not persist beyond the delisting date. Possible explanations are early unwinding by the warrant holders and selling activities by other speculators as they see the future falling trend in stocks price so they act early in order to take advantage before the fall. By the expiration date, there may not be many outstanding warrants left in the market. However, this delisting effect coincides with the results of Draper et al. (2001), who observe a large negative price effect for call covered warrants around the delisting date.

For further analysis the whole sample of call warrants is separated into two groups: in-the-money and out-of-the-money. Due to the limitation of data, this analysis assumes that the price of the underlying security at the warrant listing date is equal to the exercise price for each particular warrant. This assumption is used because exercise prices for some warrants are not available. The in-the-money call warrant can be indicated when the underlying security price on delisting is more than the underlying security price on listing (or the warrant exercise price). The out-of-the-money call warrant can be indicated when the price of underlying security at the warrant delisting less than at the warrant listing (or the warrant exercise price). Table 4.6 presents 36 call warrants in total with all the underlying securities prices on the listing dates (or the warrant exercise prices) and delisting dates. The differences in prices between each pair of these two dates are used to separate 25 in-the-money call warrants from 11 out-of-the-money call warrants.

Table 4.6: The differences of the underlying securities prices on listing and delisting dates of 36 call warrants

	Underlying securities prices on [b]		
	Listing date	**Delisting date**	***Delisting – Listing*** [a]
BRITISH SKY BCAST.GROUP*	500	562	62
MAN GROUP	327.62	426.96	99.34
WILLIAM HILL*	600	630	30
ASTRAZENECA	3033	3219	186
HBOS	957	959.5	2.5
GLAXOSMITHKLINE	1461	1464	3
GLAXOSMITHKLINE	1492	1506	14
TESCO*	330	367.75	37.75
BT GROUP*	220	259	39
BT GROUP*	240	259	19
SMITHS GROUP*	1000	895.13	-104.87
BP*	650	584.5	-65.5
BP	712	633	-79
BRITISH AMERICAN TOBACCO*	1300	1501	201
BAE SYSTEMS*	425	376	-49
BARCLAYS	681.5	622	-59.5
ROYAL BANK OF SCTL.GP.	580.33	600.67	20.34
BRITISH LAND*	1000	1348	348
LAND SECURITIES*	1800	1890	90
CABLE & WIRELESS*	110	127.5	17.5
ANGLO AMERICAN*	2100	2229.72	129.72
BRITISH AIRWAYS*	350	425.75	75.75
SAINSBURY*	300	370	70
WPP GROUP*	600	640	40
ANTOFAGASTA	373.4	454.75	81.35
ANTOFAGASTA	483.2	454.75	-28.45
REUTERS GROUP	403.5	406.25	2.75
ROLLS-ROYCE GROUP*	400	429.55	29.55
VODAFONE GROUP*	130	144.75	14.75
VODAFONE GROUP	123.64	127.64	4
VODAFONE GROUP	115.4	116.5	1.1
VODAFONE GROUP	127.14	116.5	-10.64
VODAFONE GROUP	127.64	118.89	-8.75
CORUS GROUP	438.75	368.75	-70
QINETIQ GROUP*	300	182	-118
Party Gaming*	180	110.25	-69.75

Note: Out of these 36 calls warrants, there are 20 warrants with available exercise prices. The 20 warrants are marked with *
[a] Positive number indicates in-the-money call warrant whereas negative number indicates out-of-the-money call warrant.
[b] All underlying securities prices are in pence.

Table 4.7: Abnormal returns around the delisting event for 25 in-the-money *call warrants*

The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 25 UK in-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0017	1.3020	0.0017	1.3020	0.0019	1.3130	0.0019	1.3130	0.0070	4.1691***	0.0070	4.1691***
-9	-0.0005	-0.3371	0.0011	0.6130	-0.0004	-0.1925	0.0015	0.5898	0.0047	2.5270**	0.0117	4.4096***
-8	-0.0011	-0.5834	0.0001	0.0314	-0.0010	-0.5493	0.0005	0.1673	-0.0022	-1.0830	0.0095	2.9596***
-7	0.0010	0.8166	0.0011	0.4598	0.0010	0.6873	0.0016	0.6055	-0.0062	-3.9881***	0.0033	1.3136
-6	0.0006	0.3434	0.0017	0.5661	0.0006	0.3135	0.0022	0.7850	-0.0099	-4.1449***	-0.0066	-2.2932**
-5	0.0004	0.2376	0.0021	0.6337	0.0005	0.3399	0.0026	0.8577	0.0031	2.2175**	-0.0035	-1.0322
-4	0.0061	2.6143***	0.0081	1.8296*	0.0055	2.1695**	0.0082	1.7953*	0.0027	0.9823	-0.0007	-0.1451
-3	0.0019	1.0673	0.0100	1.8314*	0.0019	1.3262	0.0101	1.9106*	0.0082	5.8246***	0.0075	1.3325
-2	0.0003	0.1530	0.0103	1.8315*	0.0002	0.1290	0.0103	1.9295*	0.0018	1.1054	0.0093	1.5812
-1	-0.0019	-1.3210	0.0084	1.6130	-0.0018	-1.2356	0.0085	1.6997*	-0.0033	-2.2887**	0.0060	1.0570
0	0.0008	0.3716	0.0092	1.4681	0.0013	0.5981	0.0098	1.6433	0.0007	0.3165	0.0067	0.9747
1	-0.0009	-0.5729	0.0083	1.5702	-0.0011	-0.6542	0.0087	1.8060*	0.0007	0.3783	0.0074	1.2498
2	-0.0021	-1.5640	0.0062	1.1882	-0.0022	-1.9145*	0.0065	1.2841	-0.0106	-7.6788***	-0.0032	-0.5001
3	0.0047	2.2264**	0.0109	1.6131	0.0050	2.4192**	0.0115	1.7720*	0.0092	4.4516***	0.0060	0.7939
4	0.0017	0.6854	0.0126	1.7858*	0.0021	0.8611	0.0136	2.1403**	0.0044	1.7613*	0.0104	1.4267
5	-0.0031	-2.4647**	0.0095	1.4035	-0.0032	-2.5637**	0.0103	1.6336	-0.0133	-9.7101***	-0.0029	-0.3855
6	0.0000	0.0041	0.0095	1.1421	0.0005	0.2310	0.0109	1.3853	-0.0053	-1.9954**	-0.0082	-0.8794
7	-0.0011	-0.5409	0.0084	0.9934	-0.0004	-0.1622	0.0105	1.4159	0.0076	2.6529***	-0.0006	-0.0687
8	-0.0001	-0.0803	0.0083	0.9785	0.0003	0.1293	0.0108	1.4914	0.0065	2.9879***	0.0059	0.6800
9	-0.0013	-0.7883	0.0070	0.8708	-0.0009	-0.5028	0.0099	1.4615	0.0036	2.1111**	0.0096	1.1508
10	0.0013	0.6859	0.0084	0.9358	0.0009	0.4689	0.0108	1.4307	0.0017	0.7521	0.0113	1.2609

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.7.1: Abnormal returns around the delisting event for 15 in-the-money *call warrants*

The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 15 UK in-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0027	1.9077*	0.0027	1.9077*	0.0026	1.4256	0.0026	1.4256	0.0087	3.9039***	0.0087	3.9039***
-9	-0.0012	-0.5159	0.0015	0.7141	-0.0012	-0.4285	0.0014	0.4144	0.0040	1.5414	0.0127	3.8604***
-8	-0.0020	-0.6512	-0.0005	-0.1344	-0.0017	-0.5674	-0.0003	-0.0710	-0.0026	-0.8008	0.0100	2.4641**
-7	0.0009	0.4342	0.0004	0.1129	0.0014	0.5687	0.0011	0.3007	-0.0066	-2.9441***	0.0034	0.9500
-6	0.0007	0.3605	0.0011	0.3471	0.0014	0.5263	0.0025	0.8363	-0.0103	-3.4336***	-0.0069	-1.8229*
-5	0.0004	0.2329	0.0015	0.3669	0.0005	0.3483	0.0030	0.7645	0.0032	1.9931**	-0.0037	-0.7432
-4	0.0062	1.7827*	0.0077	1.2622	0.0066	1.6996*	0.0096	1.4916	0.0009	0.2329	-0.0028	-0.3743
-3	0.0031	1.2198	0.0108	1.3969	0.0030	1.3922	0.0127	1.6860*	0.0092	4.7057***	0.0065	0.7520
-2	0.0031	1.7386*	0.0139	1.6217	0.0033	1.9146*	0.0159	1.9616**	0.0038	1.9541*	0.0102	1.0703
-1	-0.0009	-0.5787	0.0130	1.5920	-0.0006	-0.3740	0.0154	1.9635**	-0.0022	-1.2896	0.0081	0.8383
0	0.0036	1.2137	0.0166	1.7569*	0.0038	1.3068	0.0192	2.1115**	0.0042	1.4190	0.0123	1.1191
1	-0.0029	-1.1900	0.0137	1.7169*	-0.0028	-1.0857	0.0164	2.2023**	-0.0018	-0.7221	0.0104	1.1106
2	-0.0013	-0.6696	0.0124	1.6677*	-0.0008	-0.5334	0.0156	2.0992**	-0.0106	-6.8728***	-0.0001	-0.0110
3	0.0062	1.8369*	0.0187	1.8653*	0.0062	1.8746*	0.0218	2.2564**	0.0110	3.3206***	0.0109	0.9572
4	-0.0006	-0.1785	0.0181	1.8748*	-0.0006	-0.1876	0.0212	2.3965**	0.0035	1.0607	0.0143	1.3710
5	-0.0042	-2.0383**	0.0139	1.5303	-0.0035	-1.6613*	0.0177	2.0060**	-0.0151	-7.2659***	-0.0007	-0.0674
6	0.0018	0.6345	0.0157	1.4485	0.0021	0.7157	0.0198	1.8598*	-0.0023	-0.7494	-0.0030	-0.2332
7	-0.0010	-0.3262	0.0147	1.2710	-0.0013	-0.3484	0.0185	1.7959*	0.0091	2.4389**	0.0061	0.4879
8	-0.0024	-1.2094	0.0122	1.0548	-0.0025	-0.9130	0.0160	1.5999	0.0058	2.1573**	0.0119	0.9841
9	0.0000	-0.0330	0.0122	1.0494	-0.0001	-0.0703	0.0159	1.6151	0.0055	3.0756***	0.0174	1.4848
10	-0.0020	-0.6693	0.0102	0.7569	-0.0017	-0.6031	0.0141	1.2230	-0.0037	-1.2575	0.0137	1.0052

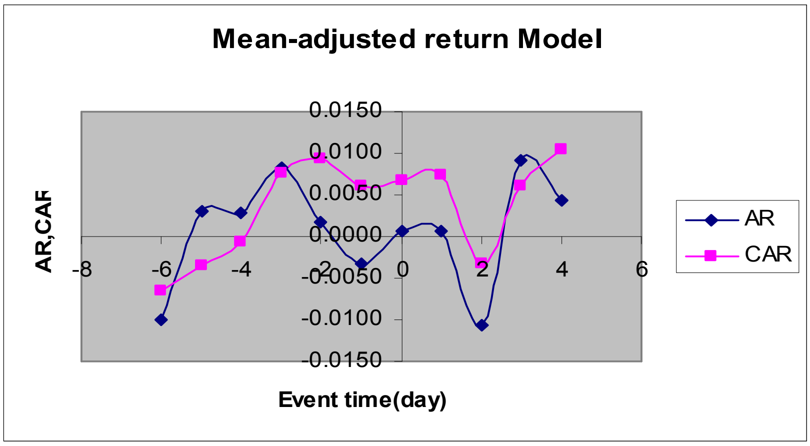
Notes: ***significant at 1% **significant at 5% *significant at 10%

The sample period extends form July 2004 until December 2006.

The estimation window consists of 300 days which range from day -310 to -11.

The first group is presented in Table 4.7 and shows the abnormal returns around the delisting event for 25 in-the-money call warrants. All three models (the market model, the market-adjusted model, and the mean-adjusted return model) employed under this analysis provide similar outcomes/trend.[37] In Table 4.7 and Figure 4.6, under the mean-adjusted return model, there is a positive abnormal return of 1.6% over day -5 to -2. This means the underlying security price is increasing before the delisting date as a result perhaps of hedging activity/delta hedging by the issuer to adjust its position before the call warrants are approaching expiration in-the-money (Chen & Wu (2001)) or as a result of trading pressure from competitors of the issuing bank. The increase is then followed by a negative abnormal return of 0.33% (at 5% significance level) on day -1. This indicates a fall in price of the underlying security a day before the delisting and supports the previous evidence of early trading from knowing the delisting dates within the market. Even though the delisting date (day 0) does not have a negative abnormal return, the return remains small and points to a falling trend in price of the underlying security as the delisting effect. However, this presents only a temporary small negative price effect which does not persist beyond the delisting date. These outcomes are similar to those for the whole delisting sample for the effect of call warrants previously analyzed. Therefore, the validity of previous explanations of the results is confirmed by this in-the-money call warrants' evidence.

Figure 4.6: Abnormal returns around the delisting event for 25 in-the-money *call warrants*
The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 25 UK in-the-money call covered warrants where mean-adjusted return model are used to generate normal return.



Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

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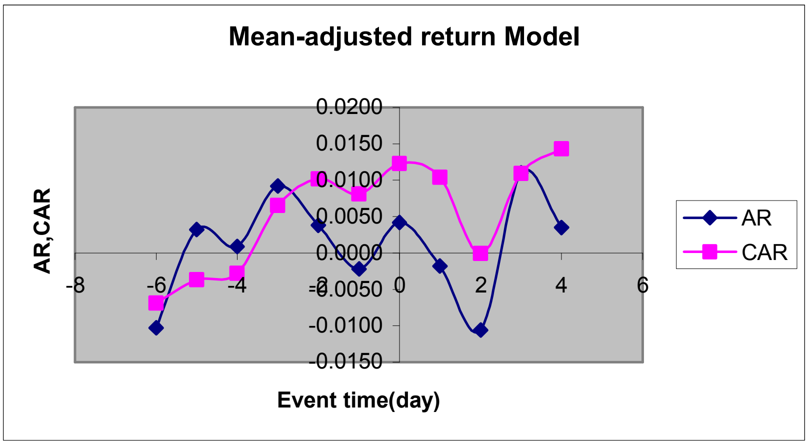
37 The abnormal returns around delisting event for 25 in-the-money call warrants under the market model and the market-adjusted model are also presented in graphs, Appendix 4.3.

To confirm the validity of the assumption used to categorise the 25 in-the-money call warrants' result, this study examines a further 20 call warrants for which exercise prices data is available. The 20 call warrants are divided into 15 in-the-money call warrants and 5 out-of-the money call warrants. The outcome can be seen in Table 4.7.1 which presents the abnormal returns around the delisting event for 15 in-the-money call warrants. As can be seen in Figure 4.6.1 (the mean-adjusted return model), the price/abnormal returns' pattern is similar to the case for the 25 in-the-money call warrants.[38] Even though, the results are less significant due to the smaller data set, this confirms the validity of the assumption consequently the results produced according to the assumption.

Figure 4.6.1: Abnormal returns around the delisting event for 15 in-the-money *call warrants*
The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 15 UK in-the-money call covered warrants where mean-adjusted return model are used to generate normal return.



Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

The second group is out-of-the-money warrants. There is no need for hedging activity before the expiration (the delta value should reasonably fall toward zero) and the issuer gradually unwinds its position (selling out the underlying securities) long before expiration. Hence, there should not be any effect on the delisting event. Appendix 4.4 and appendix 4.5 show the abnormal returns around delisting event for 11 out-of-the-money call warrants. Both table and graphs show no effect on the delisting of out-of-the money call warrants. This may be because there is no sale of the underlying stocks by the investment bank on the delisting day due to early unwinding (as expected), and no selling

[38]Appendix 4.3.1 presents the abnormal returns around delisting event for 15 in-the-money call warrants under the market model and the market-adjusted model in graphs.

activity in the underlying securities by the out-of-the money warrants holders. However, appendix 4.4 (for the mean-adjusted return model) presents some evidence of a significance negative abnormal return during the delisting that might result from other information effects.

To confirm the validity of the assumption used to categorise the results for these 11 out-of-the-money call warrants, this study examines further the 5 out-of-the-money call warrants (from 20 call warrants that have exercise prices data available). Appendix 4.4.1 and Appendix 4.5.1 present outcomes in term of table and graphs, consecutively. The outcomes confirm the evidence of no effect on the underlying securities due to the delisting of the 11 out-of-the-money call warrants.

After considering both 25 in-the-money call warrants (Table 4.7) and 11 out-of-the-money call warrants (Appendix 4.4) together, the overall impression (Table 4.5) is of a delisting effect since a large proportion of the total call warrants are in-the-money. There is a fall in price of the underlying security a day before and on the delisting date which indicates a temporary small negative price effect (that does not persist beyond the delisting date). It is consistent with the work of Draper et al. (2001) and Chen & Wu (2001) that present a negative price effect prior to the option expiration day and positive effect post expiration. However, the results are inconsistent with Klemkosky (1978) and Officer & Trennepohl (1981).

Table 4.8 and Figure 4.7 reveal the results of the study of delisting effects for the put warrants and indicate a slight fall in abnormal returns/stock prices before and shortly after the delisting date. This may result from the very early stage of unwinding the bank's position. The stock price has started to fall back to the normal level (after a sharp rise from early unwinding) and is confirmed by the significance level of negative CARs from day -4 to day 3 (Table 4.8) at around 5% significance level. It then remains quite steady (as it reaches the normal price level). We cannot separate into 2 cases (for both in/out-of-the money) because there are not enough put warrants in the sample.

Table 4.8: Abnormal returns around the delisting event for *put event*

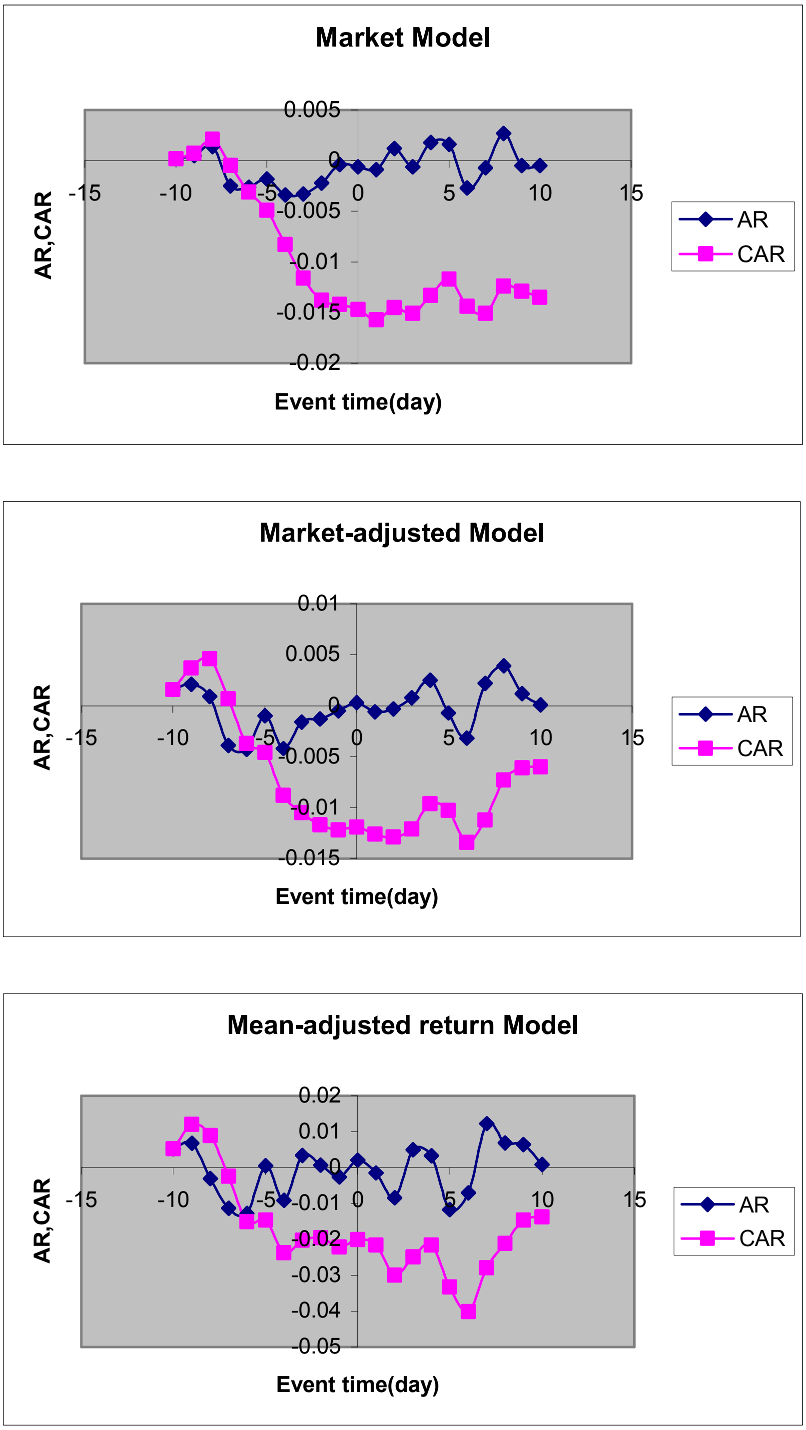
The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0002	0.1245	0.0002	0.1245	0.0016	1.0099	0.0016	1.0099	0.0052	3.1285***	0.0052	3.1285***
-9	0.0005	0.3609	0.0007	0.3792	0.0021	1.2896	0.0037	1.7562*	0.0068	4.2496***	0.0120	5.6843***
-8	0.0014	0.9575	0.0021	0.8480	0.0009	0.6768	0.0046	1.7310*	-0.0030	-2.2611**	0.0090	3.3711***
-7	-0.0025	-2.7698***	-0.0005	-0.1779	-0.0039	-3.6884***	0.0007	0.2666	-0.0113	-9.0950***	-0.0024	-0.9877
-6	-0.0026	-1.9216*	-0.0031	-1.0391	-0.0043	-2.9602***	-0.0037	-1.2463	-0.0128	-6.7395***	-0.0151	-4.9804***
-5	-0.0018	-1.5799	-0.0049	-1.5004	-0.0010	-0.9017	-0.0046	-1.4606	0.0005	0.4678	-0.0146	-4.4717***
-4	-0.0034	-1.6288	-0.0083	-2.0393**	-0.0042	-1.8832	-0.0088	-2.1600**	-0.0091	-3.9185***	-0.0237	-5.4420***
-3	-0.0033	-1.4317	-0.0116	-2.2404**	-0.0016	-0.6872	-0.0105	-2.0753**	0.0034	1.4676	-0.0203	-3.9330***
-2	-0.0022	-1.5302	-0.0138	-2.8063***	-0.0013	-0.9148	-0.0117	-2.4410**	0.0007	0.5161	-0.0196	-3.8444***
-1	-0.0004	-0.2341	-0.0142	-3.1039***	-0.0005	-0.2848	-0.0122	-2.7656***	-0.0026	-1.6121	-0.0222	-4.6544***
0	-0.0006	-0.2461	-0.0147	-2.3085**	0.0003	0.1102	-0.0119	-1.9038*	0.0021	0.8471	-0.0201	-2.9928***
1	-0.0009	-0.6963	-0.0157	-2.8208***	-0.0006	-0.4689	-0.0126	-2.3252**	-0.0015	-1.0047	-0.0216	-3.7738***
2	0.0012	1.0058	-0.0145	-2.5914***	-0.0003	-0.2793	-0.0129	-2.3071**	-0.0084	-6.4513***	-0.0300	-4.9481***
3	-0.0006	-0.4345	-0.0151	-2.3085**	0.0008	0.5784	-0.0121	-1.8963*	0.0050	3.4208***	-0.0249	-3.6477***
4	0.0018	0.8809	-0.0133	-1.7777*	0.0025	1.1685	-0.0096	-1.3516	0.0033	1.4793	-0.0216	-2.8478***
5	0.0016	1.6002	-0.0117	-1.6021	-0.0007	-0.5046	-0.0103	-1.4245	-0.0117	-8.0572***	-0.0333	-4.2905***
6	-0.0027	-1.5637	-0.0144	-1.7076*	-0.0032	-1.7283*	-0.0134	-1.5914	-0.007	-3.6710***	-0.0402	-4.4310***
7	-0.0007	-0.4512	-0.0151	-1.8534*	0.0022	1.1141	-0.0112	-1.4271	0.0123	6.3302***	-0.0279	-3.3309***
8	0.0027	2.0092**	-0.0124	-1.6210	0.0039	2.5428**	-0.0073	-1.0060	0.0069	3.0755***	-0.0211	-2.7458***
9	-0.0005	-0.3539	-0.0129	-1.8583*	0.0012	0.7703	-0.0061	-0.9407	0.0064	4.1907***	-0.0146	-2.1558**
10	-0.0005	-0.3520	-0.0135	-1.7920*	0.0001	0.0453	-0.0060	-0.8588	0.0009	0.5482	-0.0137	-1.8552*

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Figure 4.7: Abnormal returns around the delisting event for *put event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.



Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

In conclusion, call and put warrants have negative price impact on the underlying securities on both the announcement and listing days. However, the effect is more pronounced for the announcement event. The arguments can be made to explain a decline in stock price once call warrants are introduced. Firstly, there usually are constraints on short selling in the stock market especially due to the recent concern raised by the Financial Services Authority in the UK over the short selling activities, Prosser (2008). Investors who could not employ short positions previously can now take advantage of negative information and easily trade in warrants.[39] For example, if they expect the stock price to fall in the future, they can now purchase put warrants. In addition, an increased issue of call warrants can be seen as an expectation of a future fall in stock price. Secondly, due to the introduction of warrants, shifts of trading from the stock market to the warrants market may take place because warrant investment has lower transaction costs and high leverage. Thirdly, if shareholders believe that warrants introduction would work as a destabilizing factor for the underlying securities, they might also sell out their stocks. For put warrants, the negative price impact is explainable by the hedging activity of the issuer (selling the underlying securities in advance in order to protect themselves as an issuer of put warrants).

The results from the delisting of warrants do not provide evidence of an opposite direction to the introduction effects as hypothesized by Detemple & Jorion (1990). For both call and put warrants, the findings are of negative price effects for the delisting event. This might be because of the different nature of the options and covered warrants. The selling of the underlying stocks into the market after the exercise of warrants by the holders as well as the unwinding position (selling stocks) by the issuers could be a reason for the negative underlying stock price effect on call warrants delisting.

4.6.2 Volume effects

This aspect of the research focuses on the trading volume of the underlying securities after the introduction and subsequent expiration of covered warrants. Abnormal

[39] A synthetic short position consists of either buying a put warrant or writing a call warrant. This creates the similar pay off to a short position in the stock.

return patterns are often associated with abnormal trading volumes (Campbell et al. (1993)).

Early US research on the impact of option trading suggested that there is no effect on the underlying securities trading volume. Whiteside et al. (1983) show no change in the average mean-adjusted daily volume over the study sample. There was no impact on the average number of stocks traded either before or after the moratorium. The moratorium was the period from mid-1977 until early 1980. The period was called by the Securities and Exchange Commission in order to investigate the market impacts of option trading. Damodaran & Lim (1991) also found, on the whole, little change in market-adjusted trading volumes. However, later US research suggests an increase in trading volumes after option listing (Shastri, Sultan & Tandon (1996)). Long, Schinski & Officer (1994) find an increase in average trading volume for all firms due to option listing. The small and medium market value firms experience the most significant effects. With the increase in volume there is also a significant increase in the number of stock trades. The increase in volume is not only the result of larger trade size, but also more trading activity. The hypothesis that introducing an option increases investor interest in the underlying security is consistent with their finding. In addition, Kumar et al. (1998) find an increase in the market quality of the underlying asset (as measured by liquidity) after options are listed. They suggest that there is a positive effect on trading volume post option listing. Ho & Liu (1997) and Mayhew & Mihov (2000) also find increases in underlying volumes with option listing.

Volume changes have also been examined in other markets. Gjerde & Sattem (1995) reveal that similar increases in trading volumes result from option listings on the Norwegian market. Chamberlain et al. (1993) however report no significant changes in trading volumes of the underlying stocks as a result of option listing in Canada. Kumar, Sarin & Shastri (1995) observe a decreasing trend in trading volumes of the stocks after the listing of index options in the Japanese market. Index options are comparable to options on individual equities but against a group of stocks traded on the basis of market-wide information, unlike individual stocks which are traded mostly on firm specific information. This suggests that there would be a smaller effect around the listing of index options than around the listing of individual equity options although general trends can still be observed.[40]

Covered warrants create new investment opportunity for investors with lower transaction costs. The fundamental idea underlying this discussion is market incompleteness. Warrant trading may make an incomplete market more complete. When the market is incomplete, the introduction of warrants may have a significant effect on the market for the underlying stocks. The availability of warrants can move trades away from the underlying stocks towards the warrants leading to a decrease in trading volumes of the underlying stocks. They may also induce more hedging related trades from issuers, especially in the absence of any similar contracts. An additional factor is the possible manipulation of the underlying price by the warrant issuers during issue in order to achieve greater premiums.

There are a number of empirical studies concerning stock volumes around warrant trading. Chan & Wei (2001) observe a high level of stock trading activity in Hong Kong for 5 days around the warrant announcement date. They also observe a sharp rise in volumes of the stocks with warrants during the last 5 minutes of the announcement day. Chen & Wu (2001) report positive abnormal underlying stock trading volume behaviour around the derivative warrants introduction day in the Hong Kong market. There appears to be a strong relationship between price effects and trading volume. Draper et al. (2001) also examine an increase in trading volume of the underlying security during warrant introduction in Hong Kong. They find evidence indicating different results for the volume impact between the first time and subsequent warrant introductions.[41] When warrants are introduced for the first time there is no change in the market-adjusted trading volume which is consistent with the early empirical US researches.

[40] For example, due to the hypothesis of a migration of trading activity from the underlying stock market to the options market, the decrease in trading volume under the listing of index options should be smaller than the decrease in trading volume under the listing of individual options which would not have any additional spurious effects from market-wide information.

[41] The first time warrant means the initial launch of each warrant into the market.

Table 4.9: Abnormal trading volumes around the announcement event for *call event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0064	0.1082	0.0064	0.1069	0.0168	0.2736	0.0168	0.2704	-0.0274	-0.3429	-0.0274	-0.3389
-9	0.0635	0.8766	0.0699	0.9699	0.0982	1.3771	0.1150	1.5294	-0.1584	-2.0923**	-0.1858	-2.0980**
-8	-0.0603	-0.8767	0.0096	0.4060	-0.0638	-0.9285	0.0512	0.9082	-0.0516	-0.7432	-0.2374	-2.2377**
-7	-0.0478	-0.7599	-0.0382	0.0351	-0.0462	-0.7575	0.0049	0.5553	-0.1056	-1.5983	-0.3431	-3.1332***
-6	0.0282	0.4351	-0.0100	0.3114	0.0178	0.2750	0.0228	0.6157	0.0653	1.1268	-0.2778	-2.1116**
-5	-0.0703	-1.1982	-0.0803	-0.4204	-0.0747	-1.2391	-0.0520	-0.1089	-0.0201	-0.3452	-0.2979	-2.3375**
-4	0.1163	1.9786**	0.0359	0.7644	0.1070	1.8088*	0.0550	0.9644	0.1402	2.3027**	-0.1577	-0.8264
-3	-0.0634	-0.9270	-0.0274	0.1253	-0.0571	-0.8158	-0.0020	0.3710	-0.1246	-1.8687*	-0.2823	-1.8930*
-2	0.0703	1.0940	0.0429	0.8556	0.0669	1.0456	0.0649	1.1316	0.1065	1.6824*	-0.1757	-1.1140
-1	-0.0780	-1.2072	-0.0351	0.0635	-0.0796	-1.2024	-0.0147	0.3074	-0.0753	-1.1179	-0.2511	-1.8661*
0	-0.1197	-1.4317	-0.1548	-1.0694	-0.1432	-1.7076*	-0.1579	-1.1106	-0.0205	-0.2488	-0.2716	-1.9664**
1	-0.0005	-0.0087	-0.1553	-1.1789	0.0136	0.2257	-0.1443	-1.0898	-0.0932	-1.5507	-0.3648	-2.9002***
2	0.0256	0.3171	-0.1297	-0.8214	0.0487	0.5963	-0.0956	-0.5539	-0.0637	-0.7964	-0.4286	-2.9089***
3	0.0054	0.0571	-0.1243	-0.7901	-0.0356	-0.3766	-0.1312	-0.7873	0.1618	1.6932*	-0.2668	-2.2660**
4	0.0091	0.1558	-0.1152	-0.8911	0.0142	0.2463	-0.1169	-0.8742	-0.0021	-0.0375	-0.2689	-2.6590***
5	0.1812	2.6081***	0.0660	0.6837	0.1692	2.4105**	0.0523	0.6548	0.2623	3.4832***	-0.0065	-0.1125
6	-0.1448	-2.1975**	-0.0788	-0.6092	-0.1727	-2.6132***	-0.1204	-0.9242	-0.0257	-0.3715	-0.0322	-0.3442
7	-0.0664	-1.1937	-0.1451	-1.2894	-0.0446	-0.8011	-0.1650	-1.4571	-0.2026	-3.5628***	-0.2348	-2.1520**
8	0.0830	1.1668	-0.0621	-0.4835	0.0724	1.0054	-0.0925	-0.7133	0.0985	1.3130	-0.1363	-1.3658
9	0.0220	0.3003	-0.0402	-0.2600	0.0248	0.3443	-0.0677	-0.4383	0.0037	0.0545	-0.1326	-1.2060
10	-0.0213	-0.2803	-0.0615	-0.5119	-0.0348	-0.4557	-0.1025	-0.8752	0.0231	0.3140	-0.1095	-1.2161

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.10: Abnormal trading volumes around the listing event for *call event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the listing event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0574	0.7670	0.0574	0.7271	0.0550	0.7239	0.0550	0.6864	0.0208	0.2817	0.0208	0.2673
-9	0.0260	0.3458	0.0834	0.8787	0.0260	0.3458	0.0810	0.8304	0.0218	0.3056	0.0427	0.4727
-8	-0.0862	-1.6339	-0.0028	-0.0863	-0.0810	-1.5120	0.0000	-0.0556	-0.1095	-1.8455*	-0.0669	-0.6576
-7	0.0488	0.7014	0.0460	0.3981	0.0399	0.5829	0.0399	0.3318	0.0826	1.0943	0.0158	0.1347
-6	-0.0867	-1.3217	-0.0406	-0.4912	-0.0791	-1.1919	-0.0392	-0.4858	-0.1211	-1.7170*	-0.1053	-1.0897
-5	-0.0375	-0.5649	-0.0781	-0.7698	-0.0622	-0.9036	-0.1014	-0.9466	0.0087	0.1134	-0.0966	-0.8932
-4	0.1168	1.5120	0.0387	0.1751	0.1286	1.6643*	0.0272	0.0967	0.0987	1.1092	0.0021	-0.1348
-3	-0.1373	-2.1063**	-0.0986	-1.0009	-0.1362	-1.9935**	-0.1089	-1.1246	-0.1675	-2.5311**	-0.1654	-1.5839
-2	-0.0081	-0.1124	-0.1067	-1.0209	-0.0400	-0.5481	-0.1489	-1.4384	0.0970	1.0754	-0.0684	-0.6243
-1	-0.0113	-0.1287	-0.1180	-0.9847	-0.0048	-0.0563	-0.1537	-1.2762	-0.0206	-0.2095	-0.0890	-0.7708
0	0.0342	0.4970	-0.0838	-1.0421	0.0191	0.2794	-0.1347	-1.6691*	0.0177	0.2328	-0.0714	-0.7830
1	-0.1197	-1.6478	-0.2035	-1.7416*	-0.1354	-1.8253*	-0.2701	-2.2879**	-0.0389	-0.5003	-0.1102	-0.8437
2	0.0795	1.2731	-0.1239	-1.0027	0.0780	1.2575	-0.1921	-1.5626	0.0759	1.1010	-0.0344	-0.2580
3	0.0187	0.2405	-0.1052	-1.0405	0.0140	0.1801	-0.1781	-1.7782*	0.0242	0.2705	-0.0102	-0.1105
4	0.2337	3.0389***	0.1285	1.1016	0.2394	3.0948***	0.0614	0.5909	0.2130	2.1498**	0.2028	1.4317
5	-0.0811	-1.0951	0.0475	0.4090	-0.1032	-1.4068	-0.0419	-0.2808	-0.0144	-0.1600	0.1884	1.2492
6	-0.0997	-1.1787	-0.0522	-0.2747	-0.0972	-1.1549	-0.1391	-0.9996	-0.1425	-1.5953	0.0460	0.4899
7	0.0274	0.4164	-0.0248	-0.0818	0.0408	0.6020	-0.0983	-0.7272	-0.0487	-0.6292	-0.0027	0.2032
8	-0.0698	-1.0147	-0.0946	-0.6307	-0.0909	-1.3780	-0.1893	-1.4308	-0.0374	-0.4571	-0.0401	-0.0449
9	0.0869	1.5574	-0.0077	0.0048	0.0876	1.5273	-0.1017	-0.7310	0.0892	1.3356	0.0490	0.4927
10	0.0207	0.2407	0.0130	0.1610	0.0085	0.0965	-0.0932	-0.7124	0.1067	1.2913	0.1557	1.1939

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

This study tests whether the introduction (and expiration) of covered warrants affects the trading activity of the underlying stocks. Similar to the previous analysis of returns, it uses an event study methodology. This research involves three events, the announcement, listing and delisting events (for both call and put covered warrants). A 21-day event window is employed. It consists of the event day (day0) plus 10 trading days before and after the event day. The estimation window is a 300-day period from day -310 to day-11. In order to calculate the normal trading volume that is used as the benchmark to generate abnormal trading volume, the three models (the market, market-adjusted, and mean-adjusted return models) are employed for each particular case. Daily trading volume data for each firm in the sample as well as for the FTSE100 index (representing market trading volume) are used. There are mixed results as to the impact on the underlying trading volume. Table 4.9 shows the abnormal trading volumes for the underlying stocks on the announcement of call covered warrants.[42] Each model presents a mixture of results with insignificant rise and fall in the underlying abnormal trading volume. The results indicate no significant pattern associated with the underlying stock trading volume on the warrant announcement. In other words, the call covered warrant announcements have no effect on the underlying stock trading volume. Table 4.10 shows a rising trend in abnormal volume on the call covered warrant listing event, following by a decrease in abnormal volume the next day and an increase again the day after.[43] The small positive abnormal volume on the listing date for all three models (market model, market-adjusted model, and mean-adjusted return model) may be explained by both hedging activities by the issuers, and shareholders who believe that warrant introduction is a destabilizing factor for the underlying securities (Kabir, 1999). Unfortunately, the volume results here are statistically insignificant and inconsistent with the previous results of a price effect on the listing of warrants. Hedging activities increase the price of the underlying stock before the announcement event. This suggests there should be an increase in the underlying trading volume. However, the warrant announcements provide no effect on volume as shown in Table 4.9. Moreover, the price starts falling on the announcement and subsequent days. This effect continues into the following listing event. A negative price effect around the listing (because of the end to hedging activities) should be followed by a decrease in volume which is in contrast to the

[42] The graphs of abnormal trading volumes around the announcement event for call event can be seen in Appendix 4.6.

[43] The graphs of abnormal trading volumes around the listing event for call event can be seen in Appendix4.7.

volume effect found here. However, the result is statistically insignificant as already mentioned. It can reasonably be concluded that both the call covered warrant announcements and listings have no significant volume effect on the underlying stocks.

Table 4.11 summarizes the underlying volume effect for the announcement event for put warrants and reveals mixed results with falling abnormal volume around two days before the announcement date, an increase on the event date itself then falling back again a day later.[44] The increase in abnormal volume (1% significance level) on the event date of the put announcement for all three models can be explained in the same way as in the case of call warrants - issuers hedging activities, and investors' belief that warrants are a destabilizing factor for the underlying stocks. These volume results do not reveal any relationship with the previous price effects on the underlying stocks. In addition, Table 4.12 reports mixed results for the underlying volume effect on the put warrants listing day.[45] There is a positive abnormal volume of 14.32% (10% significance level) from the market-adjusted model, a non significant positive abnormal volume from the market model and a negative abnormal volume of 23.55% (10% significance level) from the mean-adjusted return model on the warrant listings. Therefore, the results under this analysis under the three models are inconclusive and provide no general pattern of the underlying volume effect. Overall, it appears there is an inconclusive volume effect from the put covered warrant announcements and listings.

[44] Appendix 4.8 provides graphs for the abnormal trading volumes around the announcement event for put event.
[45] Appendix 4.9 provides graphs for the abnormal trading volumes around the listing event for put event.

