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Hedged Dividend Capture: An Examination of the HDC Strategy on the Canadian Derivatives Market

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Abstract

The paper presents research on the risk-reward profit potential when employing a *hedged dividend capture* (HDC) by means of a protective put strategy on dividend-yielding stocks traded on the Toronto Stock Exchange. By applying quoted mid-prices as an estimate of the price of the underlying stock and put-options applied to the hedge, the HDC strategy is hugely profitable throughout the sample period. However, when applying quoted bid/ask-prices as a proxy for transaction costs, the profitability of the strategy is erased, indicating that the market is efficiently priced. The success of the HDC strategy will therefore be determined by the level of transaction costs at which the investor is able to execute trades. Defining the relevant risk for an investor aiming to employ a HDC strategy has proven to be challenging. This paper applies performance measures implementing information from the higher moments of the return distribution, such as the Omega ratio, modified value-at-risk (MVaR) and modified Sharpe-ratio (MSR), and also analyzes the shape of the return distribution of the HDC strategy. It also demonstrates that, in terms of risk-reward, the HDC strategy outperforms the UHDC strategy over the sample period. Moreover, several first- and second-order Greeks are applied to measure the sensitivity of the put-options applied to the HDC strategy. It is shown by means of Delta, Gamma and DdeltaDvol that several options in the sample carry excess risk that potentially prevents the investor from being fully delta-hedged throughout the holding period of the HDC strategy.

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Chapter I

INTRODUCTION

This paper aims to research the profit potential from capturing dividends on dividend yielding stocks on the Canadian Derivatives Exchange. The strategy of capturing dividends on dividend yielding stocks will from here on in be referred to as a *hedged dividend capture* (HDC), which is in line with previously written literature (e.g. Brown and Lummer 1984). Brown and Lummer (1986 p. 65) define an HDC as: "purchasing shares of common stock and selling call options on that stock immediately prior to an ex-dividend date and then liquidating the positon as soon as possible after the dividend has been received". Previous research has, to a large extent, focused on capturing dividends by writing covered call options on stocks, indexes and futures contracts. Another primary focus of previous studies has been centered around the favorable tax rates on dividend payments. In this study, however, the hedged dividend capture will be conducted by purchasing put-options on the underlying stock. The main point of this research will not be to focus on the tax aspect of a hedged dividend capture, but rather to ascertain its success as an investment option for institutional and retail investors, from here on in referred to as *investors*, seeking to exploit the possibilities of profiting from stocks ex-dividend.

The data material covers a time period ranging from January 2015 throughout 2017. The sample consist of 2,523 observations of daily returns in total. The HDC strategy has been analyzed over three separate holding periods: one, two and three days prior to the ex-dividend date and compared to a long position in the stock prior to ex-dividend, from here on referred to as an unhedged dividend capture (UHDC).

Research Question

The research question applied in this paper is:

> *Hedged Dividend Capture on the Canadian Derivatives Exchange: Is it profitable, from a risk-reward perspective, to employ a protective put hedging strategy on Canadian dividend-paying stocks?*

To answer the question in-depth, it has been divided into three sub-questions. The first sub-question is aimed at analyzing the strategy across different holding periods and comparing it to an UHDC strategy to determine whether the HDC strategy is more or less effective by increasing the holding period (in number of days) and whether the HDC strategy actually produces better risk-adjusted returns than simply holding the stock at ex-dividend:

a. Is the HDC strategy more profitable at a one- two- or three-day holding periods, and are the holding periods, in risk-adjusted terms, more profitable than an UHDC strategy?

Second, the HDC strategy is analyzed according to the transaction costs involved when initiating the strategy. Initially, the HDC strategy is analyzed according to quoted mid-prices. However, as will be demonstrated in this research, this assumption does not reflect the relevant transaction costs of the investor, and therefore quoted bid/ask-prices will be applied. The second sub-question therefore is:

b. Does applying quoted bid/ask-prices as the relevant transaction costs for the investor remove the profit potential of the HDC strategy?

The third sub-question is aimed at analyzing the risk involved when investing in the HDC strategy.

c. What is the relevant risk of investing in the HDC strategy, and are the applied risk measures valid?

Structure

The paper is structured as follows:

- **Chapter II** introduces the reader to previously written literature relevant to the research question, such as the price behavior of dividend-paying stocks and previous research on the HDC strategy.
- **Chapter III** introduces the reader to the theoretical framework applied throughout the paper, such as dividend dates terminology, the protective put strategy, the HDC strategy, and risk measures, such as the Greeks, modified value-at-risk (MVaR), modified Sharpe-ratio (MSR) and the Omega ratio.
- **Chapter IV** introduces the data sample applied in the analysis of this research and defines the stocks included in the sample, the dividend distribution of the sample, the time to maturity of the options in the sample, the strike prices of the options in the sample, and the bid/ask-spreads and volume of the sample.
- **Chapter V** introduces the reader to the analysis and the results, such as descriptive statistics, effects of transaction costs, bid/ask sensitivity analysis, Greek estimations, MVaR and MSR analysis, and a case study removing some of the assumptions underlying the HDC strategy. It concludes by also looking at shortcomings in the research and making recommendations for future studies.

Chapter II

RELATED LITERATURE

Price Behavior of Dividend-paying Stocks

In a Miller & Modigliani (1961) setting with perfect capital markets, the stock price of a dividend-yielding company should drop by an amount exactly equal to the dividend after payment. Any possibility of abnormal returns relating to the payment of dividends should be nonexistent (Henry and Koski 2016). If this were not the case, an investor could buy the stock prior to its dividend payment, receive the dividends, sell the stock and make a risk-free profit. However, due to market frictions, such as taxes and transaction costs, this is not a normal occurrence in the real world. Extensive research has shown that stock prices tend to fall by an amount less than the dividend (Chowdhury and Sonaer 2016; Jakob and Ma 2007; Graham and Kumar 2006; Lakonishok and Vermaelen 1986; Eades et al. 1984; Elton and Gruber 1970). Previous research has documented this price behavior for Canadian stocks as well (Athanassakos 1996). These results have been seen over many decades and across different regions of the world (Blandón et al. 2011).

Elton and Gruber (1970; also reviewed in Brooks and Edwards 1980) showed that in a rational market, an investor must be indifferent as to selling stock before and after the ex-dividend date. Through their research, the authors claim that the difference between the price decline after dividends and the dividend amount is due to the *tax-clientele effect*. Following their notation, let:

S_B: Stock price prior to ex-dividend

S_A: Stock price after ex-dividend

S_C: Stock price at which the stock was purchased

t_o: Tax rate on ordinary income

t_C: Tax rate on capital gains

D: Dividend amount

If an investor chooses to sell his stock prior to ex-dividend, he would receive any capital gains incurred from the stock less taxes on capital gains $S_B - t_C(S_B - S_C)$. If, on the other hand, he chooses to sell stock ex-dividend, he would receive the dividend amount less taxes on ordinary income and any capital gains incurred on the stock less taxes on capital gains $S_A - t_C(S_A - S_C) + D\,(1 - t_O)$. Therefore, the following equation must hold for an investor to be indifferent between selling stock before and after ex-dividend:

$$S_B - t_C(S_B - S_C) = S_A - t_C(S_A - S_C) + D(1 - t_O) \qquad (1)$$

By rearranging this equation, the following relationship between the dividend amount, stock prices cum-dividend/ex-dividend and the investor's tax rates can be illustrated:

$$\frac{S_B - S_A}{D} = \frac{1 - t_O}{1 - t_C} \qquad (2)$$

Elton and Gruber define the rearranged part of this equation as the price behavior necessary cum-dividend and ex-dividend that will make an investor with a set of tax rates (t_o, t_C) indifferent between selling his stocks cum-dividend/ex-dividend. In other words, $(S_B - S_A)/D$ therefore reflects the marginal tax rates of the investor. In their research, Elton and Gruber find that stock prices on the New York Stock Exchange on average fall by 78 percent of the dividend amount. Hence, the statistic $(S_B - S_A)/D$ equals 0.78. Further, they discover that in only 1.5 percent of the cases, $(S_B - S_A)/D$ is equal to, or greater than, one.[1]

[1] Much research has been conducted based on Elton and Grubber (1970). See for instance Jakob and Ma (2007) for a closer examination of the *tax-clientele effect*.

Another explanation in financial literature for the difference between the drop in the stock price and the dividend amount ex-dividend relies on findings from Kalay (1982). This explanation, as presented by Blandón et al. (2011), is referred to as "the short-term trading hypothesis." Kalay shows that even if investors were taxed equally between dividends and capital gains, the decrease in the stock price ex-dividend would still not equal the dividend amount. Other findings support this view: Frank and Jagannathan (1998) and Yahyaee (2008) find that there is still a difference between the decrease in the stock price ex-dividend and the dividend amount in markets where there are no taxes on either dividends or capital gains (Blandón et al. 2011). This research will not try to contribute to the discussion as to why the difference between the decrease in the stock price and dividend amount ex-dividend exists but rather try to exploit the price behavior described above. However, the price behavior of the stock price ex-dividend is highly relevant for this research due to the fact that it is a necessary condition for the profitability of the HDC strategy that the stock price falls by an amount less than the dividend.

Previous Research on the HDC Strategy

Keith C. Brown and Scott L. Lummer study the profitability of applying an HDC strategy on the New York Stock Exchange over three separate studies (1984; 1986; 1986). In their research, Brown and Lummer analyze the returns generated from writing covered calls on dividend paying stocks. The authors find positive returns generated from the HDC strategy in all three studies. Further, the authors find that the HDC strategy reduces risk while at the same time increasing returns compared to an UHDC strategy. Similarly, the authors find that the HDC reduces risk compared to the S&P 500. One interesting finding from their research is the fact that the HDC becomes more profitable and less risky when *only* including the highest dividend yielding stocks in the data sample. This finding is important and has been used as a criterion for the stock inclusion in the data sample in this research. In addition, Brown and Lummer test whether the profitability of the HDC strategy simply is due to the NYSE being in an overall bull market. They find that the returns from the HDC strategy are still positive when only including the data sample days where the S&P500 declined in value.

A number of studies have been conducted on the HDC strategy with the use of other derivatives as well: Zivney and Alderson (1986) analyze the profit potential of hedging dividend-yielding stocks by means of index options. In their research, a portfolio of dividend-yielding stocks composing the S&P100 is offset by writing index calls. In line with Brown and Lummer (1984; 1986; 1986), Zivney and Alderson find that the strategy increases returns while at the same time reduces risk compared to investing in the index by itself or investing in Treasury bills.

Dubofsky (1987) analyzes the returns from an HDC strategy by selling index futures on the S&P500 to offset a cash position in the largest dividend-yielding stocks on the S&P500. This strategy poses certain advantages to the investor compared to using option contracts such as lower transaction costs and higher liquidity. Dubofsky finds that the HDC strategy generated positive results. However, compared to only holding a cash position in the portfolio, the strategy proved less successful. Dubofsky attributes this to the market rising significantly during the sample period.

Chapter III

THEORETICAL FRAMEWORK

Dividend Dates

Several dates relating to a company's distribution of dividends should be defined: the declaration date, the cum-dividend date, the ex-dividend date, the record date and the payable date.

- **Declaration date:** the date when a company announces its next dividend payment, payable date, ex-dividend date and record date.
- **Cum-dividend date:** the date when the buyer of the stock is entitled to his next dividend payment.
- **Ex-dividend date:** the day after the last cum-dividend date. On this date, an investor purchasing stocks will not be entitled to the dividend and the right to the dividends will be transferred to the seller.
- **Record date:** the date when a company determines which shareholders hold a claim to its dividends and lists all shareholders with claims on the dividends in its shareholder register.
- **Payment date:** the date when the shareholder with claims on the dividends, according to the shareholder register, is paid his dividends.

Thus, for an investor to be eligible for dividends on a stock purchase, he must purchase stock at the latest within the last trades before the close of the last cum-dividend date or the settlement will occur ex-dividend and the seller of the stock will receive the dividends.

Protective Put Strategy

As stated in the introduction, the HDC strategy applies a long position in a put-option and the underlying stock. Therefore, the HDC strategy is actually a protective put strategy. The profit pattern from a protective put strategy is illustrated in Figure 1:

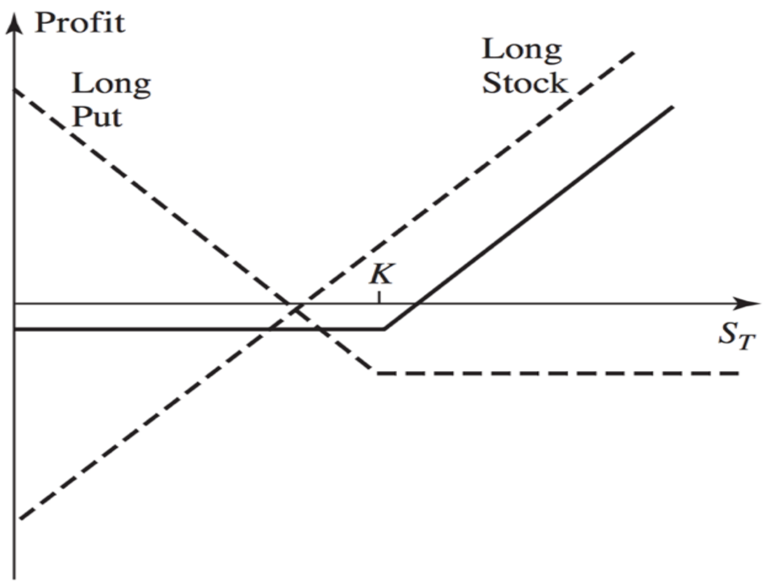

Figure 1. Profit Pattern of a Protective Put Strategy

Source: John C. Hull 2011

Figure 1 illustrates the profit or loss on the vertical axis and the stock price of the underlying stock S_T along the horizontal axis. K represents the strike price of the option. The dotted lines represent a long-put and long-stock position while the profit potential of the strategy is indicated by the solid black line. As the figure illustrates, the investor's maximum loss from the strategy will always equal the premium paid for the option, illustrated as the flat section of the profit pattern line. On the other hand, the investor would earn any capital gains from an increase in the stock price exceeding the premium initially paid for the option, illustrated as the area above the intersection of the solid black line and the horizontal stock price axis.

The HDC Strategy

The HDC strategy aims to profit on the price behavior of the dividend paying stocks and is identical to a protective put, as demonstrated previously. The investor purchases the stock and covers his position with a put-option on the same stock prior to ex-dividend. The aim of the strategy is to hedge the price risk of the underlying stock through the purchase of a put-option so that the investor makes a profit on the dividends received from the underlying stock while removing the risk of price movements in the stock from initiation to ex-dividend.

The dividend payment is known in advance and represents no risk for the investor. Thus, the risk factors relevant to the investor relate to the price movements of the underlying stock and the put-options applied to the strategy. The success of the HDC strategy depends on how well the put-options applied hedge the price movement of the underlying stock at ex-dividend.

Let $S_{cum-div}$ and S_{ex-div} denote the price of the underlying stock at the cum-dividend and ex-dividend date, and $P_{cum-div}$ *and* P_{ex-div} denote the price of the put-option at the cum-dividend and the ex-dividend date. The cumulative returns from the HDC strategy, excluding transaction costs and taxes, (r_{HDC}) can be calculated as the sum of the net profit (loss) of the long stock and put position. The returns from the HDC strategy analyzed in this paper have been calculated accordingly:

$$r_{HDC} = (S_{ex\text{-}div} - S_{cum\text{-}div} + D)/S_{cum\text{-}div}) + (P_{ex\text{-}div} - P_{cum\text{-}div})/P_{cum\text{-}div} \qquad (3)$$

Risk Measures

This study applies several of the first- and second-order Greeks to analyze the sensitivity of the options applied to the HDC strategy. The Greeks have been calculated in VBA (see Appendix 1 for code). The formulas presented in this section are based on the Black-Scholes framework (1973) and have been applied according to notations from Haug (2007). Table 1 defines several variables that will be used frequently throughout this section:

Table 1. List of Symbols

List of Symbols	
S:	Stock price of underlying asset
K:	Strike price of option
P:	Price of put-option
b:	Cost of carry (continuously compounded)*
r:	Risk-free interest rate: In this paper calculated as an annualized 1-month Canadian T-bill equal to 0.53 percent
T:	Time to expiration of option (as % of days per year)
σ:	Volatility of underlying asset (statistical volatility)
N(x):	The cumulative normal distribution function
n(x):	The standardized normal density function $n(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$
d_1:	$d_1 = \frac{\ln\left(\frac{S}{K}\right) + (b + \sigma^2/2)T}{\sigma\sqrt{T}}$
d_2:	$d_2 = d_1 - \sigma\sqrt{T}$

** b = r-q where q equals the continuously compounded dividend yield*

Delta (Δ_{put}) of the put-options applied in the sample will be calculated to analyze how well the HDC strategy manages to maintain a delta-neutral position throughout the period. As will be discussed in the next chapter, deep in-the-money put-options will be applied to the strategy to try to emulate a delta-neutral position. The delta will be used as a tool to determine how well those options manage to hedge price risk throughout the sample period. Delta of a put-option is calculated as:

$$\Delta_{put} = \frac{\partial P}{\partial S} = e^{(b-r)T}[N(d1) - 1] \tag{4}$$

The beta of the put-options applied in the HDC strategy will be calculated to measure the market risk associated with investing in the strategy. Since the HDC strategy is a protective put, the beta of the HDC strategy is the sum of the individual put-betas (β_{put}) and stock-betas (β_S). Following the notation of Rouah and Vainberg (2007), put-beta is calculated as:

$$\beta_{put} = \frac{S}{P}\Delta_{put}\beta_S \tag{5}$$

Gamma (Γ) measures the sensitivity in delta caused by a small change in the underlying asset price. Gamma will be calculated to estimate the risk of the deltas of the put-options applied to the strategy weakening the hedge from initiation to ex-dividend as a result of the expected price decline prior to ex-dividend. Gamma is calculated as:

$$\Gamma = \frac{\partial^2 P}{\partial S^2} = \frac{n(d_1)e^{(b-r)T}}{S\sigma\sqrt{T}} \tag{6}$$

Haug (2007) shows that by calculating Gamma in the traditional method, Gamma increases when time to maturity is long and the price of the underlying asset is close to zero. This is due to the fact that Gamma measures the change in delta caused by a one-unit change in the underlying asset price. Obviously, when the asset price is close to zero, this rate of change will be extremely large. Haug suggests reformulating the Gamma function to account for this. This is accomplished by calculating $Gamma\ P$ (Γ_P) which measures the percentage change in delta caused by a percentage change in the underlying asset:

$$\Gamma_P = \frac{S}{100}\Gamma = \frac{n(d_1)e^{(b-r)T}}{100\sigma\sqrt{T}} \tag{7}$$

Even if the stock price declines ex-dividend the HDC strategy might not generate profits due to the fact that the volatility of the options may change. As a consequence of this, Vega will be calculated to further ascertain the risk of investing in the HDC strategy. Vega measures the rate of change in the option value caused by changes in the volatility of the underlying asset price and is calculated as:

$$\mathrm{Vega} = \frac{\partial P}{\partial \sigma} = Se^{(b-r)T}n(d_1)\sqrt{\mathrm{T}} \tag{8}$$

Haug (2007) suggests reformulating Vega to express volatility as a percentage change to compare Vega across different assets. This is conducted by calculating Vega_P, which measures the percentage change in the put-option price caused by a 10-percent change in volatility:

$$\mathrm{Vega}_P = \frac{\sigma}{10}\mathrm{Vega} = \frac{\sigma}{10}Se^{(b-r)T}n(d_1)\sqrt{\mathrm{T}} \tag{9}$$

Delta defined above is useful at describing the risk of the HDC strategy in relation to statistical risk but does not necessarily reflect the risk associated with changes in volatility levels. To measure this risk, DdeltaDvol will be applied to the HDC strategy. DdeltaDvol measures the change in delta due to small changes in volatility levels (Haug 2003; Taleb 1997). DdeltaDvol is calculated as:

$$DdeltaDvol = \frac{\partial^2 P}{\partial S \partial \sigma} = -\frac{e^{(b-r)T}d_2}{\sigma}n(d_1) \tag{10}$$