Table 4.11: Abnormal trading volumes around the announcement event for *put event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.1410	3.1743***	0.1410	3.1743***	0.1693	3.5572***	0.1693	3.5572***	0.1447	3.1948***	0.1447	3.1948***
-9	0.0043	0.0764	0.1453	2.7392***	0.0196	0.3523	0.1889	3.3637***	-0.0449	-0.7425	0.0998	1.6089
-8	0.1087	1.4368	0.2427	3.5163***	0.0904	1.1867	0.2699	3.6276***	0.2205	2.9848***	0.2975	3.5345***
-7	0.0070	0.1274	0.2490	4.5782***	0.0223	0.3960	0.2899	4.7807***	-0.0754	-1.3859	0.2299	3.1288***
-6	0.1483	2.5716**	0.3973	6.9481***	0.1467	2.5198**	0.4366	7.5650***	0.0059	0.0914	0.2358	3.9292***
-5	-0.1272	-2.0236**	0.2701	4.3286***	-0.1643	-2.5898***	0.2722	4.4763***	-0.0023	-0.0342	0.2336	3.3022***
-4	-0.0217	-0.3485	0.2484	5.0368***	-0.0156	-0.2460	0.2567	5.2936***	0.0872	1.3329	0.3208	4.6670***
-3	-0.0995	-1.5645	0.1489	2.1707**	-0.1083	-1.6800*	0.1483	2.1955**	-0.1319	-2.2115**	0.1889	2.5126**
-2	0.0136	0.2756	0.1625	2.7684***	0.0261	0.5184	0.1744	3.0223***	-0.0095	-0.1895	0.1794	2.9034***
-1	-0.0099	-0.2392	0.1526	2.5239**	-0.0134	-0.3250	0.1610	2.7618***	-0.1802	-3.5087***	-0.0008	-0.0115
0	0.2650	4.3184***	0.4176	4.6625***	0.2488	4.1069***	0.4098	4.6592***	0.4259	6.5082***	0.4251	4.6401***
1	-0.1153	-1.9303*	0.3023	4.0627***	-0.0837	-1.3825	0.3261	4.3199***	-0.1273	-1.9389*	0.2979	3.4821***
2	0.0075	0.1206	0.3078	3.4758***	0.0013	0.0216	0.3271	3.7728***	-0.0030	-0.0475	0.2957	2.9821***
3	0.0539	0.9592	0.3468	4.2469***	0.0406	0.7113	0.3565	4.5107***	0.1111	1.9210*	0.3762	3.9129***
4	-0.3855	-6.2457***	0.0676	0.8219	-0.3933	-6.3258***	0.0717	0.8390	-0.1727	-3.0148***	0.2511	2.8087***
5	0.1738	4.5236***	0.2414	2.8538***	0.1376	3.5553***	0.2094	2.5029**	0.2264	4.4342***	0.4775	5.0435***
6	-0.1172	-2.0565**	0.1243	1.3492	-0.1334	-2.2920**	0.0760	0.8625	-0.0732	-1.3632	0.4043	4.2192***
7	0.0953	1.3569	0.2196	2.2318**	0.1253	1.8194*	0.2013	2.2061**	0.0102	0.1332	0.4144	3.4348***
8	-0.1982	-3.2600***	0.0214	0.2368	-0.2023	-3.1906***	-0.0010	-0.0120	-0.1443	-2.7017***	0.2702	2.6192***
9	0.0617	1.0974	0.0810	0.7757	0.0492	0.8645	0.0465	0.5045	0.0044	0.0794	0.2744	2.2597**
10	0.0616	1.4596	0.1405	1.3320	0.0645	1.5007	0.1088	1.1503	0.0897	2.0543**	0.3609	3.0404***

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.12: Abnormal trading volumes around the listing event for *put event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the listing event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0903	1.0284	0.0903	1.0188	0.0759	0.8618	0.0759	0.8539	0.1054	1.1464	0.1054	1.1357
-9	0.0136	0.1762	0.1039	1.4614	0.0035	0.0430	0.0793	1.0254	-0.0721	-0.9486	0.0333	0.4120
-8	0.0010	0.0160	0.1048	1.3732	0.0135	0.2184	0.0928	1.1742	0.0125	0.1973	0.0458	0.6025
-7	-0.0705	-1.1909	0.0343	0.4210	-0.0778	-1.2990	0.0149	0.1672	-0.0538	-0.8505	-0.0080	-0.1208
-6	-0.0722	-1.1908	-0.0379	-0.4909	-0.0696	-1.1431	-0.0547	-0.6993	-0.0167	-0.2544	-0.0246	-0.3197
-5	0.0332	0.5632	-0.0047	-0.0817	0.0058	0.0999	-0.0489	-0.7108	0.1248	1.9706**	0.1002	1.1656
-4	0.0272	0.4553	0.0225	0.2500	0.0585	0.9885	0.0096	0.0988	-0.1754	-2.4064**	-0.0752	-0.7671
-3	0.0303	0.5579	0.0529	0.5325	0.0711	1.3203	0.0807	0.8411	-0.0297	-0.4356	-0.1049	-1.0397
-2	-0.0074	-0.1506	0.0455	0.5189	-0.0223	-0.4590	0.0585	0.7402	0.0814	1.2942	-0.0235	-0.4908
-1	-0.2249	-5.2352***	-0.1794	-1.1817	-0.2292	-5.5678***	-0.1707	-1.0605	-0.2141	-3.7841***	-0.2376	-1.8779*
0	0.1035	1.2587	-0.0759	-0.3196	0.1432	1.8180*	-0.0275	0.0246	-0.2355	-1.8854*	-0.4732	-2.1532**
1	-0.1307	-1.9241*	-0.2066	-1.3291	-0.1559	-2.3385**	-0.1834	-1.1614	-0.0897	-1.2426	-0.5628	-2.8132***
2	-0.0954	-1.5933	-0.3020	-2.3218**	-0.1305	-2.1980**	-0.3139	-2.4339**	0.0048	0.0689	-0.5580	-3.0238***
3	0.1224	2.1455**	-0.1796	-1.1343	0.1465	2.7049***	-0.1674	-1.0651	0.1114	1.4758	-0.4466	-2.1602**
4	-0.0072	-0.1574	-0.1868	-1.1151	0.0258	0.5843	-0.1416	-0.7604	-0.1454	-2.7559***	-0.5920	-2.7617***
5	-0.0365	-0.5096	-0.2234	-1.2977	-0.0419	-0.5741	-0.1835	-1.0488	-0.0540	-0.8005	-0.6460	-2.7401***
6	-0.2398	-3.1813***	-0.4632	-2.8643***	-0.2642	-3.3665***	-0.4477	-2.8825***	-0.1282	-1.9971**	-0.7742	-3.2413***
7	0.2721	5.1820***	-0.1911	-0.9400	0.2493	4.5697***	-0.1983	-0.9654	0.2485	4.3524***	-0.5257	-2.0524**
8	-0.0287	-0.3999	-0.2198	-1.2789	-0.0038	-0.0517	-0.2021	-1.1715	-0.0870	-1.1708	-0.6127	-2.4311**
9	0.0623	1.2961	-0.1574	-0.9380	0.0620	1.2716	-0.1401	-0.7782	-0.0104	-0.1733	-0.6231	-2.3882**
10	-0.0247	-0.5221	-0.1821	-1.0221	-0.0264	-0.5559	-0.1665	-0.8947	-0.0391	-0.8161	-0.6622	-2.5312**

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

The effects of delisting the call covered warrants are presented in Table 4.13.[46] There are significant decreases in the underlying trading volume, 14.20% for the market model and 16.75% for the market-adjusted model. The mean-adjusted return model reports results in the opposite direction. The evidence does not provide any uniform pattern as to the underlying volume effect on the call covered warrant delisting. In other words, the call covered warrant delisting provides inconclusive or no general impact on the underlying stock trading volume. This study further separates the call warrants into two cases, in-the-money (Table 4.14, Appendix 4.11) and out-of-the-money (Table 4.15, Appendix 4.12) call warrants. Table 4.14 shows insignificant and no general pattern of results for the underlying abnormal trading volume for in-the-money call warrants delisting. Thus, the impact is inconclusive. Table 4.15 presents significant negative abnormal trading volumes on out-of-the-money call warrants delisting days for both the market and market-adjusted models. Though not significant, the mean-adjusted return model also provides negative abnormal trading volumes on the delisting date. These results are more likely explained by other information effects rather than the delisting event itself. If the warrants are out-of-the-money, there should not be any effect on that particular day since early unwinding by the issuers will take place. In summary, even taking into consideration the two separate cases for in/out-of-the-money call warrants the results for the delisting event on the underlying trading volume of the call warrants is inconclusive.

Table 4.16 and Appendix 4.13 report the results for abnormal trading volume on the delisting of put covered warrants. There are small increases in abnormal volume for all three models, but they are statistically insignificant. Thus, there are no significant effects on underlying stock volume as a consequence of the delisting of put warrants.

[46] This table is also present in graphs, Appendix 4.10.

Table 4.13: Abnormal trading volumes around the delisting event for *call event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0280	0.4527	0.0280	0.4527	0.0491	0.7867	0.0491	0.7867	-0.0472	-0.7336	-0.0472	-0.7336
-9	-0.0340	-0.4685	-0.0060	-0.0642	-0.0187	-0.2655	0.0304	0.3363	-0.1433	-2.0221**	-0.1905	-2.0461**
-8	0.0422	0.4768	0.0362	0.4689	0.0267	0.3119	0.0571	0.7377	0.1374	1.4379	-0.0531	-0.6849
-7	0.0462	0.6020	0.0824	0.8762	0.0277	0.3570	0.0848	0.8946	0.1454	1.7626*	0.0923	0.9673
-6	-0.1256	-1.8646*	-0.0432	-0.5790	-0.1556	-2.4135**	-0.0707	-0.9322	-0.0156	-0.2114	0.0767	1.0115
-5	-0.0372	-0.5286	-0.0793	-1.0653	0.0241	0.3713	-0.0473	-0.6590	-0.3207	-4.4308***	-0.2348	-3.2594***
-4	0.0644	0.9898	-0.0168	-0.2046	0.0480	0.7228	-0.0007	-0.0086	0.1415	2.0567**	-0.0974	-1.1951
-3	0.0300	0.3391	0.0124	0.1259	-0.0469	-0.5596	-0.0463	-0.4473	0.4063	4.7051***	0.2973	2.9436***
-2	-0.0943	-1.0697	-0.0820	-0.8389	-0.0883	-1.0051	-0.1345	-1.2374	-0.1160	-1.2414	0.1813	1.6402
-1	0.1388	1.7169*	0.0568	0.6728	0.1464	1.7907*	0.0118	0.1306	0.0867	1.0674	0.2680	2.6776***
0	-0.1420	-1.8556*	-0.0851	-1.0506	-0.1675	-2.1569**	-0.1557	-1.7494*	0.0315	1.6933*	0.2995	3.0435***
1	-0.0108	-0.1698	-0.0960	-1.0684	0.0539	0.9497	-0.1017	-1.1140	-0.3745	-4.6954***	-0.0750	-0.8563
2	0.0131	0.1912	-0.0829	-0.9495	-0.0109	-0.1651	-0.1127	-1.2331	0.1552	2.3080**	0.0802	0.8996
3	0.2195	3.6118***	0.1366	1.8310*	0.1931	3.1262***	0.0804	0.9902	0.3076	4.0721***	0.3878	4.0317***
4	-0.0588	-0.7391	0.0778	0.9688	-0.0672	-0.8346	0.0132	0.1489	0.0011	0.0133	0.3889	4.1367***
5	0.0237	0.3674	0.1015	1.5609	0.0651	0.9742	0.0782	1.2095	-0.2463	-3.3198***	0.1426	2.0273**
6	-0.0120	-0.1890	0.0902	1.1064	-0.0697	-1.1206	0.0126	0.1507	0.2709	4.3496***	0.3980	4.4814***
7	0.0093	0.0972	0.0989	1.0776	0.0209	0.2194	0.0322	0.3288	-0.0507	-0.5307	0.3502	3.4354***
8	-0.0556	-0.8441	0.0449	0.6551	-0.0760	-1.1520	-0.0416	-0.5433	0.0538	0.8206	0.4025	4.7284***
9	-0.0612	-1.0645	-0.0163	-0.1914	-0.0322	-0.5596	-0.0738	-0.7930	-0.2105	-3.7273***	0.1920	1.9717**
10	0.1449	1.9642**	0.1287	1.4595	0.1289	1.7577*	0.0552	0.6142	0.2468	3.3544***	0.4388	5.0056***

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.14: Abnormal trading volumes around the delisting event for 25 in-the-money *call warrants*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the 25 UK in-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.1027	1.6076	0.1027	1.6076	0.1291	2.0519**	0.1291	2.0519**	0.0159	0.2361	0.0159	0.2361
-9	-0.0264	-0.2926	0.0763	0.6637	-0.0082	-0.0938	0.1209	1.0972	-0.1424	-1.6321	-0.1265	-1.1230
-8	0.0078	0.0720	0.0841	0.8517	-0.0113	-0.1085	0.1096	1.1122	0.1297	1.1487	0.0032	0.0324
-7	0.0925	1.0873	0.1766	1.5955	0.0706	0.8282	0.1802	1.6170	0.1699	1.8915*	0.1731	1.5422
-6	-0.1393	-1.6191	0.0373	0.4555	-0.1766	-2.1385**	0.0036	0.0439	-0.0216	-0.2311	0.1515	1.7969*
-5	-0.1145	-1.3640	-0.0728	-0.8780	-0.0389	-0.5100	-0.0337	-0.4312	-0.4019	-4.5142***	-0.2349	-2.9079***
-4	0.0894	1.1206	0.0131	0.1376	0.0694	0.8511	0.0330	0.3557	0.1559	1.8353*	-0.0850	-0.8912
-3	0.0927	0.8293	0.1022	0.9151	-0.0019	-0.0185	0.0311	0.2661	0.4745	4.3847***	0.3712	3.2240***
-2	-0.1092	-0.9394	-0.0070	-0.0632	-0.1021	-0.8780	-0.0710	-0.5686	-0.1116	-0.9185	0.2596	2.0730**
-1	0.0555	0.9011	0.0485	0.5669	0.0641	1.0090	-0.0069	-0.0726	0.0216	0.3606	0.2812	2.8227***
0	-0.0760	-0.8432	-0.0275	-0.2843	-0.1059	-1.1517	-0.1128	-1.0523	0.0863	0.9000	0.3675	3.2384***
1	-0.0588	-0.8003	-0.0863	-0.8365	0.0196	0.2965	-0.0932	-0.9022	-0.4459	-4.9727***	-0.0784	-0.7889
2	0.0653	0.7552	-0.0210	-0.2296	0.0366	0.4355	-0.0566	-0.5960	0.2070	2.4107**	0.1286	1.3630
3	0.2116	3.1422***	0.1906	2.3234**	0.1782	2.5185**	0.1216	1.3283	0.3269	4.3784***	0.4555	4.3265***
4	-0.0538	-0.5526	0.1369	1.6677*	-0.0634	-0.6496	0.0582	0.6454	-0.0095	-0.0968	0.4460	4.5706***
5	0.0226	0.2768	0.1594	2.1861**	0.0721	0.8612	0.1302	1.8631*	-0.2658	-2.9806***	0.1802	2.1763**
6	-0.0345	-0.4281	0.1276	1.3461	-0.1060	-1.3519	0.0324	0.3418	0.2418	3.0658***	0.4034	3.8247***
7	0.0590	0.4853	0.1821	1.8357*	0.0732	0.6035	0.1000	0.9627	0.0064	0.0527	0.4093	3.5474***
8	-0.1184	-1.8442*	0.0683	0.9856	-0.1433	-2.2067**	-0.0378	-0.4829	-0.0089	-0.1408	0.4008	4.3476***
9	-0.0399	-0.5462	0.0284	0.3008	-0.0045	-0.0615	-0.0423	-0.4069	-0.1976	-2.7746***	0.2032	1.7899*
10	0.1934	2.1332**	0.2219	2.1701**	0.1744	1.9308*	0.1322	1.2818	0.2894	3.2001***	0.4926	4.7496***

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.15: Abnormal trading volumes around the delisting event for 11 out-of-the-money *call warrants*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the 11 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	-0.1877	-1.3747	-0.1877	-1.3747	-0.1819	-1.2935	-0.1819	-1.2935	-0.2294	-1.5478	-0.2294	-1.5478
-9	-0.0561	-0.4803	-0.2438	-1.9010*	-0.0490	-0.4349	-0.2309	-1.9373*	-0.1459	-1.2209	-0.3753	-2.4785**
-8	0.1416	0.9577	-0.1022	-1.2055	0.1364	0.9374	-0.0946	-1.0932	0.1595	0.8447	-0.2158	-2.4444**
-7	-0.0875	-0.5142	-0.1898	-1.2500	-0.0961	-0.5414	-0.1907	-1.2377	0.0746	0.3787	-0.1412	-0.8517
-6	-0.0859	-0.9681	-0.2757	-1.8478*	-0.0949	-1.1765	-0.2856	-1.7939*	0.0018	0.0178	-0.1394	-0.9181
-5	0.1776	1.7362*	-0.0981	-0.5715	0.1989	1.8173*	-0.0866	-0.5022	-0.0951	-1.1632	-0.2344	-1.4309
-4	-0.0050	-0.0457	-0.1030	-0.6220	-0.0114	-0.1013	-0.0980	-0.5727	0.1013	0.8863	-0.1332	-0.8044
-3	-0.1441	-1.3090	-0.2472	-1.3051	-0.1719	-1.3606	-0.2699	-1.2738	0.2168	1.9779**	0.0836	0.4121
-2	-0.0513	-0.6531	-0.2985	-1.5053	-0.0483	-0.6751	-0.3182	-1.4363	-0.1287	-1.2278	-0.0451	-0.1983
-1	0.3794	1.4995	0.0810	0.3557	0.3841	1.5124	0.0659	0.2850	0.2748	1.0332	0.2298	0.8351
0	-0.3326	-2.5287**	-0.2516	-1.8091*	-0.3453	-2.5761**	-0.2794	-1.7856*	-0.1268	-0.9228	0.1030	0.5334
1	0.1278	1.0401	-0.1238	-0.6432	0.1531	1.3936	-0.1263	-0.6213	-0.1680	-1.0552	-0.0650	-0.3358
2	-0.1380	-1.8227*	-0.2618	-1.2308	-0.1481	-1.9351*	-0.2745	-1.2038	0.0056	0.0843	-0.0594	-0.2716
3	0.2421	1.7125*	-0.0196	-0.1193	0.2360	1.7828*	-0.0385	-0.2188	0.2518	1.2079	0.1924	0.8925
4	-0.0734	-0.5304	-0.0930	-0.4606	-0.0783	-0.5375	-0.1168	-0.5061	0.0316	0.2086	0.2240	0.9504
5	0.0270	0.2879	-0.0660	-0.5049	0.0448	0.4390	-0.0719	-0.4933	-0.1899	-1.3911	0.0341	0.2544
6	0.0481	0.5484	-0.0179	-0.1092	0.0272	0.3160	-0.0447	-0.2446	0.3484	3.9884***	0.3825	2.2118**
7	-0.1234	-0.9884	-0.1413	-0.6996	-0.1187	-0.9652	-0.1634	-0.6957	-0.2031	-1.6867*	0.1794	0.8307
8	0.1187	0.6998	-0.0226	-0.1232	0.1108	0.6700	-0.0526	-0.2579	0.2280	1.3374	0.4074	1.9640**
9	-0.1229	-1.5953	-0.1455	-0.7617	-0.1122	-1.4451	-0.1647	-0.7834	-0.2479	-3.0265***	0.1595	0.7963
10	0.0048	0.0433	-0.1406	-0.9511	-0.0026	-0.0238	-0.1674	-0.9841	0.1237	1.0817	0.2832	1.7630*

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Table 4.16: Abnormal trading volumes around the delisting event for *put event*

The table presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.1636	2.8608***	0.1636	2.8608***	0.1942	3.5560***	0.1942	3.5560***	0.0920	1.5494	0.0920	1.5494
-9	-0.1948	-4.2581***	-0.0312	-0.4530	-0.1603	-3.4435***	0.0339	0.5018	-0.3008	-6.5174***	-0.2088	-2.9879***
-8	0.1222	1.8475*	0.0910	1.2668	0.0779	1.1948	0.1118	1.5821	0.2681	4.0648***	0.0593	0.8408
-7	-0.0683	-1.4454	0.0227	0.3227	-0.0786	-1.6684*	0.0332	0.4740	-0.0429	-0.8840	0.0163	0.2360
-6	-0.0557	-1.0887	-0.0330	-0.5190	-0.0832	-1.6478	-0.0500	-0.8122	-0.0112	-0.1943	0.0052	0.0706
-5	0.0576	0.7130	0.0087	0.1020	0.1731	2.2436**	0.0754	0.9033	-0.2556	-3.3128***	-0.1799	-2.1213**
-4	-0.0450	-0.7030	-0.0239	-0.2948	-0.0647	-1.0155	0.0285	0.3571	0.0188	0.2951	-0.1663	-2.0085**
-3	0.1175	1.3339	0.0612	0.7790	-0.0251	-0.3090	0.0104	0.1365	0.5243	6.4769***	0.2133	2.3111**
-2	-0.1999	-2.6549***	-0.1388	-1.6213	-0.2110	-2.7916***	-0.2007	-2.3378**	-0.1423	-1.8527*	0.0711	0.7450
-1	0.0837	1.8524*	-0.0551	-0.7284	0.0784	1.7879*	-0.1222	-1.6364	0.1222	2.6257***	0.1933	2.3915**
0	0.0336	0.5732	-0.0215	-0.3018	0.0120	0.2037	-0.1103	-1.5540	0.0713	1.1116	0.2646	2.9257***
1	-0.0808	-1.5795	-0.1023	-1.1679	0.0331	0.6344	-0.0771	-0.9111	-0.4088	-7.7553***	-0.1443	-1.5472
2	0.0527	1.6239	-0.0496	-0.5518	0.0110	0.3418	-0.0662	-0.7563	0.1921	5.9603***	0.0478	0.4848
3	-0.0223	-0.3672	-0.0719	-0.9074	-0.0721	-1.1878	-0.1383	-1.7627*	0.1265	2.1029**	0.1743	1.8435*
4	0.1077	1.3515	0.0359	0.4347	0.0963	1.2237	-0.0420	-0.5103	0.1634	1.9948**	0.3377	3.8922***
5	0.0527	0.7901	0.0885	1.1214	0.1342	2.0542**	0.0922	1.1576	-0.1880	-3.0316***	0.1497	1.8192*
6	0.1429	2.4004**	0.1920	2.3050**	0.0496	0.8580	0.1281	1.5666	0.4121	7.1261***	0.4482	4.6407***
7	-0.3659	-4.8698***	-0.0729	-0.9449	-0.3483	-4.6189***	-0.1241	-1.6730*	-0.4058	-5.3675***	0.1543	1.8352*
8	0.0469	0.7838	-0.0260	-0.2735	0.0143	0.2402	-0.1098	-1.2056	0.1568	2.6257***	0.3112	2.9988***
9	-0.0278	-0.5819	-0.0537	-0.5622	0.0231	0.5027	-0.0866	-0.9256	-0.1760	-3.7480***	0.1352	1.3313
10	0.1934	3.9090***	0.1397	1.4247	0.1690	3.3953***	0.0824	0.8174	0.2768	5.6063***	0.4121	3.8911***

Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

This study also divides the sample of call and put covered warrants based on the listing date (day0) into two categories, the smallest and largest warrant issue size to total company outstanding shares.[47] Both warrant issue size and total company outstanding shares come from market value (MV) data of Datastream.[48] The samples are separate using:

$$\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$$

The samples of each call and put covered warrant case are divided into three equal groups smallest, middle and largest groups. The small and large groups are used for analysis. I test whether the size of warrant issue compared to the underlying security issue has any impact on abnormal trading volume around the announcement event for call or put case. Table 4.17 provides a summary of the underlying securities that have been separated into the two categories. For the call warrants, Figure 4.8 reveals very small and insignificant abnormal volume differences between the small and large sample groups.[49] Both cases do not provide any observable trend/pattern of the effects and do not deviate very much from each other. For put warrant case, Figure 4.9 reports small differences in abnormal volume between the small and large sample groups.[50] Thus, taking size (market value) of warrants into consideration does not seem to provide any clearer explanation of abnormal trading volume around the announcement event for either call or put cases.

[47] The listing date is used as a division factor because the market value (MV) data of warrant first available on the listing day.
[48] According to Datastream's definition, market value (MV) means the current market value of the issue, that is, the current market price multiplied by the amount currently in issue. MV is displayed in millions of units of local currency.
[49] Abnormal trading volumes around the announcement event for call event of each small and large group can be seen in appendix 4.14 and appendix 4.15 respectively.
[50] Abnormal trading volumes around the announcement event for put event of each small and large group can be seen in appendix 4.16 and appendix 4.17 respectively.

Table 4.17: Name of the underlying securities for the small and large groups under both call and put cases

The table presents the name of the underlying securities of both the UK call and the UK put covered warrants which are separated by the market values.

Name of the underlying securities			
Call warrants effect		Put warrants effect	
Smallest	**largest**	**Smallest**	**largest**
BP	ANGLO AMERICAN	HSBC HDG.	MAN GROUP
GLAXOSMITHKLINE	SMITHS GROUP	BHP BILLITON	SHIRE
VODAFONE GROUP	WPP GROUP	BHP BILLITON	ROYAL BANK OF SCTL.GP.
ASTRAZENECA	BT GROUP	HBOS	GLAXOSMITHKLINE
BARCLAYS	BT GROUP	ROYAL DUTCH SHELL B	BG GROUP
HBOS	WILLIAM HILL	BHP BILLITON	BARCLAYS
ROYAL BANK OF SCTL.GP.	SAINSBURY	HBOS	GLAXOSMITHKLINE
BRITISH AMERICAN TOBACCO	ROLLS-ROYCE GROUP	ASTRAZENECA	CAIRN ENERGY
GLAXOSMITHKLINE	BAE SYSTEMS	ROYAL DUTCH SHELL B	ARM HOLDINGS
BP	BRITISH LAND	ANGLO AMERICAN	MARKS & SPENCER GROUP
VODAFONE GROUP	CORUS GROUP	PRUDENTIAL	ARM HOLDINGS
BRITISH SKY BCAST.GROUP	CABLE & WIRELESS	PRUDENTIAL	ROYAL BANK OF SCTL.GP.
VODAFONE GROUP	LAND SECURITIES	ASTRAZENECA	ASTRAZENECA
VODAFONE GROUP	BRITISH AIRWAYS	STANDARD CHARTERED	REUTERS GROUP
GLAXOSMITHKLINE	MAN GROUP	BP	ASTRAZENECA
VODAFONE GROUP	ANTOFAGASTA	BHP BILLITON	ANGLO AMERICAN
ROYAL BANK OF SCTL.GP.	ANTOFAGASTA	ANGLO AMERICAN	RIO TINTO
BT GROUP	PARTY GAMING	VODAFONE GROUP	LLOYDS BRITISH
BP	QINETIQ GROUP	STANDARD CHARTERED	LLOYDS BRITISH

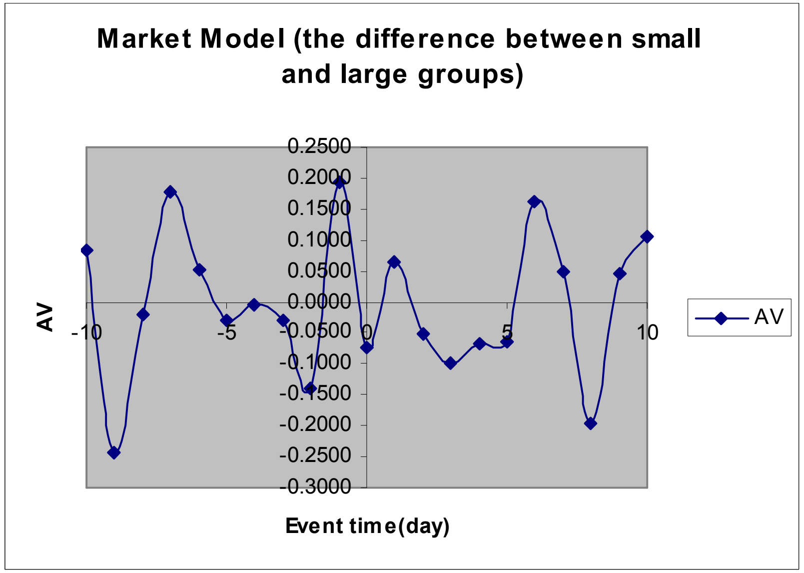
Notes: The sample period extends form July 2004 until December 2006.

The small and large groups are categorized by the equation: $\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Figure 4.8: Abnormal trading volumes around the announcement event for *call event* considering the warrant issue size *(the difference between the small and large groups)*

The below presents the differences between the small and large groups' abnormal volume (AV) of the underlying securities around the announcement event of the UK call covered warrants where market model is used to generate normal volume.

	Market Model
Day	AV
-10	0.0838
-9	-0.2422
-8	-0.0192
-7	0.1792
-6	0.0528
-5	-0.0300
-4	-0.0049
-3	-0.0292
-2	-0.1406
-1	0.1929
0	-0.0751
1	0.0649
2	-0.0531
3	-0.0997
4	-0.0689
5	-0.0652
6	0.1611
7	0.0480
8	-0.1968
9	0.0462
10	0.1062



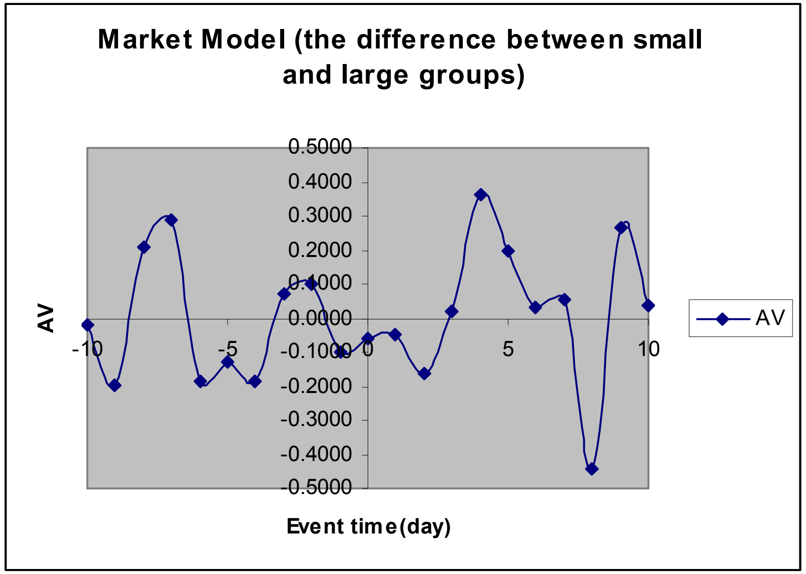
Notes: The sample period extends form July 2004 until December 2006.

The small and large groups are categorized by the equation: $\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Figure 4.9: Abnormal trading volume around the announcement event for *put event* considering the warrant issue size *(the difference between the small and large groups)*

The below presents the differences between the small and large groups' abnormal volume (AV) of the underlying securities around the announcement event of the UK put covered warrants where market model is used to generate normal volume.

Day	Market Model AV
-10	-0.0180
-9	-0.1959
-8	0.2093
-7	0.2897
-6	-0.1884
-5	-0.1272
-4	-0.1865
-3	0.0695
-2	0.0999
-1	-0.0991
0	-0.0594
1	-0.0494
2	-0.1602
3	0.0219
4	0.3646
5	0.1960
6	0.0338
7	0.0516
8	-0.4446
9	0.2651
10	0.0347



Notes: The sample period extends form July 2004 until December 2006.

The small and large groups are categorized by the equation: $\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

In conclusion, covered warrant introduction and delisting has no impact on the underlying securities trading volumes in the UK market. No relationship between abnormal return patterns and abnormal trading volumes is revealed. The evidence from this study supports the conclusion of no change in trading volume, consistent with the early empirical US research, the Canadian research of Chamberlain et al. (1993), and the first time introduction effect for the Hong Kong market (Draper et al., 2001). A possible cause of the results could come from the small warrant issue size in various cases. To examine this possibility, the subsamples of the smallest and largest warrant issue size to total company outstanding shares are formed. This additional examination confirms the no impact result of underlying securities trading volumes due to covered warrant trading activities.

4.7 Concluding remarks

Chapter 4 empirically examines the impact of announcement, listing and expiration of covered warrants on both the price and trading volume of the underlying stocks for the UK market. It provides supporting evidence for *Hypothesis 4.1* but against *Hypothesis 4.4*, given that negative price impact on the underlying securities is shown for both call and put covered warrants announcement and listing. The impact is rather more pronounced for the announcement case. The three major supporting reasons for call warrants are suggested in my study are as following. Due to the rising concern of the Financial Services Authority in the UK over the short selling (Prosser (2008)), the relaxation of short-sale constraints by alternatively trading opportunities on covered warrants lead to faster and more efficient negative information dissemination to the underlying market.[51] Moreover, due to the lower transaction cost and higher leverage introduced by the covered warrants market, investors are likely to move their trading from the underlying stock market to this new warrants market. Another reason is that because there seems to be a belief that covered warrant introduction acts as a destabilizing factor to the underlying stocks. All these reasons would definitely signal negatively to the stock market and could lead to a reduction in stocks prices. However, a possible explanation for put warrants is the investment bank (issuer)

[51] A short position in stock can be replicated by either buying a put warrant or writing a call warrant.

sells stocks short in order to hedge the put warrants which leads to negative price impact on the underlying stocks.

This study also reports negative price impacts of the delisting event for both call and put covered warrants. This supports *Hypothesis 4.2* but is in total opposition to *Hypothesis 4.3*. Possible explanations for a negative price effect associated with call warrants delisting are the sales of acquired stock by the holders after call warrant expiration, and the unwinding of positions by selling stocks when the call warrants are not exercised.[52] The evidence for reduction in the price of the underlying due to put warrants delisting might suggest that the stock price has started to fall back to the normal level after a sharp rise from early unwinding of put warrants. However, the explanation for put warrants effects is not very solid and future work could be done on this particular area.

The analyses show outcomes against *Hypothesis 4.5* and report no significant changes or impacts observed on the underlying securities trading volume from the UK call and put covered warrants announcement, listing and expiration. In addition, the subsamples of the smallest and largest warrant issue size to total company outstanding shares are formed and analysed which confirm the no volume effect of underlying securities upon covered warrant trading activities. There is no relationship between the price effect and the volume effect found in this study. Therefore, there are still room for future research to be developed regarding this area.

[52] Even though, there is no significant price effect on the underlying securities due to the call covered warrants under the out-of-the-money case. The negative securities price effect is only reported in the case of in-the-money call covered warrants.

Chapter 5 : Stock return volatility and covered warrants trading

5.1 Introduction

There are a variety of models for valuing derivatives. Among those the most well known is the classic Black-Scholes option pricing model. They treat derivatives as redundant securities which can be synthesized by investors using combinations of other existing financial instruments under the assumption of the perfect market. If this assumption is true then there should be no effects on the derivatives trading on the underlying securities. However, since the real world is never perfect, there may be relationships between derivatives and underlying stocks arising from incomplete or imperfect capital markets. Derivatives offer investors the potential for return enhancement and enable risk control. Some previous studies such as Ross (1976), Arditti & John (1980) and John (1984) show that market completion is enhanced by the trading of options. The trading activities offer investors a greater span of risk-return choices which can then result in changes in the existing demand and supply as well as in the price behaviour of the underlying securities.

5.1.1 Background

Derivatives trading may reveal information about the future trading intentions of investors. As a result of better information becoming available, stocks may become less volatile. This decrease in volatility from the introduction of derivatives might be due to the increase in trading volume of the underlying stocks due to higher interest from institutional investors, greater media coverage, more analysts' recommendations, and hedging activities by market makers. Early papers like Ma & Roa (1988) and Damodaran & Lim (1991) found a significant decline in average variance following option listing. However, of little or no variance change is reported in Whiteside, Dukes & Dunne (1983).

Derivatives trading can also increase stock return volatility. The more attractive option trading is, the more possible a decrease in underlying stocks trading volume can occur leading to increased price volatility. Skinner (1989) mentions a case involving Golden Nugget Inc. who took a law suit against the American Stock Exchange (AME). It claimed that options trading had created downside effects to its reputation, goodwill and underlying stock value. Though, the suit was later dismissed. Fedenia & Grammatikos (1992) show that market-adjusted return variance increased due to option listings on NASDAQ stocks.

5.1.2 Motivation

The recent financial crisis and bankruptcies has brought interest back to the regulation of derivatives markets. One question that is popular is how derivatives trading affect the volatility of the related underlying market. Most of the early studies concerned with the volatility effects on the underlying securities were conducted on US options trading. They seem to be conclusive in the outcome that volatility of the underlying is reduced after the options introduction.(see the US survey of Damodaran & Subramanyam (1992)) However, more recent research conducted both in and outside of the US has been less conclusive. This might be because of the more complicated new financial innovations introduced recently in many markets. One of them is of course the covered warrant. There has not been much research undertaken to test the impact of covered warrants trading, especially in the UK. Moreover, the empirical evidence on covered warrants is still inconclusive. It is interesting to see how covered warrants might effect underlying stocks in the UK market.

The next section of this chapter reviews of the literature on the underlying volatility effects related to derivatives trading. This is followed in section 5.3 by a discussion of the development of research hypotheses concerning volatility. A brief discussion of the data and methodology used in the tests is presented in section 5.4 and section 5.5 respectively. The empirical results of the price volatility tests are reported in Section 5.6. The final section of the chapter provides a summary.

5.2 Review of Literature

5.2.1 Empirical evidence on Volatility

There are many studies on the impact of derivatives introduction on stock risk. The findings of these early studies especially in the US market seemed conclusive and suggested a decline in volatility after derivative listing. More recent studies provided less conclusive outcomes. The earliest research on this area was carried out by Hayes & Tennenbaum (1979). Their method was to compare weekly proportional stock price changes which are the average percentage change between time periods for the two groups. The results show a higher decrease in the optioned versus the non-optioned stocks' groups listed on the New York Stock Exchange (NYSE). The studies by Conrad (1989), Skinner (1989) and Bansel, Pruitt & Wei (1989) also find a similar finding of a reduction in variance of the underlying securities after option listing. However, they find no change in a security's systematic risk (beta) after listing. A similar result of volatility decline is also found in other markets beside the US such as Watt, Yadav & Draper (1992) study of the UK, Sahlastrom (2001) study using Finnish data, and Kumar, Sarin & Shastri (1995) study using Japanese data. These outcomes can be explained by the introduction of options markets enabling a move toward a complete market, and better information discovery which ultimately lead to improved underlying securities price efficiency. More recent US studies are less conclusive. Freund, McCann & Webb (1994), Long, Schinski & Officer (1994) and Bollen (1998) all report no significant effect of stock return volatility from recent US options introduction. A report at modestly higher betas and total variances for stocks in the S&P 500 index after the futures index listing can be seen in Damodaran (1990).

For covered warrants trading, the impact on the underlying volatility is still inconclusive. Hernandez-Trillo (1999) bases his study on the Mexican Stock Exchange (MSE). The results suggest that covered warrants introduction did not reduce the security return volatilities even before the Mexican financial crisis of 1994. No significant effect on the underlying security return volatility following covered warrant introduction is presented by Draper, Mak & Tang (2001) for the Hong Kong market. Aitken & Segara (2005) however show that after covered warrant listing on the Australian market, a significant increase in underlying stock volatility is follow.

5.3 Research hypotheses

The following research hypotheses are fully developed from the literature regarding the rejection of the efficient market theory and the evidence of anomalies in the stock market. Please refer back to section 4.1.1 for the detail discussion of the area.

5.3.1 Volatility hypotheses

Derivatives introduction can result in an increase in risk-adjustment efficiency across securities, a higher demand for the underlying stock and consequently a decline in stock price volatility. Detemple & Selden (1991) support this claim using a general equilibrium model of the interaction between the primary stock and option markets. Later work by Sahlastrom (2001) also suggests a decrease in the underlying stock volatility from option listing. Skinner (1989) however, suggests that option exchanges and regulators are more likely to be convinced to list options on large and very risky stocks because listing on these type of stocks generates higher premiums. Ma & Rao (1988) show evidence of stable stocks become more volatile post-options listing because of the increased speculation in the derivative market by informed traders. Mayhew & Mihov (2000) find that the volatility of the underlying stock is increased from the introduction of option trading activity. The evidence generated from options trading is relevant to warrants trading due to many similarities in their characteristics. More favourable warrant premiums are likely to be secured when the underlying stocks are highly volatile given the profit incentives of issuers and capacity to time when to issue the covered warrants. This view is supported by a more recent study by Aitken & Segara (2005) based on derivative warrants trading. The findings suggest an increase in the underlying stock volatility after the warrant listings. They also point out that derivative instruments encourage speculation in the underlying instruments and indicate that warrant issuers appear to have the ability to time periods of increased speculation in the underlying stock, enabling them to achieve the benefit of higher premiums. To test how the covered warrant introduction effect on the underlying stock variance, I test the empirical hypothesis:

Hypothesis 5.1: *There should be an increase in the underlying stock return volatility following both call and put covered warrants announcement and listing.*

I also test the underlying volatility effect from covered warrants expiration on both put and call features. This may provide additional supporting evidence of the usefulness of having covered warrants trading in the UK market.

Hypothesis 5.2: *There should be significant changes in the volatility of the underlying securities return during both call and put covered warrants expiration.*

5.4 Data/Sample construction

5.4.1 Data sources and description

The covered warrants data used in this research are warrants listed on the London Stock Exchange (LSE) from 26th July 2004 to 15th December 2006 available on Datastream (DS) online database. Initially, this study intended to cover the period from 2002, the beginning of the formal trade of covered warrants in LSE. However, due to unavailability of the data, the period under study here has to start from 2004. The detail explanation on the criteria used to exclude observations from the sample is similar to Chapter 4 since this is the same data set which employed previously in the Chapter except for the data of analyzing call effect which had included 13 non-UK call covered warrants into the sampling group.[53] The final samples can be seen as the followings.

[53] To be specific, this is provided in the previous section 4.4.1 (Data sources and description).
The underlying securities of these non-UK call covered warrants include ALTRIA GP, MERCK, TOYOTA MOTOR, CISCO SYSTEMS, DELL, CONOCOPHILLIPS, CHEVRON, ABBOTT LABS, WALT DISNEY and INTEL.

For the case of the warrants announcement analysis, I divided into two parts. One is for call warrants effect, I employed 55 warrants which have only call warrants issued on the underlying stocks. Another is for put warrants effect, I had to use 58 warrants which have both call and put warrants issue on the same of each underlying stock because of the small sample of put only data.

For the listing effect of warrants, I also separated into two parts which are call and put warrants investigations. Based on the listing dates' data, 52 call only warrants are used for call effect investigation and 54 warrants with both call and put features on each underlying securities are used for put effect investigation.

For the warrants delisting effect, both call and put warrants effect are also examined. Regarding to the availability of the delisting dates' data, 48 call only warrants are tested under call analysis. The analysis examined further to see whether moneyness of the warrants would influence the results, thus the sample divided into 31 in-the-money and 17 out-of-the-money call warrants. For the put effect, 58 warrants which have both call and put on the same underlying are employed. However, due to the small sample size of put only data, the analysis cannot be done further to separate the moneyness factor influence.

5.4.2 Data construction

The volatility of trading estimation of the underlying securities

Stock returns are collected from Datastream. The natural logarithmic return for each underlying stock is used in order to calculate volatility (variance) for the sample period before and after the event day.

The standard deviation (S) of a set of N number $X_1, X_2, \ldots, X_N$ is defined by

$$S = \sqrt{\frac{\sum_{j=1}^{N}\left(X_j - \overline{X}\right)^2}{N-1}}$$

The variance of a set of data is defined as the square of the standard deviation and is given by S^2 of the standard deviation presented above.

5.5 Methodology

To test for any significant changes in the volatility of the underlying securities during the listing, announcement, and delisting of the UK covered warrants, we employ the following methodology:

5.5.1 Parametric test

A variance ratio test

Variance ratio is a measure of the randomness of a return series. F is the ratio of variances. Fisher-Snedecor F-distributed test statistic is used to compare two variances based on independent samples from two normally distributed populations. The size of these two samples (size n1 and size n2) is reflected in two degrees of freedom. Degrees of freedom are n1-1 and n2-1 corresponding to the numerator (largest sample) and denominator of the sample variances. F-distribution is right-skewed and is truncated at zero on the left-hand side. The rejection region is in the right-side tail of the distribution as long as the F-statistic is computed with the largest sample variance in the numerator.

$$\text{A variance ratio } (\text{VR}) = \frac{S_{\text{b}}^2}{S_{\text{a}}^2}$$

where S_{b}^2 = variance before the event

S_a^2=variance after the event

The F-test is then used to determine whether or not the variance S_b^2 is significantly larger than S_a^2. In practice, the sample with the larger variance is chosen as sample 1 or in this case sample period before the event.

A variance ratio test is used in this study to examine the effects on the volatility of the underlying stocks of both call and put covered warrants on their announcement, listing, and delisting events. The variance ratio is defined as the variance after the event divided by the variance before the event. This study compares the volatility of each stock for the 60 days before and after the event.

5.5.2 Nonparametric test

Since the assumption of normally distributed data may not be correct, and to check the robustness of results based on parametric tests, nonparametric tests of the data are introduced. Nonparametric tests do not require specific assumptions concerning the distribution of data. The common tests used for event studies are the sign test and the rank test:

The sign test

The sign test uses the positive and negative signs of data rather than quantitative measures of the data. It is suitable for the case of two related samples in order to test whether two conditions are different. That the variable under consideration has a continuous distribution is the only assumption of this test.

The basis of the test is that under the null hypothesis (H_0) it is equally probable that the two conditions will be positive or negative. Another way of stating H_0 is: the median difference is zero. If too few differences of one sign occur, H_0 is then rejected.

The procedure for determining the probability associated with the occurrence under H_0 of a value as extreme as the observed value of x (the number of fewer sign) depends on the size of N which is the numbers of pairs whose differences show a sign. If $N \leq 25$, the table of probabilities associated with values as small as observed values of x in the binomial test can be employed .[54] If $N > 25$, the table of probabilities associated with values as extreme as observed values of z on the normal distribution is employed.[55] The value of z must be computed using the formula:

$$z = \frac{(x \pm 0.5) - \frac{1}{2}N}{\frac{1}{2}\sqrt{N}}$$

where $x =$ the number of fewer sign

$x + 0.5$ is used when $x < \frac{1}{2}N$ and

$x - 0.5$ is used when $x > \frac{1}{2}N$

If the probability (p) yielded by the test is equal to or less than the significance level (α), reject H_0.