Tail Risk

As will be demonstrated in the next chapter, the return distribution of the HDC strategy shows signs of excess skew and kurtosis and does not follow a normal distribution. The degree of excess skew and kurtosis present in the returns of the HDC strategy has implications for the further analysis in this research. Alternatives to traditional Gaussian-based risk measures should be considered to adequately capture the tail risk apparent in the HDC strategy. One such alternative measure is suggested by Favre and Galeano (2002) through their modified value-at-risk (MVaR) model. The MVaR calculates VaR for the left tail of the distribution by using Cornish-Fisher expansion estimation of the quantiles of non-Gaussian distribution (Cavenaile and Lejeune 2010). In comparison to the regular VaR approach, the MVaR adjusts volatility to excess skew and kurtosis. Following the notation of Favre and Galeano (2002), let:

$$MVaR_{1-\alpha}=\mu+Z_{CF,\alpha}\,\sigma \tag{11}$$

$$Z_{CF,\propto}=Z_{\propto}+\frac{1}{6}\left(Z_{\propto}^{2}-1\right)S+\frac{1}{24}\left(Z_{\propto}^{3}-3Z_{\propto}\right)K-\frac{1}{36}\left(2Z_{\propto}^{3}-5Z_{\propto}\right)S^{2} \tag{12}$$

Where $Z_{\propto}$ equals the critical value for probability *(1-α)*, *S* is the skewness, *K* is excess kurtosis, μ is the mean and σ is the standard deviation. Cavenaile and Lejeune suggest that confidence levels below 95.84 percent should not be applied when calculating MVaR. A further extension of the MVaR is found in the modified Sharpe ratio (MSR) defined by Gregoriou and Gueyie (2003). The MSR replaces the standard deviation applied in the traditional Sharpe Ratio and divides the excess return on MVaR. Following the notation of Gregoriou and Gueyie the MSR is calculated as:

$$MSR_i=\frac{r_i^d-r_f}{MVaR_i} \tag{13}$$

Where r_i^d equals the return of asset i, r_f is the risk-free rate of return and $MVaR_i$ is the MVaR of asset i.

Another measure applicable to non-normal return distributions is the Omega ratio. The Omega ratio calculates the probability-weighted ratio of gains over losses at a given level of expected return (Avouyi-Dovi et al. 2004). The Omega ratio does not require any information on the distribution of the returns (Keating and Shadwick 2002). Following the notation of Keating and Shadwick the Omega ratio is calculated as:

$$\Omega(r) = \frac{\int_r^b [1 - F(x)]dx}{\int_a^r F(X)dx} \tag{14}$$

Where *F(X)* is the cumulative distribution function of an investment, *r* represents the threshold return of an investment chosen by the investor and *(a,b)* represents the lower and upper bounds of the return distributions.

Chapter IV

DATA

Stocks included in the sample

The data sample consists of the highest dividend-yielding stocks on the S&P/TSX Composite Index. The data has been collected from the historical database of the Montréal Exchange.[2] The stocks included in the data sample are summarized in Table 2. In total, the sample includes 26 stocks with an average dividend yield of two percent. The majority of stocks on S&P/TSX pay dividends quarterly. To make the data sample comparable, stocks not paying dividends quarterly have been excluded from the data sample.

Table 2. Stocks included in the sample

Company Name	**Div. Yield%***	**Market Cap****	**Company Name**	**Div. Yield%**	**Market Cap**
Bank of Montreal	3.7	64	Magna International Inc.	1.6	29
Bank of Nova Scotia	3.6	94	National Bank of Canada	2.2	21
BCE Inc.	3.6	49	Power Corporation of Canada	1.5	12
Canadian National Railway Co.	2.3	80	Restaurant Brands Int. Inc.	1.4	19
Canadian Natural Resources Ltd.	1.7	55	Roger Communications Inc.	1.7	24
Canadian Pacific Railway Ltd.	2.4	36	Royal Bank of Canada	2.0	141
Canadian Tire Corporation Ltd.	2.7	0.8	SNC-Lavalin Group Inc.	1.3	10
Emera Incorporated	2.4	9	Sun Life Financial Inc.	1.7	32
Enbridge Inc.	2.4	68	Suncor Energy Inc.	1.2	84
Fortis Inc.	2.2	17	TELUS Corporation	1.6	27
Franco-Nevada Corporation	1.6	17	Thomson Reuters Corporation	1.6	35
George Weston Limited	1.9	13	Toronto-Dominion Bank	1.7	139
Loblaw Companies Limited	1.6	25	TransCanada Corporation	1.7	48

** Annual dividend-yields as of 2017*
***Market Capitalization in billion dollars as of 06.01.2018*

[2] https://www.m-x.ca/nego_fin_jour_en.php

Dividend Distribution

The distribution of the dividend payments from the stocks in the sample are spread throughout the year. However, a large portion of the stocks distributes dividends on the same interval: March – June – September – December, as demonstrated in Figure 2. As can be seen from the figure, approximately 16 percent of the stocks distribute first-quarter dividends in March, while roughly 13 percent of the stocks distribute second, third and fourth-quarter dividends in June, September and December, respectively. In February, dividend payments are at the lowest level throughout the year. Thus, the hedged dividend capture will experience the largest amount of trades in the interval mentioned above throughout the sample period.

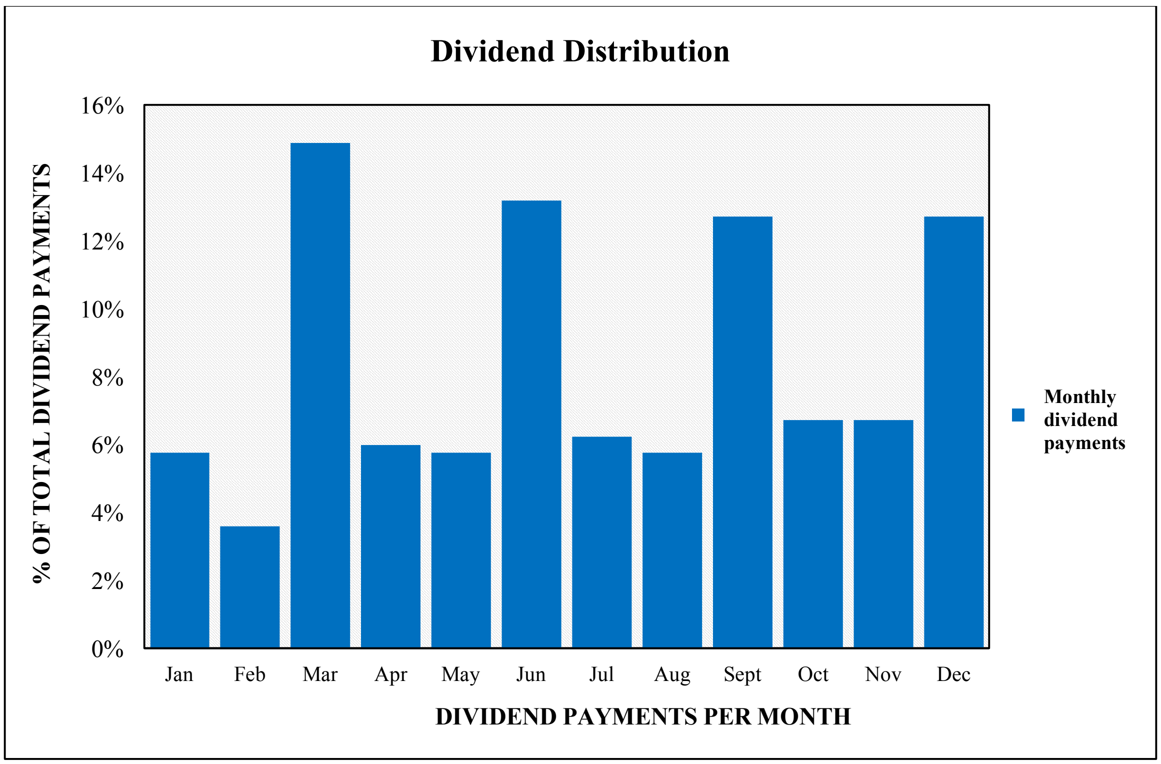

Figure 2. Dividend Distribution of Stocks in sample

Percentage distribution of dividend-payments each month for stocks in sample 2015-2017.

Time to Maturity

As discussed above, option contracts expiring two months from the ex-dividend date have been included in the sample. However, since the sample consists of stocks distributing dividends at different times within each month, and in different months within a quarter, this has not been applicable in all cases. For the options in the sample that have no two-month contracts, a three-month expiry date has been applied. Additionally, in those cases where there are no three-month contracts available, one-month contracts have been applied. Across the sample, the average number of days to expiration of the option contracts equals 50 days as shown in Figure 3. As the figure illustrates, the time to maturity varies across the sample with certain options expiring in the 70-80 days range, while other options expire in less than 30 days.

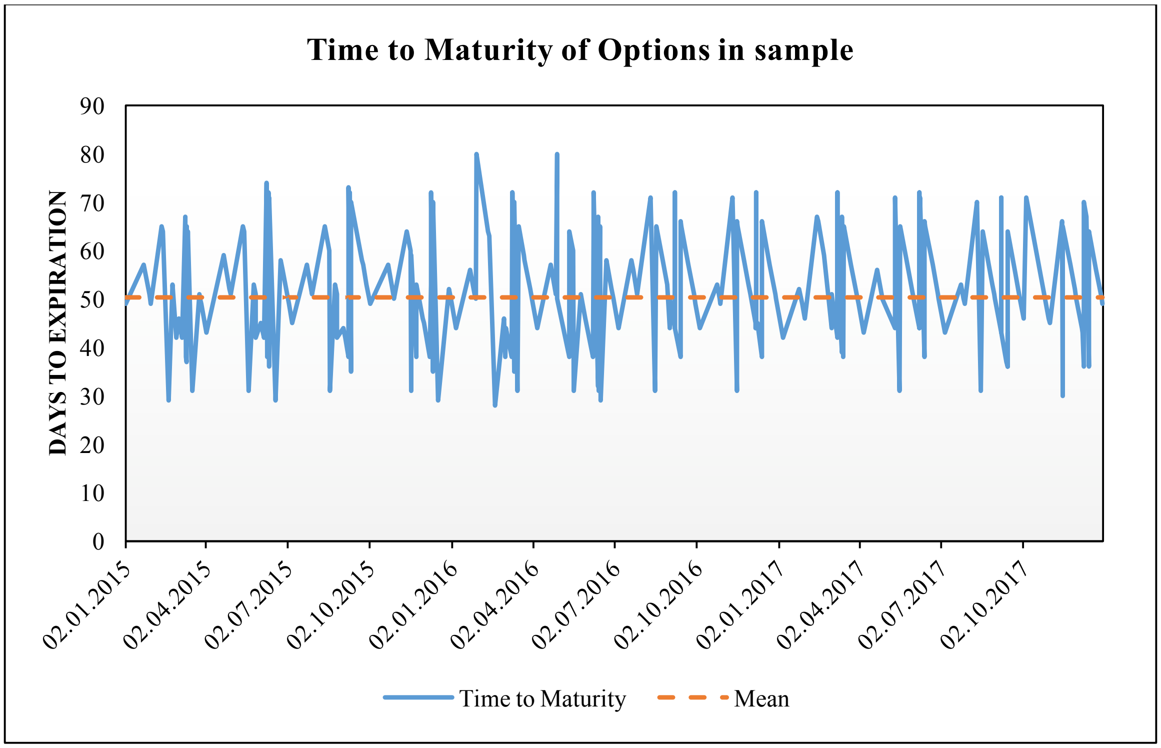

Figure 3. Time to Maturity of Options in sample

Days until expiration for options in sample compared to average.

Strike Price

Following previous discussions, the highest possible strike price has been applied for each option contract in the sample to approach a delta neutral position. On average, the strike prices of all the contracts are 22 percent in-the-money over the sample period. The strike prices of the options in the data sample are illustrated in Figure 4 below.

As Figure 4 demonstrates, the maximum strike prices available on the option contracts included in the sample varies widely between the individual option contracts. This can be illustrated by analyzing such options as those traded on Canadian Natural Resources (CNQ) and Enbridge (ENB) which are in the 60-80 percent range above at-the-money at certain ex-dividend dates throughout the period.

The fact that some of the options are significantly less in-the-money than others may have implications for the success of the HDC strategy. The deviations between the different options and their strikes might cause some of the individual put-options to have deltas away from negative one, in essence increasing the risk of the overall HDC strategy. This could cause the investor to have less downside protection for declining stock prices ex-dividend. An argument could possibly be made to only include those options that are traded at a certain level above at-the-money to ensure a delta close to negative one. In this way, the investor could possibly eliminate downside risk from the delta of put-options being far away from a fully delta hedged position.

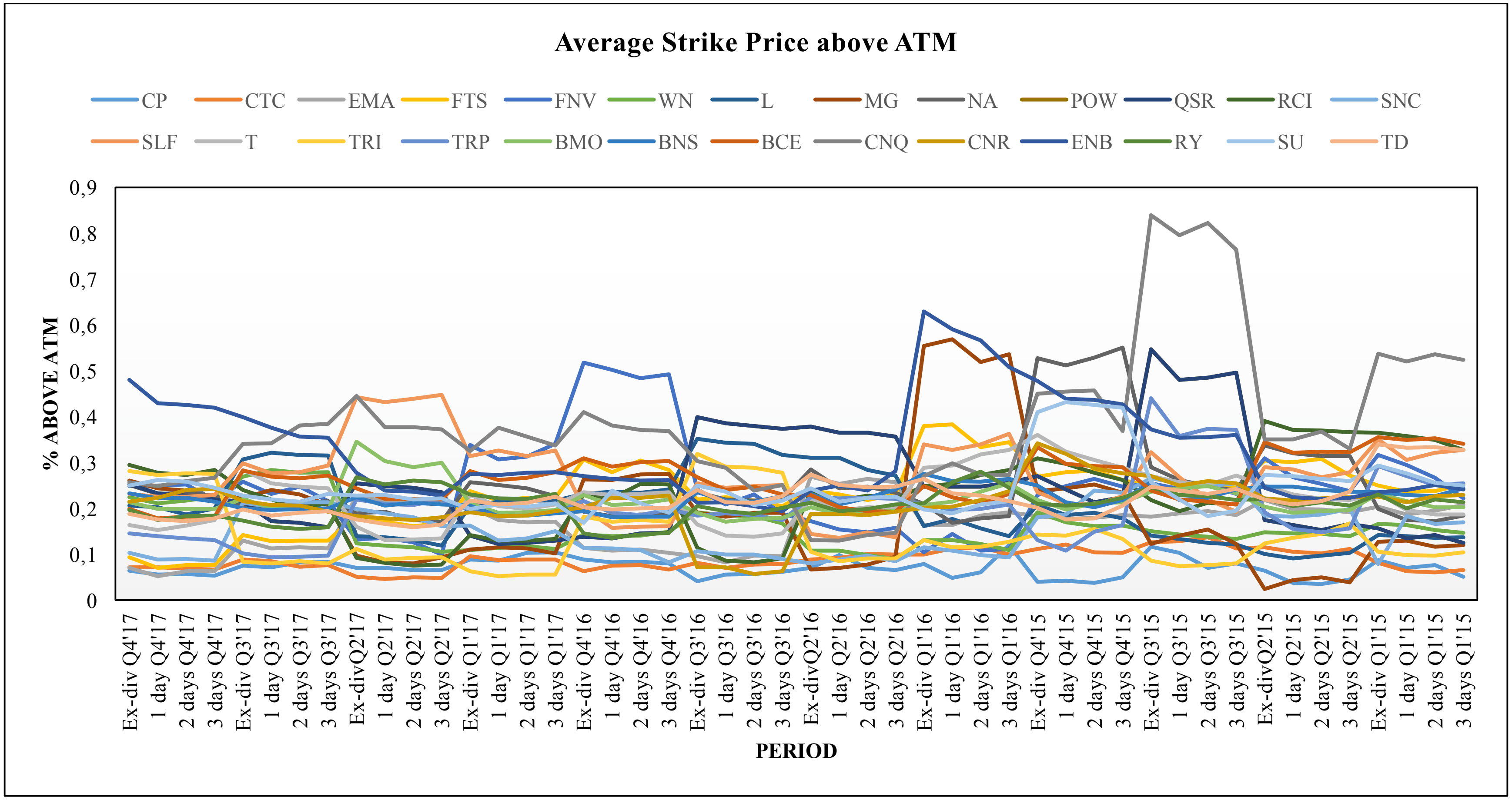

Figure 4. Average Strikes above at-the-money of Options in sample

Percent above at-the-money strike for all options in the sample from 2015-2017

Option and Stock Prices

The data sample consists of the quoted bid/ask close prices of the underlying stocks and put-options applied to the HDC strategy. As a proxy for the costs incurred from initiating a position in the HDC strategy, the mid-prices of the quoted bid/ask-prices have been applied. Applying mid-prices as a measure for the costs associated with initiating the HDC strategy may give misleading results. By applying close prices to the analysis, one might face the risk where the price movements relating to the dividend payments have already been priced in the market before the close. Due to this, returns generated according to close prices at the ex-dividend date might not be related to the dividend-payment itself, but rather to other factors throughout the trading day. Considering this, an argument could be made that intraday data should have been applied to minimize noise from factors not relating to dividends. However, this data material is hard to collect and the further analysis in this paper will be based on quoted mid-prices.

Additionally, the quoted bid/ask spreads of the put-options applied in this analysis have been calculated. The results can be seen in Figure 5. As the figure illustrates, there are certain options with an overall bid/ask-spread significantly above the average. For instance, the bid/ask-spread of Canadian Tire Company (CTC) and George Weston (WN) has been significantly above the average quoted spread at several points over the sample period. Furthermore, the figure illustrates significant spikes in the bid/ask-spread at certain points throughout the sample period, with the bid/ask-spread of some of the options lying in the range of 0.5 to 2 dollars above the average quoted spread.