In this study, the null hypothesis (H_0) is that the median of the variance ratio is one. If there is a significant difference in volatility of the underlying stocks for the period before and after the warrants event H_0 is rejected. The variance of each stock for 60 days before and after the event is used to compute the variance ratio. The events for this study are announcement, listing, and delisting events. The information used here is relates to the direction of the variance ratios. The test is used to check the robustness of results based on the previous variance ratio test (parametric test).

[54] Table D of the appendix of Siegel (1956) shows the one-tailed probability. Therefore, double the value of probability shown in the table is needed for a two-tailed test.

[55] Table A of the appendix of Siegel (1956) shows the one-tailed probability. Therefore, double the value of probability shown in the table is needed for a two-tailed test.

The Wilcoxon matched-pairs signed-ranks test

The Wilcoxon matched-pairs signed-ranks test is used to test whether the two conditions of two related samples are different. This is similar to using the sign test. However, the Wilcoxon test is a more powerful test because it uses information on both the direction (positive and negative signs) and the relative magnitude of the differences within each pair whereas the sign test uses only information of the direction of the differences within each pair.[56] If either the sum of the ranks for the negative differences or the sum of the ranks of the positive differences is too small, reject H_0.

Under the Wilcoxon test, the method for determining the significance of the observed value of T depends on the size of N (the total number of pairs whose differences having a sign (positive and negative signs)).[57] If $N \leq 25$, the table of critical values of T in the Wilcoxon matched-pairs signed-ranks test is used.[58] H_0 is rejected when observed value of T is equal to or less than the given critical T value in the table at that level of significance. If $N > 25$, the value of z must be computed using the formula:

$$z = \frac{T - \frac{N(N+1)}{4}}{\sqrt{\frac{N(N+1)(2N+1)}{24}}}$$

The associated probability under H_0 is determined.[59] H_0 is rejected when the probability obtained from the test is equal to or less than the interested significance level (α).

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[56] All the relative magnitude of differences are ranked without regard to the sign and affix the sign of the difference (positive or negative) to each rank afterward.

[57] T is defined as the smaller of the sums of the like-signed ranks, either the sum of the positive ranks or the sum of the negative ranks, whichever sum is smaller. It is the statistic on which the Wilcoxon test is based.

[58] Table G of the appendix of Siegel (1956)

[59] Table A of the appendix of Siegel (1956) which shows the one-tailed probability. Therefore, double the value of probability shown in the table is needed for a two-tailed test.

The Wilcoxon matched-pairs signed-ranks test is employed in this study to capture both the direction of the differences like the sign test and the magnitude of the differences. The null hypothesis under this test is similar to the one use in the sign test. ($H_0 = median\left(VR\right)$ where VR is variance ratio) The 60 day period before and after the event are also used to calculate variance ratios. The test is used to cover all three events of announcement/listing/delisting of call and put covered warrants. The test is used to check the robustness of parametric test as well as the accuracy of the sign test after considering the magnitude of the data.

5.6 Empirical Results

5.6.1 Volatility impacts on the underlying

The introduction of covered warrants may be expected to affect the underlying stock return volatility. The early US empirical evidence looking at the effects of option listing on the variance of underlying assets suggests a decrease in volatility after the listing. Damodaran & Subrahmanyam (1992) provide a good summary of these studies. In addition, Detemple & Jorion (1990) report a significant decrease in the volatility of the optioned stock after the listing date and also show that these effects appear to be weaker in recent periods. St. Pierre (1998) observes a decrease in unconditional variance and no change in conditional variance resulting from option listing. Haddad & Voorheis (1991) show stock price variability declines upon the introduction of option trading. The reason for this decline may be because investors view initial option trading as having a stabilizing influence on share price. Thus there are a greater number of investor participants and interest in the underlying securities following initial option trading. Aside from this, they find option introduction has no impact on systematic risk (beta). Niendorf & Peterson (1996) decompose transaction variance into three component parts : the bid-ask spread, return autocorrelation, and intrinsic variance. They claim that by studying the effects of option listing on the components of variance rather than on total variance, the potentially confounding effect of net variance change is eliminated and the total transaction return variance following option listing is not significantly different from zero. However, Long et al. (1994) show that no significant changes were found in either the firms' betas or variance following initial option listing on underlying OTC stocks. Thus there was no significant impact on the price volatility of the underlying security on introduction of an option. Moreover, Bollen (1998) suggests that option listing does not have a significant effect on stock return volatility because the average change in stock return variance in the control group is not statistically different from the average change for the optioned stocks. Mayhew & Mihov (2000) report that the underlying stock volatility increases with option listing which is consistent with the hypothesis that stock exchanges choose to issue options on stocks that they anticipate will experience an increase in volatility. In short, the results of more recent US studies are less conclusive. Beside studies of US markets, the volatility effect has also been tested in other option markets across the world. Watt et al. (1992) investigate changes in volatility in the UK. They show results consistent with the early US studies indicating that there is a significant reduction in total variance, especially for high risk stocks, after option listing. They also report that option trading results in a significant reduction in unsystematic risk but no significant effect on the beta of the underlying stocks. Kumar et al. (1995) indicates a decline in stock volatility as a result of options trading in Japan. There is evidence of a reduction in the volatility of stocks contained in the Nikkei 225 Index after index options listing. Chaudhury & Elfakhani (1997) examine the volatility effect of Canadian put options introduction on the underlying stocks. They find a decrease in variance as well as a decrease in beta risk following the listing of put options. Sahlstrom (2001) suggests the underlying stocks have lower volatility after option listing on the Finish market.

For covered warrants, the empirical evidence is inconclusive. The volatility increase for the underlying stocks post-warrant listing on the Australian Stock Exchange is discussed in Aitken & Segara (2005). Hernandez-Trillo (1999) investigating Mexican warrant introductions, find that they do not have any significant effect on stock return variances. This results hold even before the well-known Mexican financial crisis of 1994. Draper et al. (2001) also report no impact on return volatility of the underlying security after covered warrant introductions in Hong Kong market.

In this study, the return volatility effect of the underlying stock is examined during three events, the announcement, listing and delisting of the covered warrants on the London Stock Exchange (LSE). The method is to compare the volatility of each stock for the 60 days on either side of the event using variance ratio tests (both parametric and nonparametric tests). The robustness has been checked with different days of historical volatility i.e. 30 and 90 days where the results were not qualitatively different. Therefore, only the results of 60 day-period was chosen to be reported in this study.

Table 5.1 provides the variance ratio tests around the covered warrants announcement days. The variance ratio is defined as variance after the event divided by variance before the event. Comparisons of estimates of volatility calculated before and after the announcement date of both call and put covered warrants are presented in Panel A of Table 5.1. The announcement of the issue of covered call warrants increases volatility for two-third of the sample, and in around 60% of these cases the change is significant. Similar results are reported for put warrants; there is an increase in volatility after the warrant announcement for nearly two-third of the sample and for these cases, more than 70% represents a significant increase in volatility. However, these results provide a sizable percentage of no increase in volatility after the announcement under both call and put warrants. To provide a clearer picture of the results, this study also uses nonparametric tests (the sign test and the Wilcoxon signed ranks test). Under the null hypothesis, the median of variance ratio is one. The median ratio (median VR), in Panel B of Table 5.1, indicates that the volatility increases 18.7% for the call case and 27.4% increase for the put case after the announcement of warrant issue. These results are significant at a 5% level for the sign test and at a 1% level for the Wilcoxon signed ranks test. Thus, the null hypothesis of no change in volatility surrounding warrants announcement can be rejected. There is a pronounced increase in underlying volatility after the announcement of warrants.

Table 5.1: Volatility test around announcement days

Panel A. Variance ratio F-test of Volatility around announcement days

	Announcement Day			
	Call case		**Put case**	
	Variance b>Variance a = 18	Variance b<Variance a = 37	Variance b>Variance a = 20	Variance b<Variance a = 38
Significance Level	**Variance b>Variance a**	**Variance b<Variance a**	**Variance b>Variance a**	**Variance b<Variance a**
1%	1	14	0	14
5%	5	4	2	6
10%	1	4	2	8
Below 10%	11	15	16	10

Notes: The sample period extends form July 2004 until December 2006.
Numbers represent numbers of observations: 55 in total call case sample and 58 in total put case sample.
Variance a = Variance after event
Variance b = Variance before event

Panel B. Variance ratio Sign Test and Wilcoxon Signed Ranks Test of Volatility around announcement days

	Announcement Day	
	Call case	**Put case**
Mean VR[a]	1.394	1.514
Median VR	1.187	1.274
No. of VR>1(No. of firms for which variance increase)	37	38
No. of VR<1(No. of firms for which variance decrease)	18	20
Sign Test(two-tailed)[b]**: z-statistic**	-2.427	-2.232
p-value	0.015	0.026
Wilcoxon Signed Ranks Test(two-tailed) [b]**: z-statistic**	-3.444	-4.224
p-value	0.001	0.000

Notes: The sample period extends form July 2004 until December 2006.

(a) Variance ratio (VR)= $\frac{\text{Variance after event}}{\text{Variance before event}}$

(b) Based on No. of VR<1(No. of firms for which variance decrease)

Table 5.2: Volatility test around listing days

Panel A. Variance ratio F-test of Volatility around listing days

	Listing Day			
	Call case		**Put case**	
	Variance b>Variance a = 13	Variance b<Variance a = 39	Variance b>Variance a = 20	Variance b<Variance a = 34
Significance Level	**Variance b>Variance a**	**Variance b<Variance a**	**Variance b>Variance a**	**Variance b<Variance a**
1%	1	14	2	14
5%	2	4	0	4
10%	2	4	4	3
Below 10%	8	17	14	13

Notes: The sample period extends form July 2004 until December 2006.
Numbers represent numbers of observations: 52 in total call case sample and 54 in total put case sample.
Variance a = Variance after event
Variance b = Variance before event

Panel B. Variance ratio Sign Test and Wilcoxon Signed Ranks Test of Volatility around listing days

	Listing Day	
	Call case	**Put case**
Mean VR[(a)]	1.520	1.394
Median VR	1.268	1.247
No. of VR>1(No. of firms for which variance increase)	39	34
No. of VR<1(No. of firms for which variance decrease)	13	20
Sign Test(two-tailed) [(b)]**: z-statistic**	-3.467	-1.769
p-value	0.001	0.077
Wilcoxon Signed Ranks Test(two-tailed) [(b)]**: z-statistic**	-4.162	-3.647
p-value	0.000	0.000

Notes: The sample period extends form July 2004 until December 2006.

(a) Variance ratio (VR)= $\frac{\text{Variance after event}}{\text{Variance before event}}$

(b) Based on No. of VR<1(No. of firms for which variance decrease)

The volatility tests around listing days are reported in Table 5.2. Listing days of covered warrants are followed by a rise in volatility, evidence consistent with the previous announcement days' results. Panel A of Table 5.2, indicates that three quarters of all underlying stocks of call warrants show increasing volatility after the listing event and of these 56% of cases are significant. For put warrants, two-third of the sample indicates a rise in volatility after the warrant listing and more than 60% have a significant effect. This study also provides nonparametric test results. Under the null hypothesis, the median of the variance ratio is one. The median ratio (median VR), in Panel B of Table 5.2, shows an increase in underlying stocks' variance ratio of 26.8% for call and 24.7% for put warrants. Both the sign test and the Wilcoxon signed ranks test indicate a significant change at a 1 % level. The exception is the sign test of the put that is significant at a 10% significance level.

In contrast, the delisting event indicates a significant decrease in the volatility of the underlying stocks. Panel A of table 5.3 shows that two-third of the call sample has reduced volatility after the delisting and around 59% of this change is significant. In addition, the put sample also indicates a decrease in the volatility after delisting for slightly more than half of the whole sample. For 47% of cases the changes are significant. The additional results from nonparametric tests are presented in Panel B of Table 5.3. Under the null hypothesis, the median of variance ratio is one. The results are presented through the median ratio (median VR). For the case of call warrants, a 20% decrease in variance ratio is presented at the 5% significance level after delisting for both the sign test and the Wilcoxon signed ranks test. Put warrants also indicate a decline in volatility after the delisting, although there is no evidence of any significant changes. However, the mean ratio presents a contradictory result. For call and put cases, all variance ratios are added and then divided by the number of underlying stocks. According to the null hypothesis of no changes in volatility, the mean ratio (mean VR) for all stocks should equal one. If the null hypothesis is being rejected, there is an indication of a change in volatility. However, this research does not focus on the mean ratio results because of the outliers in the data which tend to have positive bias. This can lead to a misinterpretation of the direction of the volatility.

Table 5.3: Volatility test around delisting days

Panel A. Variance ratio F-test of Volatility around delisting days

	Delisting Day			
	Call case		**Put case**	
	Variance b>Variance a = 32	Variance b<Variance a = 16	Variance b>Variance a = 30	Variance b<Variance a = 28
Significance Level	**Variance b>Variance a**	**Variance b<Variance a**	**Variance b>Variance a**	**Variance b<Variance a**
1%	6	4	4	8
5%	7	1	6	4
10%	6	0	4	4
Below 10%	13	11	16	12

Notes: The sample period extends form July 2004 until December 2006.
Numbers represent numbers of observations: 48 in total call case sample and 58 in total put case sample.
Variance a = Variance after event
Variance b = Variance before event

Panel B. Variance ratio Sign Test and Wilcoxon Signed Ranks Test of Volatility around delisting days

	Delisting Day	
	Call case	**Put case**
Mean VR[a]	1.044	1.188
Median VR	0.802	0.966
No. of VR>1(No. of firms for which variance increase)	16	28
No. of VR<1(No. of firms for which variance decrease)	32	30
Sign Test(two-tailed) [b]**: z-statistic**	-2.165	-0.131
p-value	0.030	0.896
Wilcoxon Signed Ranks Test(two-tailed) [b]**: z-statistic**	-2.174	-1.289
p-value	0.030	0.197

Notes: The sample period extends form July 2004 until December 2006.

(a) Variance ratio (VR)= $\frac{\text{Variance after event}}{\text{Variance before event}}$

(b) Based on No. of VR>1(No. of firms for which variance increase)

Table 5.4: Volatility test around delisting days (In/Out-of-the-money Call case)

Panel A. Variance ratio F-test of Volatility around delisting days (In/Out-of-the-money Call case)

	Delisting Day(Call case)			
	In-the-money		**Out-of-the-money**	
	Variance b>Variance a = 21	Variance b<Variance a = 10	Variance b>Variance a = 11	Variance b<Variance a = 6
Significance Level	**Variance b>Variance a**	**Variance b<Variance a**	**Variance b>Variance a**	**Variance b<Variance a**
1%	6	2	1	2
5%	2	0	5	1
10%	3	0	2	0
Below 10%	10	8	3	3

Notes: The sample period extends form July 2004 until December 2006.
Numbers represent numbers of observations: 31 in total in-the-money call case sample and 17 in total out-of-the-money call case sample.
Variance a = Variance after event
Variance b = Variance before event

Panel B. Variance ratio Sign Test and Wilcoxon Signed Ranks Test of Volatility around delisting days (In/Out-of-the-money Call case)

	Delisting Day(Call case)	
	In-the-money	**Out-of-the-money**
Mean VR[a]	0.904	1.291
Median VR	0.806	0.772
No. of VR>1(No. of firms for which variance increase)	10	6
No. of VR<1(No. of firms for which variance decrease)	21	11
Sign Test(two-tailed) [b]**: z-statistic**	-1.796	- [c]
p-value	0.072	0.332[c]
Wilcoxon Signed Ranks Test(two-tailed) [b]**: z-statistic**	-2.175	-0.781
p-value	0.030	0.435

Notes: The sample period extends form July 2004 until December 2006.

(a) $\text{Variance ratio (VR)} = \frac{\text{Variance after event}}{\text{Variance before event}}$

(b) Based on No. of VR>1(No. of firms for which variance increase)

(c) Binomial distribution used

This research extends the call warrant delisting analysis into in-the-money and out-of-the-money cases. Panel A of table 5.4 shows a decrease in volatility for two-third of the sample after the delisting, for the underlying securities of both in and out-of-the-money call warrants. These results are supported in Panel B of table 5.4 (the median ratio; median VR) which indicates approximately 20% significance decrease in variance ratio after the delisting for the in-the-money call warrants using both the sign test and the Wilcoxon signed ranks test. Although there is no significance result for out-of-the-money call warrants, a decrease in the underlying volatility after the delisting is found.

In summary, the evidence indicates a clear effect on the underlying securities' volatility. The results from both call and put covered warrants suggest, on average, that warrant announcements increase stocks volatility. This supports the increase in stock volatility following the listing of warrants. The result here is in line with the hypothesis that stock exchanges choose to allow the issuance of warrants mostly on stocks which they expect to show an increase in volatility.[60] A more favourable warrant premium will be secured during a time when the underlying security is expected to be more volatile. This increase in volatility links with a decline in the underlying security value. The evidence has already been presented in the earlier results of the negative impact on the underlying securities' price (value) during warrant introductions. The additional suggestion by Ma & Roa (1988) indicates that stable stocks become more volatile after listing because of the increased speculation in the derivatives market from informed traders. This has been claimed mostly by market observers and policy makers.[61] An opposite effect is reported during the delisting event. The delisting of warrants significantly decreases the volatility of the underlying stocks.

[60] This idea is purposed by Mayhew & Mihov (2000) on options listing. However, the endogeneity of the option listing decision is applicable to warrant listings.
[61]Skinner (1989) supported this controversy.

5.7 Conclusions

There has been a long, inconclusive debate over the economic impacts on the underlying assets from derivatives trading, especially the concerns about the magnitude of risk these new innovative products would generate into the underlying existing markets. Many previous studies have been conducted on the impact of option trading but few have touched on covered warrants trading. This study attempts to add more empirical evidence and Chapter 5 examines empirically whether trading of covered warrants has an impact on the volatility of underlying stocks listed in the UK.

The findings support our *Hypothesis 5.1* which indicate an increase in volatility of the underlying stocks due to covered warrants announcement and listing. This evidence holds true for both call and put conditions of warrant trading upon announcement. Moreover, the listing event generated similar results and shows the rise in the underlying stock volatility for both call and put warrants cases. There are four major reasons supporting these increases in stocks volatility effects. Firstly, the issuance of warrants is usually allowed by the stock exchanges on which the underlying stocks are expected to see an increasing sign. This is the case apply to most covered warrants trading within the UK market. Secondly, the profit motive of warrants issuers and their abilities to time when stock is expected to be volatile to issue warrants for the highest possible premiums. Thirdly, covered warrant instruments lead to an increase in the underlying instruments speculation. Lastly, the increased speculation in the derivatives market generally comes from informed trader resulting in stable underlying stocks become more volatile. Moreover, the results can also be related back to the findings in Chapter 4 because when there was the decrease in the underlying security price due to the announcement and listing of both call and put covered warrants, investors and speculators may react which could lead to an increase in the trading volatility of the underlying securities as presented in this Chapter 5.

These results of an increase in stocks' volatility after the introduction of covered warrants in the UK are in contrast to earlier U.S. results on the effect of option listing on the underlying security. They suggest that options listing on individual stocks leads to a reduction in the volatility of these stocks. However, the result is consistent with the study on derivative warrants by Aitken & Segara (2005) of the Australian market in which they also report an increase in the stock volatility due the warrants listing, similar to my finding here. [62]

The analyses in this study are carried out further to test the impact of the underlying stocks during the expiration of the UK covered warrants. The results support *Hypothesis 5.2* which states that there are significant changes in the stock volatility as a consequence from the warrants expiration. This impact shows a decreasing stock volatility. If my reason given in Chapter 4 regarding the belief of covered warrant introduction acts as a destabilizing factor to the underlying stock stays valid, the expiration of warrant should bring the underlying market back toward stabilization stage. Therefore, this would lead to a reduction in the underlying stock volatility as shown here in the result of this Chapter 5.

[62] The term "derivative warrants" is used interchangeable with "covered warrants" especially in Hong Kong and Australia, etc.

Chapter 6 : Covered Warrants Valuation with default risk

6.1 Introduction

It has been traditionally implicitly assumed that covered warrants have no default risk. However, this section gives background evidence on how default risk could possibly be related directly with this financial product. Both fraudulent traders and the recent subprime mortgage crisis of the UK financial institutions, major issuers of covered warrants, may substantially shape the way the product is originally priced. Moreover, the motivation to conduct this research is summarized towards the end of this section 6.1.

6.1.1 Major evidence of Default risk in financial institutions in the UK

The Fraudulent trader

Barings Bank

Barings Bank had a long established history and had been the oldest merchant bank in London until its collapse in 1995, after one of the bank's employees, Nick Leeson's fraudulent trading. He speculated primarily on futures contracts and accumulated losses of £827 million ($1.4 billion) from speculating over a period of three years while he was a Singapore-based management employee of Barings Bank. The reason he could manage to carry out the transactions was through the manipulation of records, which hid his wrongdoing until February 1995. The total losses were twice the bank's available trading capital. As soon as the losses were disclosed, the bank was forced to default on its accounts.

The Barings Bank collapse (costing another £100 million) was dramatic. Employees around the world not only did not receive their bonuses, but also lost their jobs. It became a pivotal turning point in banking history, and a classic example of accounting fraud. In addition, the fraud led to a huge reappraisal of the control systems within banks and financial institutions around the world.

The subprime mortgage crisis

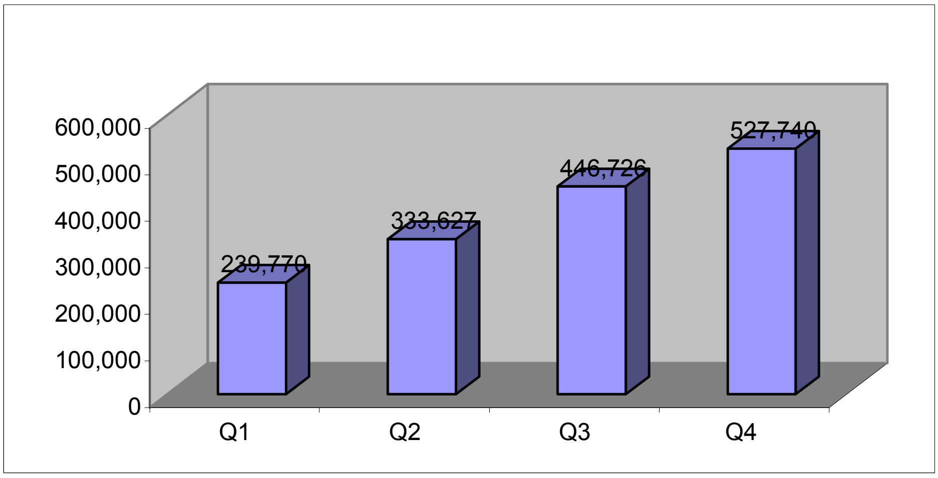
The practice of giving loans to borrowers who lack the credit-worthiness required to pay the best market interest rates (perhaps due to their deficient credit history or inability to prove that they have enough income to meet the periodic payments on the loan they apply for) is called *subprime lending* (*B-paper*, *near-prime*, or *second chance lending*). The term "subprime" refers to the credit-worthiness of the borrower, and does not refer to the interest rate on the loan itself. Subprime lending includes a number of credit intruments such as subprime mortgages, subprime credit cards, subprime car loans, etc. This lending is risky by nature for both creditors and debtors, because a mixture of high interest rates (due to the increased risk), poor credit history, and murky financial situations may be associated with subprime borrowers.

Subprime lending has generated some controversy. Supporters of such lending say that subprime lending generates sources of credit for people who otherwise would not be qualified for it, thus helping to "complete" the market for credit. This helps generate more trading activities within the credit market. Borrowers are also often told that accepting subprime credit, often at high interest rates (particularly in the case of credit cards), will assist them in rebuilding their credit worthiness. There have been allegations by critics that lenders have acted as so called "predatory lenders", taking advantage of borrowers and deliberately lending to people who could never pay back their loans, charging naïve borrowers outrageous fees and sky-high interest rates. Such lenders may tell the borrowers that the borrowers' credit scores are worse than they actually are and therefore are able to charge much higher interest rates than justified by the borrowers' real credit scores. The result may often be bankruptcy, seizure of collateral, and foreclosure.

The subprime mortgage crisis started in the United States in late 2006 with a very large rise in home foreclosures and became a world financial crisis in 2007 and 2008. The effects of the crisis seem likely to continue to be felt for a period of time. This phenomenon has been depicted as a financial contagion which has led to restrictions on the availability of credit in global financial markets, and government interventions to save troubled banks. The crisis began with the bursting of the housing bubble in the US and high default rates on subprime and other adjustable rate mortgages (ARM) made to higher-risk borrowers.

Reduced credit history requirements, loan incentives and a long-term house price boom persuaded people to borrow via mortgages in the hope of cheaper refinancing later. Additionally, some lenders were willing to lend more than 100% of the value of the property being purchased. However, when housing prices began to drop in 2006-2007 in the U.S., refinancing became increasingly difficult. According to RealtyTrac (2008b), the U.S. housing properties subject to foreclosure in 2007 were up approximately 75% compared to 2006. Hundreds of thousands of borrowers have defaulted and many major American subprime lenders have filed for bankruptcy.

Figure 6.1: U.S. Household Properties with Foreclosure Activity – 2007



Source Data: RealtyTrac(2008a)

Not only have first line mortgage lenders who retained the credit risk of borrows' default payments been affected, but other investors have also been affected by the subprime mortgage crisis. This is because of a well known feature of financial engineering, securitization. Risks related to the inability of homeowners to make mortgage payments have been transferred to third-party investors via securitized pools of mortgages such as mortgage-backed securities (MBS) and collateralized debt obligations (CDO). Therefore, the fall in value of underlying mortgage assets has lead to significant losses faced by individual, corporate and institutional investors holding these MBS and CDO.

Northern Rock (NRK)

On 31 March Northern Rock bank released its annual report for 2007, showing a loss of £167 million. In addition, on 14 September 2007, the bank, which was the UK's fifth largest mortgage provider, had to seek an emergency bail-out from the Bank of England as a consequence of effects in international credit markets attributed to the subprime lending crisis (Durrant, 2007). Moreover, the tight balance sheets and uncertainty over the future of what remains of its business led to difficulties in finding buyers (Reuters, 2007) and the bank was nationalized on 22 February 2008 after two unsuccessful takeover bids by the Virgin Group and the in-house management consortium, as neither of them were able to offer sufficient value for money to the taxpayers (BBC, 2008a).

Northern Rock historically always had sufficient assets to cover its liabilities, but after the US subprime crisis, institutional lenders became nervous about lending to mortgage banks. This led to liquidity problems. Northern Rock is not the only British bank to have called on the Bank of England for financial aid since the subprime crisis began. However, it is the only one which has had emergency financial support from the Tripartite Authority (The Bank of England, The FSA and HM Treasury).

The fraudulent trader & the subprime mortgage crisis

Société Générale (SocGen, SG)

Société Générale is one of the oldest banks in France and a major European financial services company. It also maintains extensive activities in others parts of the world. The bank can be considered a major player within the UK financial market.

Société Générale stunned investors on 24 January 2008 (BBC, 2008b) when it announced £1.5 billion ($3 billion) write-downs from failed investments in collateralized debt obligations (CDOs) and bond insurers in the United States. This was due to the meltdown in America's subprime market. In addition, it has seemingly uncovered a £3.8 billion ($7.6 billion) fraud by a Paris-based futures trader (Jérôme Kerviel, a junior employee) who has since been suspended. This loss apparently due to fraud is the largest such loss in history, and considerably larger than the transactions by Nick Leeson that brought down Barings Bank. The total announced lost of Société Générale added up to £5.3 billion ($10.6 billion). Two credit rating agencies downgraded the bank's long term debt ratings on that day, from AA to AA- (Fitch); and from Aa1 to Aa2 (Moody's) (Generale, 2008). The following day, the bank announced it would immediately seek €5.5 billion in financing.

Losses have affected banking around the globe, the UK being unexceptional. The reputation of the British banking industry has been harmed by the recent subprime crisis, but this has not only affected the banking industry in the UK. There are reported losses from major banks and other financial institutions around the world of approximately U.S. $1 Trillion (as of Dec 2008), due to the subprime crisis and it has been predicted that the amount will continue to grow.

6.1.2 Summary

The "impossible" is always possible within the financial world. History seems to repeat itself sporadically, as in the case of the rogue trader of Barings Bank and possibly also for Société Générale. This indicates the difficulties of controlling large financial institutions. Moreover, default risk has risen and this seems likely to lead to greater volatility. An example is the subprime problem and a failure of banks' risk management systems to appreciate that the new "structured finance vehicles" that they used to offload their risky subprime investments may have liquidity problems in difficult market conditions. The International Monetary Fund (IMF) also emphasizes that financial sector supervision and regulation lag behind the rapid innovation and shifts in business models, leaving scope for excessive risk-taking.

Therefore, the soaring degree of leverage and volatility in the financial system could be major supporting evidence for why default risk is not necessarily due to negligence alone, and should be taken into account when valuing any investment (such as covered warrants in this study).

6.1.3 Motivation

There are no guarantees on covered warrant trading provided by the London Stock Exchange (LSE), no perfect hedge (for dynamic trading) by warrant issuer because of market imperfections, and the recent financial distress caused by the subprime crisis as well as the exceptional fraud at Société Générale (SG) make the possibility of default a relevant factor to be considered in the warrant-pricing model.[63] The recent write down/loss due to the crisis incurred by the investment bank along with downgrade in its credit rating, are also supporting evidence of the important of default risk. This suggests that the issuer's credit risk should be taken into consideration when evaluating UK covered warrants. The Black-Scholes (1973) option-pricing model may not be adequate since it does not include a default risk factor. However, Johnson & Stulz (1987) introduced a Vulnerable option model which takes default risk into account. This model was later modified by Klein (1996) and can be used to value UK covered warrants although data limitation make it hard to apply.

The remainder of this chapter is organized as follows. Section 6.2 explores the background literature of the pricing model and bankruptcy costs determination. Section 6.3 develops research hypotheses and gives some background motivation. Section 6.4 discusses data sources and description. It also shows how samples have been constructed. Section 6.5 explains valuation models employed in the study. The analyses of results are presented in Section 6.6 while Section 6.7 offers some concluding discussion.

6.2 Review of Literature

6.2.1 Background literature: Pricing model with credit risk

Regarding to the credit risk in options, Johnson & Stulz (1987) was the first research conducted on this area. They examine the effect of credit risk under the assumption of stochastic processes for the assets value of the option issuer and the assets

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[63] Société Générale is the major issuer in the UK's covered warrant market.

value of the option underlying. They also assume that the option holder receives all the assets of the counterparty writing an option if the writer is unable to meet with the promised payment. Hull & White (1995) extend John & Stulz model to estimate the impact of credit risk where equal ranking claim (bonds that issued by the counterparty) can exist. Thus, option holders are assumed to receive only a proportion of its no-default claims when counterparty is unable to deliver a promised payment. Jarrow & Turnbull (1995) provide another approach for pricing derivative securities concerning credit risk. This approach assumes stochastic term structures of risky debt and default free interest rates. The risk-neutral valuation procedure can then be derived by applying arbitrage-free dynamics given these two term structures. Klein (1996) extends Hull & White (1995) and Jarrow & Turnbull (1995) by relaxing the assumption of independence between the assets of the counterparty and the asset underlying the option, and by specifying a payout ratio which is explicitly related to the value of the assets of the counterparty (a proportional recovery of nominal claims of option in default). The model reveals the effect of credit risk on Black-Scholes options values as being much less for positive correlation between the assets of the counterparty and the asset underlying the option in comparison to when this correlation is negative, therefore supporting the finding that the price of an option is greater than in Johnson & Stulz (1987) which understated the real option value especially for the positive correlation case. The results are also compared to Hull & White (1995). The effect of credit risk calculated using the model is generally less than that reported by Hull & White (1995) for European options, and is similar to their calculations for American options. This difference is due to the relatively higher payout ratio assumed which allows the possibility of the assets of the counterparty to be recovered subsequent to default before the option maturity date.

6.2.2 Background literature: Bankruptcy costs

Bankruptcy occurs when the debt obligations of a firm cannot be met. This results in a transfer of ownership and a formal reorganization of the firm's capital structure. The costs associated with this activity are called bankruptcy costs which can be categorized as direct and indirect. In other words, they are the deadweight economic costs of a firm going bankrupt. Direct bankruptcy costs include reorganization costs, legal, accounting, filing, and other professional fees. These costs are naturally easier to measure than indirect costs of bankruptcy which include the lost sales as a result of customer concerns over future operating difficulties, declining margins due to an increase in input costs from suppliers, loss of key personnel, and loss of management effort(Cays (2001)).

The early discussion of bankruptcy costs related to corporate financing policy can be seen in Modigliani & Miller (1958; 1963). They claim that if interest payments are tax deductible and debt is default free, firms will use their debt financing to the maximum. This has also been discussed in some other literature (Higgins & Schall (1975), Horne (1977) and Haugen & Senbet (1978)) where it is stated that bankruptcy costs do not exist in a perfect and frictionless capital market where there are a variety of participants who are assumed to be rational in their behaviour. However, Robichek & Myers (1966) suggest that there are bankruptcy costs which may offset the tax benefits of debt financing when considering firms' capital structure policy. There are also other papers supporting the relaxation of the no bankruptcy cost assumption; for example Kraus & Litzenberger (1973), Scott (1976) and Kim (1978) have formally develop models that include bankruptcy costs under the concept managers maximise firm value by increasing debt financing to the level where the present value of marginal tax benefits equals the present value of marginal future bankruptcy costs.[64]

6.3 Research hypotheses

6.3.1 Pricing hypotheses

The only published empirical study related to UK company warrant pricing to date is Gemmill & Thomas (1997). This deals explicitly with Investment Trust warrants and is of limited applicability to the wider covered warrant market. There is not yet any study on the pricing of UK covered warrants and only a very limited amount of research on their pricing generally. Chen (2003) considers the credit risk of the covered warrant issuer when

[64] Moreover, the debate concerning whether bankruptcy costs are either high or low can be seen in Warner (1977), Haugen & Senbet (1978), etc.

evaluating pricing within the Taiwan market. Relevant studies of derivative pricing (particularly options) which involve the issuer's default risk are Johnson & Stulz (1987), Hull & White (1995), Jarrow & Turnbull (1995) and Klein (1996). They suggest that the counterparty credit risk has become an important factor in pricing options because of the fast-growing over-the-counter market. This non-exchange-traded market generally involves issuers with limited assets and thus subject to default risk (unable to make payments at the expiration date of option). The reason for taking default risks into account in a study of UK covered warrants arises from concern as to the issuers' credit worthiness particularly due to traders' fraudulent action and the subprime problem in the market, as well as the difficulties of hedging (for dynamic trading) by warrant issuers due to market imperfections.

Hypothesis 6.1: *There should be differences among Vulnerable warrant price (VP), Black-Scholes price (BS) and warrant market price of UK's covered warrant.*

Hypothesis 6.2: *There should be a consistency of results no matter various bankruptcy costs for Vulnerable warrant price (VP) calculation are employed.*

Chen (2003) applies Klein's (1996) Vulnerable option pricing model to price 23 plain vanilla covered warrants in the Taiwan market over the period August 1997 to December 2000.[65] There are two main motivations to adapt this model to Taiwan warrant data. Firstly, the Taiwan market provides no margin settlement mechanism for existing covered warrants, therefore, the credit risk of the warrant issuer should be taken into account when evaluating a covered warrant price. Secondly, perfect hedging is not practical because of market imperfections, and thus the warrant issuer cannot perfectly hedge its exposure on the spot market. In addition, warrant issuers not only face underwriting risk, but also other operating and financial risks. Hence, the issuer's credit risk must be considered in warrant pricing. Chen (2003) compares the Vulnerable warrant price with 'theoretical' Black-Scholes (1973) values and warrant market values. The results show the daily price of each Vulnerable warrant is consistently lower than Black-Scholes price during its lifetime. However, the differences between the two warrant values are not significant. For example, Yuan Ta-China Develop Mar. 99 has zero mean in the difference,

[65] An outline of Klein's Vulnerable option model is presented in the "methodology" section of this chapter, section 6.5.

Tah Hsin-CMC Magnetics Corp. Jul. 99 has a negative 0.0022% difference in means. It appears that the default risks utilized in calculating the warrant pricing model do not have a significant influence on price. There is also evidence that the average daily theoretical values of all Vulnerable warrants are lower than their market prices. The paper concludes that the market prices of Taiwan covered warrants are possibly overvalued. Each warrant lifetime is divided into in-the-money, at-the-money and out-of-the-money and further study examines the differences between Vulnerable warrant and Black-Scholes values. The Vulnerable warrant value is lower than the Black-Scholes value, and this difference is larger in magnitude for in-the-money warrants than that for out-of-the-money warrants. The given reason is that investors face default risk of the issuers only when the Vulnerable warrant is in-the-money. When a warrant is out-of-the-money the current exercise value is zero. Hence, it is not necessary to consider the credit risk. This given explanation by Chen (2003) could possibly be argued because when the warrant is out-of-the-money, its exercise value is indeed zero, but its price is still positive because of the possibility that its exercise value will be positive at some time in the future, and true value of this could still be subjected to the creditworthiness of the issuer. Nevertheless, in-the-money warrant should still be involved with higher credit risk in comparison to out-of-the-money warrant. Thus, my next hypothesis is built upon this belief.

Hypothesis 6.3: *The Vulnerable warrant price (VP) should be less than warrant market price of UK covered warrant for in-the-money than out-of-the-money cases due to higher default risk associated with in-the-money warrant.*

6.3.2 Event Study hypotheses

This study calculates warrant price based on the Black-Scholes (1973) model as well as Klein's (1996) Vulnerable model in order to make a comparison with the existing warrant market price. However, extreme caution is required in evaluating the results for the Vulnerable pricing model. Calculating the parameter estimates of the Vulnerable model is very difficult. The asset value of the warrant issuer is only available infrequently and consequently it is difficult to generate accurate daily data. The initial debt of the issuer is specific to the chosen date when the information is collected. The estimate of the correlation coefficient between the underlying security and the issuer's assets is imprecise and depends on the accuracy of the issuer's asset daily data. The estimation of the asset volatility is also very dependent on the issuer's asset data. Similarly it is difficult to estimate a bankruptcy cost for the warrant issuer. Despite these difficulties I provide some estimates but am reluctant to place much reliance on them. The difficulty of estimating the parameters suggests that an alternative approach might be more fruitful. The losses from the subprime crisis and trading problems indicate that default risk has increased and that the market became aware of this over a short window of time. If credit risk is important we would expect warrant values to change (fall) after revaluation following the losses. The observation of the change in warrant price before and after this event should provide some indication of the importance of credit risk for warrant valuation. In effect, we take the subprime crisis and SG fraudulent trader where credit risk is obviously known to be altered and conduct a "natural experiment" on the UK's covered warrants during that period to see how the price of the warrant before and after the event changes.[66] This is based on the idea that default risk could be an important factor in pricing UK, and indeed any, covered warrants. By looking at the market prices and the prices calculated by means of the Black-Scholes model as well as the Vulnerable model, the movement of these prices around the event can indicate the evidence of default risk.

Hypothesis 6.4: *The UK covered warrants should be overpriced during the period of financial distress because of the ignorance to take default risk into consideration. (evidence in both percentage and money-term)*

Hypothesis 6.5: *There should be differences between Vulnerable warrant price (VP) and Black-Scholes price (BS) of UK's covered warrant before and at/after financial distress.*

Hypothesis 6.6: *There should be differences between Vulnerable warrant price (VP) and warrant market price of UK's covered warrant before and at/after financial distress.*

[66] A natural experiment is a naturally occurring event or situation, which can be exploited by a researcher to help answer a research question.

Hypothesis 6.7: *There should be negative abnormal returns around and after the event day (financial distress) under both market price and Black-Scholes price (BS) of UK's covered warrant in order to indicate that credit risk has a significant impact upon covered warrant trading.*

6.4 Data/Sample construction

6.4.1 Data sources and description

303 call covered warrants (plain vanilla European warrants with cash settlements) were issued and expired on the London Stock Exchange (LSE) from 11th April 2007 to 19th December 2008. Excluding 142 warrants listed after 24th January 2008, the event day (the day that Société Générale announced a loss of £5.3 billion ($10.6 billion) due to the subprime crisis and fraudulent trader) and 7 warrants with an error in the data, the total number left is 154 covered warrants in the sample. The data are collected from each warrant prospectus and the LSE. Financial data of the warrant issuer was collected from Société Générale's website, Datastream and BBC news. Time to maturity, daily market prices of each warrant and the underlying stock price were obtained from Datastream. Exercise prices, expiration dates and parity ratios are accessible through each warrant prospectus. Nominal risk free interest rates are released by the Bank of England.

All covered warrants employed here are issued solely by Société Générale, the main issuer of such products. Each warrant has an issue size of 50 million units. They are all Plain Vanilla in style and have an individual stock as the underlying security. The settlement conditions are in cash which means that the issuer will pay a cash amount for the intrinsic value of the warrants at the expiry date for the European-style covered warrants used here. Appendix 6.1 gives the issuance status of all 154 call covered warrants in the sample. There are a total of 46 listed stocks underlying the warrants. Except for 7 stocks, the rest of the underlying stocks were included in the FTSE100.[67] At issue, there were 9 in-

[67] The 7 underlying stocks that were not included in FTSE100 constituent are ARM HOLDINGS PLC, CENTRICA PLC, INVESCO PLC, PERSIMMON PLC, ROYAL & SUN ALL.IN. GROUP PLC, SCOTTISH & NEWCASTLE PLC, and YELL GROUP PLC.

the-money and 145 out-of-the-money warrants. The fundamental conversion ratios for the warrants are either 0.1 or 1.

For the part of the Vulnerable warrant pricing study, the sample size is reduced from 154 call covered warrants to 103 call covered warrants. I filter out 47 covered warrants which have not yet expired during the time I conducted this study and 4 more covered warrants are deleted due to incomplete data sets needed for the calculations of various parameters required by the Vulnerable warrant model, therefore, the sample size is finalized at 103 covered warrants.

6.4.2 Data construction

Volatility estimation

Historical and implied estimates of volatilities are widely used for valuation purposes. Volatility is a key variable input into the Black-Scholes and other models for deriving 'fair value' prices. High volatility means large daily, weekly or monthly movements in prices and can lead to considerable advantages because of the limited loss, unlimited upside characteristic of warrants.

This study uses historical volatility measured by the standard deviation of past movements in the underlying stock price. We use historic volatility as an estimate of future volatility, as in practice it is difficult to forecast the true value of future volatility. Thus, the historical volatility is popularly used as a proxy.

A standard methodology for calculating historical volatility is to calculate annual volatility as a percentage, based on daily prices observed for a set period such as the previous 30, 60, or 250 days. This study employs estimates based on a 60 day-period because the market has been very volatile during the study period.[68] The historical volatility is computed as the standard deviation of daily log returns, and annualised assuming that

[68] Both 30 and 90-day periods were also tested and the empirical results are not qualitatively different to the ones reported in this study.

there are 252 trading days per year, as is conventional in derivatives pricing.[69] The estimation of both the underlying stock return volatility (σ_S) and the asset volatility (σ_V), used in the pricing models are derived accordingly.

The underlying stock prices and the asset values of the issuer estimation

I assume that both the stock prices (S) of the warrant's underlying and asset values (V) of the warrant issuer follow a 'diffusion process'. The diffusion processes of these two values are defined by

$$\frac{\Delta S}{S} = \mu \Delta t + \sigma_s \Delta z$$

$$\frac{\Delta V}{V} = \mu \Delta t + \sigma_v \Delta z$$

where $\frac{\Delta S}{S} = (S_{t+\Delta t} - S_t)/S_t$ = the rate of return on the underlying stock price

$\frac{\Delta V}{V} = (V_{t+\Delta t} - V_t)/V_t$ = the rate of return on the asset value

μ = the expected return on the underlying stock prices/asset values per unit of time; μ is constant

Δt = a unit of time, here a day.

σ = the standard deviation of the stock's return during the unit of time

z = a random variable that is normally distributed with a mean of zero and a variance of t. z is called a Wiener process. Over small intervals of time, changes in z, Δz, are normally distributed random variables, with $E(\Delta z) = 0$ and $\text{var}(\Delta z) = \Delta t$. The covariance of any two Δz is zero; in other words, $\text{cov}(\Delta z_{t2}, \Delta z_{t1}) = 0$.

Δz is just a normally distributed random variable with a mean of zero and a variance per unit time of Δt. Suppose Δt is one day (use in this study). A value of Δz can be drawn out of a probability distribution that has a mean of zero and a variance of one. The mean is always zero, and the variance is proportional to time.

[69] Assuming that returns are "lognormally distributed"

The correlation coefficient estimation (between the underlying stock and the issuer asset value)

This is the correlation between the price of underlying stock (S) and the asset value of the warrant issuer (V). The daily returns on underlying stock price and the stock price of the issuer (assumed as a representative of V) are used. The correlation is calculated for the period which warrant is being calculated.

The bankruptcy costs estimation

The classic paper on this area is Warner (1977). He investigated 11 US bankruptcy railroads which the Interstate Commerce Commission (ICC) reported bankruptcy costs for between 1933 and 1955. Evidence on the direct costs of corporate bankruptcy reveals it to be about 1% on average of the market value of the firm in the seventh year prior to bankruptcy. At the time the firm filed a bankruptcy petition, the bankruptcy cost is 5.3% on average of the market value of the firm. Warner's work is based on a narrow definition of bankruptcy costs (it only included direct costs of bankruptcy) and a very small and specialized sample. Later work by Altman (1984) provided additional evidence. He introduced for the first time a proxy methodology to calculate the indirect cost of bankruptcy. He examined 18 US firms (of retailers and industrial firms) which went bankrupt between 1970 and 1978. The average bankruptcy cost (of firm value), direct cost plus indirect bankruptcy cost, ranged from 11% to 17% up to three years before bankruptcy petition. Even though, percentages of bankruptcy costs are relatively small and reasonable to use according to these two classic papers, they are considerably too high for a financial institution. Thus, I do not apply these numbers directly to my study which is conducted on banking industry (issuer of covered warrants). Kareken & Wallace (1978) study of the banking industry indicates a lower bankruptcy cost. They analyze various banking industry equilibrium and assume that the bankruptcy is costly (reorganization cost is unavoidable) and report between zero and one percent as a bankruptcy value. I use Kareken & Wallace's range of bankruptcy cost and then divide the study into three cases of 0%, 0.5%, and 1% of firm/bank value. In addition, it may be worth mention about the recent bankrutcy case of one of Wall Street's investment giants, Lehman Brothers. The investment bank filed for bankruptcy protection on 15 September 2008 after tremendous losses in the mortgage market, a loss of investor confidence and its inability to find a buyer (Times, 2008). Instead of trying to intervene or bail-out Lehman Brothers, the US government allowed the bank to collapse (Reuters, 2008). The bank's demise creates huge effects throughout the financial system. A crisis of confidence exacerbated because of the uncertainty surrounding transactions which it has had with other banks and hedge funds. Some activities of the bank are simply being shut down and others sold off at much lower values than previously. The tighter in credit market was a direct consequence. This is forcing governments around the world to take immediate actions to try to clam panicked markets. Therefore, some might argue that due to Lehman's bankruptcy, the costs associated are possibly far beyond zero and one percent of bank value. However, in the absence of reliable figures of the bankruptcy cost, this is the major weakness point in the estimation of my study here.

6.5 Methodology

6.5.1 Brief development of covered warrants model

The Black-Scholes (1973) pricing model is the standard benchmark for analysts valuing options or synthetic warrants. According to McHattie (2005), the model is adopted for UK covered warrant. Therefore, this study employs the model to calculate the covered warrant price. The approach here is to regard the Black-Scholes results as a benchmark and to use them to gauge whether market prices are overvalued or undervalued. Further investigation is required to test whether the credit risk of the issuer has a significant effect on the warrant price. Klein's (1996) Vulnerable option pricing model is the most applicable theory to incorporate the credit risk into the warrant price calculation. This study tries to observe the change in price of the warrant before and after an obvious change in credit risk via the model modified by Klein. However, due to the difficulties in evaluating the parameters required by the model as well as its limited impact (Chen (2003)), the estimates generated by the model may not be too reliable.

6.5.2 The pricing model for Vulnerable covered warrants

The generalized pricing model for Vulnerable options (Klein (1996)) is applied for the pricing of UK covered warrants in this study. The asset value (V) of the warrant issuer includes the current market value of all assets of the issuer as well as the marked to market value of all derivative and other contracts. The assumption is that both V and the underlying stock price (S) of the covered warrant follow geometric Brownian motion with instantaneous volatility σ_V and σ_S . The appropriate risk neutral processes for V and S can be shown below using the risk neutrality approach of Cox & Ross (1976) and Harrison & Pliska (1981) for the purpose of pricing derivative securities dependent on V and S.

$$\frac{dS}{S} = rdt + \sigma_S dw \qquad (1)$$

$$\frac{dV}{V} = rdt + \sigma_V dz \qquad (2)$$

where r denotes the risk free rate, w and z follow standard Wiener processes. These processes imply that $\ln S_T$ and $\ln V_T$ are normally distributed with mean of $(r - \sigma_S^2/2)(T-t)$ and $(r - \sigma_V^2/2)(T-t)$, and standard deviation of $\sigma_S(T-t)^{1/2}$ and $\sigma_V(T-t)^{1/2}$, respectively. $T-t$ is the time to maturity of the warrant. In addition, the joint distribution of $\ln S_T$ and $\ln V_T$ are bivariate lognormally distributed as:

$$n_2\left(\ln S_t + (r - 0.5\sigma_S^2)(T-t), \ln V_t + (r - 0.5\sigma_V^2)(T-t), \sigma_S\sqrt{T-t}, \sigma_V\sqrt{T-t}, \rho\right) \qquad (3)$$

where n_2 is the probability density function of standard bivariate normal distribution. ρ is the correlation coefficient between $\ln S_T$ and $\ln V_T$.

The Vulnerable call covered warrant value (W) is the present value of the expectation of the value of the cash flow from a non-Vulnerable covered warrant times the value of a claim on the risky issuer at maturity. At maturity date, a default loss occurs (issuer is bankrupted) if V_T is smaller than D^*. Due to the possibility of a counterparty continuing in operation even during the bankruptcy stage, D^* can be smaller than D. The proportion of $(1-\alpha)V_T/D$ of nominal claim is paid out by the issuer in the event of a bankruptcy, where α is the deadweight costs associated with bankruptcy expressed as a percentage of the asset value of the issuer.[70] This means warrant holders cannot get full claims from the issuer at expiration date if the issuer is bankrupt. Under these conditions, W can be written as:

$$W = e^{-r(T-t)}E[\max(S_T - K,0)([1 \mid V_T \geq D^*] + [(1-\alpha)V_T/D \mid V_T < D^*])] \qquad (4)$$

where E is the risk neutral expectation over S_T and V_T. K is the exercise price.

It should be noted that under this equation (4), if there is no credit risk (D^* equal zero), the equation immediately simplifies to the standard expression for a non-Vulnerable warrant model (The Black-Scholes model).

Equation (4) can be restated and expressed as the following pricing formula for the value of a Vulnerable European call warrant:

$$\begin{aligned} W &= S_t N_2(a_1, a_2, \rho) - e^{-r(T-t)} K N_2(b_1, b_2, \rho) \\ &+ \frac{(1-\alpha)V_T}{D}\left(S_t e^{(r+\rho\sigma_S\sigma_V)(T-t)} N_2(c_1, c_2, -\rho) - K N_2(d_1, d_2, -\rho)\right) \end{aligned} \qquad (5)$$

where N_2 = the bivariate (standard) normal cumulative distribution function

$$a_1 = \frac{\ln(S_t/K) + (r + 0.5\sigma_S^2)(T-t)}{\sigma_S\sqrt{T-t}}$$

$$a_2 = \frac{\ln(V_t/D^*) + (r - 0.5\sigma_V^2 + \rho\sigma_S\sigma_V)(T-t)}{\sigma_V\sqrt{T-t}}$$

$$b_1 = \frac{\ln(S_t/K) + (r - 0.5\sigma_S^2)(T-t)}{\sigma_S\sqrt{T-t}}$$

$$b_2 = \frac{\ln(V_t/D^*) + (r - 0.5\sigma_V^2)(T-t)}{\sigma_V\sqrt{T-t}}$$

[70] The deadweight costs include the direct cost of the bankruptcy or reorganization process plus/minus the effects of distress on the business operations of the firm (issuer). In other words, the deadweight costs represent both direct and indirect costs of the bankruptcy.

$$c_1 = \frac{\ln(S_t/K) + (r + 0.5\sigma_S^2 + \rho\sigma_S\sigma_V)(T-t)}{\sigma_S\sqrt{T-t}}$$

$$c_2 = -\frac{\ln(V_t/D^*) + (r + 0.5\sigma_V^2 + \rho\sigma_S\sigma_V)(T-t)}{\sigma_V\sqrt{T-t}}$$

$$d_1 = \frac{\ln(S_t/K) + (r - 0.5\sigma_S^2 + \rho\sigma_S\sigma_V)(T-t)}{\sigma_S\sqrt{T-t}}$$

$$d_2 = -\frac{\ln(V_t/D^*) + (r + 0.5\sigma_V^2)(T-t)}{\sigma_V\sqrt{T-t}}$$

Equation (5) shows that a Vulnerable warrant value can be influenced by many factors such as the exercise price (K), the warrant time to maturity ($T-t$), the issuer outstanding debt value at maturity (D), the underlying stock price (S), the underlying stock return volatility (σ_S), the asset value (V), the asset volatility(σ_V), the correlation coefficient between the underlying stock and the issuer asset value (ρ) and the risk free rate (r).

This study applies this equation (5) to find the value of UK Vulnerable covered warrants.

6.6 Empirical Results

6.6.1 Pricing using Vulnerable warrant model

This study applies Klein's (1996) Vulnerable option pricing model to price UK covered warrants because of the belief that default risk is an important factor. The results are presented in Table 6.1, average warrant price over each 103 warrant life. The Vulnerable warrants are separated into three cases where the bankruptcy costs are 0%, 0.5%, and 1%.[71] The outcomes are slightly differences across all three cases. This study then compares these Vulnerable warrant prices with the Black-Scholes prices and the market prices for each warrant over its life-time. Majority of the Vulnerable warrant prices are lower than both the Black-Scholes and market prices for all 103 warrants. However, the inclusion of the possibility of default for the issuer to the pricing model does not really make tremendous difference to the estimated Black-Scholes price.

[71] Due to the recent financial crisis and the announcement of bankruptcy in September 2008 by Lehman Brothers investment bank, there is a possibility that the bankruptcy costs are higher than what we assume in our analysis here. Thus, Appendix 6.6 provides the Vulnerable warrant prices for 20% bankruptcy costs using the same sample set. As predicted, the Vulnerable warrant prices are lower than our assumption of lower bankruptcy costs. However, these outcomes are still not much difference across all cases.

Table 6.1: Comparison of Vulnerable Warrant Price, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)				
			Vulnerable model			Black-Scholes model	Market
			α = 0%	α = 0.5%	α = 1%		
98748T	3I GP.PLC.	256	2.13	2.12	2.11	2.13	3.39
1859J9	3I GROUP PLC	132	1.46	1.45	1.45	1.46	2.85
1720FT	ANGLO AMER.	192	36.21	34.34	34.31	36.21	33.26
97092F	ANGLO AMER.	251	28.86	27.96	27.92	28.86	21.16
1842CP	ANGLO AMER.	139	16.69	16.66	16.63	16.69	18.64
1842CT	ANTOFAGASTA	139	59.19	59.13	59.06	59.19	68.26
1651RX	ANTOFAGASTA	220	103.82	103.73	103.65	103.82	116.49
97092H	ANTOFAGASTA	251	149.55	149.10	149.03	149.55	162.51
1794RR	ANTOFAGOSTA	157	38.71	38.65	38.58	38.71	48.94
98748X	ARM HDGS.	256	6.83	6.82	6.80	6.83	9.15
1859DP	ARM HOLDINGS	132	2.44	2.44	2.43	2.44	2.31
1651R2	AZEN.	220	7.56	7.54	7.52	7.56	11.36
1842CV	AZEN.	139	6.42	6.40	6.38	6.42	9.61
1859DR	AVIVA	132	2.49	2.48	2.48	2.49	2.44
1651R1	AVIVA	220	3.50	3.49	3.49	3.50	3.87
98749E	AVIVA	256	1.53	1.52	1.52	1.53	1.46
98749H	BAE	256	29.20	29.14	29.09	29.20	35.65
1859DV	BAE SYSTEMS	132	8.45	8.42	8.39	8.45	16.89
1807ND	BARCLAYS	154	29.18	29.14	29.10	29.18	24.84
1807NE	BARCLAYS	154	19.79	19.75	19.71	19.79	16.79
1720FV	BARCLAYS	192	23.65	23.61	23.56	23.65	16.04
1720FW	BARCLAYS	192	12.52	12.48	12.45	12.52	7.22
1842JH	BG.GP.	139	14.67	13.77	13.76	14.67	15.85
1842JJ	BG.GP.	139	8.93	8.06	8.05	8.93	10.17
1720F7	BHP BILLITON	192	16.72	15.69	15.67	16.72	16.98
1720F8	BHP BILLITON	192	10.25	10.10	10.09	10.25	10.09
97092J	BHP BILLITON	251	29.64	28.85	28.83	29.64	29.87
97092K	BP PLC.	251	34.02	33.95	33.88	34.02	40.66
97092L	BP PLC.	251	8.72	8.68	8.63	8.72	12.98
98751T	BRIT.EN.	256	6.13	5.86	5.85	6.13	6.69
1859D1	BRITISH ENERGY	132	11.54	11.01	11.01	11.54	11.62
1842JK	BRIT.LAND	139	5.21	5.20	5.19	5.21	5.46
1842JL	BRIT.LAND	139	3.17	3.17	3.16	3.17	3.22
1651R9	BRIT.LAND	220	2.81	2.80	2.79	2.81	3.64
1859D9	BRITISH SKY	132	1.25	1.24	1.24	1.25	1.82
98751V	BSB.	256	1.81	1.81	1.80	1.81	2.92
1842JT	BT GROUP	139	3.83	3.82	3.80	3.83	8.22
1842JU	BT GROUP	139	0.78	0.78	0.77	0.78	3.14

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Table 6.1(con't): Comparison of Vulnerable Warrant Price, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)				
			Vulnerable model			Black-Scholes model	Market
			α = 0%	α = 0.5%	α = 1%		
1859F6	CABLE & WIRELESS	132	2.30	2.29	2.29	2.30	5.42
98769J	CBW PLC.	255	4.11	4.10	4.08	4.11	7.07
98769K	PUT-CBW PLC.	255	14.38	14.36	14.35	14.38	23.83
1859FU	CENTRICA	132	3.42	3.41	3.40	3.42	6.01
98769L	CENTRICA	255	4.78	4.76	4.73	4.78	12.20
1859JN	DIAGEO PLC.	132	2.92	2.91	2.90	2.92	5.21
98769N	DIAGEO PLC.	255	1.92	1.91	1.90	1.92	3.41
98769Q	EXPERIAN GP.	255	0.90	0.90	0.90	0.90	2.02
1859JQ	EXPERIAN GROUP	132	1.66	1.66	1.65	1.66	2.31
1859J2	HAMMERSON PLC.	132	4.59	4.58	4.57	4.59	5.11
98769T	HAMMERSON PLC.	255	1.88	1.87	1.86	1.88	4.55
1859JW	HBOS PLC	132	0.98	0.98	0.97	0.98	1.04
98769W	HBOS PLC.	255	1.64	1.63	1.63	1.64	1.93
97108W	HSBC HDG.	274	1.86	1.85	1.84	1.86	2.71
97108X	HSBC HDG.	274	0.21	0.21	0.21	0.21	0.63
1842TH	HSBC HDG.	138	2.36	2.35	2.34	2.36	3.02
1842TJ	HSBC HDG.	138	6.51	6.08	6.08	6.51	7.00
98770E	INVESCO PLC.	255	5.70	5.69	5.68	5.70	7.83
1840PT	LAND SECURITIES	140	8.17	8.16	8.14	8.17	11.29
1840PU	LAND SECURITIES	140	5.47	5.45	5.44	5.47	8.55
1840PV	LAND SECURITIES	140	3.61	3.60	3.59	3.61	6.40
1859KD	LEGAL & GENERAL	132	4.52	4.51	4.50	4.52	6.58
98902F	LGL.& GEN.	251	3.07	3.05	3.04	3.07	2.77
97109C	LLOYDS	274	15.70	15.65	15.59	15.70	20.71
97109D	LLOYDS	274	4.15	4.12	4.09	4.15	9.26
1840PP	LLOYDS TSB GROUP	140	19.29	19.26	19.22	19.29	19.12
1840PQ	LLOYDS TSB GROUP	140	10.54	10.51	10.48	10.54	10.77
97109E	MAN GROUP	274	47.36	45.07	45.00	47.36	57.22
1842TL	M&S.	138	0.82	0.82	0.82	0.82	1.04
1842TN	M&S.	138	0.27	0.27	0.27	0.27	0.57
1655VU	M&S.	219	2.26	2.25	2.25	2.26	2.87
1863KU	PERSIMMON	131	3.01	3.01	3.00	3.01	2.60
98902N	PERSIMMON	251	2.93	2.92	2.91	2.93	3.80
1842TP	PRUDENTIAL	121	4.07	4.07	4.06	4.07	4.36
1842TQ	PRUDENTIAL	121	1.77	1.76	1.76	1.77	2.05
97107E	RIO TINTO	274	143.18	140.92	140.88	143.18	141.08
97107F	RIO TINTO	274	130.18	127.92	127.87	130.18	127.69
1859KV	ROLLS ROYCE	132	0.69	0.68	0.68	0.69	1.27

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Table 6.1(con't): Comparison of Vulnerable Warrant Price, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)				
			Vulnerable model				
			α = 0%	α = 0.5%	α = 1%	Black-Scholes model	Market
98902U	ROLLS ROYCE	251	1.02	1.01	1.01	1.02	1.56
1860EV	RSA IN.GP.PLC.	132	3.11	3.10	3.09	3.11	4.49
98902D	RSA IN.GP.PLC.	251	4.31	4.29	4.28	4.31	6.10
1720HL	RBOS.	192	7.71	7.69	7.67	7.71	12.74
1720HM	RBOS.	192	4.79	4.77	4.75	4.79	7.96
97107C	RBOS.	274	3.09	3.07	3.04	3.09	10.97
97109H	ROYAL DUTCH	276	7.34	7.32	7.29	7.34	8.74
97109J	ROYAL DUTCH	276	3.66	3.64	3.62	3.66	4.74
1860EX	SAINSBURY	132	0.99	0.99	0.99	0.99	0.78
98901W	SAINSBURY	251	1.02	1.02	1.02	1.02	1.53
1860F0	SCOT.& STHN.	132	1.43	1.42	1.41	1.43	3.56
98901L	SCOT.& STHN.	251	4.78	4.77	4.75	4.78	9.93
98901P	SCOT.& NEWC.	251	6.88	6.13	6.13	6.88	9.03
1844W2	STD.CHT.	138	6.25	6.24	6.22	6.25	8.94
1844W4	STD.CHT.	138	3.16	3.15	3.14	3.16	5.31
98817H	STD.LF.	251	4.63	4.61	4.59	4.63	8.07
1840PW	TESCO PLC	140	0.76	0.75	0.75	0.76	1.29
1860F3	UTD.UTILS.	132	1.20	1.19	1.19	1.20	2.48
98817C	UTD.UTILS.	251	1.02	1.01	1.01	1.02	2.58
1720HP	VODAFONE	192	6.49	6.47	6.46	6.49	7.13
97107P	VODAFONE	121	8.27	8.25	8.24	8.27	9.55
1844W6	VODAFONE	138	2.67	2.66	2.65	2.67	4.31
1844W7	VODAFONE	138	5.36	5.35	5.33	5.36	7.39
1860F5	XSTRATA	132	31.22	27.96	27.93	31.22	43.38
98817E	XSTRATA	251	49.67	47.93	47.89	49.67	52.99
1860F8	YELL	132	0.32	0.32	0.32	0.32	0.94
98818H	YELL	250	0.82	0.82	0.81	0.82	2.87

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

In addition, we divide each warrant life-time into in-the-money, at-the-money, and out-of-the-money. The further examination is conducted to see the difference between Vulnerable warrant value (for the case $\alpha = 1\%$) and market value. Appendix 6.7 presents these results for the whole 103 call covered warrants. In total of 103 samples, 65 samples are always out-of-the-money during their life-time, 17 samples are out-of-the-money at most of the time, and the remaining 21 samples are either in-the-money or out-of-the-money for at least twenty days. The 12 out of these 21 samples show that the mean difference between the vulnerable warrant value and the market value is larger when the warrant is in-the-money than out-of-the-money (Table 6.2). For example, 1842TJ (SCGN. HSBC HDG. COVERED WTS. 20/06/08) warrant sample shows the mean difference of in-the-money days is 49.5% in comparison to 3% of out-of-the-money days and on average there is 11.7% difference in mean for in-the-money versus 5.3% for out-of-the-money warrants. The negative signs in Table 6.2 mean that Vulnerable warrant price is less than market price. These outcomes are consistence with the claim that investors face higher default when the warrant is in-the-money than out-of-the-money. In other words, the Vulnerable warrant price is generally much lower than the market warrant price under in-the-money in comparison to out-of-the-money status. This gap becomes narrow when warrant is out-of-the-money but never actually becomes zero because as long as out-of-the-money warrant has not yet reached maturity, there is always a chance that it may get back to in-the-money status again. Therefore, default risk has to be taken into account to arrive at the true warrant value in any circumstances no matter in or out-of-the-money.

Table 6.2: Mean of Price Difference between Vulnerable Warrant (α=1%) and Market Value (The case of In/Out-of-the-money for 12 call covered warrants)

Warrant DS Code	Name of underlying stock	Mean of price difference	
		in-the-money	out-of-the-money
97092H	ANTOFAGASTA	-0.081	-0.043
1842JH	BG.GP.	-0.108	-0.047
1842JJ	BG.GP.	-0.226	-0.113
1720F7	BHP BILLITON	-0.073	-0.019
97092J	BHP BILLITON	-0.024	-0.007
1859D1	BRITISH ENERGY	-0.034	-0.020
1842TJ	HSBC HDG.	-0.495	-0.030
97109E	MAN GROUP	-0.129	-0.127
97107E	RIO TINTO	0.005	0.000
97107F	RIO TINTO	0.012	0.003
1860F5	XSTRATA	-0.204	-0.203
98817E	XSTRATA	-0.050	-0.032
Average		-0.117	-0.053

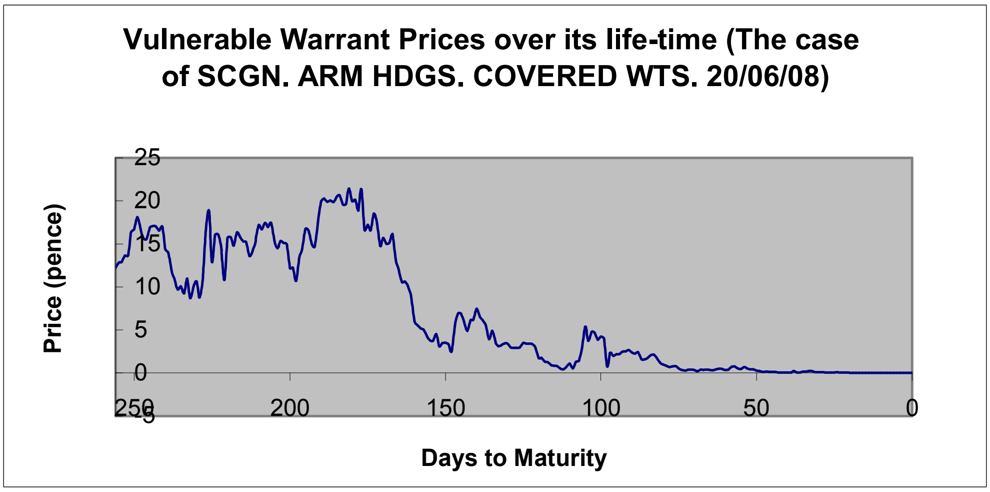
Notes: α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

The high percentages of price differences in some cases presented in the table are possible due to the following supporting evidences. Firstly, the absolute term between both prices may not be very different but the percentage term may. For example, warrant 1842TJ on 11/06/2008 has the vulnerable warrant price of 2.01 and the market price of 3.02, etc. Secondly, Black (1975) states that model prices tend to differ from market prices in certain systematic ways. This is especially the case for options that are either deep in or deep out of the money. In addition, the biases are usually based on the strong assumption that the underlying stock follows a stationary geometric Brownian motion which implies the stock price is lognormal distributed and the variance is constant.

Furthermore, we illustrate the daily Vulnerable warrant prices over a warrant's lifetime. Figure 6.2 shows the daily prices for SCGN. ARM HDGS. Covered WTS. 20/06/08 over its 256 days to maturity. This represents the general pattern for price movement of most warrants. The price of the Vulnerable warrant varies over time because the underlying stock price varies and the debt and the asset value of the issuer varies. The price falls toward zero because it is presumably an out-of-the money warrant and when warrant is approaching the maturity.

Figure 6.2: Daily prices of Vulnerable warrant over its life-time (The case of SCGN. ARM HDGS. Covered WTS. 20/06/08: 98748X)



Note: This warrant sample has 256 days to maturity.

6.6.2 An event study around a period of financial distress

A natural experiment is carried out to identify whether there are changes which might have affected covered warrant prices during a period of considerable financial distress (January 2008) in the financial market. The Black-Scholes (1973) pricing model is used as a benchmark. An event study methodology is used and the full discussion of this method can be found in Chapter 3. Event studies work by diversifying away risk but if all the events are at the same date, this is difficult. Brown & Warner (1980; 1985) refer to the simultaneous occurrence of events as event clustering. The event day behaviour is increasingly dependence when event clustering is involved. Even though this could lead to a lower power of the tests and too frequently rejected of the null hypothesis, their analyses suggest that the methodologies which incorporate information about the market's realised return still perform well in comparison with others complicated event study methodologies. Moreover, later analysis here employed only the market model is because Brown & Warner (1980) show evidence that the market model perform substantially better even than another simple model of mean-adjusted return.

In this study, the 31-day event window is defined as 15 trading days before and 15 trading days after the event day (the 2008 financial distress, 24 January 2008) plus the event day itself. Day 0 stands for the event day. The daily price differences between the Black-Scholes price and market value of 154 call covered warrants are presented in Table 6.3.

Table 6.3 shows that the daily market prices of covered warrants are consistently higher than the Black-Scholes prices on average before and on the event day. The Black-Scholes price is around 23.77% on average (statistically significant abnormal return at 1% level) lower than the market price over the 15 days before the event day. It appears that the market prices of covered warrants are overpriced during the January 2008 period of financial distress (Black-Scholes model as a benchmark).[72] This is similar to the finding for covered warrants under normal market condition in Taiwan (Chen (2003)). From the day following the event onward, both market prices and Black-Scholes prices of covered warrants decline. The main reason to explain this phenomenon is an increase in the default risk as a consequence of the financial distress. The market prices decline at a faster rate in comparison with the Black-Scholes prices which leads to the Black-Scholes prices becoming larger than the market prices. There are positive abnormal returns on average after the event day. The Black-Scholes price is approximately 5.02% on average (not statistically significant) higher than the market price for the 15-day periods after the event day.[73] This percentage value is rather small as well as statistically insignificant.

[72] The method of analyzing the relative difference between the market price and the model price in order to identify the mispricing of the derivatives is commonly used (See Lung & Marshall (2002) for an example). Even though it is very common to present the results in percentage differences like in Table 6.3, this study also provides another two alternative ways of presenting the results in Appendix 6.8, the differences presented in pence and Appendix 6.9, the differences presented base on the underlying security prices.

[73] The average cumulative abnormal returns provide all 1% significance level over the whole 31-day event window.

Table 6.3: Price Difference between Black-Scholes Price and Market Value of 154 call covered warrants

	Black-Scholes Price and Market Value[a]			
Day	Max	Min	Mean	SD
-15	1.5227	-0.8623	-0.2398	0.3297
-14	1.4111	-0.8819	-0.2733	0.3390
-13	1.6346	-0.8885	-0.2505	0.3656
-12	1.4596	-0.9163	-0.2494	0.3523
-11	1.6421	-0.9417	-0.2625	0.3668
-10	1.7033	-0.9434	-0.2317	0.3969
-9	1.8227	-0.9492	-0.2386	0.4151
-8	2.1988	-0.9387	-0.2253	0.4252
-7	2.4651	-0.9777	-0.2492	0.4439
-6	2.1541	-0.9711	-0.2383	0.4462
-5	2.5150	-0.9611	-0.2026	0.4681
-4	2.7665	-0.9626	-0.2164	0.4751
-3	1.5825	-0.9931	-0.3623	0.4315
-2	2.6570	-0.9505	-0.1621	0.5579
-1	2.9819	-0.8893	-0.1630	0.5467
0	4.5732	-0.8315	-0.0114	0.7115
1	6.4220	-0.8365	0.0945	0.8935
2	5.7865	-0.8558	0.0824	0.8207
3	5.0645	-0.8099	0.0866	0.8153
4	4.6650	-0.8323	0.0652	0.7528
5	4.5815	-0.8515	0.0677	0.7364
6	5.2050	-0.8033	0.0734	0.7454
7	4.4704	-0.7683	0.0500	0.7314
8	3.2001	-0.8469	-0.0109	0.6038
9	3.3605	-0.8757	0.0381	0.6755
10	4.0716	-0.9341	0.0098	0.7266
11	4.1667	-0.9226	0.0558	0.7384
12	4.5292	-0.9624	0.0272	0.7337
13	3.5819	-0.9015	0.0415	0.6485
14	3.2145	-0.8498	0.0556	0.6703
15	3.2591	-0.8772	0.0166	0.6587

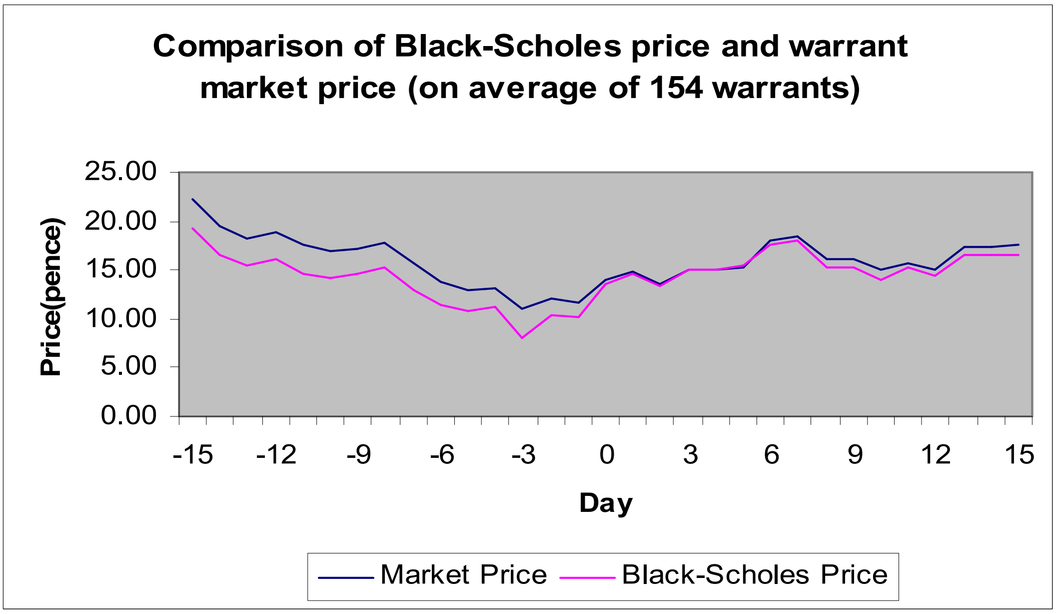
Note: The sample period extends form April 2007 until December 2008.

[a] The price difference between Black-Scholes price and market value is calculated as: (Black-Scholes price - market value)/market value.

The high percentages of price differences in some cases presented in the table are possible due to the following supporting evidences. Firstly, the absolute term between both prices may not be very different but the percentage term may. For example, the maximum value in day 1 of 6.422 comes from the percentage difference between Black-Scholes price (pence) of 2.1524 and market value (pence) of 0.29, the minimum value in day -3 of -0.9931 comes from the percentage difference between Black-Scholes price (pence) of 0.0024 and market value (pence) of 0.35, etc. Secondly, Black (1975) states that model prices tend to differ from market prices in certain systematic ways. This is especially the case for options that are either deep in or deep out of the money. In addition, the biases are usually based on the strong assumption that the underlying stock follows a stationary geometric Brownian motion which implies the stock price is lognormal distributed and the variance is constant.

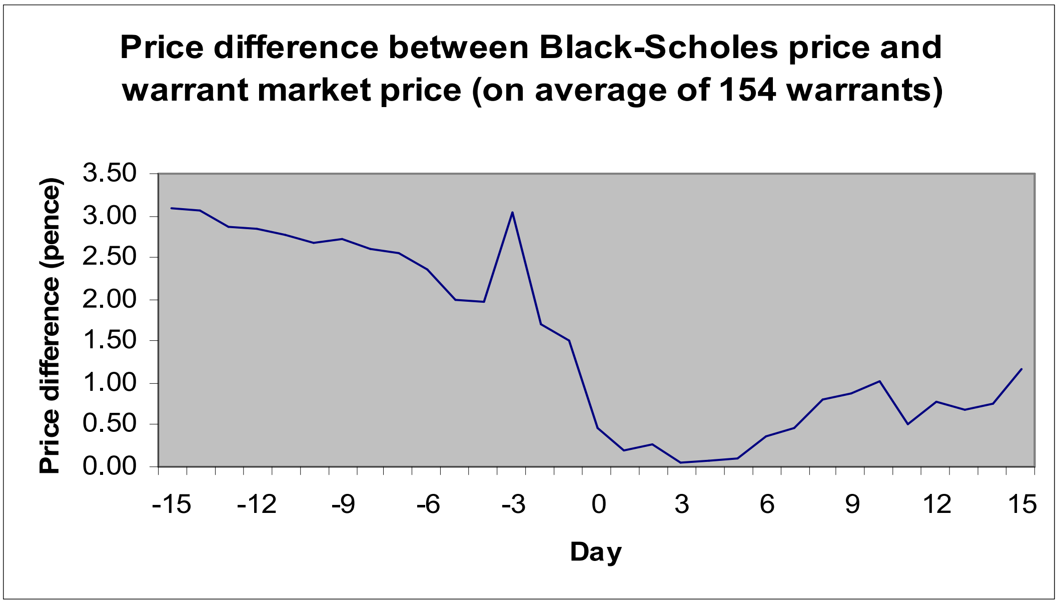
This study also compares the daily differences between Black-Scholes prices and market prices in money-term (pence) as a comparison to the previous results presented in percentage-term (Table 6.3). Figure 6.3 shows these two daily prices on average for the 154 call covered warrants. The Black-Scholes warrant prices are generally lower than the warrant market prices during the whole 31-day period, with a maximum difference of 3.09 pence or 23.98%. The difference is gradually decreasing over times as can be seen in Figure 6.4, supporting the previous discussion that both market prices and Black-Scholes prices of covered warrants have declined after the event day. Hence, financial distress has an effect on covered warrant prices suggesting that the issuer's credit risk should be taken into account when calculating the fair value of the covered warrant.

Figure 6.3: Comparison of Black-Scholes Price and Market Value (on average for the case of 154 call covered warrants)



Note: The sample period extends form April 2007 until December 2008.

Figure 6.4: Price difference between Black-Scholes Price and Market Value (on average for the case of 154 call covered warrants)



Note: The sample period extends form April 2007 until December 2008.

Due to the faster decline rate of market prices compared with the Black-Scholes price immediately after the event day, the Black-Scholes price become slightly larger than the market price (see Table 6.3 where the mean percentage of the price difference turns positive after the event day). This suggests that Black-Scholes pricing model might no longer be an accurate approximation of the covered warrants values. In other words, the model inadequately captures major relevant factors that should be considered when pricing the warrant. Following Klein (1996), the model can be adjusted by adding in the default risk of the issuer in order to get the fair value of a covered warrant. We would expect to see Klein's Vulnerable warrant prices to be lower than the Black-Scholes prices. Chen (2003)'s comparison of Klein's model with Black-Scholes model for Taiwan covered warrants revealed little difference in price suggesting that the credit risk is very small. However, his analysis did not cover a major period of financial turmoil.

For further analysis, we continue using the same data set of the 103 UK Vulnerable call covered warrant prices presented at the beginning of the empirical results section. The results under three bankruptcy costs (0%, 0.5%, and 1% of firm/bank value) are only slightly difference. This suggests that they are not so sensitive to different bankruptcy costs. Therefore, we present here only the results under the case of 1% bankruptcy cost as shown in Table6.4 (The daily price differences between Vulnerable Warrant Price for the case α = 1%, Black-Scholes Price and Market Value of 103 call covered warrants).[74]

Table 6.4 shows that the average daily price of each Vulnerable warrant is generally lower than Black-Scholes warrant price during the event period of financial distress. The maximum average difference between the Vulnerable warrant and Black-Scholes warrant prices is a negative 1.12% on day -3 and the minimum average difference between these two prices is a negative 0.63% on day 7. Therefore, there are price differences between the Vulnerable warrant and the Black-Scholes warrant during the period of financial distress.

Furthermore, the relationship between Black-Scholes price and market price provided in Table 6.4 is similar to the results for the 154 call covered warrants which have already been discussed in the previous part of this study's empirical results.[75] Table 6.4 also compares Vulnerable warrant prices and market prices during the period of financial distress. Since the Vulnerable warrant prices are only slightly lower than the Black-Scholes prices, the results of comparison both of them with the market prices are pretty much similar. The average daily price of all of the Vulnerable warrants values are generally much lower than their market prices before the event of financial distress which suggests that UK covered warrants may possibly be overvalued. The largest and smallest average difference between the two prices during that period are 38.97% on day -3 and 18.06% on day -2 respectively. After the event, both market prices and Vulnerable prices of covered warrants decline but the market prices decrease at a faster rate due to an increase in the credit risk as a consequence of the financial distress. The differences between the two prices are smaller in comparison to the case of the differences between Black-Scholes prices and market prices, therefore, Vulnerable model seems to provide a slight better valuation of covered warrants than the Black-Schloes model.

The comparison of Vulnerable Warrant Price, Black-Scholes Price and Market Value for the 103 call covered warrants is provided in Table 6.5. The average of Vulnerable warrant prices, under all three cases of α = 0%, 0.5%, and 1%, fall during a short period

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[74] The daily price differences between Vulnerable Warrant Price for the case α = 0%/ α = 0.5%, Black-Scholes Price and Market Value of 103 call covered warrants are shown in Appendix 6.2/6.3.

[75] These are discussion of Table 6.3, Figure 6.3, and Figure 6.4.

around 6 days before the event day. The information of losses from the subprime crisis and trading problems indicate that default risk has increased and that the market becomes aware of this and reacts over a short period of time. However, there is a slight effect from the increase in default risk on the prices of UK covered warrants. Furthermore, both the average market price of warrant and the average Black-Scholes price of warrant show similar decreasing trend over a short period leading to the event day.

Figure 6.5 shows consistent results with the expected relationship under the consideration of credit risk factor among the three prices (the Vulnerable warrant price, the Black-Scholes warrant price, and the market warrant price) which are the Vulnerable price should be the smallest following by Black-Scholes price and then the actual market price should present the highest value among all.

Table 6.4: Price Difference between Vulnerable Warrant Price (for the case α = 1%), Black-Scholes Price and Market Value of 103 call covered warrants

	Vulnerable Warrant Price and Black-Scholes Price[a]				Vulnerable Warrant Price and Market Value[b]				Black-Scholes Price and Market Value[c]			
Day	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD
-15	-0.0004	-0.0296	-0.0064	0.0046	1.5043	-0.8643	-0.2334	0.3623	1.5227	-0.8623	-0.2292	0.3638
-14	-0.0005	-0.0328	-0.0074	0.0052	1.3911	-0.8838	-0.2736	0.3694	1.4111	-0.8819	-0.2690	0.3712
-13	-0.0006	-0.0319	-0.0074	0.0052	1.6117	-0.8905	-0.2474	0.4040	1.6346	-0.8885	-0.2426	0.4063
-12	-0.0005	-0.0323	-0.0074	0.0052	1.4381	-0.9180	-0.2513	0.3878	1.4596	-0.9163	-0.2466	0.3900
-11	-0.0006	-0.0329	-0.0081	0.0060	1.6170	-0.9434	-0.2694	0.4038	1.6421	-0.9417	-0.2646	0.4059
-10	-0.0006	-0.0364	-0.0079	0.0057	1.6770	-0.9448	-0.2423	0.4262	1.7033	-0.9434	-0.2372	0.4288
-9	-0.0006	-0.0378	-0.0081	0.0058	1.7965	-0.9505	-0.2506	0.4404	1.8227	-0.9492	-0.2455	0.4431
-8	-0.0005	-0.0398	-0.0079	0.0058	2.1717	-0.9401	-0.2343	0.4568	2.1988	-0.9387	-0.2292	0.4597
-7	-0.0006	-0.0482	-0.0090	0.0067	2.4337	-0.9788	-0.2651	0.4751	2.4651	-0.9777	-0.2597	0.4780
-6	-0.0007	-0.0432	-0.0090	0.0063	2.1258	-0.9723	-0.2559	0.4731	2.1541	-0.9711	-0.2504	0.4759
-5	-0.0009	-0.0407	-0.0088	0.0061	2.4836	-0.9627	-0.2134	0.5039	2.5150	-0.9611	-0.2075	0.5071
-4	-0.0007	-0.0407	-0.0090	0.0063	2.7292	-0.9641	-0.2265	0.5176	2.7665	-0.9626	-0.2208	0.5207
-3	-0.0010	-0.0525	-0.0112	0.0078	1.5528	-0.9935	-0.3897	0.4582	1.5825	-0.9931	-0.3847	0.4605
-2	-0.0009	-0.0359	-0.0088	0.0058	2.6240	-0.9522	-0.1806	0.6134	2.6570	-0.9505	-0.1745	0.6182
-1	-0.0010	-0.0298	-0.0088	0.0057	2.9502	-0.8926	-0.1915	0.5860	2.9819	-0.8893	-0.1856	0.5899
0	-0.0008	-0.0261	-0.0071	0.0045	4.5361	-0.8341	0.0056	0.8133	4.5732	-0.8315	0.0120	0.8191
1	-0.0007	-0.0263	-0.0067	0.0043	6.3747	-0.8389	0.1320	1.0389	6.4220	-0.8365	0.1390	1.0463
2	-0.0007	-0.0286	-0.0070	0.0044	5.7393	-0.8581	0.1032	0.9371	5.7865	-0.8558	0.1103	0.9439
3	-0.0007	-0.0273	-0.0066	0.0044	5.0237	-0.8127	0.1058	0.9384	5.0645	-0.8099	0.1126	0.9455
4	-0.0006	-0.0284	-0.0068	0.0044	4.6241	-0.8371	0.0753	0.8569	4.6650	-0.8323	0.0821	0.8634
5	-0.0005	-0.0290	-0.0067	0.0044	4.5394	-0.8558	0.0801	0.8355	4.5815	-0.8515	0.0869	0.8419
6	-0.0003	-0.0278	-0.0064	0.0043	5.1561	-0.8088	0.0929	0.8530	5.2050	-0.8033	0.0997	0.8599
7	-0.0003	-0.0261	-0.0063	0.0042	4.4288	-0.7722	0.0656	0.8372	4.4704	-0.7683	0.0721	0.8440
8	-0.0003	-0.0287	-0.0074	0.0047	3.1598	-0.8503	-0.0193	0.6582	3.2001	-0.8469	-0.0124	0.6638
9	-0.0004	-0.0295	-0.0071	0.0045	3.3189	-0.8794	0.0402	0.7438	3.3605	-0.8757	0.0472	0.7498
10	-0.0004	-0.0333	-0.0081	0.0055	4.0187	-0.9355	0.0032	0.7959	4.0716	-0.9341	0.0105	0.8025
11	-0.0004	-0.0323	-0.0077	0.0051	4.1120	-0.9251	0.0489	0.8225	4.1667	-0.9226	0.0564	0.8294
12	-0.0004	-0.0363	-0.0082	0.0055	4.4642	-0.9638	0.0066	0.8082	4.5292	-0.9624	0.0142	0.8157
13	-0.0003	-0.0306	-0.0073	0.0049	3.5350	-0.9045	0.0276	0.7080	3.5819	-0.9015	0.0347	0.7138
14	-0.0003	-0.0272	-0.0073	0.0047	3.1715	-0.8539	0.0423	0.7294	3.2145	-0.8498	0.0495	0.7357
15	-0.0003	-0.0287	-0.0076	0.0050	3.2104	-0.8807	-0.0075	0.7036	3.2591	-0.8772	-0.0004	0.7103

Notes: The sample period extends form April 2007 until December 2008.
α = Bankruptcy costs (both direct and indirect costs)
[a] The price difference between Vulnerable warrant price and Black-Scholes price is calculated as: (Vulnerable warrant price - Black-Scholes price)/Black-Scholes price.
[b] The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value.
[c] The price difference between Black-Scholes price and market value is calculated as: (Black-Scholes price - market value)/market value.