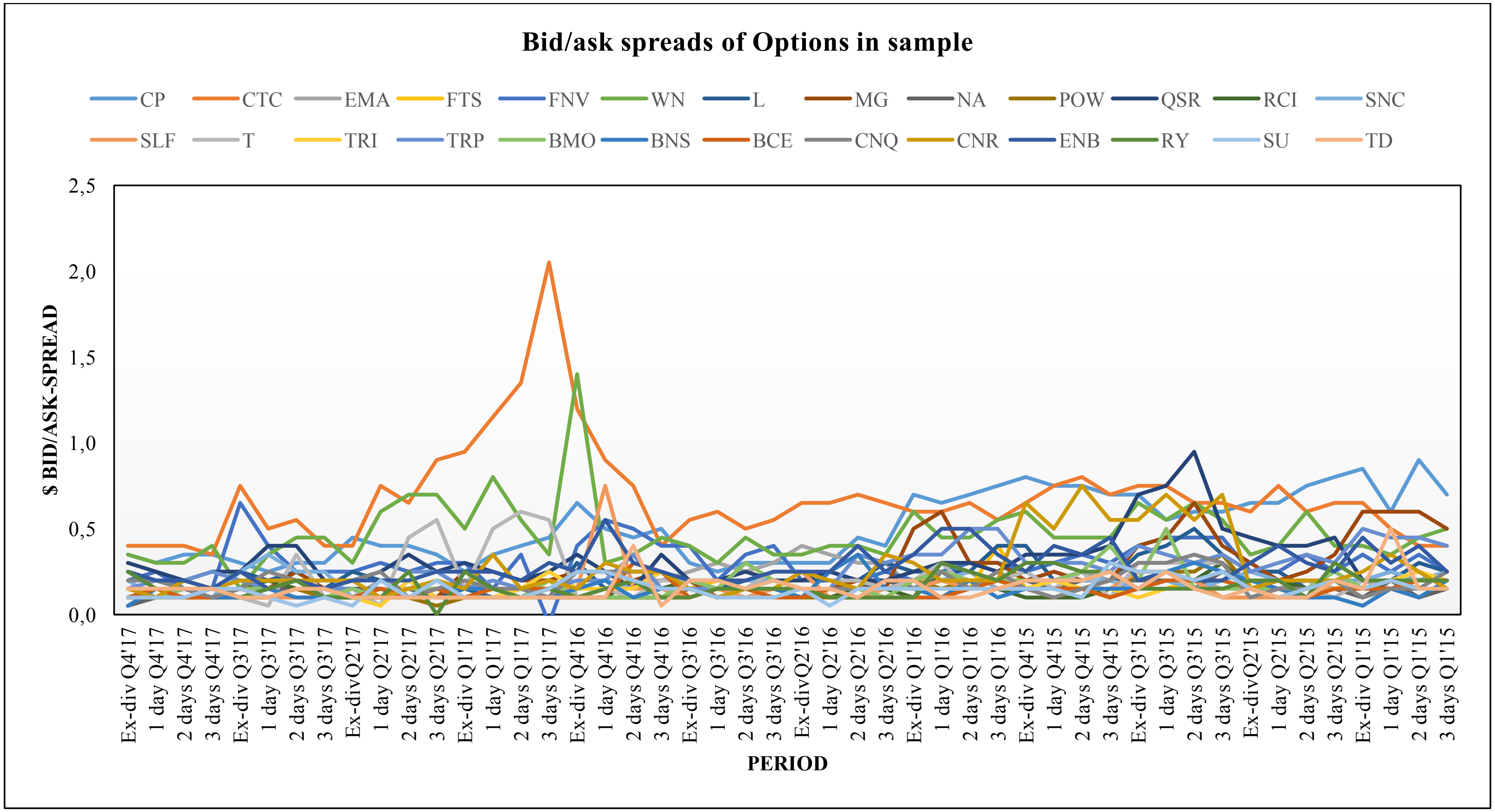

Figure 5. Bid/ask-spreads of Options in sample

Dollar-amount bid/ask-spread of all Options included in the data sample from 2015-2017

Volume

One implication of applying deep in-the-money put-options to the HDC strategy, as discussed above, is that the liquidity of the put-options in most cases declines significantly. In other words, the lack of open interest and traded volume of the put-options applied to the HDC strategy may expose the investor to liquidity risk, defined as "additional risk due to the timing and size of a trade" (Çetin et al. 2010. pp. 2). In this paper, as stated above, the put-options applied to the HDC strategy are based on mid-prices of quoted spreads. The liquidity risk may lead to the quoted spreads deviating from effective spreads, and in essence making the mid-prices of quoted spreads an unrealistic cost of the put-options applied in the strategy. Additionally, this low liquidity might lead to order-flow imbalances between the bid and offer side of the market (Bessembinder and Venkataraman 2010). One implication of this is that large trades might lead to price impacts on the quoted spreads and in essence affect the prices of the put-option contracts. As a consequence of this, one could argue that investors involved in smaller trades would benefit more from the HDC strategy than large investors, due to the fact that smaller trades would potentially have a smaller price impact on the quoted spreads than large trades.

To illustrate the potential liquidity risk of the HDC strategy, option contracts from the data sample of some of the largest companies at the Toronto Stock Exchange, such as Bank of Nova Scotia, Royal Bank of Canada, and Toronto-Dominion Bank, are shown in Figure 6. As the figure illustrates, the open interest and volume of the put-options included in the sample are significantly lower than options trading at-the-money and at the mid between the options included in the sample and at-the-money options:

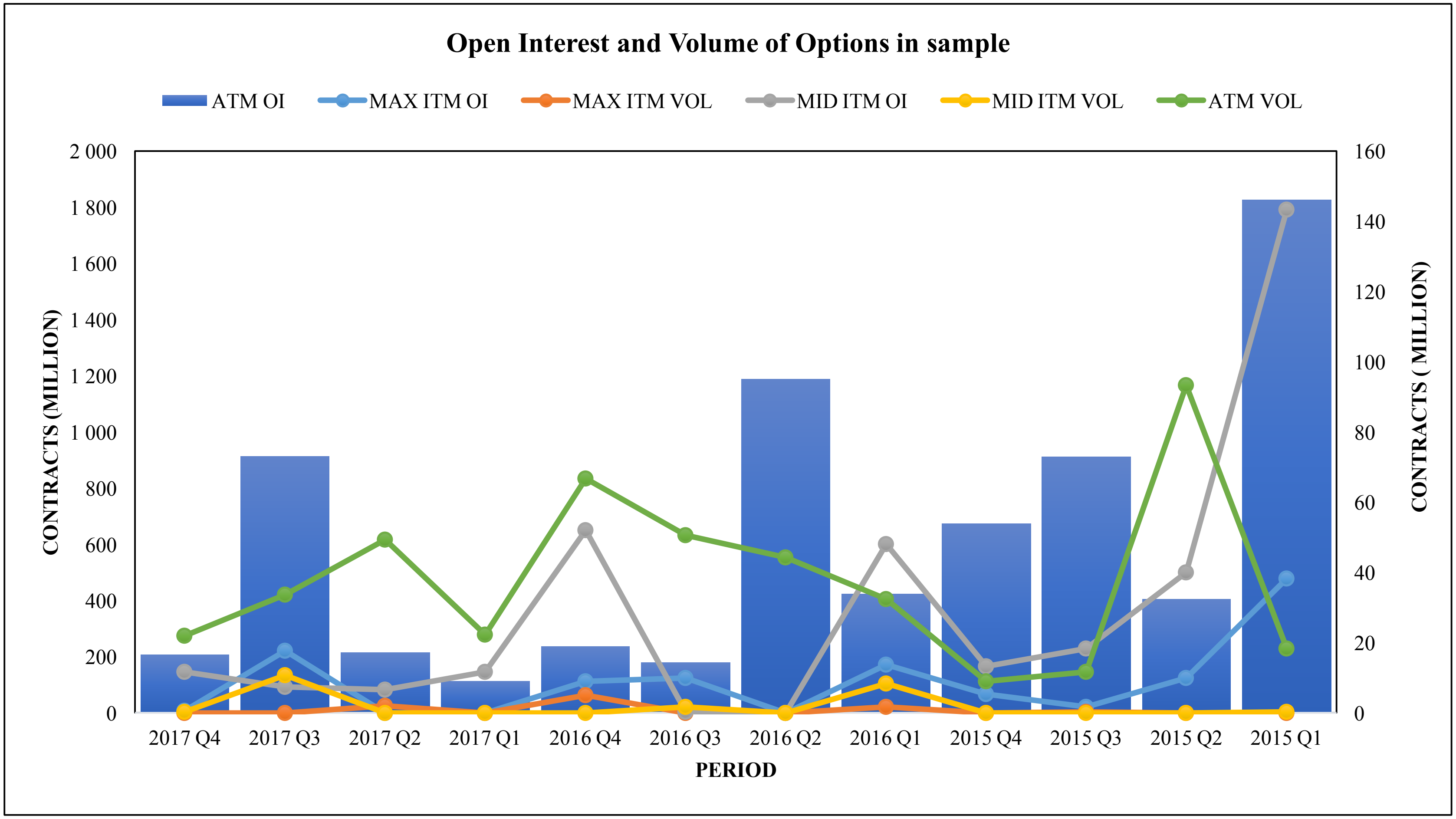

Figure 6. Open Interest and Volume of certain Options in sample

Open interest of ATM options on left axis. Open interest of mid- and max ITM options and volume of all options on the right axis.

Chapter V

ANALYSIS & RESULTS

The returns presented in this chapter are based on two separate calculations:

- Returns from only investing in the HDC strategy (in-and-out strategy)
- Returns from investing in the HDC strategy and investing in Canadian T-Bills on all other trading-days (continual strategy)

As the strategy depends on dividends, which occur at irregular intervals throughout the sample period, difficulties arise as to how to best capture the real risk and return involved when investing in the HDC strategy. By annualizing returns generated by only investing in the one-day HDC strategy and doing nothing on days without dividends (in-and-out strategy), the investor would achieve an annual return of 228.46 percent and standard deviation of 89.51 percent. However, this approach annualizes returns that are not occurring on a daily interval, hence possibly overstating the returns from the strategy. An alternative measure has been calculated by annualizing the returns from the HDC strategy and returns generated from investing in one-month Canadian T-Bills on all other trading-days (continual strategy). Annualized, the return and standard deviation from the continual strategy would amount to 50.82 and 48.40 percent. It should be noted that this way of measuring the standard deviation of the HDC strategy may underestimate risk. While the annual standard deviation from only investing in the HDC strategy is high, introducing the modest returns achieved by T-Bills on the remaining days reduces the standard deviation significantly. Even though this reflects the standard deviation of the entire returns from the holding period, it may understate the risk of only investing in the HDC strategy.

Figure 7 illustrates the cumulative continuously compounded dollar-amount returns from an $10,000 investment in the in-and-out HDC strategy from 2015 to 2017. As the figure illustrates, an investor would have earned a cumulative return of 152% ($15,215) for the one-day holding period, 52% ($5,228) for the two-day holding period and 65% ($6,475) for the three-day holding period by investing in the in-and-out HDC strategy.

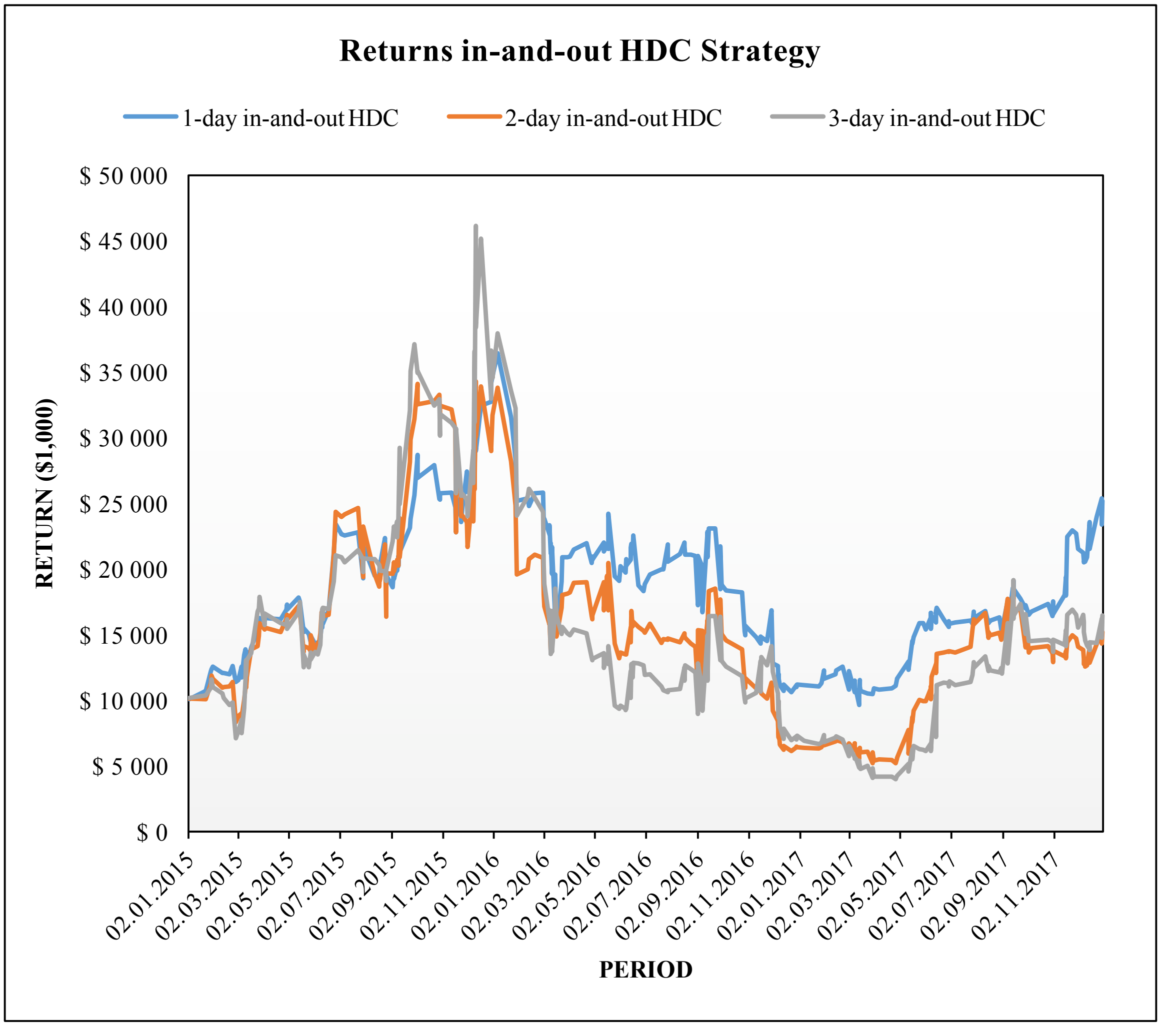

Figure 7. Dollar-amount Return Generated from the in-and-out HDC Strategy

Continuously compounded dollar-amount return from investing $10,000 in the in-and-out HDC strategy at the beginning of 2015.

Similarly, Figure 8 illustrates the continuously compounded dollar-amount returns from an \$10,000 investment in the continual HDC strategy from 2015-2017. As the figure illustrates, an investor would have earned a cumulative annual return of 132% (\$13,186) for the one-day holding period, 42% (\$4,187) for the two-day holding period and -7% (\$701,55) for the three holding periods by investing in the continual HDC strategy.

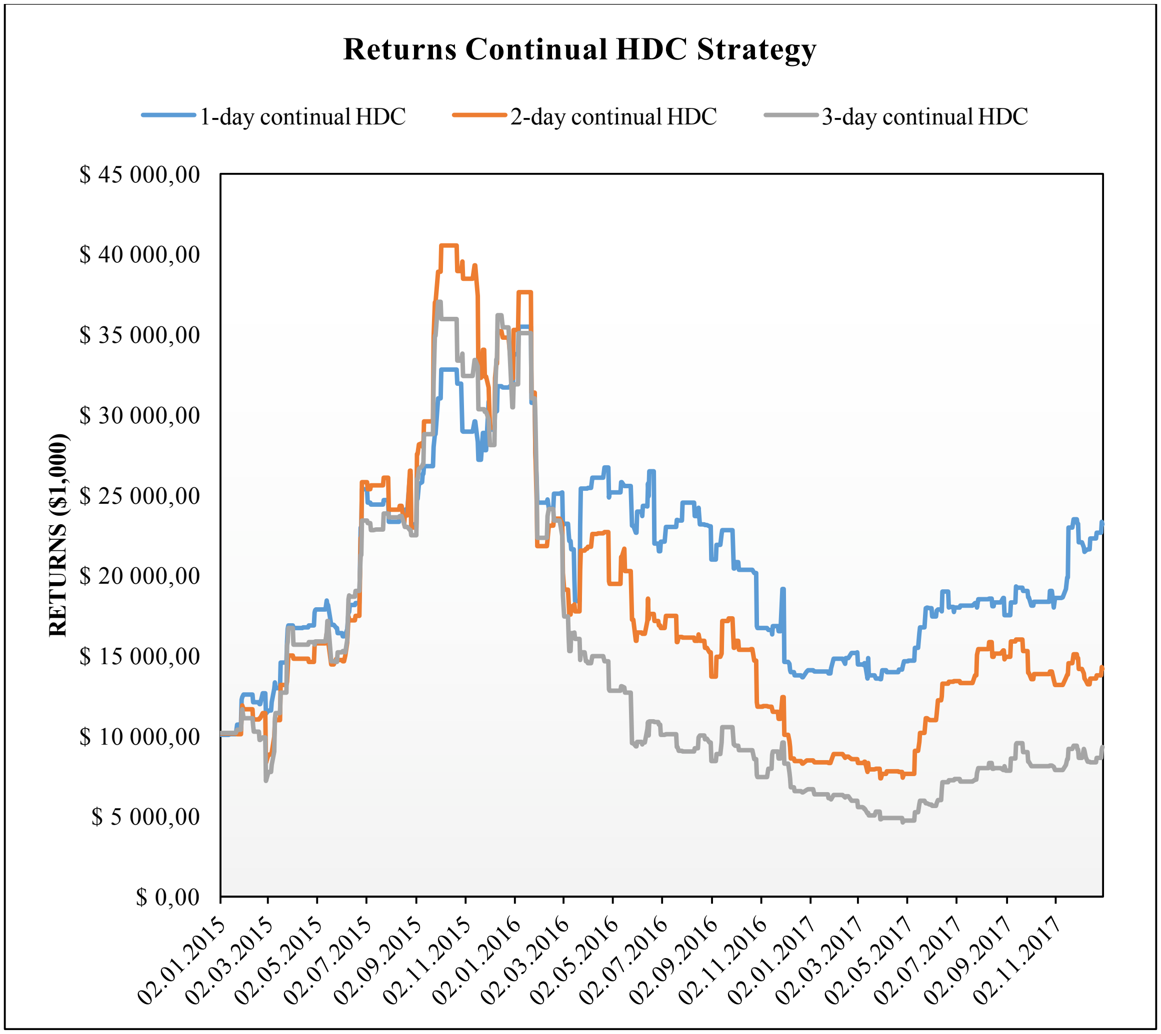

Figure 8. Dollar-amount Return Generated from the continual HDC Strategy

Continuously compounded dollar-amount return from investing \$10,000 in the continual HDC strategy at the beginning of 2015.

Table 3. Descriptive Statistics

	UHDC Strategy			HDC Strategy			S&P/TSX
	1 day	**2 days**	**3 days**	**1 day**	**2 days**	**3 days**	
In-and-out strategy:							
Return*	-14.92	-18.88	-30.21	228.46	166.72	213.87	4.23
Std. dev*	22.13	27.50	31.36	89.51	112.35	114.59	11.80
Sharpe	-0.70	-0.71	-0.98	2.55	1.48	1.86	0.31
Omega	0.31	0.38	0.39	0.97	0.94	0.96	0.15
Max**	10.32	8.69	9.02	25.75	28.82	23.31	2.94
Min**	-4.57	-6.90	-8.99	-23.83	-28.88	-29.69	-3.12
Kurtosis	10.49	3.50	3.20	4.21	3.42	2.24	2.07
Skewness	1.54	0.44	-0.04	0.14	0.04	-0.42	-0.26
Positive returns***	45.51	45.83	47.44	55.45	54.49	51.92	53.21
Continual strategy:							
Return*	-4.03	-5.56	-7.59	50.82	34.74	16.19	4.23
Std. dev*	12.37	14.78	16.60	48.40	58.35	56.46	11.80
Sharpe	-0.21	-0.22	-0.26	0.56	0.30	0.14	0.31
Omega	0.09	0.16	0.17	0.60	0.62	0.58	0.15
Max**	10.32	8.69	9.02	25.75	28.82	23.31	2.94
Min**	-4.57	-6.90	-8.99	-23.83	-28.88	-29.69	-3.12
Kurtosis	49.87	23.57	23.97	25.25	18.62	16.04	2.07
Skewness	3.27	0.71	-0.49	1.81	0.71	-0.32	-0.26
Positive returns***	84.63	84.76	85.70	87.43	86.63	85.70	53.21
Sum observations	748	748	748	748	748	748	748

* *Returns and standard deviations in annual figures*
** *Maximum and minimum one-day % change in returns*
*** *Number of positive returns (days) in percent over the entire sample period*

Table 3 illustrates descriptive statistics for the HDC strategy. As mentioned above, the returns and standard deviations from the HDC strategy decrease significantly by investing in the continual HDC strategy compared to investing in the in-and-out HDC strategy. For the one-, two- and three-day holding periods, the annualized returns from the in-and-out HDC strategy were 228.46, 166.72 and 213.87 percent, while the annualized returns from the continual HDC strategy were 50.82, 34.74 and 16.19 percent. Additionally, the standard deviations were 89.51, 112.35 and 114.59 for the in-and-out

HDC strategy, and 48.40, 58.35 and 56.46 for the continual HDC strategy. In contrast, the returns generated from the UHDC strategy were negative. The in-and-out UHDC strategy generated negative annualized returns of -14.92, -18.88 and -30.21 percent and standard deviations of 22.13, 27.50 and 31.36, while the continual UHDC strategy generated negative annualized returns of -4.03, -5.56 and -7.59 percent, and standard deviations of 12.37, 14.78 and 16.60. Had an investor rather chosen to invest in the S&P/TSX composite index, he would have earned an annualized return of 4.23 percent and a standard deviation of 11.80 percent over the sample period.