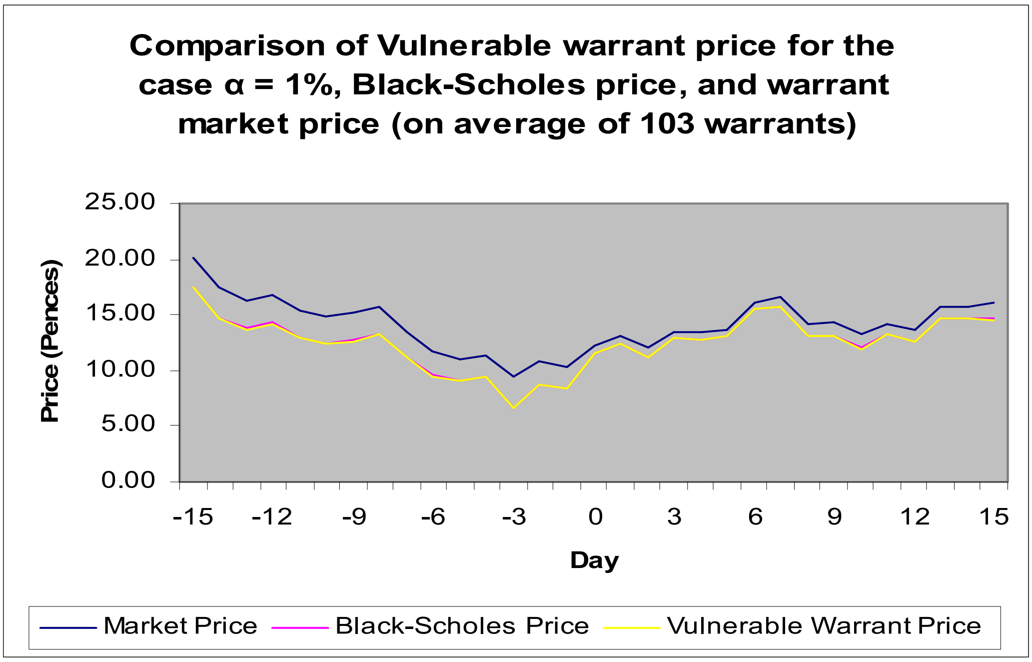
Table 6.5: Comparison of Vulnerable Warrant Price, Black-Scholes Price and Market Value (on average for the case of 103 call covered warrants)

Day	Average Vulnerable Warrants Prices (pences)			Average Black-Scholes Prices (pences)	Average Market Prices (pences)
	$\alpha = 0\%$	$\alpha = 0.5\%$	$\alpha = 1\%$		
-15	17.45	17.43	17.40	17.45	20.17
-14	14.77	14.75	14.73	14.77	17.51
-13	13.74	13.71	13.69	13.74	16.27
-12	14.25	14.23	14.21	14.25	16.78
-11	12.89	12.87	12.85	12.89	15.36
-10	12.44	12.42	12.40	12.44	14.86
-9	12.68	12.66	12.64	12.68	15.15
-8	13.32	13.30	13.28	13.32	15.71
-7	11.14	11.12	11.10	11.14	13.51
-6	9.55	9.53	9.51	9.55	11.75
-5	9.12	9.10	9.08	9.12	11.02
-4	9.41	9.39	9.37	9.41	11.29
-3	6.65	6.64	6.63	6.65	9.52
-2	8.72	8.70	8.69	8.72	10.76
-1	8.38	8.36	8.35	8.38	10.30
0	11.51	11.49	11.47	11.51	12.25
1	12.39	12.37	12.35	12.39	13.14
2	11.24	11.22	11.20	11.24	12.12
3	12.98	12.96	12.94	12.98	13.54
4	12.75	12.73	12.71	12.75	13.47
5	13.12	13.10	13.08	13.12	13.62
6	15.57	15.55	15.53	15.57	16.13
7	15.81	15.79	15.77	15.81	16.66
8	13.13	13.11	13.09	13.13	14.24
9	13.14	13.12	13.10	13.14	14.38
10	11.99	11.97	11.96	11.99	13.30
11	13.33	13.31	13.29	13.33	14.16
12	12.58	12.56	12.55	12.58	13.71
13	14.76	14.74	14.72	14.76	15.75
14	14.66	14.64	14.62	14.66	15.72
15	14.63	14.61	14.59	14.63	16.03

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Figure 6.5: Price difference between Vulnerable warrant price for the case α = 1%, Black-Scholes Price and Market Value (on average for the case of 103 call covered warrants)[76]



Notes: The sample period extends form April 2007 until December 2008.
α = Bankruptcy costs (both direct and indirect costs)

According to the previous discussed results, there is a slight difference in the price of UK covered warrants if we compare the Vulnerable model with Black-Scholes model. The small difference in price suggests that the credit risk is small or some error in estimated parameters of the model. Thus, this study examines the problem by taking an additional different perspective. It takes an event where credit risk is known to have changed. It then asks whether there is an observed change in price of the warrant before versus after the event, significant changes are evidenced in market prices as follows.

In order to analyse the effect of the financial distress on the prices of covered warrants, the market prices are examined using an event study methodology via the market model. By taken into account the beta of the covered warrant, the abnormal returns and the

[76] The similar results can be seen under Appendix 6.4 and 6.5 for the case that Vulnerable warrant prices are calculate based on α = 0% and α = 0.5% respectively.

cumulative abnormal returns are calculated and presented in Table 6.6.[77] The calculations are based on 154 call covered warrants. Day 0 represent the event day (financial distress) where the default risks were largely indicated due to the subprime crisis and the SG fraudulent trader. It can be seen that there are generally negative returns around the event period. Significant negative abnormal returns are reported from day -1 to day 6. Moreover, a negative 9.01% abnormal return is presented at 1% significance level on the event day shows a decrease in price of the covered warrants as a consequence from the financial distress. However, the effect is only temporary existed around the event day and does not go beyond a week after the event. Figure 6.6 plots the graph of the cumulative abnormal returns of the market prices during the period of the financial distress. Even if there might be various other explanations, the financial distress from the crisis as well as the issuer's credit risk is the most possible reason to explain the decreasing trend around the event period of the study. Moreover, this credit risk explanation is consistent with the earlier finding of the section 6.6.2 that after the period of the financial distress the market price falls towards the Black-Scholes price which means the warrants became less overvalued, suggesting that the credit risk factor becomes important factor in deriving a fair value of the warrant. Therefore, the results of significant negative abnormal returns as well as cumulative abnormal returns of the covered warrant market prices around the event period could possibly be suggested as a consequence of the default risks involved with the covered warrants traded in the UK market.

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[77] To estimate the beta for a covered warrant for the period from t=-16 to t=-75 (60 days preceding the event window) via regression analysis use:

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2} = \frac{\sum_{t=-16}^{-75}\left[\left(R_{it}-\overline{R}_{it}\right)\left(R_{mt}-\overline{R}_{mt}\right)\right]}{\sum_{t=-16}^{-75}\left(R_{mt}-\overline{R}_{mt}\right)^2}$$

where R_{it} measures the rate of return of the covered warrant i in period t, R_{mt} measures the rate of return of the market portfolio in period t, σ_{im} is the covariance between the rates of return of the covered warrant and the market portfolio, and σ_m^2 is the variance of the rate of return of the market portfolio. The market portfolio is represented by FTSE100 in this study.

Table 6.6: Abnormal returns (AR) and Cumulative abnormal returns (CAR) of market prices around the financial distress event for 154 call covered warrants via the market model

Day	Market Model			
	AR	T-test(AR)	CAR	T-test(CAR)
-15	-0.0213	-1.6354	-0.0213	-1.6354
-14	-0.0247	-1.5337	-0.0459	-1.1474
-13	-0.0283	-1.5837	-0.0742	-1.5605
-12	-0.0102	-1.128	-0.0844	-1.422
-11	-0.0301	-1.6173	-0.1145	-1.5207
-10	-0.0057	-0.7092	-0.1202	-1.5991
-9	0.0115	1.055	-0.1087	-1.4388
-8	0.0166	1.0336	-0.0921	-1.2352
-7	-0.0115	-1.1174	-0.1035	-1.5585
-6	-0.0124	-1.1846	-0.116	-1.9591*
-5	0.0116	1.3058	-0.1044	-1.5696
-4	-0.0104	-1.0996	-0.1147	-1.5107
-3	0.0128	0.6331	-0.102	-1.8261*
-2	0.0267	1.4268	-0.0753	-1.3783
-1	-0.0895	-4.3053***	-0.1648	-2.7940***
0	-0.0901	-5.3286***	-0.2549	-4.7437***
1	-0.0622	-4.4349***	-0.3171	-5.2158***
2	-0.0233	-2.5969***	-0.3403	-4.8684***
3	-0.0185	-2.4104**	-0.3588	-3.6069***
4	-0.0154	-1.8156*	-0.3742	-2.3585**
5	-0.0128	-1.7788*	-0.3869	-4.8130***
6	-0.0258	-2.0549**	-0.4127	-2.4133**
7	0.0218	1.4552	-0.3909	-1.3105
8	-0.0274	-1.5889	-0.4183	-1.089
9	0.015	1.522	-0.4033	-1.3268
10	-0.0175	-1.2495	-0.4208	-1.5386
11	-0.0182	-1.3799	-0.439	-1.3982
12	-0.0124	-1.353	-0.4514	-1.3503
13	0.0171	1.557	-0.4342	-1.3857
14	0.0158	1.6043	-0.4185	-1.421
15	-0.0124	-1.215	-0.4309	-1.5485

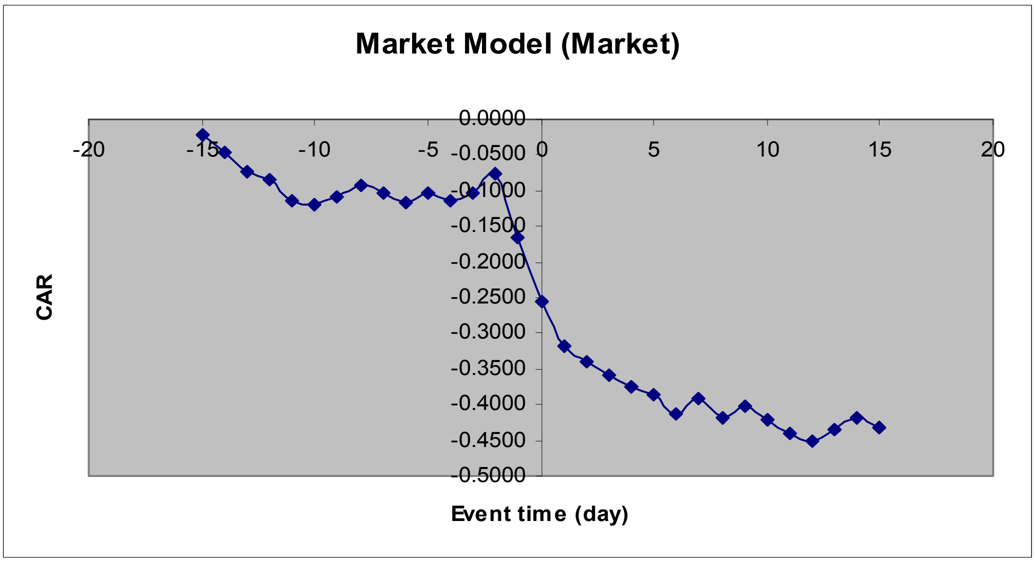
Notes: The sample period extends form January 2007 until December 2008.

Abnormal return (under the market-adjusted model) calculation is $AR_{it} = R_{it} - \hat{R}_{it}$

where $\hat{R}_{it} = \alpha_i + \beta_i R_{mt}$

***significant at 1% **significant at 5% *significant at 10%

Figure 6.6: Cumulative abnormal returns (CAR) of market price around the financial distress event for 154 call covered warrants via the market model



Note: The sample period extends form January 2007 until December 2008.

6.7 Conclusions and discussion

Chapter 6 presents an empirical analysis of the UK call covered warrant pricing. Most of the previous studies emphasize on option pricing. There are hardly any empirical work on covered warrant pricing and none within the UK market so far. I apply Klein's (1996) Vulnerable option model to study the UK covered warrant prices. After taken the credit risk of the warrant issuer into consideration for the pricing model, the Vulnerable warrant value is generally lower than both the Black-Scholes price and warrant market price during the warrant's lifetime. This may suggest the overvalued of warrant prices in the UK. Moreover, there are only small differences in Vulnerable warrants value among three cases of bankruptcy costs (0%, 0.5% and 1%) which proved the robustness of the results. In other words, the use of different bankruptcy costs does not very much alter the results of the study. The moneyness of warrants is the next focus of this study. We show that mean difference between the Vulnerable warrant price and market price is larger when warrant is in-the-money rather than out-of-the-money and far from maturity rather than nearer to maturity. This is because investor faces higher rate of default under in-the-money case in comparison to out-of-the-money case. There are evidences that the Vulnerable warrant prices are normally associate with a high fluctuation until they reach the zero value at maturity.

Furthermore, an event study has been employed to analyze effect of warrant prices around a period of financial distress. The warrants are shown to be overpriced during the financial distress under the assumption that the issuer's credit risk should be considered to achieve fair value of the warrant pricing. These overpricing warrant results are consistent with Chen (2003) and Horst & Veld (2008) who find call warrants are overvalued in Taiwan and Dutch markets respectively. There seem to be a small difference between Vulnerable warrant and Black-Scholes prices which might be because of a small effect from the issuer's credit risk or some error in parameters' estimation for the Vulnerable model. However, the Vulnerable warrant price is reasonably lower than the market price. There is also an indication that the market becomes aware of the credit risk on a short-term basis. By taken into account the beta of the covered warrant, the report on significant negative abnormal returns surrounding and after the event day of financial distress for the covered warrant market prices provide some support of credit risk upon covered warrants traded in the UK market.

In order to make an analysis of the covered warrants market in the UK becomes more complete, this Chapter 6 is an additional on the valuation study of the UK covered warrants to an interesting finding of the effects on price, volume and volatility of the underlying securities which were introduced in the previous Chapter 4 and Chapter 5.

Chapter 7 : Conclusion

Covered warrant trading is now well established in the European markets and it has retained its popularity over time and has recently been introduced to the UK market (in 2002). Its popularity has elevated since introduction and become a typical discussion issue in the financial markets among practitioners and regulators. The interaction between covered warrants and their underlying securities is one of the main concerns. Moreover, there has not yet been any clear or generally accepted pricing model introduced specifically for this financial instrument, but rather the fundamental options pricing Black-Scholes (1973) model has been adapted for current usage. The reason behind this adaptation is large similarities in characteristics between options and covered warrants, though it may be argued that various differences do exist. The empirical studies investigating the impacts of covered warrants trading on the underlying market have also been very limited, while the academic community has focused its research more on examining the effects of straight options trading. Therefore, there is still lively debate among all parties involved over the economic impact of covered warrants.

This thesis attempts to bridge this gap by providing valuable empirical evidence of the impacts of UK covered warrants trading which have been introduced and expired during the period July 2004 – December 2006. This covers both call and put covered warrants. Furthermore, the study is divided into an examination of the announcement, listing, and expiration of the warrants. The impacts of the warrants underlying securities are categorized into price, volume and volatility effects. In addition, this thesis also attempts to redress another concern, namely, the issue of the most appropriate covered warrants pricing model. The empirical work is based on the recently traded UK covered warrants which have been introduced and expired over the period April 2007 to December 2008. Hence, this thesis provides answers to the hypotheses raised throughout chapters 4, 5 and 6 as outlined in the summary in this chapter.

7.1 Comparison of main findings

7.1.1 Price and Volume effects

In my investigation of the underlying price and volume effects from covered warrants trading, three general models as benchmark calculations of normal returns (Market model, Market-adjusted model, and mean-adjusted return model) are employed under the event study methodology. The findings suggest that both call and put covered warrants trading had a detrimental effect on the underlying stocks prices upon their introductions in the UK market. This is possibly due to the following reasons: the relaxation of short-sell constraints, movement of trading from stocks to warrants because of lower transaction costs and higher leverage, and the sentiment held by some market participants that the introduction of covered warrants acts as a destabilizing factor for the underlying stocks. This is supported by Kabir (1999), whose study shows a decline in stock prices once options were introduced in the Netherlands. Aitken & Segara (2005) report similar outcomes on Australian derivatives warrants and suggest that warrant issuers have the ability to time their warrant issues when there is a high interest in the underlying securities and when they expect to see a decline in the underlying stock prices. Moreover, there is more reliable and clearer evidence of the impact of the announcement date in comparison to the listing date. According to Draper, Mak & Tang (2001), this is probably because the information has here been released to the market for the first time.

Further results on in-the-money call warrants expiration report a temporary decrease in the underlying stock price which indicates a fall in price a day before and on the delisting date, not persisting beyond the delisting date. A possible explanation is the early unwinding by the warrant holders and selling activities by other speculators as they expect stock prices to fall in the future, hoping to take this early advantage before the actual fall takes place. This outcome is consistent with Draper et al. (2001) and Chen & Wu (2001), who demonstrate a negative price effect before the derivative warrant expiration day and a positive effect after expiration, but is inconsistent with Klemkosky (1978) and Officer & Trennepohl (1981). The put warrants show a similar decreasing stock price effect. However, there is no impact observed in the case of out-of-the-money call warrants.

My study shows no impact on the underlying stocks trading volume from the introduction and expiration of both call and put covered warrants in the UK market. There is no relationship between abnormal return patterns and abnormal trading volumes. However, this lack of change in trading volume is consistent with other research such as those of Chamberlain, Cheung & Kwan (1993) and Draper et al. (2001).

7.1.2 Volatility effects

In investigating the impact of covered warrants trading on the stocks' volatility, I use both parametric and non-parametric tests to confirm the robustness of the results. Given the ongoing controversies over the inconclusive volatility impact, this study helps to move this discussion along by supporting the negative side-effect that shows an increase in volatility of the underlying stock market in the UK. The significant increase in volatility following the introduction (announcement and listing events) of both call and put covered warrants is clearly reported. The evidence here is in line with the idea that stock exchanges generally allow the issuance of derivatives mostly on stocks which they expect to show an increase in volatility (Mayhew & Mihov (2000)). There have been various claims made by both market observers and policy makers that most of the stable stocks turn out to be more volatile as a consequence of the increased speculation in the derivatives by informed traders (Ma & Roa (1988)). Moreover, there is a profit motive of warrants issuers relating to their ability to time when there would be a change in volatility of stock movement in order to secure high premiums (Aitken & Segara (2005)). However, counter empirical arguments exist that covered warrants introduction produces no impact on the underlying stock return variance. This is supported by Draper et al. (2001), who also report no significant impact on the underlying stock return volatility after Hong Kong covered warrant introduction. The early research in this area conducted mostly on options trading provides evidence of a decrease in volatility from the derivatives introductions.[78]

On the other hand, this thesis analyzes the delisting event and indicates a significant decrease in the volatility of the underlying stocks for both call and put covered warrants. This research also extends the call warrant delisting analysis into in-the-money and out-of-the-money cases. A significant decrease in stock variance after the delisting for the in-the-money call warrants is also found. Even though a no-significance result for out-of-the-money call warrants is presented, a decreasing trend in the underlying volatility after the delisting is still reported.

7.1.3 Covered warrants valuation

There are four issues which need to be understood as background to this part of the thesis: no guarantees are provided by the London Stock Exchange (LSE); no perfect hedging is made by warrants issuers due to market imperfections; the recent financial crisis stemmed from subprime defaults; and there was a recent case of trader fraud at Société Générale (SG). This thesis presents empirical evidence suggesting that the most appropriate way to price covered warrants is via Klein's (1996) Vulnerable valuation model.[79] The event study methodology based on the Market-adjusted model for normal returns calculation is also used in order to test whether we can observe a change in price of the warrants before and after the financial problem event where credit risk is known to have changed.

This thesis suggests that covered warrants have been overpriced in the UK due to the neglect of default risk; the evidence is provided inside the body of Chapter 6 in both percentage and money terms. These overpriced warrant outcomes are consistent with Chen (2003) and Horst & Veld (2008). The Vulnerable warrant price is lower than the Black-Scholes price and the market covered warrant price. The robustness of the results is tested across various bankruptcy costs employed in the Vulnerable pricing model. Because of the

[78] For detail discussion, please refer back to Chapter 5.
[79] Société Générale is the major issuer in the UK's covered warrants market

higher default risk faced by investors associated with larger exercise potential for in-the-money warrants, the Vulnerable warrant price under this in-the-money case is much less than the warrant market price, in contrast with the out-of-the-money case. Moreover, the possibility of some parameter estimation error of the Vulnerable warrant model may explain the small differences between Vulnerable warrant price and Black-Scholes warrant price. Furthermore, the significant negative abnormal returns of the covered warrant market prices, around and after the event day, suggest some supporting evidence of the default risk upon covered warrants trading within the UK. However, the effect can only be seen on a short-term basis.

7.2 Limitations

Besides the considerable time and effort in assembling a comprehensive dataset and in robust checks, there are several limitations in my data and my methodological issues associated with the study, which necessitate a careful interpretation of the empirical results.

In Chapter 4, I have to use the percentage change in daily trading volume of the underlying securities from the previous day trading volume of the underlying securities for the analysis instead of using the general relative volume which is the ratio of the number of securities traded over the number of securities outstanding. This is due to the infrequent (almost static) movement of the daily outstanding trading volume of securities and too large a difference between the number of securities traded and the number of securities outstanding which leads a very small value for the ratio.

The dataset employed throughout Chapter 4 and Chapter 5 for the analyses of put covered warrants are subject to the assumption that effects of put covered warrants on the underlying securities can be explained by the warrants which have both call and put features on the same underlying securities. The reason behind this is a lack of availability of securities with only put covered warrants, and without call warrants. Moreover, because of this small sample size, the separation between in-and-out-of-the-money put covered warrants is not possible.

In Chapter 6, the accuracy of the covered warrant price calculated by both the Black-Scholes model and Vulnerable Warrant model depends greatly upon a volatility factor. There are various ways to estimate the volatility of the underlying security; a historical volatility is used in this study. Even though this appeared to give reasonable outcomes, a change in volatility estimating method could lead to significantly different results.

7.3 Discussions and suggestions for further research

This thesis serves the purpose of narrowing the gap in empirical research on the impact of the covered warrants announcement/listing/expiration on the underlying market which has been very limited so far, largely due to the lack of readily available data of covered warrants and characteristics of the existing covered warrants. Employing some available data as well as a unique set of hand-collected data, supplemented by public and private data from the main covered warrants issuer and the Datastream database, I am able to provide much supporting evidence in relation to the UK market to augment the current debates and controversies based on other international markets trading warrants effects. Furthermore, quantitative evidence on the best approximate model for covered warrants price estimation is also sparse. I contribute to this research area by providing UK empirical evidence to suggest the default risk add-on factor in order to arrive at a more appropriate covered warrants pricing model. The finding of this thesis would therefore be very useful for both practitioners and regulators and may also provide some guidance for other countries that are interested in launching this new financial innovation of covered warrants into their existing stock exchanges.

The suggestions for future research concern four main analyses. Firstly, most empirical testing evidence can be extended by an expansion of the data set when it becomes available in the future. This aims to analyze the consistency of the results over time, especially when the market reaches the maturity stage. Comparisons between the initial markets and more mature markets may provide additional insights. Secondly, it would be useful to be able to detect the driving factors which lead to the continually increasing popularity of the exchange traded covered warrants. Thirdly, examinations of the effects of other new innovative warrants types on the spot markets, such as those covering the movements in a basket of equities or an index and those based on commodities, may give a broader perspective on the issues involved in pricing and hedging with warrants in general. The evidence generated from these wider studies could be compared with the results from this thesis, which focused purely on equities based warrants (covered warrants), and this may allow us to make wider generalisations as to the affects that such instruments have on the market for the underlying security. Fourthly, parameter estimation of the warrant pricing model may be improved. In particular, the volatility estimation of the underlying stock return, instead of using historic volatility employed in this study as an estimate of future volatility, could instead utilize implied volatility. Additionally, existing studies (for example Klein (1996)), typically make simplified assumptions in estimating correlations between the asset price of issuer and those of the stock underlying the warrant. Further research could examine the correlation structure more carefully. For example, where asset prices do not follow joint elliptic distributions, the concept of correlation may be meaningless (Eydeland & Wolyniec (2003)). Moreover, where stochastic volatility exists, correlations may be measured with error. Future research could therefore examine the extent to which such issues pose problems in incorporating credit risk into covered warrant pricing.

Appendices

Appendix 4.1: Abnormal returns around the listing event for *put event*

The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the listing event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0036	1.4775	0.0036	1.4775	0.0042	1.6435	0.0042	1.6435	0.0049	1.7024*	0.0049	1.7024*
-9	0.0023	1.5569	0.0059	2.1497**	0.0026	1.7375*	0.0067	2.3636**	0.0018	1.0744	0.0067	2.2395**
-8	0.0017	1.1963	0.0076	2.3220**	0.0022	1.5602	0.0090	2.6540***	0.0023	1.5304	0.0090	2.4751**
-7	-0.0016	-1.1832	0.0060	1.9863**	-0.0018	-1.2522	0.0072	2.3456**	-0.0038	-2.4012**	0.0052	1.5461
-6	-0.0041	-2.5969***	0.0019	0.5950	-0.0032	-1.9062*	0.0040	1.2079	-0.0026	-1.3069	0.0026	0.7342
-5	0.0006	0.2396	0.0025	0.6085	0.0009	0.3615	0.0049	1.1515	0.0006	0.2393	0.0033	0.7354
-4	-0.0026	-1.6463	-0.0001	-0.0307	-0.0022	-1.4310	0.0027	0.6297	-0.0021	-1.3290	0.0012	0.2451
-3	0.0012	0.7260	0.0011	0.2835	0.0020	1.1725	0.0047	1.1482	0.0027	1.5288	0.0039	0.9158
-2	0.0008	0.5168	0.0019	0.4651	0.0012	0.7497	0.0059	1.3750	0.0021	1.2854	0.006	1.3590
-1	0.0003	0.2094	0.0022	0.4999	0.0006	0.5022	0.0065	1.4389	0.0004	0.3259	0.0064	1.3835
0	0.0001	0.0382	0.0023	0.3803	0.0002	0.0585	0.0067	1.0817	-0.0010	-0.2703	0.0054	0.9175
1	0.0015	1.7735*	0.0039	0.6539	0.0027	2.9896***	0.0094	1.5540	0.0051	4.6665***	0.0105	1.8626*
2	0.0007	0.4637	0.0045	0.7083	0.0007	0.4839	0.0101	1.5550	-0.0014	-0.9093	0.0091	1.4951
3	-0.0030	-1.4455	0.0015	0.2181	-0.0027	-1.2366	0.0074	1.0335	-0.0027	-1.0624	0.0064	0.9179
4	-0.0010	-0.4859	0.0006	0.0801	-0.0003	-0.1723	0.0070	0.9743	-0.0004	-0.1680	0.0060	0.8810
5	-0.0012	-0.7607	-0.0007	-0.0918	-0.0008	-0.4955	0.0062	0.8428	-0.0023	-1.2459	0.0037	0.5345
6	-0.0044	-3.7189***	-0.0051	-0.7300	-0.0038	-3.1693***	0.0024	0.3364	-0.0022	-1.5723	0.0015	0.2233
7	-0.0036	-2.3291**	-0.0087	-1.1525	-0.0033	-2.0299**	-0.0008	-0.1093	-0.0025	-1.1142	-0.0010	-0.1362
8	-0.0018	-0.9727	-0.0104	-1.5197	-0.0024	-1.3127	-0.0032	-0.4636	-0.0059	-2.7892***	-0.0069	-0.9819
9	0.0023	1.4276	-0.0082	-1.2346	0.0023	1.3806	-0.0009	-0.1409	0.0001	0.0400	-0.0068	-1.0161
10	0.0002	0.1090	-0.0080	-1.2103	0.0019	1.0857	0.0009	0.1392	0.0069	3.7424***	0.0001	0.0166

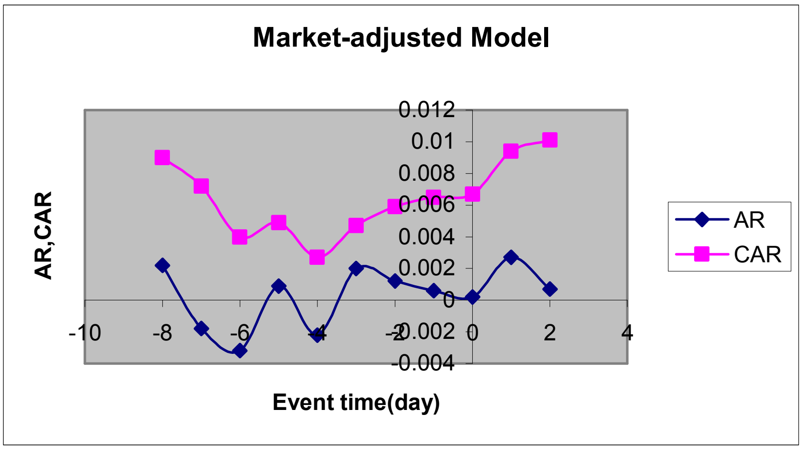
Notes: ***significant at 1% **significant at 5% *significant at 10%

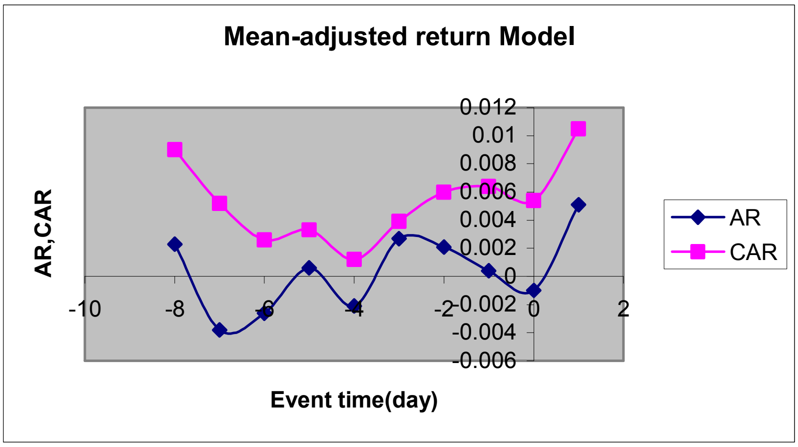
The sample period extends form July 2004 until December 2006.

The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.2: Abnormal returns around the listing event for *put event*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the listing event of the UK put covered warrants where market-adjusted model and mean-adjusted return model are used to generate normal return.

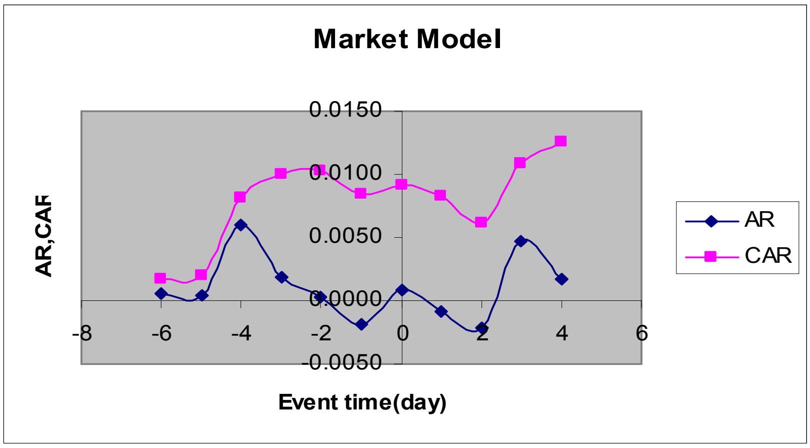


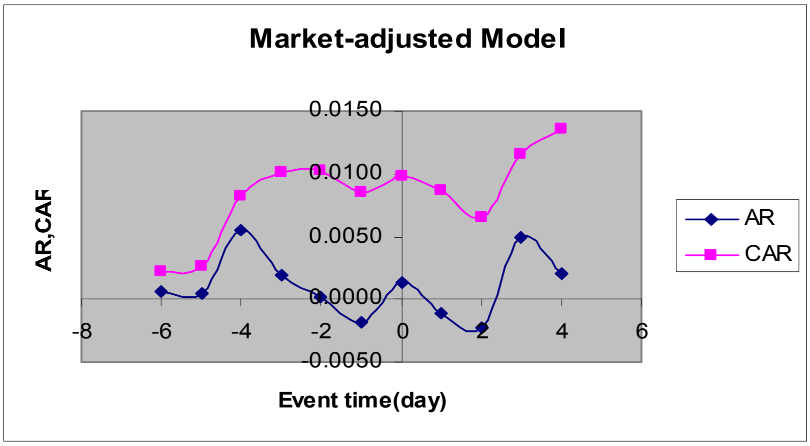


Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.3: Abnormal returns around the delisting event for 25 in-the-money *call warrants*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 25 UK in-the-money call covered warrants where market model and market-adjusted model are used to generate normal return.

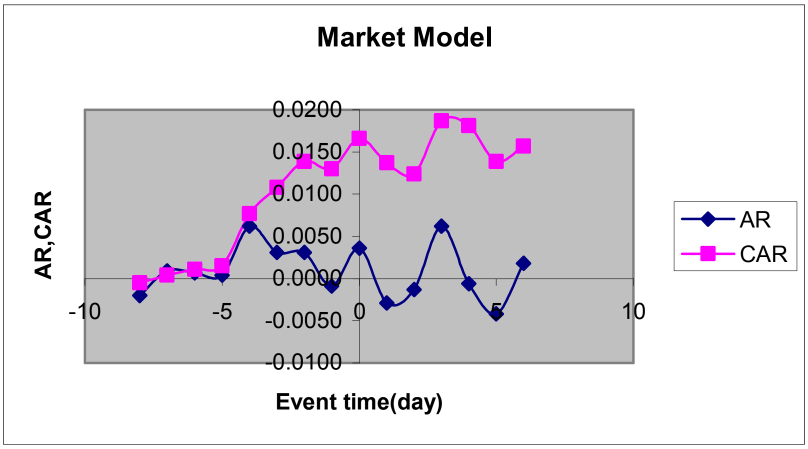


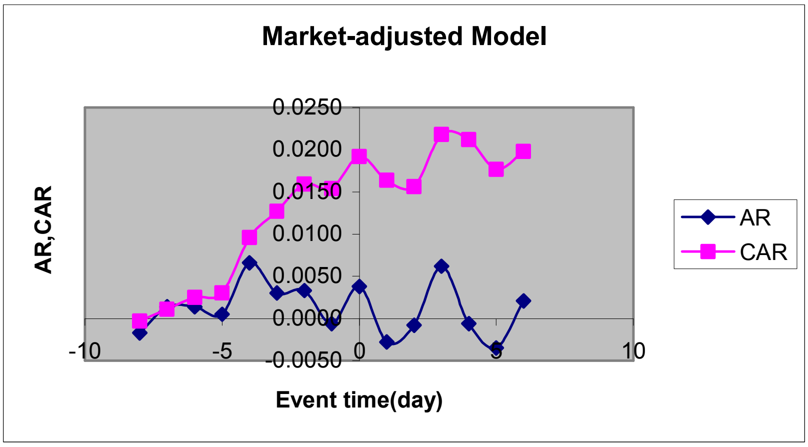


Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.3.1: Abnormal returns around the delisting event for 15 in-the-money *call warrants*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 15 UK in-the-money call covered warrants where market model and market-adjusted model are used to generate normal return.





Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.4: Abnormal returns around the delisting event for 11 out-of-the-money *call warrants*

The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 11 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

	Market Model				Market-adjusted Model				Mean-adjusted return Model			
Day	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0007	0.6562	0.0007	0.6562	0.0022	1.5437	0.0022	1.5437	0.0076	4.5011***	0.0076	4.5011***
-9	-0.0005	-0.2010	0.0002	0.0682	0.0007	0.2587	0.0029	0.7977	0.0060	2.1929**	0.0135	3.5837***
-8	0.0013	0.4770	0.0015	0.5674	0.0007	0.2667	0.0037	1.0689	0.0003	0.1056	0.0138	4.3219***
-7	0.0040	2.3204**	0.0055	2.1690**	0.0015	0.7875	0.0052	1.9411*	-0.0050	-2.3470**	0.0088	3.4530***
-6	-0.0098	-1.5306	-0.0043	-0.7784	-0.0135	-2.1385**	-0.0083	-1.4334	-0.0238	-3.6717***	-0.0149	-2.7081***
-5	0.0000	-0.0023	-0.0043	-0.6740	0.0006	0.2068	-0.0077	-1.1744	0.0039	1.3355	-0.0111	-1.6547*
-4	-0.0003	-0.0895	-0.0046	-0.7105	-0.0014	-0.3957	-0.0091	-1.3998	-0.0007	-0.1522	-0.0118	-1.3808
-3	0.0026	0.8471	-0.0020	-0.2294	0.0044	1.4888	-0.0048	-0.5780	0.0118	4.0060***	-0.0001	-0.0052
-2	0.0007	0.3527	-0.0013	-0.1360	0.0008	0.4114	-0.0039	-0.4517	0.0035	1.3853	0.0034	0.3141
-1	0.0002	0.0561	-0.0010	-0.1465	-0.0005	-0.1342	-0.0045	-0.7450	-0.0018	-0.4356	0.0016	0.1727
0	-0.0105	-1.4483	-0.0115	-0.9437	-0.0110	-1.5371	-0.0155	-1.3142	-0.0132	-1.9076*	-0.0116	-0.8305
1	0.0064	1.5046	-0.0051	-0.5451	0.0068	1.6319	-0.0087	-1.0404	0.0106	2.5019**	-0.0009	-0.0806
2	-0.0003	-0.1101	-0.0054	-0.5112	-0.0031	-1.0164	-0.0118	-1.1367	-0.0103	-2.9865***	-0.0112	-0.7903
3	-0.0040	-1.4500	-0.0094	-0.7990	-0.0029	-0.9904	-0.0147	-1.2892	0.0012	0.4185	-0.0100	-0.6919
4	0.0055	2.4748**	-0.0039	-0.3475	0.0061	2.3993**	-0.0085	-0.8077	0.0078	2.2242**	-0.0021	-0.1721
5	-0.0009	-0.6295	-0.0048	-0.4106	-0.0043	-2.7712***	-0.0128	-1.1149	-0.0128	-7.2057***	-0.0149	-1.0756
6	-0.0010	-0.2987	-0.0058	-0.4129	-0.0031	-0.9302	-0.0159	-1.1575	-0.0108	-3.1401***	-0.0257	-1.6109
7	0.0041	1.6483	-0.0017	-0.1137	0.0062	2.1515**	-0.0096	-0.6731	0.0119	2.9364***	-0.0138	-0.8891
8	0.0040	1.4484	0.0023	0.1597	0.0058	1.7164*	-0.0038	-0.2728	0.0115	3.1067***	-0.0023	-0.1561
9	0.0034	1.2117	0.0058	0.4417	0.0046	1.7102*	0.0007	0.0629	0.0082	2.5350**	0.0059	0.4585
10	0.0002	0.0512	0.0059	0.4801	0.0001	0.0362	0.0008	0.0799	0.0038	1.0859	0.0097	0.7915

Notes: ***significant at 1% **significant at 5% *significant at 10%

The sample period extends form July 2004 until December 2006.

The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.4.1: Abnormal returns around the delisting event for 5 out-of-the-money *call warrants*

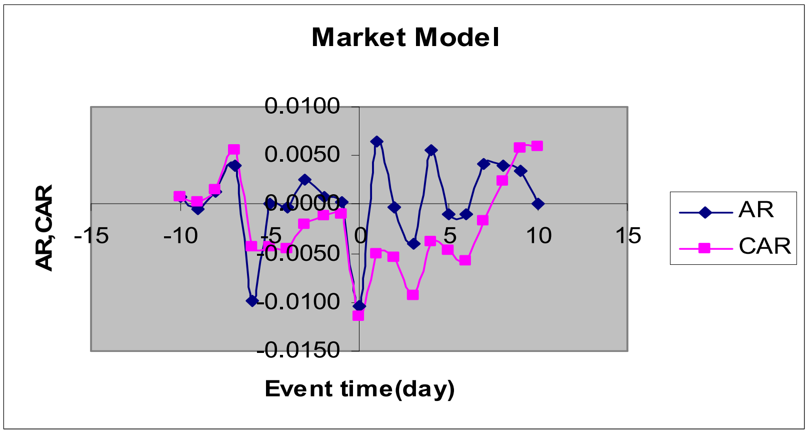
The table presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 5 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.

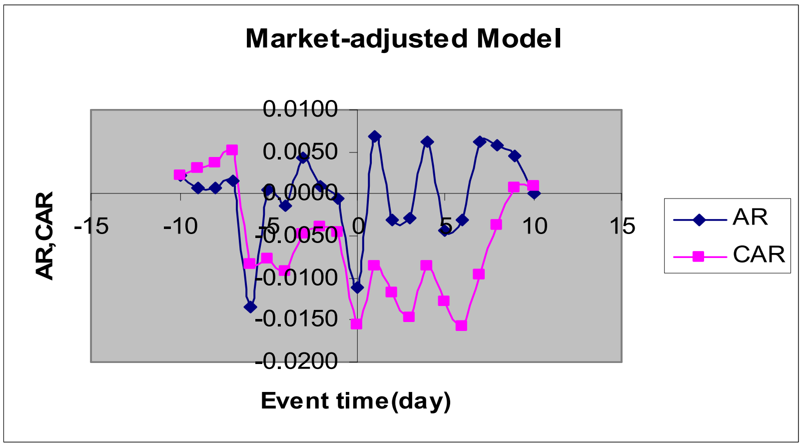
Day	Market Model				Market-adjusted Model				Mean-adjusted return Model			
	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)	AR	T-test(AR)	CAR	T-test(CAR)
-10	0.0019	0.4859	0.0019	0.4859	0.0022	0.5946	0.0022	0.5946	0.0082	2.6682***	0.0082	2.6682***
-9	0.0034	0.5877	0.0053	0.6831	0.0036	0.6232	0.0058	0.7679	0.0092	1.5508	0.0174	2.2580**
-8	-0.0011	-0.1828	0.0042	1.1698	-0.0017	-0.2738	0.0040	0.9649	-0.0021	-0.3373	0.0153	4.3566***
-7	0.0023	0.4045	0.0065	1.1045	0.0009	0.1606	0.0049	0.8791	-0.0058	-1.1940	0.0095	1.5757
-6	-0.0179	-0.9977	-0.0114	-0.8277	-0.0199	-1.0996	-0.0150	-1.0158	-0.0306	-1.6493	-0.0211	-1.4980
-5	0.0031	0.5464	-0.0082	-0.4932	0.0030	0.5237	-0.0119	-0.6736	0.0065	1.1493	-0.0146	-0.8787
-4	0.0008	0.1542	-0.0074	-0.6160	0.0000	0.0087	-0.0119	-0.9038	-0.0008	-0.0970	-0.0153	-1.1473
-3	0.0040	0.6828	-0.0034	-0.2051	0.0044	0.7199	-0.0075	-0.4166	0.0120	2.0027**	-0.0033	-0.1964
-2	-0.0022	-0.5137	-0.0056	-0.3224	-0.0025	-0.5738	-0.0100	-0.5263	-0.0002	-0.0440	-0.0035	-0.1906
-1	0.0031	0.2918	-0.0025	-0.3171	0.0024	0.2294	-0.0076	-0.8170	0.0013	0.1206	-0.0022	-0.2209
0	-0.0184	-0.9441	-0.0209	-0.7869	-0.0190	-0.9690	-0.0266	-0.9338	-0.0202	-1.0399	-0.0225	-0.8304
1	0.0110	0.9101	-0.0099	-0.6481	0.0108	0.9155	-0.0158	-0.9201	0.0142	1.1924	-0.0082	-0.5092
2	-0.0003	-0.0370	-0.0102	-0.4819	-0.0018	-0.2521	-0.0176	-0.7651	-0.0094	-1.3626	-0.0176	-0.8286
3	-0.0049	-0.9014	-0.0151	-0.5779	-0.0049	-0.8479	-0.0224	-0.7877	-0.0001	-0.0128	-0.0177	-0.6680
4	0.0004	0.0432	-0.0148	-0.5600	0.0002	0.0248	-0.0222	-0.7833	0.0030	0.2851	-0.0147	-0.5989
5	0.0029	0.9749	-0.0119	-0.4286	0.0011	0.3406	-0.0212	-0.7066	-0.0081	-1.6503*	-0.0228	-0.8724
6	-0.0029	-0.7614	-0.0148	-0.4944	-0.0043	-1.0665	-0.0255	-0.7905	-0.0108	-1.8864*	-0.0337	-1.1933
7	-0.0066	-2.3359**	-0.0214	-0.6840	-0.0061	-2.0548**	-0.0315	-0.9342	0.0014	0.2048	-0.0323	-1.0529
8	-0.0025	-0.3871	-0.0239	-0.8064	-0.0021	-0.3139	-0.0336	-1.0214	0.0047	0.6994	-0.0276	-0.9220
9	0.0080	1.0425	-0.0158	-0.6019	0.0081	1.0831	-0.0255	-0.8727	0.0127	1.4000	-0.0149	-0.5238
10	0.0021	0.3637	-0.0138	-0.5763	0.0017	0.3117	-0.0238	-0.9100	0.0043	0.5733	-0.0106	-0.4512

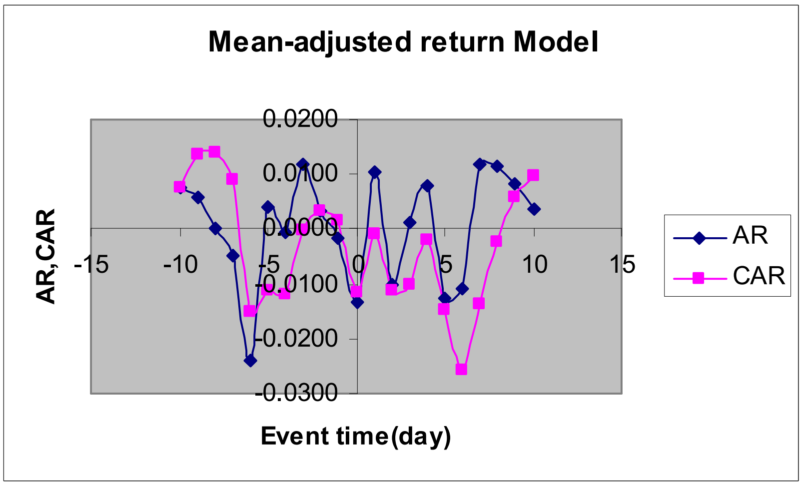
Notes: ***significant at 1% **significant at 5% *significant at 10%
The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.5: Abnormal returns around the delisting event for 11 out-of-the-money *call warrants*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 11 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.



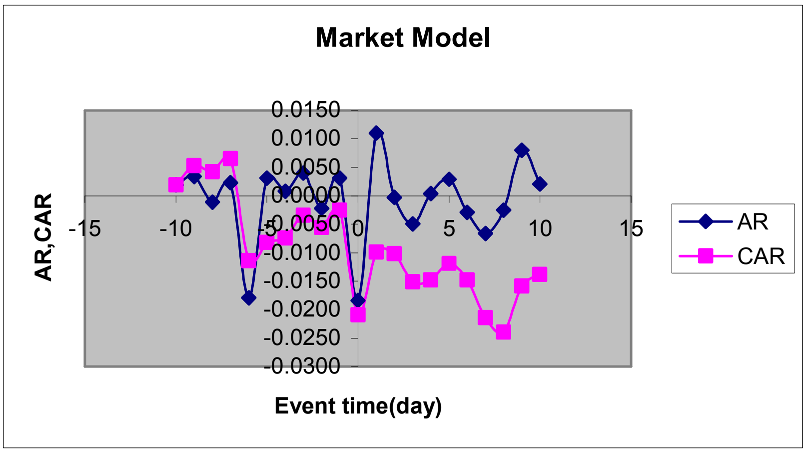


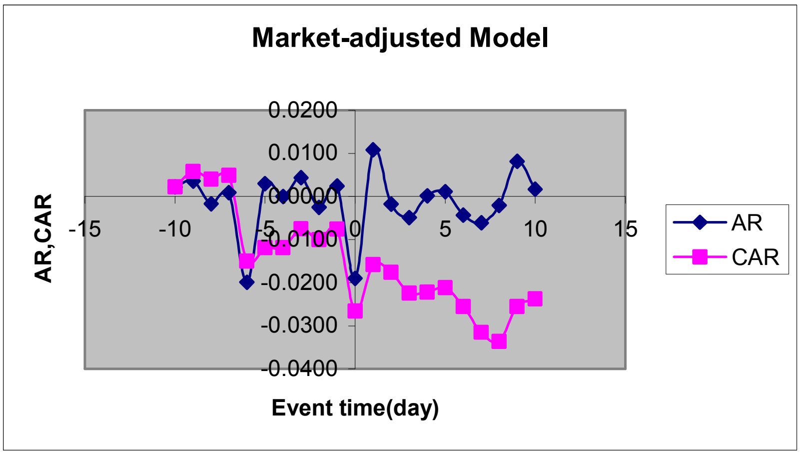


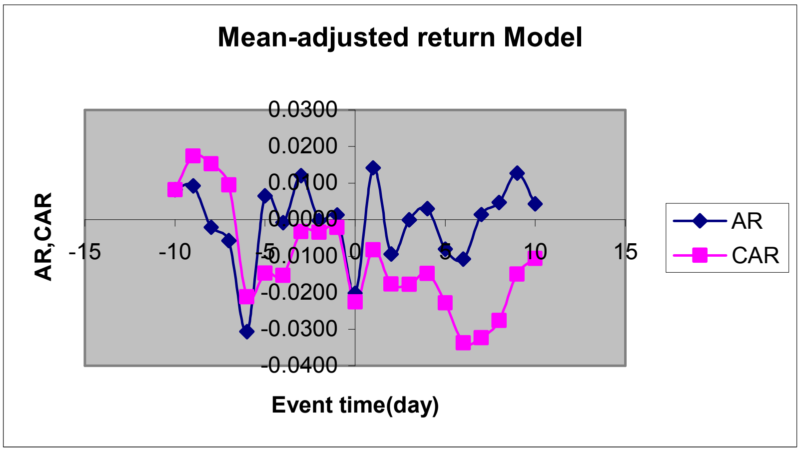
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.5.1: Abnormal returns around the delisting event for out-of-the-money 5 *call warrants*

The figure presents abnormal return (AR) and cumulative abnormal return (CAR) of the underlying securities around the delisting event of the 5 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal return.



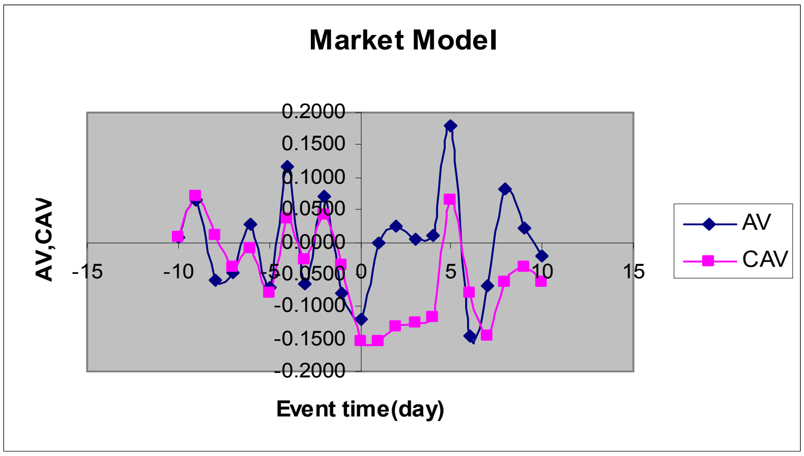


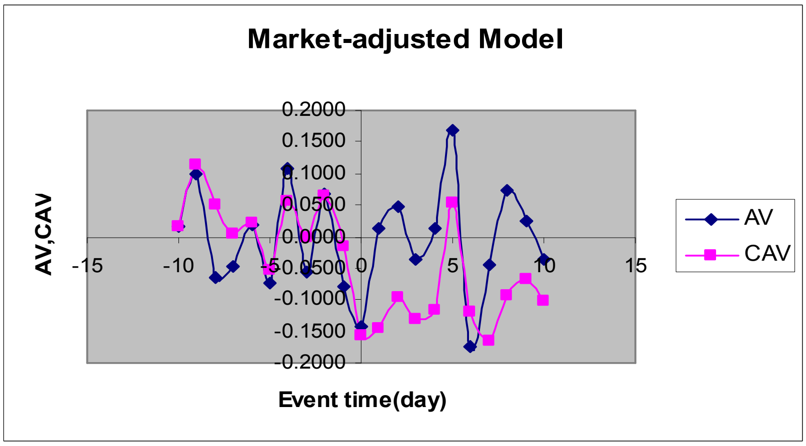


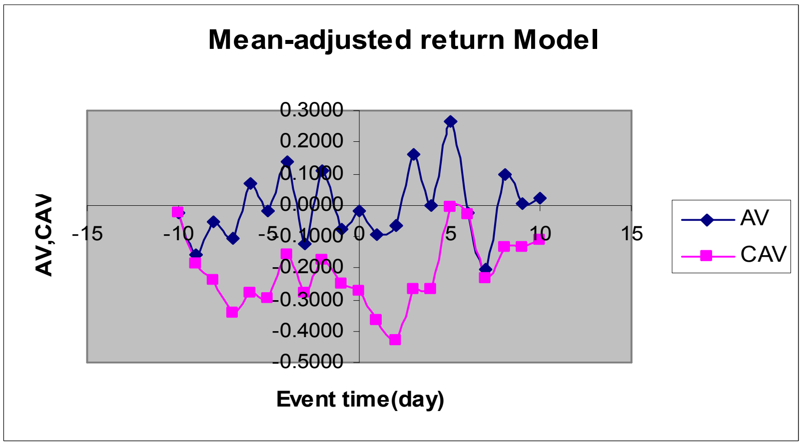
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.6: Abnormal trading volumes around the announcement event for *call event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



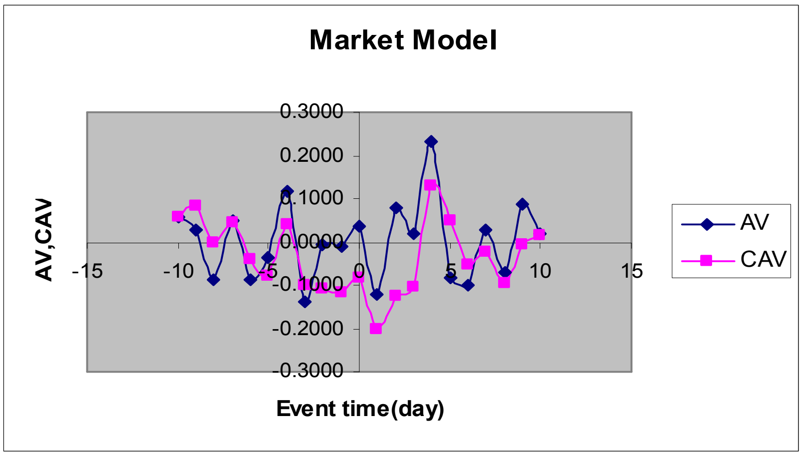


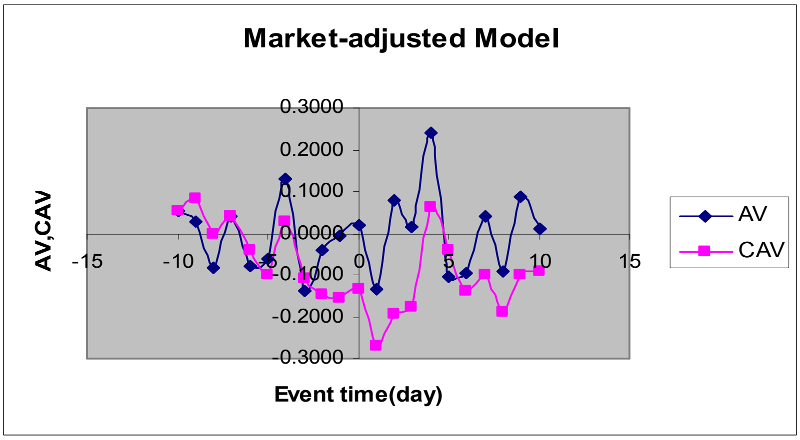


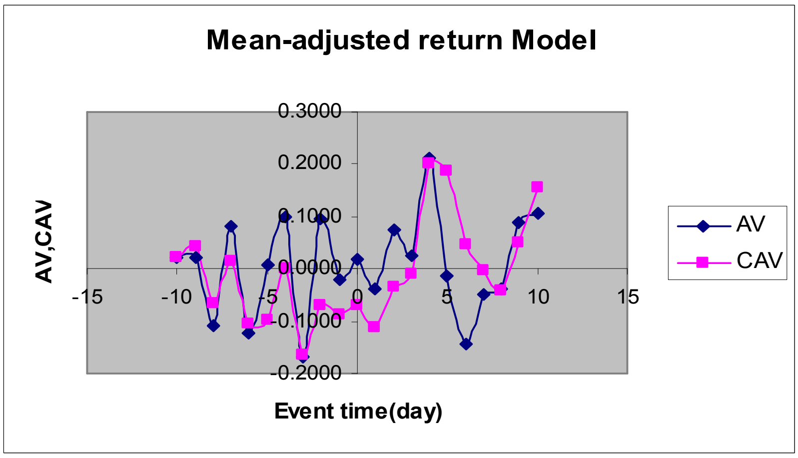
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.7: Abnormal trading volumes around the listing event for *call event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the listing event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



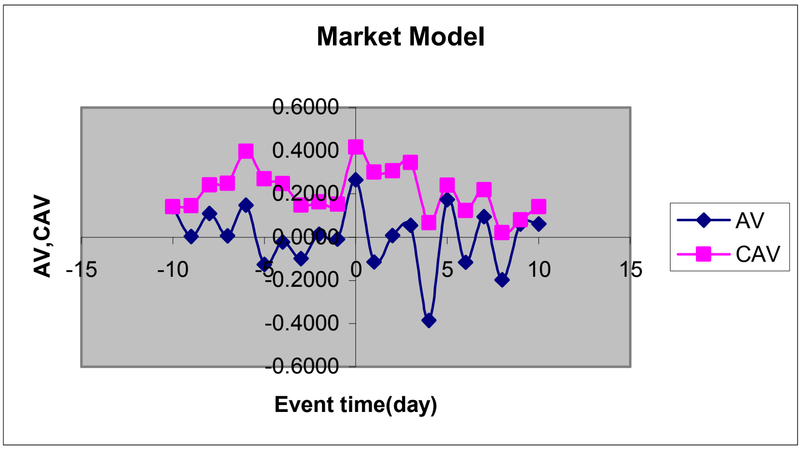


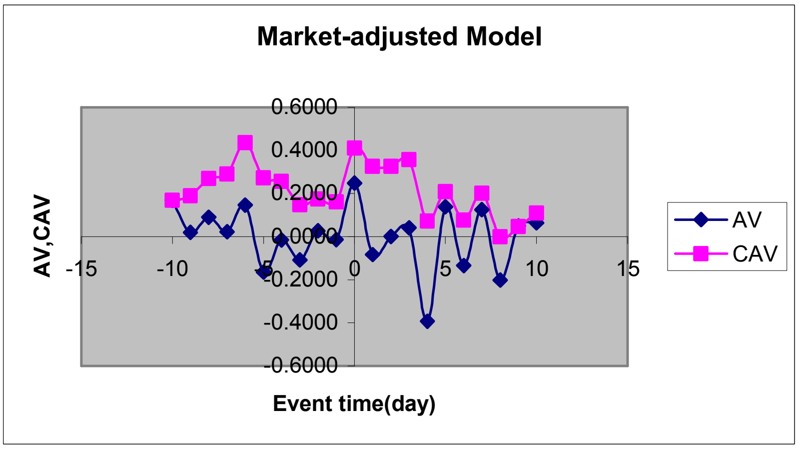


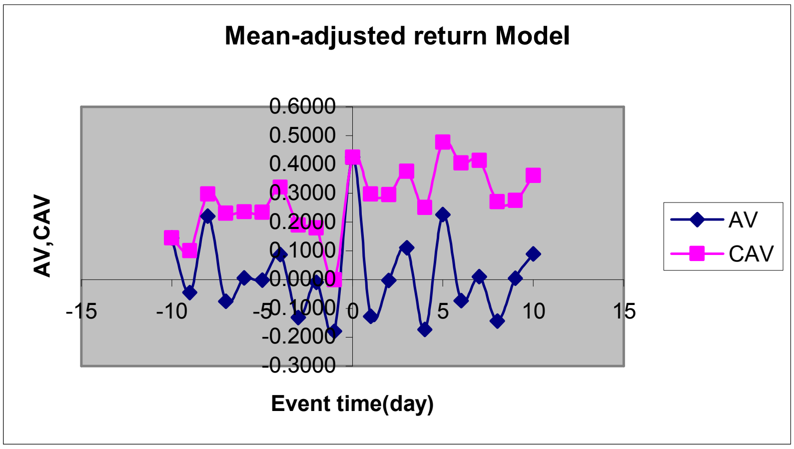
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.8: Abnormal trading volumes around the announcement event for *put event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



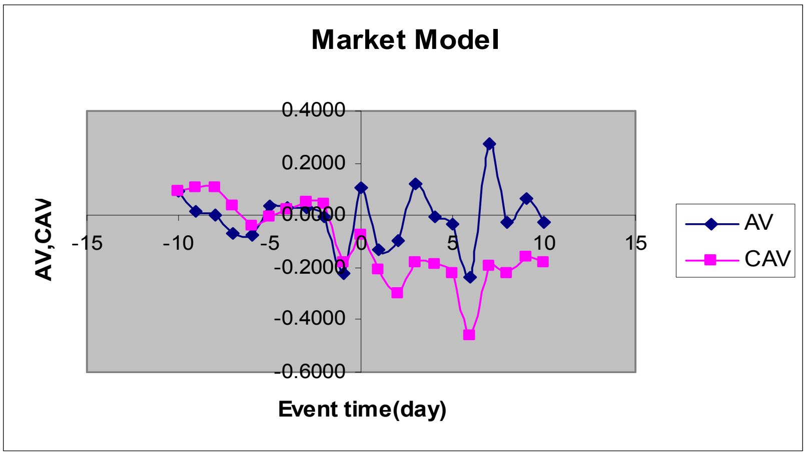


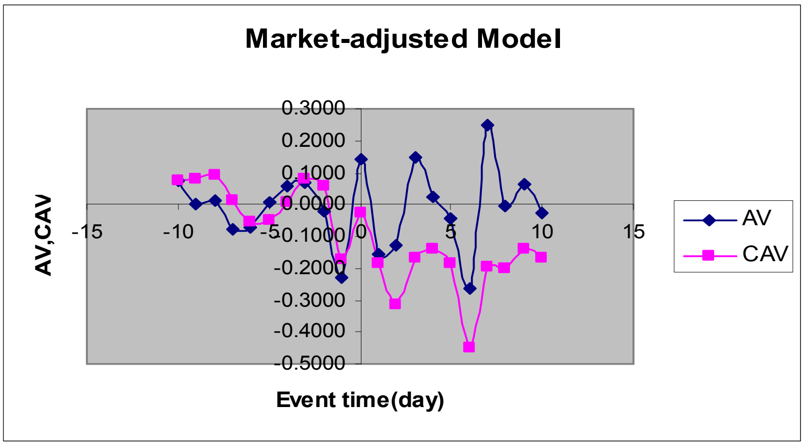


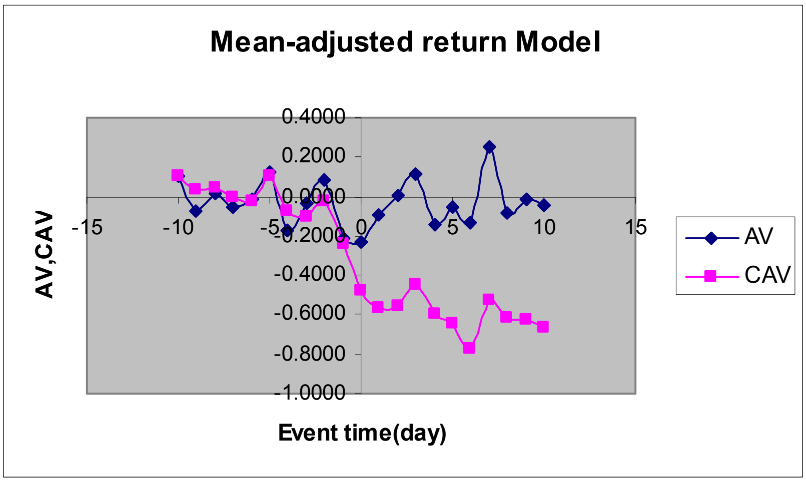
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.9: Abnormal trading volumes around the listing event for *put event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the listing event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



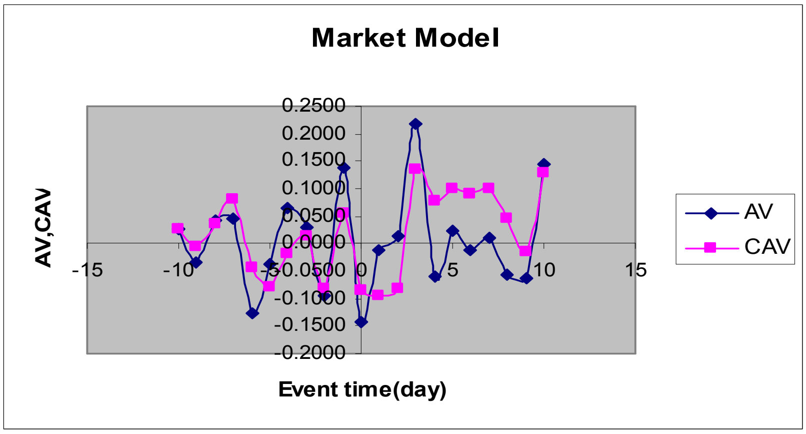


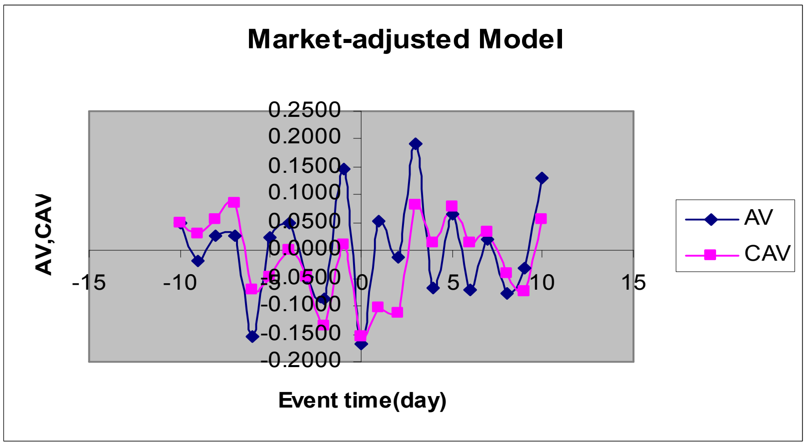


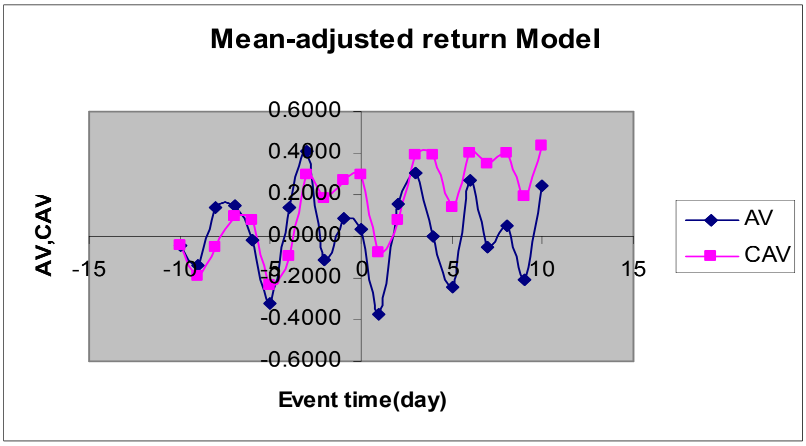
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.10: Abnormal trading volumes around the delisting event for *call event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the UK call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



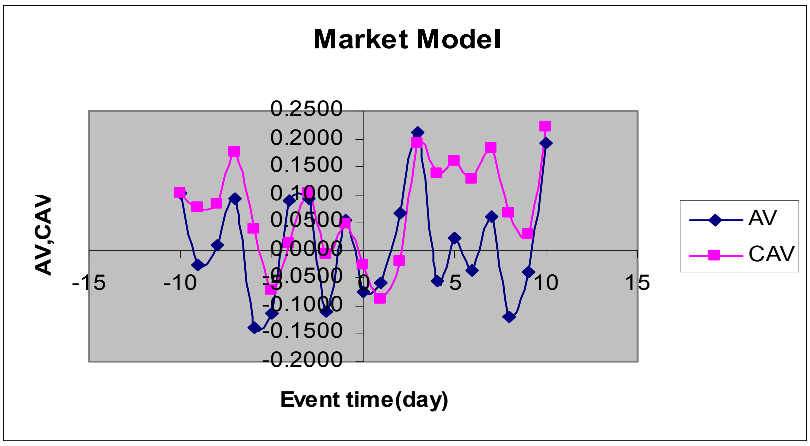


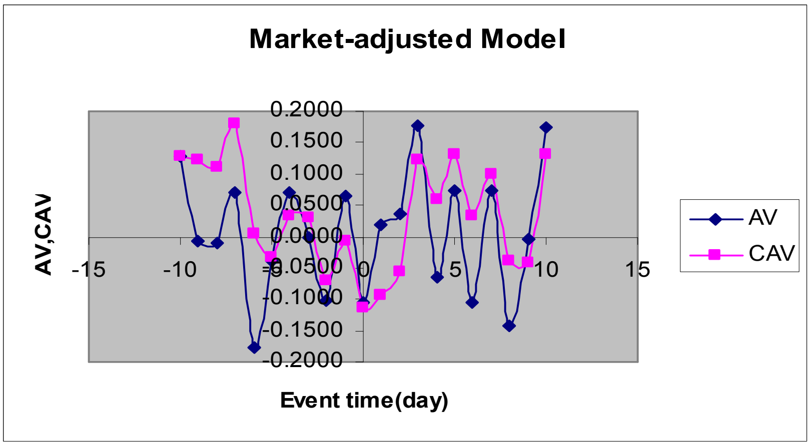


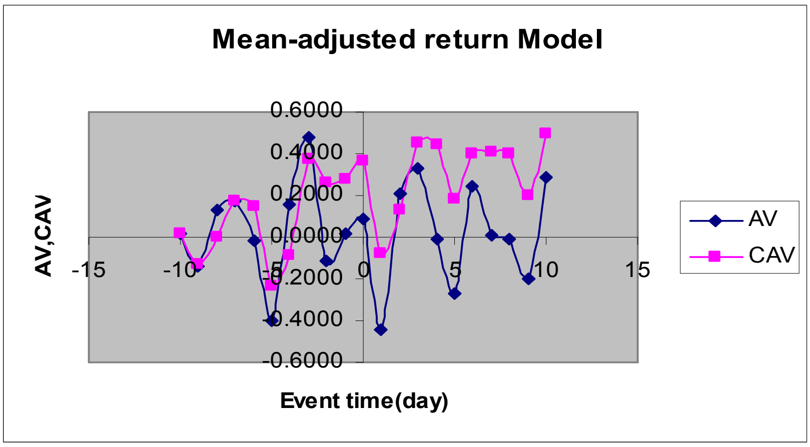
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.11: Abnormal trading volumes around the delisting event for 25 in-the-money *call warrants*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the 25 UK in-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



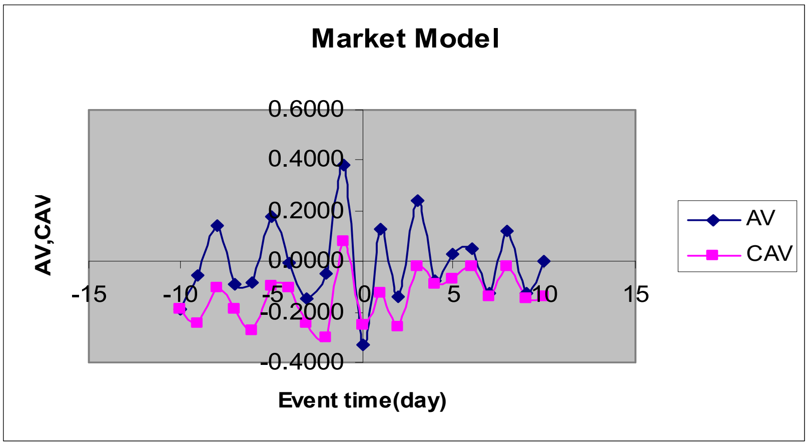


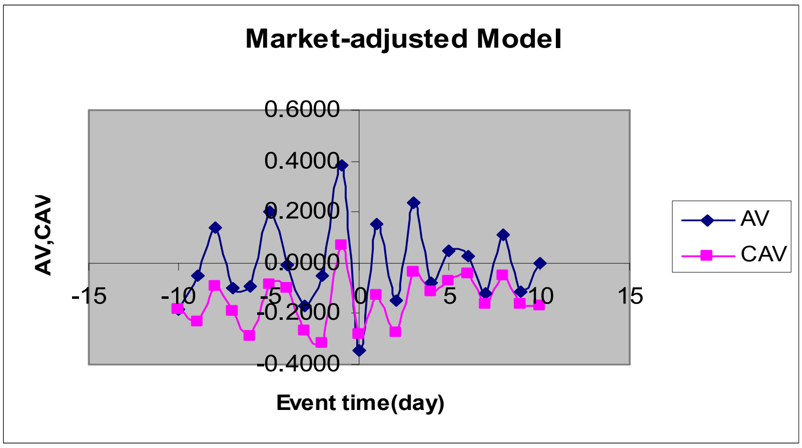


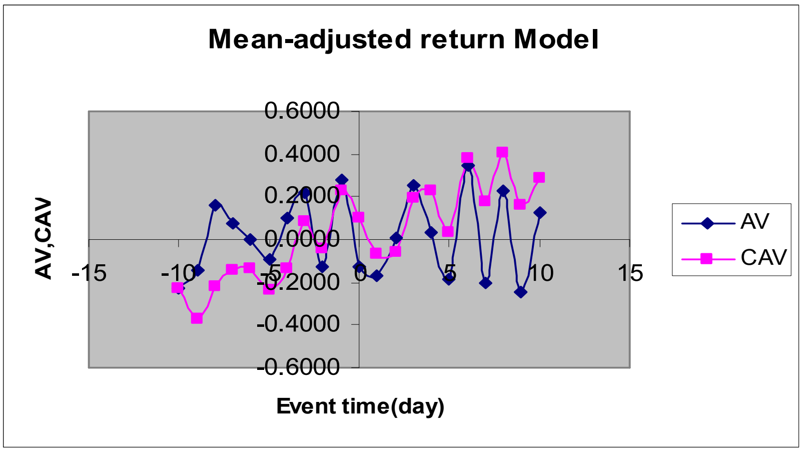
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.12: Abnormal trading volumes around the delisting event for 11 out-of-the-money *call warrants*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the 11 UK out-of-the-money call covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.



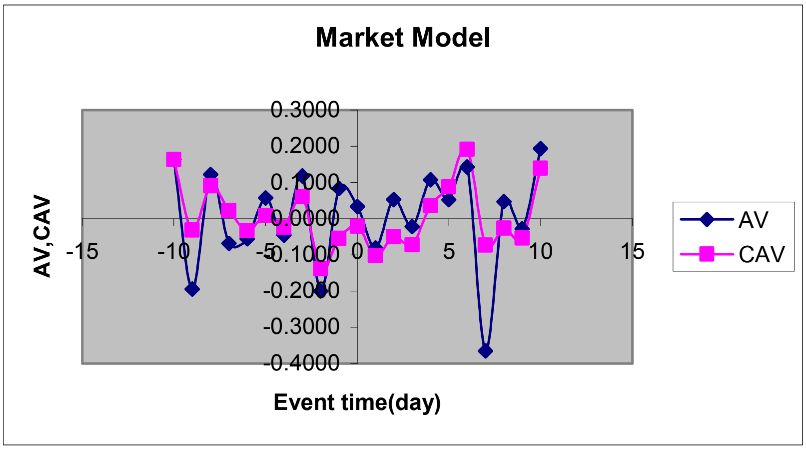


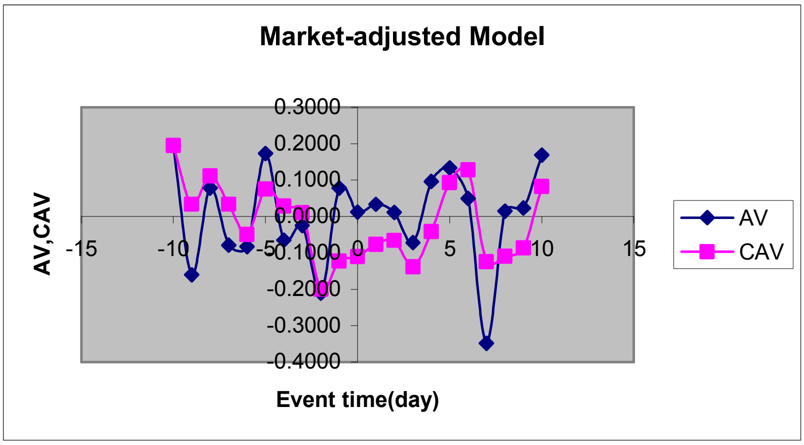


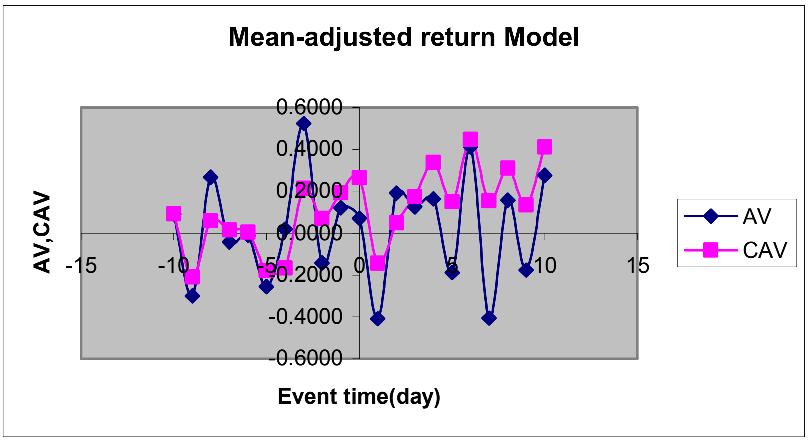
Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.13: Abnormal trading volumes around the delisting event for *put event*

The figure presents abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the delisting event of the UK put covered warrants where market model, market-adjusted model and mean-adjusted return model are used to generate normal volume.





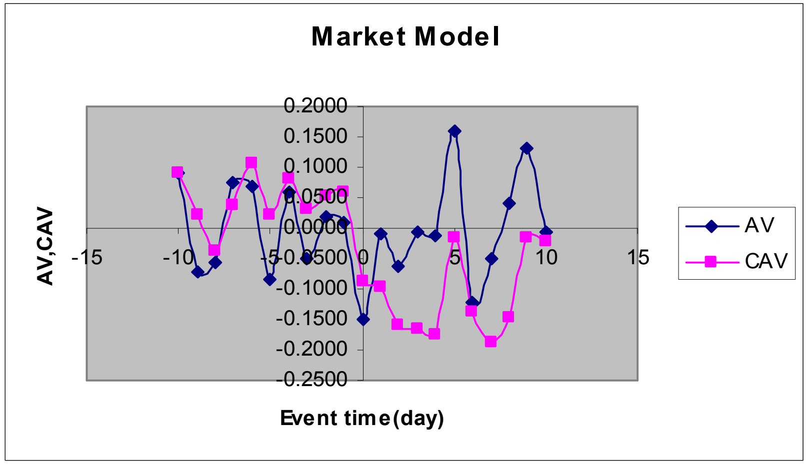


Notes: The sample period extends form July 2004 until December 2006.
The estimation window consists of 300 days which range from day -310 to -11.

Appendix 4.14: Abnormal trading volumes around the announcement event for *call event (the small group)*

The below presents the small group's abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK call covered warrants where market model is used to generate normal volume.

	Market Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0919	0.9398	0.0919	0.9398
-9	-0.0716	-0.8163	0.0203	0.1904
-8	-0.0565	-0.6703	-0.0361	-0.2799
-7	0.0746	1.0536	0.0385	0.3087
-6	0.0684	0.9997	0.1069	0.8986
-5	-0.0850	-1.3185	0.0219	0.2563
-4	0.0599	0.7074	0.0818	0.6053
-3	-0.0500	-0.4857	0.0318	0.2082
-2	0.0198	0.2151	0.0516	0.3445
-1	0.0085	0.0950	0.0600	0.5433
0	-0.1487	-2.1263**	-0.0887	-0.7021
1	-0.0087	-0.0961	-0.0974	-0.7030
2	-0.0610	-0.8994	-0.1584	-1.0894
3	-0.0059	-0.0555	-0.1644	-0.9616
4	-0.0110	-0.1514	-0.1754	-1.2608
5	0.1607	2.2625**	-0.0147	-0.0868
6	-0.1225	-1.1586	-0.1372	-0.8117
7	-0.0501	-0.7145	-0.1872	-1.1393
8	0.0418	0.3437	-0.1455	-0.9014
9	0.1303	1.0243	-0.0151	-0.1036
10	-0.0061	-0.0759	-0.0213	-0.1370



Notes: ***significant at 1% **significant at 5% *significant at 10%

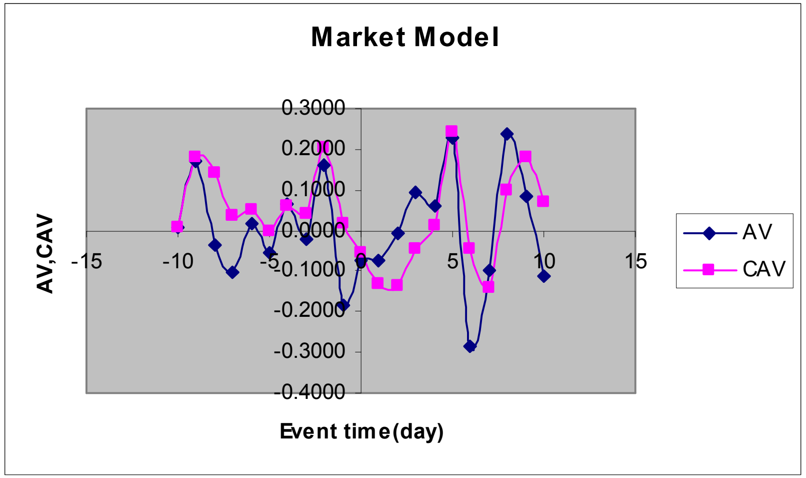
The sample period extends form July 2004 until December 2006.

The small group is categorized by the equation: $\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Appendix 4.15: Abnormal trading volumes around the announcement event for *call event (the large group)*

The below presents the large group's abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK call covered warrants where market model is used to generate normal volume.

Day	Market Model			
	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.0081	0.1068	0.0081	0.1068
-9	0.1706	1.4572	0.1788	1.5685
-8	-0.0373	-0.4715	0.1415	1.2219
-7	-0.1046	-1.4327	0.0369	0.3316
-6	0.0156	0.1224	0.0524	0.2704
-5	-0.0550	-0.4874	-0.0026	-0.0137
-4	0.0648	0.7551	0.0623	0.3276
-3	-0.0208	-0.2256	0.0414	0.2196
-2	0.1604	1.4862	0.2019	1.1877
-1	-0.1844	-1.7720*	0.0175	0.0956
0	-0.0736	-0.3976	-0.0561	-0.2681
1	-0.0736	-0.7036	-0.1297	-0.7310
2	-0.0079	-0.0640	-0.1376	-0.8669
3	0.0938	0.6938	-0.0437	-0.2495
4	0.0579	0.6419	0.0142	0.1000
5	0.2259	1.7105*	0.2401	1.4664
6	-0.2836	-2.7249***	-0.0435	-0.2223
7	-0.0981	-0.8947	-0.1416	-0.8552
8	0.2386	2.1976**	0.0969	0.5528
9	0.0841	0.8186	0.1810	0.9489
10	-0.1123	-0.7006	0.0687	0.4065



Notes: ***significant at 1% **significant at 5% *significant at 10%

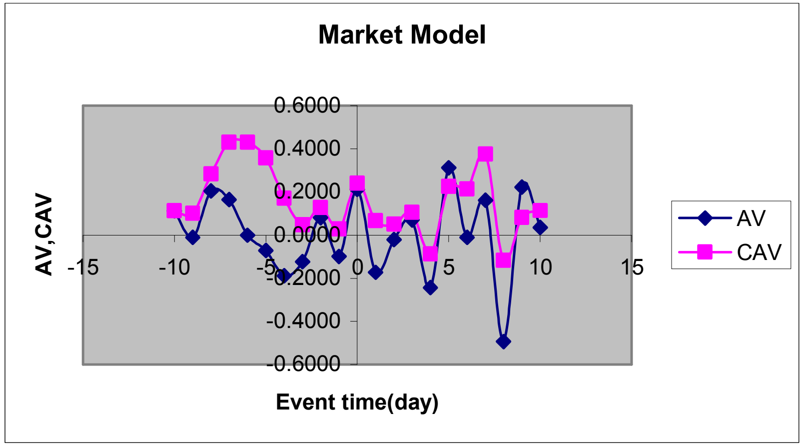
The sample period extends form July 2004 until December 2006.