According to the Sharpe ratios presented in Table 3, the HDC strategy out-performed the UHDC strategy, and the S&P/TSX for all holding periods with the exception of the two- and three-day continual HDC strategy for the latter. For the in-and-out HDC strategy, the Sharpe ratios were 2.55, 1.48 and 1.86, for the one-, two- and three-day holding periods, whereas the continual HDC strategy generated Sharpe ratios of 0.56, 0.30 and 0.14 for the three holding periods. On the other hand, the UHDC strategy generated negative Sharpe ratios. In comparison, the S&P/TSX composite index achieved a Sharpe ratio of 0.31 over the same period.

As briefly mentioned in Chapter III, the data sample shows signs of excess skew and kurtosis. The excess skew is positive for all one- and two-day holding periods. The kurtosis is higher for the UHDC at all holding periods compared to the HDC strategy, especially at the one-day holding period, where the Kurtosis is 49.87 for the continual UHDC strategy compared to 25.25 for the continual HDC strategy. These results are to be expected, as the HDC hedges the extreme values one might experience with the UHDC which has no downside (upside) protection to price risk. Additionally, the returns generated from the HDC strategy deviate from the average. For instance, the minimum and maximum returns generated from the HDC strategy throughout the sample period were -23.83 and 25.75 percent for the one-day holding period, -28.88 and 28.82 percent for the two-day holding period, and -29.61 and 23.31 for the three-day holding period.

The excess kurtosis and skew give an indication as to the shape of the return distribution of the HDC strategy. Figure 9 illustrates the return distribution of the HDC strategy in a histogram. As the figure illustrates, the returns from the one-day HDC strategy do not seem to follow a normal distribution. In addition, in Table 4, a Jarque-Bera test has been applied to the returns of the HDC strategy. The data has been tested at a 5 percent significance-level and all p-values are significant. Based on this it can be concluded that the return distribution of the HDC strategy is not normally distributed.

Furthermore, the Omega ratios of the HDC strategy have been calculated. The Omega ratio for the in-and-out HDC strategy was 0.97, 0.94 and 0.96 for the one-, two- and three-day holding periods, while the continual HDC strategy generated Omega ratios of 0.60, 0.62 and 0.58 for the three holding periods. Due to the excess skew and kurtosis mentioned above, it can be concluded that when accounting for the higher moments present in the distribution of the HDC strategy, the strategy did manage to outperform the benchmark. Moreover, the Omega ratio indicates that the adjusted risk performance of the three holding periods is quite similar. For the in-and-out HDC strategy the difference between the three holding periods is minimal. For the continual HDC strategy, the two-day period performed slightly better than the one- and three-day holding periods. This is in contrast to findings from the Sharpe ratio, where the one-day period performed better than the two- and three-day holding periods, especially for the in-and-out HDC strategy.

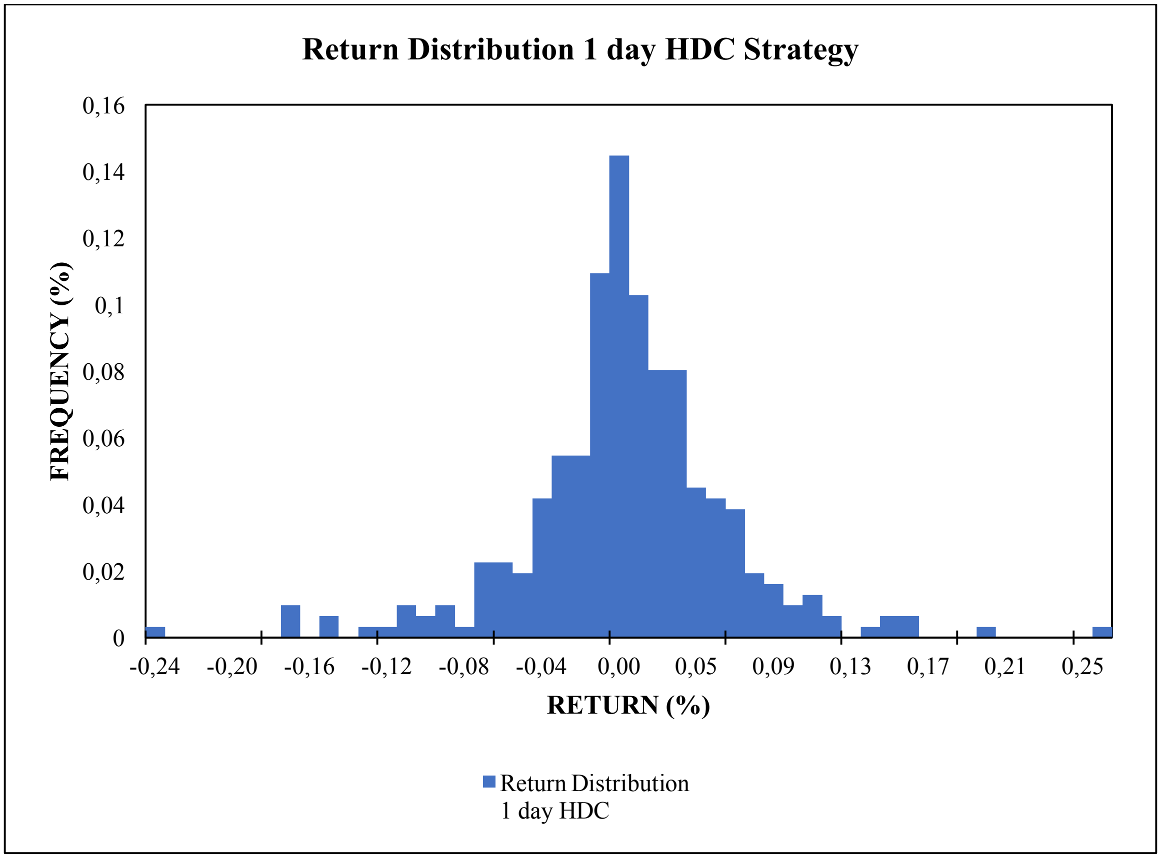

Figure 9. HDC Strategy Return Distribution

Table 4. Jarque-Bera Test

	HDC Strategy		
Test statistic	**1 day**	**2 days**	**3 days**
Full period	226.57	147.44	74.34
p-value	6.31E-50	9.65E-33	7.19E-17
2017	23.46	223.14	4.65
p-value	8.04E-06	3.51E-49	9.79E-02
2016	55.26	20.74	13.46
p-value	1.00E-12	3.13E-05	1.19E-03
2015	70.29	35.10	44.28
p-value	5.46E-16	2.39E-08	2.42E-10

HDC strategy tested at 5% significance level for the entire sample period and each individual year.

Transaction Costs

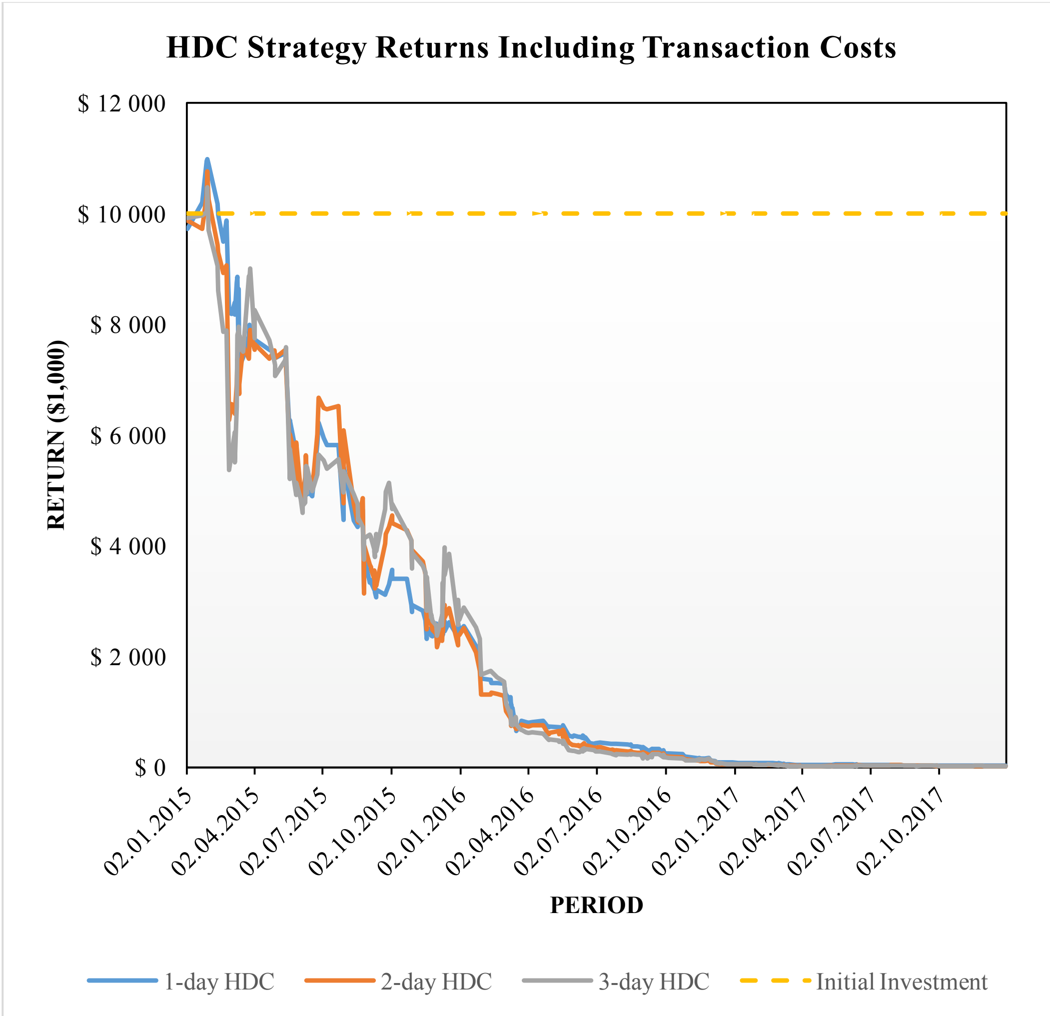

Figure 10 Returns from in-and-out HDC Strategy including Transaction Costs

Dollar-amount return from investing $10,000 in the HDC strategy from 2015-2017 when applying bid/ask as proxy for transaction cost

As discussed above, the transaction costs associated with initiating the HDC strategy will determine the profitability of the strategy. Up to this point, it has been assumed that the quoted mid-prices reflect the cost of trading the put-options and the underlying stocks applied to the HDC strategy. However, due to such above-mentioned factors as the low liquidity in trading deep in-the-money put-options, the resulting order-flow imbalances this might cause, and the potential price impact of large orders and the periodic large bid/ask-spreads previously found in the data sample, this assumption alone may not be sufficient to analyze the profit potential of the HDC strategy. With this in mind, it is assumed that the investor initiates his position by purchasing put-options and the underlying stocks at the quoted bid/ask-prices. When taking this into account, the profits generated from the HDC strategy are eliminated, as illustrated in Figure 10 above. Table 5 summarizes the descriptive statistics of including transaction costs in the return calculations of the HDC strategy. As Table 5 illustrates, returns from both the in-and-out and the continual HDC strategy are highly negative when including transaction costs. The standard deviations of the different holding periods did not change significantly. However, the return distribution of the HDC strategy did change significantly. Most notably, the skew is negative for all holding periods, indicating that the return distribution of the HDC strategy might underestimate risk. The kurtosis of the HDC strategy has also become less positive for all holding periods.