The large group is categorized by the equation: $\dfrac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Appendix 4.16: Abnormal trading volumes around the announcement event for *put event (the small group)*

The below presents the small group's abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK put covered warrants where market model is used to generate normal volume.

Day	Market Model			
	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.1115	1.8944*	0.1115	1.8944*
-9	-0.0108	-0.1628	0.1007	1.4539
-8	0.2044	1.5020	0.2835	2.2185**
-7	0.1646	2.1583**	0.4308	3.2927***
-6	-0.0006	-0.0058	0.4302	3.8476***
-5	-0.0717	-0.8502	0.3585	2.9187***
-4	-0.1883	-2.1178**	0.1702	3.0373***
-3	-0.1238	-1.3289	0.0465	0.4660
-2	0.0810	0.9330	0.1274	1.9623**
-1	-0.0990	-1.6190	0.0284	0.2973
0	0.2121	4.1021***	0.2405	2.2060**
1	-0.1733	-3.1936***	0.0672	0.5054
2	-0.0215	-0.2847	0.0502	0.4181
3	0.0700	0.6075	0.1054	1.0585
4	-0.2436	-2.2785**	-0.0869	-0.7804
5	0.3114	3.9188***	0.2245	2.0468**
6	-0.0103	-0.1089	0.2142	1.5834
7	0.1620	1.1364	0.3762	1.9862**
8	-0.4940	-4.1100***	-0.1179	-0.7421
9	0.2224	2.1211**	0.0811	0.3453
10	0.0355	0.5249	0.1129	0.4938



Notes: ***significant at 1% **significant at 5% *significant at 10%

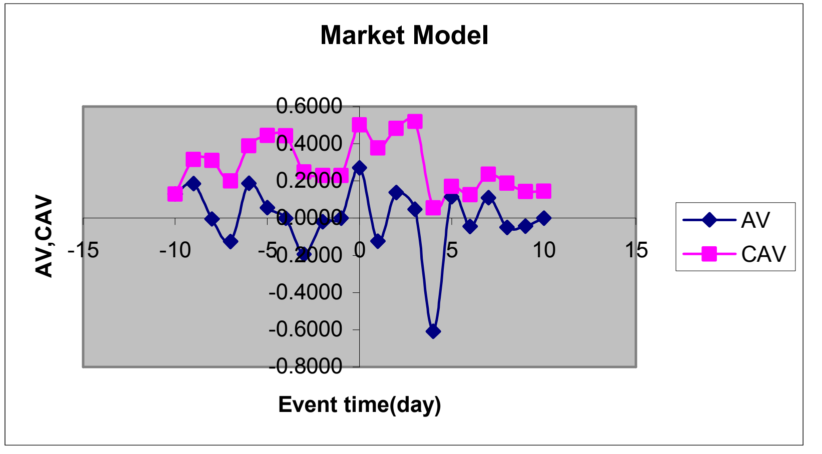
The sample period extends form July 2004 until December 2006.

The small group is categorized by the equation: $\frac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Appendix 4.17: Abnormal trading volumes around the announcement event for *put event (the large group)*

The below presents the large group's abnormal volume (AV) and cumulative abnormal volume (CAV) of the underlying securities around the announcement event of the UK put covered warrants where market model is used to generate normal volume.

	Market Model			
Day	AV	T-test(AV)	CAV	T-test(CAV)
-10	0.1295	1.5708	0.1295	1.5708
-9	0.1851	1.3295	0.3145	2.8128***
-8	-0.0049	-0.0325	0.3102	2.4993**
-7	-0.1251	-1.1182	0.1998	2.7935***
-6	0.1878	1.8680*	0.3877	3.4304***
-5	0.0555	0.3733	0.4432	5.7371***
-4	-0.0018	-0.0142	0.4414	3.8219***
-3	-0.1933	-1.7021*	0.2482	2.2157**
-2	-0.0189	-0.2121	0.2292	2.1184**
-1	0.0001	0.0010	0.2293	1.8749*
0	0.2715	1.9699**	0.5008	2.5864***
1	-0.1239	-0.9335	0.3768	3.0908***
2	0.1387	0.9069	0.4829	2.5919***
3	0.0481	0.6134	0.5197	3.0241***
4	-0.6082	-5.9174***	0.0546	0.3462
5	0.1154	2.1973**	0.1700	0.9734
6	-0.0442	-0.3761	0.1258	0.6577
7	0.1103	0.8535	0.2361	1.2946
8	-0.0494	-0.5476	0.1867	1.1841
9	-0.0427	-0.4227	0.1440	0.9703
10	0.0008	0.0094	0.1448	0.9172



Notes: ***significant at 1% **significant at 5% *significant at 10%

The sample period extends form July 2004 until December 2006.

The large group is categorized by the equation: $\dfrac{\text{Market value (MV) of warrant issue}}{\text{MV of the outstanding underlying securities}}$

Appendix 4.18: The details of all covered warrant samples used in the analysis of call covered warrants

Warrants Name	Underlying security name	Announcement Date	Listing Date	Delisting Date
Societe Generale British Sky Broadcasting Covered Warrants	BRITISH SKY BCAST.GROUP	12/01/2006	17/01/2006	15/09/2006
Societe Generale Man Group Covered Warrants	MAN GROUP	14/02/2006	21/02/2006	10/10/2006
Societe Generale William Hill Covered Warrants	WILLIAM HILL	19/01/2006	26/01/2006	28/11/2006
Dresdner Bank Astrazeneca Covered Warrants	ASTRAZENECA	11/04/2006	21/04/2006	05/07/2006
Dresdner Bank HBOS Public Limited Company Covered Warrants	HBOS	11/03/2005	03/12/2005	05/12/2006
Societe Generale Glaxosmithkline Covered Warrants	GLAXOSMITHKLINE	01/02/2006	02/02/2006	15/09/2006
Societe Generale Glaxosmithkline Covered Warrants	GLAXOSMITHKLINE	10/03/2006	21/03/2006	22/10/2006
Dresdner Bank Glaxosmithkline Covered Warrants	GLAXOSMITHKLINE	21/04/2006	28/04/2006	25/11/2006
Societe Generale Tesco Covered Warrants	TESCO	12/07/2004	19/07/2004	12/10/2004
Societe Generale BT Group Covered Warrants	BT GROUP	21/02/2006	24/02/2006	15/08/2006
Societe Generale BT Group Covered Warrants	BT GROUP	23/04/2006	30/04/2006	12/10/2006
Societe Generale Smiths Industries Covered Warrants	SMITHS GROUP	12/01/2006	12/01/2006	30/09/2006
Societe Generale BP Covered Warrants	BP	23/02/2006	24/02/2006	15/09/2006
Societe Generale BP Covered Warrants	BP	25/03/2006	04/04/2006	12/11/2006
Dresdner Bank BP Public Limited Company Covered Warrants	BP	11/05/2006	23/05/2006	27/12/2006
Goldman Sachs Jersey Next Covered Warrants	NEXT	26/07/2004	31/07/2004	28/07/2005
Goldman Sachs Jersey Next Covered Warrants	NEXT	26/07/2005	05/07/2005	30/07/2006
Societe Generale British American Tobacco Covered Warrants	BRITISH AMERICAN TOBACCO	12/01/2006	18/01/2006	15/09/2006
Societe Generale BAE Systems Covered Warrants	BAE SYSTEMS	18/03/2006	19/03/2006	25/11/2006
Dresdner Bank Barclays Bank Covered Warrants	BARCLAYS	11/04/2004	21/04/2004	05/03/2005
Societe Generale Royal Bank of Scotland Covered Warrants	ROYAL BANK OF SCTL.GP.	12/01/2004	18/01/2004	15/09/2004
Societe Generale Royal Bank of Scotland Covered Warrants	ROYAL BANK OF SCTL.GP.	20/03/2004	26/03/2004	30/11/2004
Societe Generale British Land Covered Warrants	BRITISH LAND	12/01/2006	19/01/2006	15/09/2006

Appendix 4.18(con't): The details of all covered warrant samples used in the analysis of call covered warrants

Warrants Name	Underlying security name	Announcement Date	Listing Date	Delisting Date
Societe Generale Land Securities Covered Warrants	LAND SECURITIES	01/02/2006	02/02/2006	12/08/2006
Societe Generale Cable and Wireless Covered Warrants	CABLE & WIRELESS	12/04/2006	17/04/2006	10/11/2006
Societe Generale Rio Tinto Covered Warrants	RIO TINTO	20/03/2006	23/03/2006	23/11/2006
Societe Generale Anglo American Covered Warrants	ANGLO AMERICAN	12/01/2006	17/01/2006	15/09/2006
Societe Generale British Airways Covered Warrants	BRITISH AIRWAYS	12/01/2005	18/01/2005	15/09/2005
Societe Generale Sainsbury Covered Warrants	SAINSBURY	10/03/2005	16/03/2005	19/11/2005
Societe Generale WPP Covered Warrants	WPP GROUP	12/01/2006	15/01/2006	25/09/2006
Societe Generale Antofagasta Covered Warrants	ANTOFAGASTA	09/03/2006	15/03/2006	17/11/2006
Societe Generale Antofagasta Covered Warrants	ANTOFAGASTA	12/04/2006	13/04/2006	18/12/2006
Societe Generale Reuters Covered Warrants	REUTERS GROUP	01/02/2006	25/02/2006	08/09/2006
Societe Generale Rolls Royce Covered Warrants	ROLLS-ROYCE GROUP	12/01/2006	13/01/2006	18/10/2006
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	20/08/2004	30/08/2004	08/12/2004
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	11/09/2006	18/09/2006	09/01/2005
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	17/10/2004	30/10/2004	11/02/2005
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	29/11/2004	30/11/2004	21/08/2005
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	31/12/2004	10/12/2004	30/09/2005
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	01/02/2005	08/02/2005	14/11/2006
Dresdner Bank Vodafone Covered Warrants	VODAFONE GROUP	10/03/2006	20/03/2006	15/12/2006
Societe Generale Corus Covered Warrants	CORUS GROUP	12/04/2006	19/04/2006	20/09/2006
Societe Generale Qinetiq Group Public Limited Company Covered Warrants	QINETIQ GROUP	09/02/2006	16/02/2006	07/10/2006
Societe Generale Party Gaming Covered Warrants	Party Gaming	12/01/2006	19/01/2006	15/07/2006

Appendix 4.19: The details of all covered warrant samples used in the analysis of put covered warrants

Warrants Name	Underlying security name	Announcement Date	Listing Date	Delisting Date
Societe Generale Man Group Covered Warrants	MAN GROUP	12/12/2004	18/12/2004	20/02/2006
Societe Generale Man Group Covered Warrants	MAN GROUP	09/05/2005	11/05/2005	15/09/2006
Societe Generale Astrazeneca Covered Warrants	ASTRAZENECA	25/10/2005	22/10/2005	21/04/2006
Societe Generale Astrazeneca Covered Warrants	ASTRAZENECA	25/12/2005	22/12/2005	21/06/2006
Societe Generale Astrazeneca Covered Warrants	ASTRAZENECA	21/02/2006	24/02/2006	15/09/2006
Societe Generale Astrazeneca Covered Warrants	ASTRAZENECA	21/04/2006	23/04/2006	15/11/2006
Societe Generale HSBC Holdings Covered Warrants	HSBC	01/09/2004	09/09/2004	11/10/2005
Societe Generale HSBC Holdings Covered Warrants	HSBC	21/12/2004	24/12/2004	26/05/2006
Societe Generale Arm Holdings Covered Warrants	ARM HOLDINGS	12/04/2006	18/04/2006	23/09/2006
Societe Generale Arm Holdings Covered Warrants	ARM HOLDINGS	12/06/2006	18/06/2006	23/12/2006
Societe Generale Shire Pharmaceuticals Covered Warrants	SHIRE	12/01/2006	27/01/2006	15/09/2006
Societe Generale Shire Pharmaceuticals Covered Warrants	SHIRE	12/02/2006	27/02/2006	15/11/2006
Societe Generale HBOS Covered Warrants	HBOS	01/05/2005	04/05/2005	06/04/2006
Societe Generale HBOS Covered Warrants	HBOS	05/08/2005	07/08/2005	10/09/2006
Societe Generale Billiton Covered Warrants	BHP BILLITON	12/09/2004	18/09/2004	15/09/2005
Societe Generale Billiton Covered Warrants	BHP BILLITON	08/12/2006	15/12/2006	18/09/2006
Societe Generale Glaxosmithkline Covered Warrants	GLAXOSMITHKLINE	25/10/2005	23/12/2005	21/04/2006
Societe Generale Glaxosmithkline Covered Warrants	GLAXOSMITHKLINE	25/12/2005	23/2/2006	21/12/2006
Societe Generale BP Covered Warrants	BP	25/10/2005	23/12/2005	30/06/2006
Societe Generale BP Covered Warrants	BP	25/03/2006	23/05/2005	21/10/2006
Societe Generale Royal Dutch Covered Warrants	ROYAL DUTCH SHELL B	21/02/2006	23/02/2006	15/09/2006
Societe Generale Royal Dutch Covered Warrants	ROYAL DUTCH SHELL B	21/04/2006	23/04/2006	15/11/2006
Societe Generale Marks and Spencer Covered Warrants	MARKS & SPENCER GROUP	12/01/2004	18/01/2004	15/09/2005
Societe Generale Marks and Spencer Covered Warrants	MARKS & SPENCER GROUP	12/05/2004	17/05/2004	15/01/2006
Societe Generale BAE Systems Covered Warrants	BAE SYSTEMS	12/04/2006	18/04/2006	15/09/2006
Societe Generale BAE Systems Covered Warrants	BAE SYSTEMS	12/05/2006	18/05/2006	09/10/2006
Societe Generale Barclays Covered Warrants	BARCLAYS	25/10/2005	23/12/2005	21/04/2006
Societe Generale Barclays Covered Warrants	BARCLAYS	21/12/2005	23/12/2005	10/09/2006
Societe Generale Royal Bank of Scotland Covered Warrants	ROYAL BANK OF SCTL.GP.	25/08/2005	23/08/2005	21/01/2006

Appendix 4.19(con't): The details of all covered warrant samples used in the analysis of put covered warrants

Warrants Name	Underlying security name	Announcement Date	Listing Date	Delisting Date
Societe Generale Royal Bank of Scotland Covered Warrants	ROYAL BANK OF SCTL.GP.	25/10/2005	23/12/2005	21/04/2006
Societe Generale Standard Chartered Covered Warrants	STANDARD CHARTERED	21/02/2004	23/02/2004	15/09/2005
Societe Generale Standard Chartered Covered Warrants	STANDARD CHARTERED	10/01/2005	18/01/2006	15/09/2006
Societe Generale Prudential Covered Warrants	PRUDENTIAL	21/02/2006	24/02/2006	15/09/2006
Societe Generale Prudential Covered Warrants	PRUDENTIAL	21/03/2006	24/03/2006	15/10/2006
Societe Generale British Land Covered Warrants	BRITISH LAND	12/04/2006	18/04/2006	15/09/2006
Societe Generale British Land Covered Warrants	BRITISH LAND	12/05/2006	18/05/2006	20/12/2006
Societe Generale Land Securities Covered Warrants	LAND SECURITIES	12/01/2006	18/01/2006	10/08/2006
Societe Generale Land Securities Covered Warrants	LAND SECURITIES	12/06/2006	18/06/2006	15/11/2006
Societe Generale Rio Tinto Covered Warrants	RIO TINTO	01/05/2005	31/05/2005	21/04/2006
Societe Generale Rio Tinto Covered Warrants	RIO TINTO	23/10/2005	25/10/2005	21/06/2006
Societe Generale Rio Tinto Covered Warrants	RIO TINTO	01/02/2006	03/02/2006	15/09/2006
Societe Generale Rio Tinto Covered Warrants	RIO TINTO	01/03/2006	03/03/2006	15/10/2006
Societe Generale Anglo American Covered Warrants	ANGLO AMERICAN	20/10/2005	26/10/2005	21/04/2006
Societe Generale Anglo American Covered Warrants	ANGLO AMERICAN	25/12/2005	26/12/2005	21/06/2006
Societe Generale Anglo American Covered Warrants	ANGLO AMERICAN	12/04/2006	18/04/2006	18/12/2006
Societe Generale Anglo American Covered Warrants	ANGLO AMERICAN	04/01/2006	10/01/2006	18/10/2006
Societe Generale Billiton Covered Warrants	BHP BILLITON	12/04/2006	18/04/2006	15/09/2006
Societe Generale Billiton Covered Warrants	BHP BILLITON	12/06/2006	18/06/2006	15/11/2006
Societe Generale Cairn Energy Covered Warrants	CAIRN ENERGY	07/01/2006	09/01/2006	10/08/2006
Societe Generale Cairn Energy Covered Warrants	CAIRN ENERGY	12/04/2006	12/04/2006	10/09/2006
Societe Generale BG Group Covered Warrants	BG GROUP	21/02/2006	21/02/2006	12/11/2006
Societe Generale BG Group Covered Warrants	BG GROUP	01/02/2006	26/02/2006	08/12/2006
Societe Generale Reuters Covered Warrants	REUTERS GROUP	01/03/2004	04/07/2004	12/11/2004
Societe Generale Reuters Covered Warrants	REUTERS GROUP	23/05/2004	20/06/2004	12/08/2005
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	01/05/2005	29/6/2005	21/04/2006
Societe Generale Vodafone Covered Warrants	VODAFONE GROUP	25/10/2005	24/11/2005	21/10/2006
Societe Generale Lloyds Covered Warrants	LLOYDS BRITISH	21/08/2005	27/08/2005	18/04/2006
Societe Generale Lloyds Covered Warrants	LLOYDS BRITISH	21/02/2006	27/02/2006	18/10/2006

Appendix 6.1: Issuance status of 154 call covered warrant samples

Name of Warrant	Date of Issuance	Underlying Company	Date of Listing	Offer Price (£)	Strike Price (£)	Moneyness	Parity
SCGN. 3I GP.PLC. COVERED WTS. 20/06/08	27/6/2007	3I GROUP PLC	28/06/2007	1.52	13.5	out	10/1
SCGN. 3I GROUP PLC COVERED WTS. 19/12/08	17/12/2007	3I GROUP PLC	19/12/2007	0.10	13	out	10/1
SCGN. 3I GROUP PLC COVERED WTS. 20/06/08	17/12/2007	3I GROUP PLC	19/12/2007	0.11	11	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 19/12/08	7/12/2007	ANGLO AMERICAN PLC	10/12/2007	0.42	45	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 19/12/08	8/11/2007	ANGLO AMERICAN PLC	14/11/2007	0.57	36	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 19/12/08	8/11/2007	ANGLO AMERICAN PLC	14/11/2007	0.44	40	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 20/06/08	25/9/2007	ANGLO AMERICAN PLC	26/09/2007	0.36	33	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 20/06/08	31/5/2007	ANGLO AMERICAN PLC	05/07/2007	0.37	35	out	10/1
SCGN. ANGLO AMER. COVERED WTS. 20/06/08	7/12/2007	ANGLO AMERICAN PLC	10/12/2007	0.42	37	out	10/1
SCGN. ANTOFAGASTA COVERED WTS. 19/12/08	8/11/2007	ANTOFAGASTA PLC	14/11/2007	1.13	10	out	1/1
SCGN. ANTOFAGASTA COVERED WTS. 20/06/08	7/12/2007	ANTOFAGASTA PLC	10/12/2007	1.26	8	out	1/1
SCGN. ANTOFAGASTA COVERED WTS. 20/06/08	16/8/2007	ANTOFAGASTA PLC	17/08/2007	0.99	7.5	out	1/1
SCGN. ANTOFAGASTA COVERED WTS. 20/06/08	31/5/2007	ANTOFAGASTA PLC	05/07/2007	0.81	6.5	out	1/1
SCGN. ANTOFAGOSTA COVERED WTS. 20/06/08	8/11/2007	ANTOFAGASTA PLC	14/11/2007	1.03	9	out	1/1
SCGN. ARM HDGS. COVERED WTS. 20/06/08	27/6/2007	ARM HOLDINGS PLC	28/06/2007	0.18	1.6	out	1/1
SCGN. ARM HOLDINGS COVERED WTS. 19/12/08	17/12/2007	ARM HOLDINGS PLC	19/12/2007	0.19	1.55	out	1/1
SCGN. ARM HOLDINGS COVERED WTS. 20/06/08	17/12/2007	ARM HOLDINGS PLC	19/12/2007	0.16	1.4	out	1/1
SCGN. AZEN. COVERED WTS. 19/12/08	7/12/2007	ASTRAZENECA PLC	10/12/2007	0.15	29	out	10/1
SCGN. AZEN. COVERED WTS. 19/12/08	16/8/2007	ASTRAZENECA PLC	17/08/2007	0.38	26	out	10/1
SCGN. AZEN. COVERED WTS. 20/06/08	16/8/2007	ASTRAZENECA PLC	17/08/2007	0.32	25	out	10/1
SCGN. AZEN. COVERED WTS. 20/06/08	7/12/2007	ASTRAZENECA PLC	10/12/2007	0.26	23	in	10/1
SCGN. AVIVA COVERED WTS. 19/12/08	17/12/2007	AVIVA PLC	19/12/2007	0.09	8	out	10/1
SCGN. AVIVA COVERED WTS. 20/06/08	17/12/2007	AVIVA PLC	19/12/2007	0.09	7	out	10/1
SCGN. AVIVA COVERED WTS. 20/06/08	16/8/2007	AVIVA PLC	17/08/2007	0.93	7.5	out	10/1
SCGN. AVIVA COVERED WTS. 20/06/08	27/6/2007	AVIVA PLC	28/06/2007	0.76	8.75	out	10/1
SCGN. BAE COVERED WTS. 20/06/08	27/6/2007	BAE SYSTEMS PLC	28/06/2007	0.47	5	out	1/1
SCGN. BAE SYSTEMS COVERED WTS. 19/12/08	17/12/2007	BAE SYSTEMS PLC	19/12/2007	0.50	5.75	out	1/1
SCGN. BAE SYSTEMS COVERED WTS. 20/06/08	17/12/2007	BAE SYSTEMS PLC	19/12/2007	0.33	5.5	out	1/1
SCGN. BARCLAYS COVERED WTS. 19/12/08	7/12/2007	BARCLAYS BANK PLC	10/12/2007	0.87	6	out	1/1
SCGN. BARCLAYS COVERED WTS. 19/12/08	7/12/2007	BARCLAYS BANK PLC	10/12/2007	0.55	7	out	1/1
SCGN. BARCLAYS COVERED WTS. 20/06/08	16/11/2007	BARCLAYS BANK PLC	19/11/2007	0.62	5.5	out	1/1

Appendix 6.1(con't): Issuance status of 154 call covered warrant samples

Name of Warrant	Date of Issuance	Underlying Company	Date of Listing	Offer Price (£)	Strike Price (£)	Moneyness	Parity
SCGN. BARCLAYS COVERED WTS. 20/06/08	16/11/2007	BARCLAYS BANK PLC	19/11/2007	0.45	6	out	1/1
SCGN. BARCLAYS COVERED WTS. 20/06/08	25/9/2007	BARCLAYS BANK PLC	26/09/2007	0.73	6.5	out	1/1
SCGN. BARCLAYS COVERED WTS. 20/06/08	25/9/2007	BARCLAYS BANK PLC	26/09/2007	0.39	7.5	out	1/1
SCGN. BARCLAYS COVERED WTS. 20/06/08	25/9/2007	BARCLAYS BANK PLC	26/09/2007	0.50	8	out	1/1
SCGN. BG GP. COVERED WTS. 19/12/08	8/11/2007	BG GROUP PLC	14/11/2007	0.13	10	out	10/1
SCGN. BG.GP. COVERED WTS. 20/06/08	7/12/2007	BG GROUP PLC	10/12/2007	0.12	11	out	10/1
SCGN. BG.GP. COVERED WTS. 20/06/08	7/12/2007	BG GROUP PLC	10/12/2007	0.08	12	out	10/1
SCGN. BHP BILLITON COVERED WTS. 19/12/08	7/12/2007	BHP BILLITON PLC	10/12/2007	0.37	17	out	10/1
SCGN. BHP BILLITON COVERED WTS. 19/12/08	7/12/2007	BHP BILLITON PLC	10/12/2007	0.30	19	out	10/1
SCGN. BHP BILLITON COVERED WTS. 20/06/08	25/9/2007	BHP BILLITON PLC	26/09/2007	0.17	18	out	10/1
SCGN. BHP BILLITON COVERED WTS. 20/06/08	25/9/2007	BHP BILLITON PLC	26/09/2007	0.12	20	out	10/1
SCGN. BHP BILLITON COVERED WTS. 20/06/08	31/5/2007	BHP BILLITON PLC	05/07/2007	0.13	15	out	10/1
SCGN. BP PLC. COVERED WTS. 19/09/08	10/10/2007	BP PLC	11/10/2007	0.44	6.5	out	1/1
SCGN. BP PLC. COVERED WTS. 20/06/08	31/5/2007	BP PLC	05/07/2007	0.80	6	in	1/1
SCGN. BP PLC. COVERED WTS. 20/06/08	31/5/2007	BP PLC	05/07/2007	0.40	7	out	1/1
SCGN. BRIT.EN. COVERED WTS. 20/06/08	27/6/2007	BRITISH ENERGY GROUP PLC	28/06/2007	0.84	6	out	10/1
SCGN. BRITISH ENERGY COVERED WTS. 19/12/08	17/12/2007	BRITISH ENERGY GROUP PLC	19/12/2007	0.05	6.5	out	10/1
SCGN. BRITISH ENERGY COVERED WTS. 20/06/08	17/12/2007	BRITISH ENERGY GROUP PLC	19/12/2007	0.06	5.5	out	10/1
SCGN. BRIT.LAND COVERED WTS. 19/12/08	7/12/2007	BRITISH LAND CO PLC	10/12/2007	0.09	12	out	10/1
SCGN. BRIT.LAND COVERED WTS. 20/06/08	7/12/2007	BRITISH LAND CO PLC	10/12/2007	0.10	10	out	10/1
SCGN. BRIT.LAND COVERED WTS. 20/06/08	7/12/2007	BRITISH LAND CO PLC	10/12/2007	0.07	11	out	10/1
SCGN. BRIT.LAND COVERED WTS. 20/06/08	16/8/2007	BRITISH LAND CO PLC	17/08/2007	0.14	14	out	10/1
SCGN. BRITISH SKY COVERED WTS. 19/12/08	17/12/2007	BRITISH SKY BCAST.GROUP PLC	19/12/2007	0.07	7	out	10/1
SCGN. BRITISH SKY COVERED WTS. 20/06/08	17/12/2007	BRITISH SKY BCAST.GROUP PLC	19/12/2007	0.06	6.5	out	10/1
SCGN. BSB. COVERED WTS. 20/06/08	27/6/2007	BRITISH SKY BCAST.GROUP PLC	28/06/2007	0.61	7.25	out	10/1
SCGN. BT GROUP COVERED WTS. 19/12/08	8/11/2007	BT GROUP PLC	14/11/2007	0.32	3.75	out	1/1
SCGN. BT GROUP COVERED WTS. 20/06/08	7/12/2007	BT GROUP PLC	10/12/2007	0.33	3	out	1/1
SCGN. BT GROUP COVERED WTS. 20/06/08	7/12/2007	BT GROUP PLC	10/12/2007	0.17	3.5	out	1/1
SCGN. CABLE & WIRELESS COVERED WTS. 19/12/08	17/12/2007	CABLE & WIRELESS PLC	19/12/2007	0.23	2.3	out	1/1
SCGN. CABLE & WIRELESS COVERED WTS. 20/06/08	17/12/2007	CABLE & WIRELESS PLC	19/12/2007	0.23	2	out	1/1
SCGN. CBW PLC. COVERED WTS. 20/06/08	27/6/2007	CABLE & WIRELESS PLC	29/06/2007	0.27	2.15	out	1/1

Appendix 6.1(con't): Issuance status of 154 call covered warrant samples

Name of Warrant	Date of Issuance	Underlying Company	Date of Listing	Offer Price (£)	Strike Price (£)	Moneyness	Parity
SCGN. PUT-CBW PLC. COVERED WTS. 20/06/08	27/6/2007	CABLE & WIRELESS PLC	29/06/2007	0.16	1.75	in	1/1
SCGN. CENTRICA COVERED WTS. 19/12/08	17/12/2007	CENTRICA PLC	19/12/2007	0.32	4.25	out	1/1
SCGN. CENTRICA COVERED WTS. 20/06/08	17/12/2007	CENTRICA PLC	19/12/2007	0.32	4	out	1/1
SCGN. CENTRICA COVERED WTS. 20/06/08	27/6/2007	CENTRICA PLC	29/06/2007	0.38	4.5	out	1/1
SCGN. DIAGEO PLC. COVERED WTS. 19/12/08	17/12/2007	DIAGEO PLC	19/12/2007	0.08	13	out	10/1
SCGN. DIAGEO PLC. COVERED WTS. 20/06/08	17/12/2007	DIAGEO PLC	19/12/2007	0.11	11	out	10/1
SCGN. DIAGEO PLC. COVERED WTS. 20/06/08	27/6/2007	DIAGEO PLC	29/06/2007	0.81	12	out	10/1
SCGN. EXPERIAN GP. COVERED WTS. 20/06/08	27/6/2007	EXPERIAN GROUP LIMITED	29/06/2007	0.71	7	out	10/1
SCGN. EXPERIAN GROUP COVERED WTS. 19/12/08	17/12/2007	EXPERIAN GROUP LIMITED	19/12/2007	0.05	5	out	10/1
SCGN. EXPERIAN GROUP COVERED WTS. 20/06/08	17/12/2007	EXPERIAN GROUP LIMITED	19/12/2007	0.04	4.5	out	10/1
SCGN. GLXSX. COVERED WTS. 19/12/08	11/6/2007	GLAXOSMITHKLINE PLC	12/06/2007	0.11	15	out	10/1
SCGN. HAMMERSON PLC COVERED WTS. 19/12/08	17/12/2007	HAMMERSON PLC	19/12/2007	0.09	14	out	10/1
SCGN. HAMMERSON PLC COVERED WTS. 20/06/08	17/12/2007	HAMMERSON PLC	19/12/2007	0.09	12	out	10/1
SCGN. HAMMERSON PLC. COVERED WTS. 20/06/08	27/6/2007	HAMMERSON PLC	29/06/2007	1.99	16.5	out	10/1
SCGN. HBOS PLC COVERED WTS. 19/12/08	17/12/2007	HBOS PLC	19/12/2007	0.10	10	out	10/1
SCGN. HBOS PLC COVERED WTS. 20/06/08	17/12/2007	HBOS PLC	19/12/2007	0.09	9	out	10/1
SCGN. HBOS PLC. COVERED WTS. 20/06/08	27/6/2007	HBOS PLC	29/06/2007	0.95	11.25	out	10/1
SCGN. HSBC HDG. COVERED WTS. 19/12/08	8/11/2007	HSBC HOLDING PLC	14/11/2007	0.06	11	out	10/1
SCGN. HSBC HDG. COVERED WTS. 20/06/08	31/5/2007	HSBC HOLDING PLC	04/06/2007	0.09	10	out	10/1
SCGN. HSBC HDG. COVERED WTS. 20/06/08	31/5/2007	HSBC HOLDING PLC	04/06/2007	0.03	12	out	10/1
SCGN. HSBC HDG. COVERED WTS. 20/06/08	7/12/2007	HSBC HOLDING PLC	11/12/2007	0.06	9	out	10/1
SCGN. HSBC HDG. COVERED WTS. 20/06/08	7/12/2007	HSBC HOLDING PLC	11/12/2007	0.10	8	in	10/1
SCGN. INVESCO PLC. COVERED WTS. 20/06/08	27/6/2007	INVESCO PLC	29/06/2007	0.86	6.75	out	10/1
SCGN. LAND SECS. COVERED WTS. 19/12/08	16/8/2007	LAND SECURITIES PLC	20/08/2007	0.23	20	out	10/1
SCGN. LAND SECURITIES COVERED WTS. 20/06/08	7/12/2007	LAND SECURITIES PLC	07/12/2007	0.18	16	out	10/1
SCGN. LAND SECURITIES COVERED WTS. 20/06/08	7/12/2007	LAND SECURITIES PLC	07/12/2007	0.14	17	out	10/1
SCGN. LAND SECURITIES COVERED WTS. 20/06/08	7/12/2007	LAND SECURITIES PLC	07/12/2007	0.11	18	out	10/1
SCGN. LEGAL & GENERAL COVERED WTS. 19/12/08	17/12/2007	LEGAL & GENERAL GROUP PLC	19/12/2007	0.15	1.6	out	1/1
SCGN. LEGAL & GENERAL COVERED WTS. 20/06/08	17/12/2007	LEGAL & GENERAL GROUP PLC	19/12/2007	0.15	1.4	out	1/1
SCGN. LGL.& GEN. COVERED WTS. 20/06/08	27/6/2007	LEGAL & GENERAL GROUP PLC	05/07/2007	0.18	1.75	out	1/1
SCGN. LLOYDS COVERED WTS. 20/06/08	31/5/2007	LLOYDS TSB GROUP PLC	04/06/2007	0.78	6	out	1/1

Appendix 6.1(con't): Issuance status of 154 call covered warrant samples

Name of Warrant	Date of Issuance	Underlying Company	Date of Listing	Offer Price (£)	Strike Price (£)	Moneyness	Parity
SCGN. LLOYDS COVERED WTS. 20/06/08	31/5/2007	LLOYDS TSB GROUP PLC	04/06/2007	0.42	7	out	1/1
SCGN. LLOYDS TSB GROUP COVERED WTS. 19/12/08	7/12/2007	LLOYDS TSB GROUP PLC	07/12/2007	0.49	6	out	1/1
SCGN. LLOYDS TSB GROUP COVERED WTS. 20/06/08	7/12/2007	LLOYDS TSB GROUP PLC	07/12/2007	0.60	5	out	1/1
SCGN. LLOYDS TSB GROUP COVERED WTS. 20/06/08	7/12/2007	LLOYDS TSB GROUP PLC	07/12/2007	0.41	5.5	out	1/1
SCGN. MAN GROUP COVERED WTS. 19/12/08	8/11/2007	MAN GROUP PLC	14/11/2007	0.76	6.5	out	1/1
SCGN. MAN GROUP COVERED WTS. 20/06/08	31/5/2007	MAN GROUP PLC	04/06/2007	0.90	6	out	1/1
SCGN. M&S. COVERED WTS. 19/12/08	8/11/2007	MARKS & SPENCER GROUP PLC	14/11/2007	0.06	7.5	out	10/1
SCGN. M&S. COVERED WTS. 20/06/08	7/12/2007	MARKS & SPENCER GROUP PLC	11/12/2007	0.07	6	out	10/1
SCGN. M&S. COVERED WTS. 20/06/08	7/12/2007	MARKS & SPENCER GROUP PLC	11/12/2007	0.04	7	out	10/1
SCGN. M&S. COVERED WTS. 20/06/08	16/8/2007	MARKS & SPENCER GROUP PLC	20/08/2007	0.08	6.5	out	10/1
SCGN. PERSIMMON COVERED WTS. 19/12/08	17/12/2007	PERSIMMON PLC	20/12/2007	0.09	10	out	10/1
SCGN. PERSIMMON COVERED WTS. 20/06/08	17/12/2007	PERSIMMON PLC	20/12/2007	0.07	9	out	10/1
SCGN. PERSIMMON COVERED WTS. 20/06/08	27/6/2007	PERSIMMON PLC	05/07/2007	1.52	13.5	out	10/1
SCGN. PRUDENTIAL COVERED WTS. 19/12/08	16/8/2007	PRUDENTIAL PLC	20/08/2007	0.14	7	out	10/1
SCGN. PRUDENTIAL COVERED WTS. 19/12/08	8/11/2007	PRUDENTIAL PLC	14/11/2007	0.10	9	out	10/1
SCGN. PRUDENTIAL COVERED WTS. 20/06/08	7/12/2007	PRUDENTIAL PLC	03/01/2008	0.10	7	in	10/1
SCGN. PRUDENTIAL COVERED WTS. 20/06/08	7/12/2007	PRUDENTIAL PLC	03/01/2008	0.07	8	out	10/1
SCGN. RIO TINTO COVERED WTS. 19/12/08	8/11/2007	RIO TINTO PLC	14/11/2007	0.57	55	in	10/1
SCGN. RIO TINTO COVERED WTS. 19/12/08	8/11/2007	RIO TINTO PLC	14/11/2007	0.73	50	in	10/1
SCGN. RIO TINTO COVERED WTS. 20/06/08	31/5/2007	RIO TINTO PLC	04/06/2007	0.59	38	out	10/1
SCGN. RIO TINTO COVERED WTS. 20/06/08	31/5/2007	RIO TINTO PLC	04/06/2007	0.51	40	out	10/1
SCGN. ROLLS ROYCE COVERED WTS. 19/12/08	17/12/2007	ROLLS-ROYCE GROUP PLC	19/12/2007	0.06	6.5	out	10/1
SCGN. ROLLS ROYCE COVERED WTS. 20/06/08	17/12/2007	ROLLS-ROYCE GROUP PLC	19/12/2007	0.06	5.75	out	10/1
SCGN. ROLLS ROYCE COVERED WTS. 20/06/08	27/6/2007	ROLLS-ROYCE GROUP PLC	05/07/2007	0.49	6.25	out	10/1
SCGN. RSA IN.GP.PLC. COVERED WTS. 19/12/08	17/12/2007	ROYAL & SUN ALL.IN. GROUP PLC	19/12/2007	0.17	1.8	out	1/1
SCGN. RSA IN.GP.PLC. COVERED WTS. 20/06/08	17/12/2007	ROYAL & SUN ALL.IN. GROUP PLC	19/12/2007	0.16	1.6	out	1/1
SCGN. RSA IN.GP.PLC. COVERED WTS. 20/06/08	27/6/2007	ROYAL & SUN ALL.IN. GROUP PLC	05/07/2007	0.17	1.75	out	1/1
SCGN. RBOS. COVERED WTS. 20/06/08	25/9/2007	ROYAL BANK OF SCTL.GP. PLC	26/09/2007	0.68	5.5	out	1/1
SCGN. RBOS. COVERED WTS. 20/06/08	25/9/2007	ROYAL BANK OF SCTL.GP. PLC	26/09/2007	0.48	6	out	1/1
SCGN. RBOS. COVERED WTS. 20/06/08	31/5/2007	ROYAL BANK OF SCTL.GP. PLC	04/06/2007	0.74	7	out	1/1
SCGN. ROYAL DUTCH COVERED WTS. 19/12/08	8/11/2007	ROYAL DUTCH SHELL PLC-B SHS	14/11/2007	0.23	23	out	10/1

Appendix 6.1(con't): Issuance status of 154 call covered warrant samples

Name of Warrant	Date of Issuance	Underlying Company	Date of Listing	Offer Price (£)	Strike Price (£)	Moneyness	Parity
SCGN. ROYAL DUTCH COVERED WTS. 20/06/08	31/5/2007	ROYAL DUTCH SHELL PLC-B SHS	31/05/2007	0.15	22	out	10/1
SCGN. ROYAL DUTCH COVERED WTS. 20/06/08	31/5/2007	ROYAL DUTCH SHELL PLC-B SHS	31/05/2007	0.10	24	out	10/1
SCGN. SAINSBURY COVERED WTS. 20/06/08	17/12/2007	J SAINSBURY PLC	19/12/2007	0.05	4.75	out	10/1
SCGN. SAINSBURY COVERED WTS. 20/06/08	27/6/2007	J SAINSBURY PLC	05/07/2007	0.57	6.5	out	10/1
SCGN. SCOT.& STHN. COVERED WTS. 19/12/08	17/12/2007	SCOT.& SOUTHERN ENERGY PLC	19/12/2007	0.13	20	out	10/1
SCGN. SCOT.& STHN. COVERED WTS. 20/06/08	17/12/2007	SCOT.& SOUTHERN ENERGY PLC	19/12/2007	0.13	18	out	10/1
SCGN. SCOT.& STHN. COVERED WTS. 20/06/08	27/6/2007	SCOT.& SOUTHERN ENERGY PLC	05/07/2007	1.55	16.5	out	10/1
SCGN. SCOT.& NEWC. COVERED WTS. 20/06/08	27/6/2007	SCOTTISH & NEWCASTLE PLC	05/07/2007	0.72	7.25	out	10/1
SCGN. STD.CHT. COVERED WTS. 19/12/08	7/12/2007	STANDARD CHARTERED BANK PLC	11/12/2007	0.27	23	out	10/1
SCGN. STD.CHT. COVERED WTS. 19/12/08	8/11/2007	STANDARD CHARTERED BANK PLC	14/11/2007	0.21	21	out	10/1
SCGN. STD.CHT. COVERED WTS. 20/06/08	7/12/2007	STANDARD CHARTERED BANK PLC	11/12/2007	0.26	20	out	10/1
SCGN. STD.CHT. COVERED WTS. 20/06/08	7/12/2007	STANDARD CHARTERED BANK PLC	11/12/2007	0.19	22	out	10/1
SCGN. STD.LF. COVERED WTS. 20/06/08	27/6/2007	STANDARD LIFE PLC	05/07/2007	0.29	4	out	1/1
SCGN. TESCO PLC COVERED WTS. 19/12/08	7/12/2007	TESCO PLC	07/12/2007	0.05	5.5	out	10/1
SCGN. TESCO PLC COVERED WTS. 20/06/08	7/12/2007	TESCO PLC	07/12/2007	0.05	5	out	10/1
SCGN. UTD.UTILS. COVERED WTS. 19/12/08	17/12/2007	UNITED UTILITIES PLC	19/12/2007	0.06	9	out	10/1
SCGN. UTD.UTILS. COVERED WTS. 20/06/08	17/12/2007	UNITED UTILITIES PLC	19/12/2007	0.07	8	out	10/1
SCGN. UTD.UTILS. COVERED WTS. 20/06/08	27/6/2007	UNITED UTILITIES PLC	05/07/2007	0.75	8.5	out	10/1
SCGN. VODAFONE COVERED WTS. 19/12/08	8/11/2007	VODAFONE GROUP PLC	14/11/2007	0.21	2.2	out	1/1
SCGN. VODAFONE COVERED WTS. 20/06/08	25/9/2007	VODAFONE GROUP PLC	26/09/2007	0.11	2	out	1/1
SCGN. VODAFONE COVERED WTS. 20/06/08	31/5/2007	VODAFONE GROUP PLC	03/01/2008	0.12	1.7	in	1/1
SCGN. VODAFONE COVERED WTS. 20/06/08	7/12/2007	VODAFONE GROUP PLC	11/12/2007	0.13	2.1	out	1/1
SCGN. VODAFONE COVERED WTS. 20/06/08	7/12/2007	VODAFONE GROUP PLC	11/12/2007	0.21	1.9	out	1/1
SCGN. VODAFONE COVERED WTS. 20/06/08	7/12/2007	VODAFONE GROUP PLC	11/12/2007	0.34	1.8	in	1/1
SCGN. XSTRATA COVERED WTS. 19/12/08	17/12/2007	XSTRATA PLC	19/12/2007	0.64	45	out	10/1
SCGN. XSTRATA COVERED WTS. 20/06/08	17/12/2007	XSTRATA PLC	19/12/2007	0.53	40	out	10/1
SCGN. XSTRATA COVERED WTS. 20/06/08	27/6/2007	XSTRATA PLC	05/07/2007	4.69	35	out	10/1
SCGN. YELL COVERED WTS. 19/12/08	17/12/2007	YELL GROUP PLC	19/12/2007	0.07	5	out	10/1
SCGN. YELL COVERED WTS. 20/06/08	17/12/2007	YELL GROUP PLC	19/12/2007	0.06	4.5	out	10/1
SCGN. YELL COVERED WTS. 20/06/08	27/6/2007	YELL GROUP PLC	06/07/2007	1.04	5.5	out	10/1

Appendix 6.2: Price Difference between Vulnerable Warrant Price (for the case α = 0%), Black-Scholes Price and Market Value of 103 call covered warrants

Day	Vulnerable Warrant Price and Black-Scholes Price[a]				Vulnerable Warrant Price and Market Value[b]				Black-Scholes Price and Market Value[c]			
	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD
-15	0.0000	0.0000	0.0000	0.0000	1.5227	-0.8623	-0.2292	0.3638	1.5227	-0.8623	-0.2292	0.3638
-14	0.0000	0.0000	0.0000	0.0000	1.4111	-0.8819	-0.2690	0.3712	1.4111	-0.8819	-0.2690	0.3712
-13	0.0000	0.0000	0.0000	0.0000	1.6346	-0.8885	-0.2426	0.4063	1.6346	-0.8885	-0.2426	0.4063
-12	0.0000	0.0000	0.0000	0.0000	1.4596	-0.9163	-0.2466	0.3900	1.4596	-0.9163	-0.2466	0.3900
-11	0.0000	0.0000	0.0000	0.0000	1.6421	-0.9417	-0.2646	0.4059	1.6421	-0.9417	-0.2646	0.4059
-10	0.0000	0.0000	0.0000	0.0000	1.7033	-0.9434	-0.2372	0.4288	1.7033	-0.9434	-0.2372	0.4288
-9	0.0000	0.0000	0.0000	0.0000	1.8227	-0.9492	-0.2455	0.4431	1.8227	-0.9492	-0.2455	0.4431
-8	0.0000	0.0000	0.0000	0.0000	2.1988	-0.9387	-0.2292	0.4597	2.1988	-0.9387	-0.2292	0.4597
-7	0.0000	0.0000	0.0000	0.0000	2.4651	-0.9777	-0.2597	0.4780	2.4651	-0.9777	-0.2597	0.4780
-6	0.0000	0.0000	0.0000	0.0000	2.1541	-0.9711	-0.2504	0.4759	2.1541	-0.9711	-0.2504	0.4759
-5	0.0000	0.0000	0.0000	0.0000	2.5150	-0.9611	-0.2075	0.5071	2.5150	-0.9611	-0.2075	0.5071
-4	0.0000	0.0000	0.0000	0.0000	2.7665	-0.9626	-0.2208	0.5207	2.7665	-0.9626	-0.2208	0.5207
-3	0.0000	0.0000	0.0000	0.0000	1.5825	-0.9931	-0.3847	0.4605	1.5825	-0.9931	-0.3847	0.4605
-2	0.0000	0.0000	0.0000	0.0000	2.6570	-0.9505	-0.1745	0.6182	2.6570	-0.9505	-0.1745	0.6182
-1	0.0000	0.0000	0.0000	0.0000	2.9819	-0.8893	-0.1856	0.5899	2.9819	-0.8893	-0.1856	0.5899
0	0.0000	0.0000	0.0000	0.0000	4.5732	-0.8315	0.0120	0.8191	4.5732	-0.8315	0.0120	0.8191
1	0.0000	0.0000	0.0000	0.0000	6.4220	-0.8365	0.1390	1.0463	6.4220	-0.8365	0.1390	1.0463
2	0.0000	0.0000	0.0000	0.0000	5.7865	-0.8558	0.1103	0.9439	5.7865	-0.8558	0.1103	0.9439
3	0.0000	0.0000	0.0000	0.0000	5.0645	-0.8099	0.1126	0.9455	5.0645	-0.8099	0.1126	0.9455
4	0.0000	0.0000	0.0000	0.0000	4.6650	-0.8323	0.0821	0.8634	4.6650	-0.8323	0.0821	0.8634
5	0.0000	0.0000	0.0000	0.0000	4.5815	-0.8515	0.0869	0.8419	4.5815	-0.8515	0.0869	0.8419
6	0.0000	0.0000	0.0000	0.0000	5.2050	-0.8033	0.0997	0.8599	5.2050	-0.8033	0.0997	0.8599
7	0.0000	0.0000	0.0000	0.0000	4.4704	-0.7683	0.0721	0.8440	4.4704	-0.7683	0.0721	0.8440
8	0.0000	0.0000	0.0000	0.0000	3.2001	-0.8469	-0.0124	0.6638	3.2001	-0.8469	-0.0124	0.6638
9	0.0000	0.0000	0.0000	0.0000	3.3605	-0.8757	0.0472	0.7498	3.3605	-0.8757	0.0472	0.7498
10	0.0000	0.0000	0.0000	0.0000	4.0716	-0.9341	0.0105	0.8025	4.0716	-0.9341	0.0105	0.8025
11	0.0000	0.0000	0.0000	0.0000	4.1667	-0.9226	0.0564	0.8294	4.1667	-0.9226	0.0564	0.8294
12	0.0000	0.0000	0.0000	0.0000	4.5292	-0.9624	0.0142	0.8157	4.5292	-0.9624	0.0142	0.8157
13	0.0000	0.0000	0.0000	0.0000	3.5819	-0.9015	0.0347	0.7138	3.5819	-0.9015	0.0347	0.7138
14	0.0000	0.0000	0.0000	0.0000	3.2145	-0.8498	0.0495	0.7357	3.2145	-0.8498	0.0495	0.7357
15	0.0000	0.0000	0.0000	0.0000	3.2591	-0.8772	-0.0004	0.7103	3.2591	-0.8772	-0.0004	0.7103

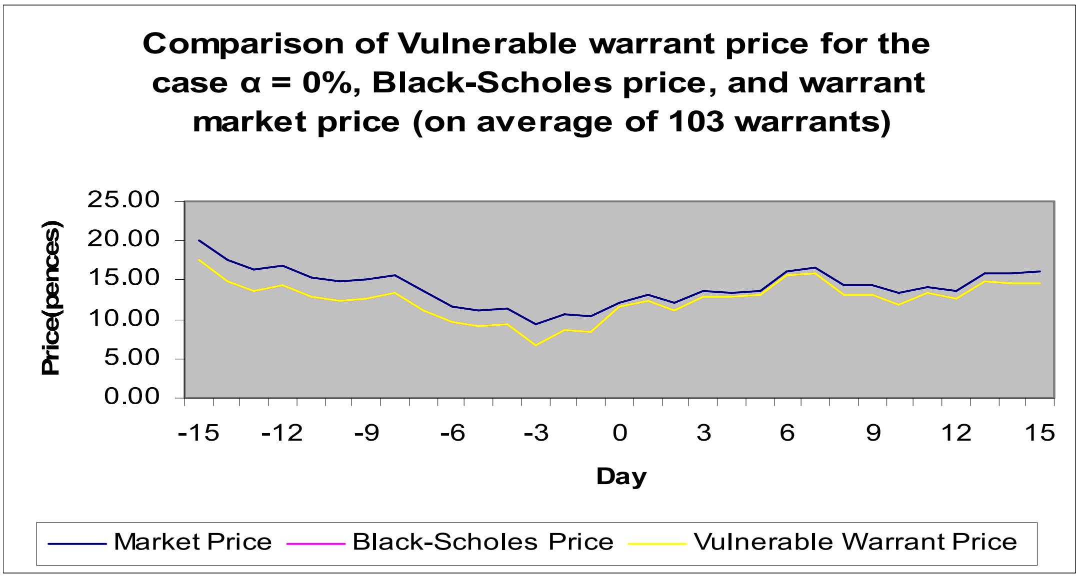
Notes: The sample period extends form April 2007 until December 2008.
α = Bankruptcy costs (both direct and indirect costs)
[a] The price difference between Vulnerable warrant price and Black-Scholes price is calculated as: (Vulnerable warrant price - Black-Scholes price)/Black-Scholes price.
[b] The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value.
[c] The price difference between Black-Scholes price and market value is calculated as: (Black-Scholes price - market value)/market value.

Appendix 6.3: Price Difference between Vulnerable Warrant Price (for the case α = 0.5%), Black-Scholes Price and Market Value of 103 call covered warrants

	Vulnerable Warrant Price and Black-Scholes Price[a]				Vulnerable Warrant Price and Market Value[b]				Black-Scholes Price and Market Value[c]			
Day	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD
-15	-0.0002	-0.0149	-0.0032	0.0023	1.5135	-0.8633	-0.2313	0.3631	1.5227	-0.8623	-0.2292	0.3638
-14	-0.0003	-0.0165	-0.0037	0.0026	1.4011	-0.8829	-0.2713	0.3703	1.4111	-0.8819	-0.2690	0.3712
-13	-0.0003	-0.0160	-0.0037	0.0026	1.6232	-0.8895	-0.2450	0.4051	1.6346	-0.8885	-0.2426	0.4063
-12	-0.0003	-0.0162	-0.0037	0.0026	1.4488	-0.9171	-0.2490	0.3889	1.4596	-0.9163	-0.2466	0.3900
-11	-0.0003	-0.0165	-0.0040	0.0030	1.6295	-0.9425	-0.2670	0.4049	1.6421	-0.9417	-0.2646	0.4059
-10	-0.0003	-0.0183	-0.0040	0.0028	1.6901	-0.9441	-0.2398	0.4275	1.7033	-0.9434	-0.2372	0.4288
-9	-0.0002	-0.0190	-0.0041	0.0029	1.8096	-0.9499	-0.2481	0.4418	1.8227	-0.9492	-0.2455	0.4431
-8	-0.0002	-0.0200	-0.0039	0.0029	2.1852	-0.9394	-0.2317	0.4582	2.1988	-0.9387	-0.2292	0.4597
-7	-0.0003	-0.0243	-0.0045	0.0034	2.4494	-0.9782	-0.2624	0.4766	2.4651	-0.9777	-0.2597	0.4780
-6	-0.0003	-0.0218	-0.0045	0.0032	2.1399	-0.9717	-0.2532	0.4745	2.1541	-0.9711	-0.2504	0.4759
-5	-0.0004	-0.0205	-0.0044	0.0031	2.4993	-0.9619	-0.2104	0.5055	2.5150	-0.9611	-0.2075	0.5071
-4	-0.0003	-0.0206	-0.0045	0.0032	2.7478	-0.9634	-0.2237	0.5191	2.7665	-0.9626	-0.2208	0.5207
-3	-0.0005	-0.0265	-0.0056	0.0039	1.5676	-0.9933	-0.3872	0.4594	1.5825	-0.9931	-0.3847	0.4605
-2	-0.0004	-0.0181	-0.0044	0.0029	2.6405	-0.9514	-0.1776	0.6158	2.6570	-0.9505	-0.1745	0.6182
-1	-0.0005	-0.0149	-0.0044	0.0029	2.9660	-0.8909	-0.1886	0.5879	2.9819	-0.8893	-0.1856	0.5899
0	-0.0004	-0.0131	-0.0035	0.0023	4.5546	-0.8328	0.0088	0.8162	4.5732	-0.8315	0.0120	0.8191
1	-0.0004	-0.0132	-0.0033	0.0021	6.3980	-0.8377	0.1354	1.0426	6.4220	-0.8365	0.1390	1.0463
2	-0.0003	-0.0144	-0.0035	0.0022	5.7629	-0.8570	0.1068	0.9405	5.7865	-0.8558	0.1103	0.9439
3	-0.0003	-0.0137	-0.0033	0.0022	5.0438	-0.8113	0.1092	0.9419	5.0645	-0.8099	0.1126	0.9455
4	-0.0003	-0.0143	-0.0034	0.0022	4.6446	-0.8347	0.0787	0.8602	4.6650	-0.8323	0.0821	0.8634
5	-0.0003	-0.0146	-0.0034	0.0022	4.5604	-0.8536	0.0835	0.8387	4.5815	-0.8515	0.0869	0.8419
6	-0.0002	-0.0140	-0.0032	0.0021	5.1805	-0.8060	0.0963	0.8565	5.2050	-0.8033	0.0997	0.8599
7	-0.0002	-0.0131	-0.0032	0.0021	4.4496	-0.7703	0.0689	0.8406	4.4704	-0.7683	0.0721	0.8440
8	-0.0002	-0.0144	-0.0037	0.0023	3.1799	-0.8485	-0.0159	0.6610	3.2001	-0.8469	-0.0124	0.6638
9	-0.0002	-0.0148	-0.0036	0.0023	3.3397	-0.8775	0.0437	0.7468	3.3605	-0.8757	0.0472	0.7498
10	-0.0002	-0.0168	-0.0041	0.0027	4.0451	-0.9348	0.0068	0.7992	4.0716	-0.9341	0.0105	0.8025
11	-0.0002	-0.0162	-0.0039	0.0026	4.1393	-0.9238	0.0527	0.8259	4.1667	-0.9226	0.0564	0.8294
12	-0.0002	-0.0183	-0.0041	0.0028	4.4964	-0.9631	0.0104	0.8119	4.5292	-0.9624	0.0142	0.8157
13	-0.0002	-0.0154	-0.0037	0.0025	3.5585	-0.9030	0.0312	0.7109	3.5819	-0.9015	0.0347	0.7138
14	-0.0002	-0.0137	-0.0036	0.0024	3.1929	-0.8519	0.0459	0.7326	3.2145	-0.8498	0.0495	0.7357
15	-0.0002	-0.0144	-0.0038	0.0025	3.2348	-0.8790	-0.0040	0.7070	3.2591	-0.8772	-0.0004	0.7103

Notes: The sample period extends form April 2007 until December 2008.
α = Bankruptcy costs (both direct and indirect costs)
[a] The price difference between Vulnerable warrant price and Black-Scholes price is calculated as: (Vulnerable warrant price - Black-Scholes price)/Black-Scholes price.
[b] The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value.
[c] The price difference between Black-Scholes price and market value is calculated as: (Black-Scholes price - market value)/market value.

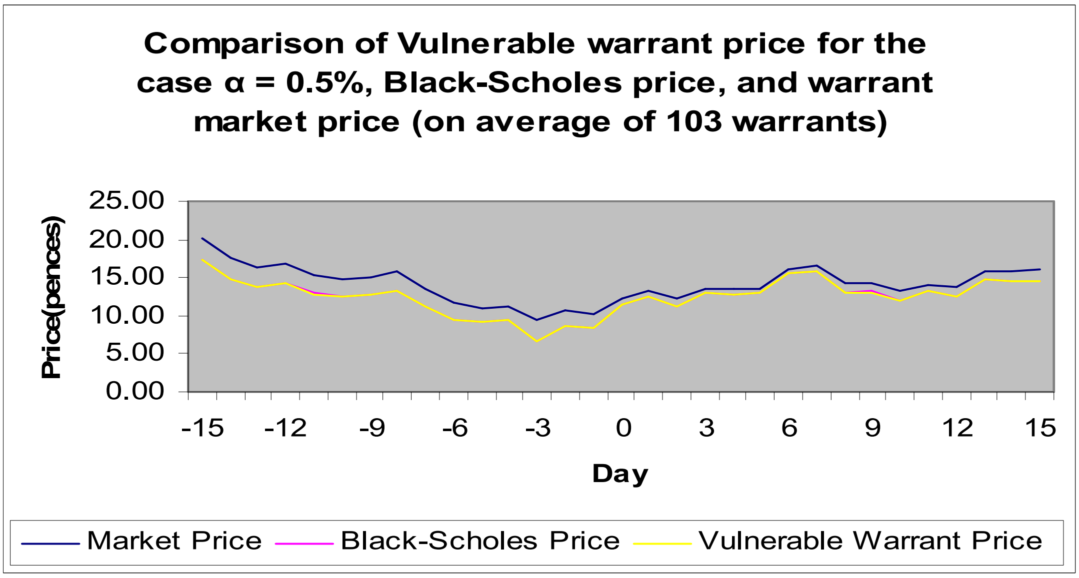
Appendix 6.4: Price difference between Vulnerable warrant price for the case α = 0%, Black-Scholes Price and Market Value (on average for the case of 103 call covered warrants).



Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Appendix 6.5: Price difference between Vulnerable warrant price for the case α = 0.5%, Black-Scholes Price and Market Value (on average for the case of 103 call covered warrants).



Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Appendix 6.6: Comparison of Vulnerable Warrant Price for the case α = 20%, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)		
			Vulnerable model α = 21.49%	Black-Scholes model	Market
98748T	3I GP.PLC.	256	1.97	2.13	3.39
1859J9	3I GROUP PLC	132	1.36	1.46	2.85
1720FT	ANGLO AMER.	192	33.69	36.21	33.26
97092F	ANGLO AMER.	251	27.22	28.86	21.16
1842CP	ANGLO AMER.	139	16.15	16.69	18.64
1842CT	ANTOFAGASTA	139	57.89	59.19	68.26
1651RX	ANTOFAGASTA	220	102.14	103.82	116.49
97092H	ANTOFAGASTA	251	147.66	149.55	162.51
1794RR	ANTOFAGOSTA	157	37.45	38.71	48.94
98748X	ARM HDGS.	256	6.56	6.83	9.15
1859DP	ARM HOLDINGS	132	2.32	2.44	2.31
1651R2	AZEN.	220	7.14	7.56	11.36
1842CV	AZEN.	139	6.08	6.42	9.61
1859DR	AVIVA	132	2.39	2.49	2.44
1651R1	AVIVA	220	3.36	3.50	3.87
98749E	AVIVA	256	1.41	1.53	1.46
98749H	BAE	256	28.05	29.20	35.65
1859DV	BAE SYSTEMS	132	7.83	8.45	16.89
1807ND	BARCLAYS	154	28.34	29.18	24.84
1807NE	BARCLAYS	154	19.04	19.79	16.79
1720FV	BARCLAYS	192	22.78	23.65	16.04
1720FW	BARCLAYS	192	11.86	12.52	7.22
1842JH	BG.GP.	139	13.60	14.67	15.85
1842JJ	BG.GP.	139	7.86	8.93	10.17
1720F7	BHP BILLITON	192	15.36	16.72	16.98
1720F8	BHP BILLITON	192	9.80	10.25	10.09
97092J	BHP BILLITON	251	28.52	29.64	29.87
97092K	BP PLC.	251	32.63	34.02	40.66
97092L	BP PLC.	251	7.79	8.72	12.98
98751T	BRIT.EN.	256	5.74	6.13	6.69
1859D1	BRITISH ENERGY	132	10.94	11.54	11.62
1842JK	BRIT.LAND	139	5.05	5.21	5.46
1842JL	BRIT.LAND	139	3.04	3.17	3.22
1651R9	BRIT.LAND	220	2.66	2.81	3.64
1859D9	BRITISH SKY	132	1.17	1.25	1.82
98751V	BSB.	256	1.69	1.81	2.92
1842JT	BT GROUP	139	3.56	3.83	8.22
1842JU	BT GROUP	139	0.67	0.78	3.14

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Appendix 6.6 (con't): Comparison of Vulnerable Warrant Price for the case α = 20%, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)		
			Vulnerable model α = 21.49%	Black-Scholes model	Market
1859F6	CABLE & WIRELESS	132	2.13	2.30	5.42
98769J	CBW PLC.	255	3.80	4.11	7.07
98769K	PUT-CBW PLC.	255	14.00	14.38	23.83
1859FU	CENTRICA	132	3.13	3.42	6.01
98769L	CENTRICA	255	4.26	4.78	12.20
1859JN	DIAGEO PLC.	132	2.75	2.92	5.21
98769N	DIAGEO PLC.	255	1.71	1.92	3.41
98769Q	EXPERIAN GP.	255	0.84	0.90	2.02
1859JQ	EXPERIAN GROUP	132	1.59	1.66	2.31
1859J2	HAMMERSON PLC.	132	4.43	4.59	5.11
98769T	HAMMERSON PLC.	255	1.72	1.88	4.55
1859JW	HBOS PLC	132	0.92	0.98	1.04
98769W	HBOS PLC.	255	1.51	1.64	1.93
97108W	HSBC HDG.	274	1.67	1.86	2.71
97108X	HSBC HDG.	274	0.17	0.21	0.63
1842TH	HSBC HDG.	138	2.22	2.36	3.02
1842TJ	HSBC HDG.	138	5.95	6.51	7.00
98770E	INVESCO PLC.	255	5.48	5.70	7.83
1840PT	LAND SECURITIES	140	7.89	8.17	11.29
1840PU	LAND SECURITIES	140	5.22	5.47	8.55
1840PV	LAND SECURITIES	140	3.40	3.61	6.40
1859KD	LEGAL & GENERAL	132	4.32	4.52	6.58
98902F	LGL.& GEN.	251	2.85	3.07	2.77
97109C	LLOYDS	274	14.61	15.70	20.71
97109D	LLOYDS	274	3.59	4.15	9.26
1840PP	LLOYDS TSB GROUP	140	18.56	19.29	19.12
1840PQ	LLOYDS TSB GROUP	140	9.96	10.54	10.77
97109E	MAN GROUP	274	43.69	47.36	57.22
1842TL	M&S.	138	0.78	0.82	1.04
1842TN	M&S.	138	0.25	0.27	0.57
1655VU	M&S.	219	2.16	2.26	2.87
1863KU	PERSIMMON	131	2.91	3.01	2.60
98902N	PERSIMMON	251	2.77	2.93	3.80
1842TP	PRUDENTIAL	121	3.96	4.07	4.36
1842TQ	PRUDENTIAL	121	1.68	1.77	2.05
97107E	RIO TINTO	274	140.15	143.18	141.08
97107F	RIO TINTO	274	127.09	130.18	127.69
1859KV	ROLLS ROYCE	132	0.64	0.69	1.27

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Appendix 6.6 (con't): Comparison of Vulnerable Warrant Price for the case α = 20%, Black-Scholes Price, and Market Value (on average for each of 103 call covered warrants over its life-time)

Warrant DS Code	Name of underlying stock	Trading Days	Average Warrants Prices (pence)		
			Vulnerable model α = 21.49%	Black-Scholes model	Market
98902U	ROLLS ROYCE	251	0.93	1.02	1.56
1860EV	RSA IN.GP.PLC.	132	2.93	3.11	4.49
98902D	RSA IN.GP.PLC.	251	4.04	4.31	6.10
1720HL	RBOS.	192	7.26	7.71	12.74
1720HM	RBOS.	192	4.44	4.79	7.96
97107C	RBOS.	274	2.67	3.09	10.97
97109H	ROYAL DUTCH	276	6.88	7.34	8.74
97109J	ROYAL DUTCH	276	3.31	3.66	4.74
1860EX	SAINSBURY	132	0.95	0.99	0.78
98901W	SAINSBURY	251	0.94	1.02	1.53
1860F0	SCOT.& STHN.	132	1.28	1.43	3.56
98901L	SCOT.& STHN.	251	4.45	4.78	9.93
98901P	SCOT.& NEWC.	251	5.91	6.88	9.03
1844W2	STD.CHT.	138	5.97	6.25	8.94
1844W4	STD.CHT.	138	2.96	3.16	5.31
98817H	STD.LF.	251	4.27	4.63	8.07
1840PW	TESCO PLC	140	0.70	0.76	1.29
1860F3	UTD.UTILS.	132	1.10	1.20	2.48
98817C	UTD.UTILS.	251	0.90	1.02	2.58
1720HP	VODAFONE	192	6.18	6.49	7.13
97107P	VODAFONE	121	8.00	8.27	9.55
1844W6	VODAFONE	138	2.50	2.67	4.31
1844W7	VODAFONE	138	5.12	5.36	7.39
1860F5	XSTRATA	132	27.31	31.22	43.38
98817E	XSTRATA	251	47.18	49.67	52.99
1860F8	YELL	132	0.30	0.32	0.94
98818H	YELL	250	0.76	0.82	2.87

Notes: The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

Appendix 6.7: Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
98748T	3I GP.PLC.	S>X	0				
		S=X	0				
		S<X	256	0.60	-1.00	-0.56	0.43
1859J9	3I GROUP PLC	S>X	0				
		S=X	0				
		S<X	132	-0.28	-1.00	-0.65	0.21
1720FT	ANGLO AMER.	S>X	65	0.28	-16.06	-0.11	1.16
		S=X	0				
		S<X	127	0.94	-0.73	0.11	0.23
97092F	ANGLO AMER.	S>X	7	1.02	-309.91	-1.22	19.56
		S=X	0				
		S<X	244	1.65	-0.73	0.40	0.30
1842CP	ANGLO AMER.	S>X	0				
		S=X	0				
		S<X	139	0.50	-3.06	-0.20	0.41
1842CT	ANTOFAGASTA	S>X	22	0.00	-0.41	-0.03	0.07
		S=X	0				
		S<X	117	0.06	-1.00	-0.22	0.30
1651RX	ANTOFAGASTA	S>X	99	0.19	-0.42	-0.05	0.10
		S=X	0				
		S<X	121	0.20	-1.00	-0.14	0.24
97092H	ANTOFAGASTA	S>X	225	0.19	-0.65	-0.08	0.12
		S=X	0				
		S<X	26	0.00	-3.49	-0.04	0.25
1794RR	ANTOFAGOSTA	S>X	0				
		S=X	0				
		S<X	157	0.32	-1.00	-0.34	0.29
98748X	ARM HDGS.	S>X	0				
		S=X	0				
		S<X	256	3.37	-1.00	-0.02	0.93
1859DP	ARM HOLDINGS	S>X	0				
		S=X	0				
		S<X	132	3.13	-1.00	0.50	1.08
1651R2	AZEN.	S>X	13	0.00	-0.20	-0.01	0.04
		S=X	0				
		S<X	207	0.00	-1.00	-0.44	0.23

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
1842CV	AZEN.	S>X	5	0.00	-0.25	-0.01	0.04
		S=X	0				
		S<X	134	0.00	-1.00	-0.41	0.22
1859DR	AVIVA	S>X	0				
		S=X	0				
		S<X	132	0.75	-1.00	-0.01	0.38
1651R1	AVIVA	S>X	9	0.01	-0.09	0.00	0.01
		S=X	0				
		S<X	211	1.07	-1.00	-0.07	0.38
98749E	AVIVA	S>X	0				
		S=X	0				
		S<X	256	4.23	-1.00	0.19	0.82
98749H	BAE	S>X	17	0.05	-0.23	-0.01	0.03
		S=X	0				
		S<X	239	0.18	-1.02	-0.28	0.28
1859DV	BAE SYSTEMS	S>X	0				
		S=X	0				
		S<X	132	-0.34	-1.00	-0.64	0.22
1807ND	BARCLAYS	S>X	9	0.29	0.00	0.01	0.03
		S=X	0				
		S<X	145	2.04	-1.00	0.14	0.52
1807NE	BARCLAYS	S>X	0				
		S=X	0				
		S<X	154	1.10	-1.00	0.11	0.54
1720FV	BARCLAYS	S>X	6	0.30	0.00	0.01	0.05
		S=X	0				
		S<X	186	3.85	-1.00	0.88	1.14
1720FW	BARCLAYS	S>X	0				
		S=X	0				
		S<X	192	7.45	-1.01	1.62	2.03
1842JH	BG.GP.	S>X	104	0.03	-8.83	-0.11	0.75
		S=X	0				
		S<X	35	0.00	-0.37	-0.05	0.09
1842JJ	BG.GP.	S>X	55	0.00	-27.80	-0.23	2.36
		S=X	0				
		S<X	84	0.00	-0.49	-0.11	0.12

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
1720F7	BHP BILLITON	S>X	58	0.14	-12.88	-0.07	0.93
		S=X	0				
		S<X	134	0.30	-0.72	-0.02	0.15
1720F8	BHP BILLITON	S>X	10	0.04	-0.13	0.00	0.01
		S=X	0				
		S<X	182	0.55	-34.44	-0.18	2.50
97092J	BHP BILLITON	S>X	169	0.11	-4.33	-0.02	0.28
		S=X	0				
		S<X	82	0.23	-0.60	-0.01	0.09
97092K	BP PLC.	S>X	85	0.16	-0.26	-0.03	0.08
		S=X	0				
		S<X	166	0.24	-1.09	-0.15	0.17
97092L	BP PLC.	S>X	0				
		S=X	0				
		S<X	251	2.14	-1.02	-0.21	0.51
98751T	BRIT.EN.	S>X	69	0.09	-7.56	-0.03	0.47
		S=X	0				
		S<X	187	0.30	-0.72	-0.12	0.17
1859D1	BRITISH ENERGY	S>X	94	0.24	-4.94	-0.03	0.43
		S=X	0				
		S<X	38	0.11	-0.31	-0.02	0.05
1842JK	BRIT.LAND	S>X	9	0.10	-0.01	0.00	0.02
		S=X	0				
		S<X	130	0.15	-1.00	-0.30	0.39
1842JL	BRIT.LAND	S>X	0				
		S=X	0				
		S<X	139	0.26	-1.00	-0.32	0.45
1651R9	BRIT.LAND	S>X	0				
		S=X	0				
		S<X	220	0.28	-1.01	-0.40	0.37
1859D9	BRITISH SKY	S>X	0				
		S=X	0				
		S<X	132	-0.01	-1.00	-0.49	0.33
98751V	BSB.	S>X	0				
		S=X	0				
		S<X	256	0.10	-1.00	-0.46	0.30

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
1842JT	BT GROUP	S>X	0				
		S=X	0				
		S<X	139	-0.39	-1.00	-0.68	0.20
1842JU	BT GROUP	S>X	0				
		S=X	0				
		S<X	139	-0.53	-1.01	-0.82	0.15
1859F6	CABLE & WIRELESS	S>X	0				
		S=X	0				
		S<X	132	-0.41	-1.00	-0.71	0.15
98769J	CBW PLC.	S>X	0				
		S=X	0				
		S<X	255	0.02	-1.00	-0.55	0.27
98769K	PUT-CBW PLC.	S>X	108	1.34	-0.29	0.17	0.32
		S=X	0				
		S<X	147	0.00	-1.00	-0.43	0.41
1859FU	CENTRICA	S>X	0				
		S=X	0				
		S<X	132	-0.22	-1.00	-0.67	0.26
98769L	CENTRICA	S>X	0				
		S=X	0				
		S<X	255	-0.48	-1.01	-0.72	0.16
1859JN	DIAGEO PLC.	S>X	0				
		S=X	0				
		S<X	132	-0.22	-1.00	-0.55	0.24
98769N	DIAGEO PLC.	S>X	0				
		S=X	0				
		S<X	255	0.09	-1.00	-0.52	0.28
98769Q	EXPERIAN GP.	S>X	0				
		S=X	0				
		S<X	255	-0.30	-1.03	-0.71	0.23
1859JQ	EXPERIAN GROUP	S>X	3	0.00	-0.24	-0.01	0.03
		S=X	0				
		S<X	129	0.04	-1.00	-0.37	0.22
1859J2	HAMMERSON PLC.	S>X	0				
		S=X	0				
		S<X	132	1.05	-1.00	-0.31	0.48

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
98769T	HAMMERSON PLC.	S>X	0				
		S=X	0				
		S<X	255	-0.17	-1.00	-0.64	0.23
1859JW	HBOS PLC	S>X	0				
		S=X	0				
		S<X	132	3.27	-1.00	-0.11	0.84
98769W	HBOS PLC.	S>X	0				
		S=X	0				
		S<X	255	2.06	-1.00	-0.20	0.64
97108W	HSBC HDG.	S>X	0				
		S=X	0				
		S<X	274	0.21	-1.00	-0.35	0.29
97108X	HSBC HDG.	S>X	0				
		S=X	0				
		S<X	274	0.10	-1.13	-0.73	0.29
1842TH	HSBC HDG.	S>X	0				
		S=X	0				
		S<X	138	0.00	-1.01	-0.29	0.23
1842TJ	HSBC HDG.	S>X	91	0.04	-61.36	-0.50	5.22
		S=X	0				
		S<X	47	0.10	-0.43	-0.03	0.08
98770E	INVESCO PLC.	S>X	27	0.00	-0.19	-0.01	0.03
		S=X	0				
		S<X	145	0.02	-1.00	-0.29	0.23
1840PT	LAND SECURITIES	S>X	8	0.00	-0.25	-0.01	0.05
		S=X	0				
		S<X	132	0.00	-1.00	-0.37	0.24
1840PU	LAND SECURITIES	S>X	0				
		S=X	0				
		S<X	140	-0.21	-1.00	-0.48	0.23
1840PV	LAND SECURITIES	S>X	0				
		S=X	0				
		S<X	140	-0.25	-1.00	-0.56	0.22
1859KD	LEGAL & GENERAL	S>X	0				
		S=X	0				
		S<X	132	0.06	-1.00	-0.42	0.28

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
98902F	LGL.& GEN.	S>X	0				
		S=X	0				
		S<X	251	2.22	-1.00	0.08	0.67
97109C	LLOYDS	S>X	0				
		S=X	0				
		S<X	274	4.03	-1.00	0.17	1.01
97109D	LLOYDS	S>X	0				
		S=X	0				
		S<X	274	6.72	-1.01	0.14	1.52
1840PP	LLOYDS TSB GROUP	S>X	1	0.00	-0.16	0.00	0.01
		S=X	0				
		S<X	139	0.60	-1.00	-0.13	0.41
1840PQ	LLOYDS TSB GROUP	S>X	0				
		S=X	0				
		S<X	140	0.81	-1.00	-0.14	0.48
97109E	MAN GROUP	S>X	35	0.00	-26.03	-0.13	1.57
		S=X	0				
		S<X	239	0.23	-0.54	-0.13	0.18
1842TL	M&S.	S>X	0				
		S=X	0				
		S<X	138	1.43	-1.00	-0.15	0.84
1842TN	M&S.	S>X	0				
		S=X	0				
		S<X	138	1.22	-1.01	-0.52	0.61
1655VU	M&S.	S>X	2	0.00	-0.09	0.00	0.01
		S=X	0				
		S<X	217	2.87	-1.07	-0.19	0.82
1863KU	PERSIMMON	S>X	0				
		S=X	0				
		S<X	131	0.79	-1.00	-0.16	0.56
98902N	PERSIMMON	S>X	0				
		S=X	0				
		S<X	251	1.27	-1.01	-0.22	0.56
1842TP	PRUDENTIAL	S>X	13	0.14	-0.24	-0.01	0.05
		S=X	0				
		S<X	108	0.15	-1.00	-0.14	0.29

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
1842TQ	PRUDENTIAL	S>X	0				
		S=X	0				
		S<X	121	0.14	-1.00	-0.27	0.35
97107E	RIO TINTO	S>X	215	0.36	-2.64	0.01	0.17
		S=X	0				
		S<X	59	0.16	-0.23	0.00	0.05
97107F	RIO TINTO	S>X	198	0.39	-2.90	0.01	0.18
		S=X	0				
		S<X	76	0.24	-0.25	0.00	0.07
1859KV	ROLLS ROYCE	S>X	0				
		S=X	0				
		S<X	132	0.04	-1.00	-0.55	0.29
98902U	ROLLS ROYCE	S>X	0				
		S=X	0				
		S<X	251	0.06	-1.00	-0.45	0.30
1860EV	RSA IN.GP.PLC.	S>X	0				
		S=X	0				
		S<X	132	0.11	-1.02	-0.42	0.26
98902D	RSA IN.GP.PLC.	S>X	0				
		S=X	0				
		S<X	251	0.03	-1.00	-0.42	0.25
1720HL	RBOS.	S>X	0				
		S=X	0				
		S<X	192	1.79	-1.00	-0.22	0.66
1720HM	RBOS.	S>X	0				
		S=X	0				
		S<X	192	3.25	-1.00	-0.21	0.82
97107C	RBOS.	S>X	0				
		S=X	0				
		S<X	274	4.43	-1.02	-0.33	0.90
97109H	ROYAL DUTCH	S>X	1	0.00	0.00	0.00	0.00
		S=X	0				
		S<X	275	0.88	-1.87	-0.13	0.29
97109J	ROYAL DUTCH	S>X	0				
		S=X	0				
		S<X	276	0.83	-1.01	-0.21	0.37

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
1860EX	SAINSBURY	S>X	0				
		S=X	0				
		S<X	132	1.33	-1.00	-0.14	0.67
98901W	SAINSBURY	S>X	0				
		S=X	0				
		S<X	251	4.15	-1.00	-0.06	1.31
1860F0	SCOT.& STHN.	S>X	0				
		S=X	0				
		S<X	132	-0.41	-1.00	-0.75	0.19
98901L	SCOT.& STHN.	S>X	8	0.00	-0.40	-0.01	0.07
		S=X	0				
		S<X	243	0.00	-1.01	-0.59	0.21
98901P	SCOT.& NEWC.	S>X	171	6.87	-8.14	-0.10	0.82
		S=X	0				
		S<X	80	0.00	-0.83	-0.17	0.27
1844W2	STD.CHT.	S>X	0				
		S=X	0				
		S<X	138	-0.01	-1.02	-0.38	0.23
1844W4	STD.CHT.	S>X	0				
		S=X	0				
		S<X	138	-0.11	-1.00	-0.50	0.22
98817H	STD.LF.	S>X	0				
		S=X	0				
		S<X	251	2.59	-1.00	-0.29	0.58
1840PW	TESCO PLC	S>X	0				
		S=X	0				
		S<X	140	-0.11	-1.00	-0.52	0.22
1860F3	UTD.UTILS.	S>X	0				
		S=X	0				
		S<X	132	-0.34	-1.00	-0.61	0.18
98817C	UTD.UTILS.	S>X	0				
		S=X	0				
		S<X	251	-0.44	-1.00	-0.67	0.15
1720HP	VODAFONE	S>X	0				
		S=X	0				
		S<X	192	0.10	-1.00	-0.32	0.32

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.7 (con't): Price Difference between Vulnerable Warrant for the case α = 1% and Market Value (In case of In-the-money, At-the-money, and Out-of-the-money for 103 call covered warrants)

Warrant DS Code	Name of underlying stock	Moneyness	Days	Max	Min	Mean	SD
97107P	VODAFONE	S>X	31	0.00	-0.27	-0.04	0.07
		S=X	0				
		S<X	90	0.49	-1.00	-0.07	0.32
1844W6	VODAFONE	S>X	0				
		S=X	0				
		S<X	138	-0.16	-1.00	-0.67	0.27
1844W7	VODAFONE	S>X	1	0.00	-0.18	0.00	0.02
		S=X	0				
		S<X	137	0.00	-1.00	-0.50	0.25
1860F5	XSTRATA	S>X	42	0.00	-15.62	-0.20	1.36
		S=X	0				
		S<X	90	0.00	-0.49	-0.20	0.17
98817E	XSTRATA	S>X	120	0.33	-5.54	-0.05	0.36
		S=X	0				
		S<X	131	0.52	-0.47	-0.03	0.15
1860F8	YELL	S>X	0				
		S=X	0				
		S<X	132	-0.40	-1.00	-0.83	0.22
98818H	YELL	S>X	0				
		S=X	0				
		S<X	250	-0.27	-1.00	-0.83	0.16

Notes:
The sample period extends form April 2007 until December 2008.

α = Bankruptcy costs (both direct and indirect costs)

The price difference between Vulnerable warrant price and market value is calculated as: (Vulnerable warrant price - market value)/market value. Therefore, the negative signs in the table mean that Vulnerable warrant price is less than market price.

S = stock price
X = exercise price
S>X in-the-money
S=X at-the-money
S<X out-of-the-money

Appendix 6.8: Price Difference (in pence) between Black-Scholes Price and Market Value of 154 call covered warrants

	Black-Scholes Price and Market Value[a]			
Day	Max	Min	Mean	SD
-15	16.7700	-19.6070	-2.5640	5.3819
-14	15.7800	-18.1380	-2.5903	5.2397
-13	15.0700	-16.7340	-2.4756	5.0508
-12	16.3300	-16.8230	-2.4745	5.1832
-11	15.8600	-17.0990	-2.3844	5.1328
-10	16.5100	-16.6260	-2.2739	5.0187
-9	15.9800	-17.5750	-2.2910	4.9538
-8	15.5900	-17.8080	-2.1628	4.9672
-7	12.9800	-17.7170	-2.1128	4.7777
-6	13.1420	-15.4410	-1.8802	4.5839
-5	15.6120	-16.4220	-1.5569	4.7250
-4	16.6890	-16.0990	-1.5474	4.9131
-3	9.2380	-22.5930	-2.5624	4.7953
-2	20.0430	-19.0290	-1.2638	5.1871
-1	17.7990	-16.7070	-1.0573	4.9984
0	21.6940	-14.3440	-0.4337	5.6478
1	25.9800	-14.4520	0.2569	5.9066
2	25.9060	-14.2590	0.1654	5.6848
3	27.8100	-13.7490	0.4457	5.9055
4	27.1400	-15.8190	0.3280	5.8549
5	28.2800	-13.8850	0.4471	5.8499
6	19.2830	-9.5670	0.0183	3.8390
7	19.6730	-9.4790	0.2486	4.0756
8	13.4740	-8.9870	-0.1003	3.3197
9	12.8280	-6.9290	0.0837	3.2340
10	12.1130	-6.9079	0.1040	3.0749
11	13.0390	-9.2000	0.1181	3.6638
12	11.1140	-6.1860	0.0259	2.9530
13	12.9140	-9.0330	0.0382	3.2217
14	13.5490	-6.7470	0.0231	3.3257
15	10.5750	-7.3300	0.0825	2.8666

Note: The sample period extends form April 2007 until December 2008.

[a] The price difference between Black-Scholes price and market value is calculated as: Black-Scholes price - market value

Appendix 6.9: Price Difference between Black-Scholes Price and Market Value (based on the underlying security price) of 154 call covered warrants

Day	Black-Scholes Price and Market Value[a]			
	Max	Min	Mean	SD
-15	0.0186	-0.0622	-0.0073	0.0128
-14	0.0177	-0.0614	-0.0074	0.0130
-13	0.0193	-0.0610	-0.0069	0.0125
-12	0.0153	-0.0611	-0.0071	0.0126
-11	0.0177	-0.0625	-0.0070	0.0127
-10	0.0176	-0.0613	-0.0068	0.0124
-9	0.0175	-0.0588	-0.0067	0.0122
-8	0.0177	-0.0555	-0.0064	0.0119
-7	0.0206	-0.0538	-0.0062	0.0118
-6	0.0202	-0.0500	-0.0060	0.0117
-5	0.0221	-0.0497	-0.0055	0.0115
-4	0.0205	-0.0509	-0.0059	0.0120
-3	0.0166	-0.0495	-0.0073	0.0131
-2	0.0264	-0.0416	-0.0052	0.0120
-1	0.0366	-0.0384	-0.0046	0.0118
0	0.0442	-0.0382	-0.0031	0.0122
1	0.0499	-0.0342	0.0021	0.0113
2	0.0446	-0.0347	0.0022	0.0105
3	0.0431	-0.0356	0.0018	0.0105
4	0.0436	-0.0341	0.0019	0.0106
5	0.0412	-0.0340	0.0020	0.0104
6	0.0409	-0.0360	0.0014	0.0105
7	0.0409	-0.0375	0.0020	0.0100
8	0.0292	-0.0319	-0.0015	0.0076
9	0.0549	-0.0387	0.0023	0.0112
10	0.0536	-0.0584	0.0026	0.0117
11	0.0534	-0.0384	0.0017	0.0106
12	0.0557	-0.0380	0.0018	0.0101
13	0.0571	-0.0373	0.0015	0.0101
14	0.0573	-0.0399	0.0014	0.0101
15	0.0562	-0.0445	0.0022	0.0106

Note: The sample period extends form April 2007 until December 2008.

[a] The price difference between Black-Scholes price and market value is calculated as: (Black-Scholes price - market value)/underlying security price

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