Table 5. Descriptive Statistics including Transaction Costs

	In-and-out HDC			**HDC Continual**			**S&P/TSX**
	1 day	**2 days**	**3 days**	**1 day**	**2 days**	**3 days**	
Return*	-98.68	-98.87	-98.64	-68.60	-70.98	-74.83	4.23
Std. dev*	89.79	111.43	115.08	48.95	58.71	59.13	11.80
Max**	19.46	21.43	19.82	12.61	13.31	9.60	2.94
Min**	-26.06	-32.45	-32.88	-26.06	-23.74	-18.71	-3.12
Kurtosis	3.34	2.89	2.43	21.14	16.72	16.61	2.07
Skewness	-0.62	-0.69	-0.70	-2.07	-1.87	-2.03	-0.26

** Returns and standard deviations in annual figures*
*** Maximum and minimum one-day % change in returns*

All the results presented above indicates that the HDC strategy is not profitable when introducing the bid/ask-spread as a proxy for transaction costs. However, before drawing this conclusion, it should be considered what the investor´s relevant transaction cost actually is. Henry and Koski (2016) show that bid/ask-spreads might not allow for an actual calculation of the profitability of dividend captures. If investors are able to trade within the bid/ask-spread, this proxy will overstate transaction costs. However, the opposite may also be true, as transaction costs include commissions, spreads and the price impact of trades. If these are not fully reflected in the bid/ask-spread, the proxy might understate the transaction costs. Furthermore, Henry and Koski show that after including transaction costs, only certain institutions with trade execution skills can profit from dividend captures. This differs from the discussions above, suggesting that due to the low volume in the options chosen in this research, the HDC strategy might be most preferable for retail investors. Taking all this into account, the bid/ask-spreads might be a sufficient proxy for transaction costs for most investors. However, for individuals and institutions able to trade between the bid/ask-spread, the HDC strategy may still be profitable.

Bid/ask Sensitivity

Due to transaction costs diminishing profits generated from the HDC strategy, a scenario analysis has been conducted on the quoted bid/ask-spread to determine at which level of transaction costs (as a percentage of full transaction cost) the HDC strategy becomes profitable. Figure 11 illustrates the profits generated from the in-and-out HDC strategy when decreasing transaction costs from 100 percent (quoted bid/ask), to zero percent (quoted mid-prices). The HDC strategy is unprofitable until the bid/ask-spread is approximately 20 percent above quoted mid. At this point, the profits from the HDC strategy are higher than the break-even (B.E.) threshold. The three-day holding period breaks the B.E. threshold at 21 percent above quoted mid, while the one- and three-day holding periods break the B.E. threshold at 20 and 19 percent over quoted mid.

Similarly, a scenario analysis has been conducted on the bid/ask-spread of the continual HDC strategy, as illustrated in Figure 12. For the continual HDC strategy, the one-day holding period breaks the B.E. threshold at 25 percent above quoted mid, while the two-day holding periods breaks the B.E. threshold at 18 percent above quoted mid. The three-day holding period, rather surprisingly, breaks the B.E. threshold 10 percent above quoted mid. These findings show, in relation to previous discussions, that investors able to trade between the bid/ask-spread, might have a possibility of profiting from the HDC strategy. This will be determined by the level of transaction costs the investor will be able to execute trades at. To illustrate this profit potential, the B.E. points, and the profits generated from exceeding the B.E. points by 1 and 2 percentage points are illustrated in Table 6.

Table 6. HDC Strategy Break-even Points

	In-and-out HDC			Continual HDC		
	1-day	2-days	3-days	1-day	2-days	3-days
B.E.-point %*	20	19	21	25	18	10
Return % at B.E.-point**	4.03	0.08	0.15	0.09	1.27	0.17
Return $ at B.E.-point***	$10,403	$10,008	$10,014	$10,009	$10,127	$10,016
Return % at 1 point below B.E.-point	9.96	5.86	5.84	1.68	2.86	1.72
Return $ at 1 point below B.E.-point	$10,996	$10,586	$10,584	$10,168	$10,286	$10,172
Return % at 2 points below B.E.-point	16.22	11.97	11.85	3.30	4.48	3.31
Return $ at 2 points below B.E.-point	$11,622	$11,197	$11,185	$10,330	$10,448	$10,331

** Break-even point as percent above quoted mid. 100% above=full transaction costs*
*** Annualized return at break-even points in percent.*
**** Calculated based on an initial investment of $10,000*
***** Percentage points below B.E. point*

As Table 6 illustrates, investors able to execute trades 1 point below the B.E. point could potentially earn returns of $10,996 (9.96%), $10,586 (5.86%) and $10,584 (5.84%) for the in-and-out HDC strategy and $10,168 (1.68%), $10,286 (2.86%) and $10,172 (1.72%) for the continual HDC strategy. Furthermore, investors able to execute trades 2 points below the B.E. point could potentially earn returns of $11,622 (16.22%), $11,197 (11.97%) and $11,185 (11.85%) for the in-and-out HDC strategy and $10,330 (3.30%), $10,488 (4.48%) and $10,331 (3.31%) for the continual HDC strategy.

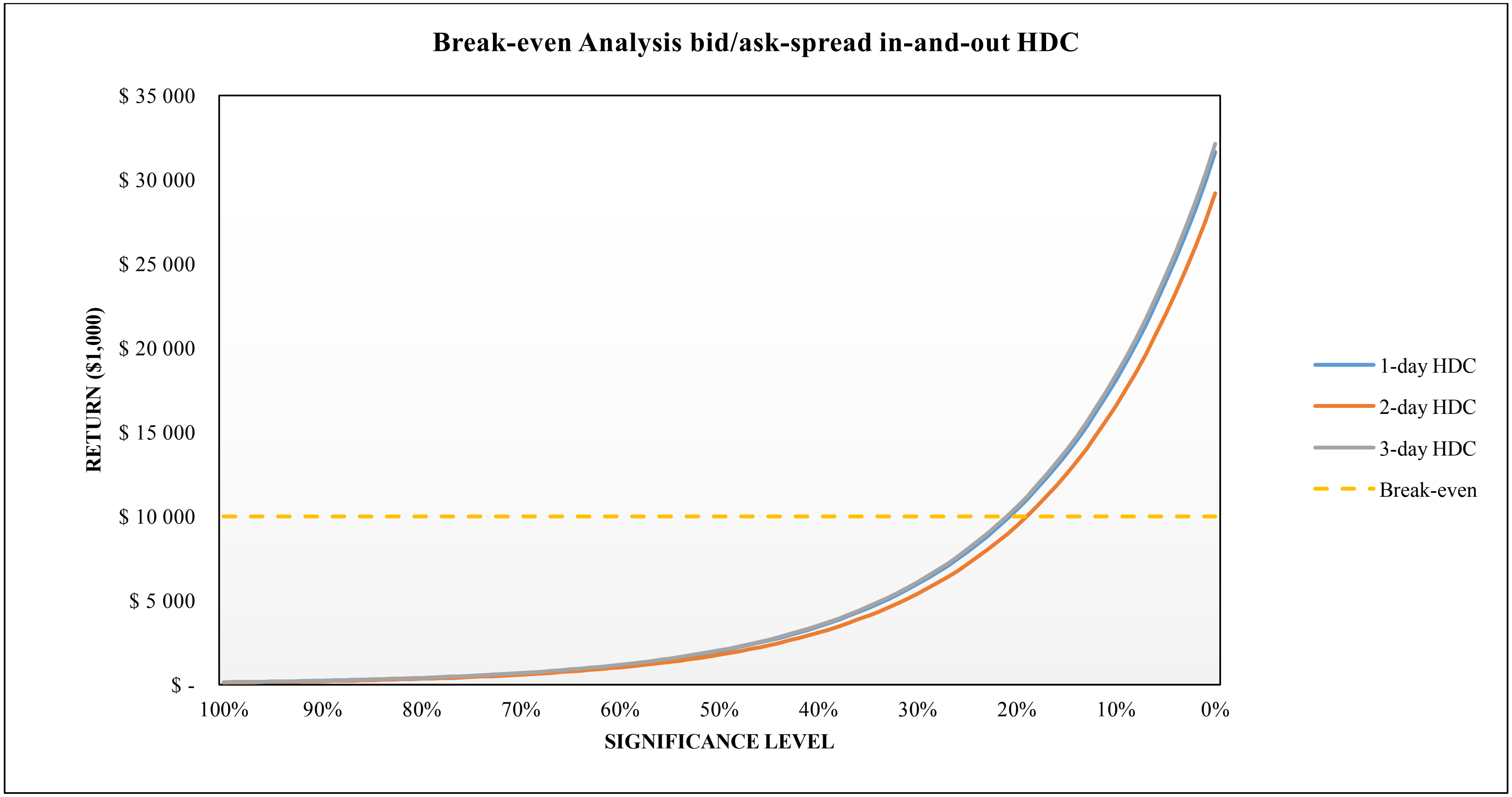

Figure 11 Break-even Analysis of bid/ask-spread in-and-out HDC Strategy

Sensitivity analysis conducted on interval from 100% transaction costs (quoted bid/ask) to 0% transaction costs (quoted mid) compared to break-even threshold (B.E. threshold) equal to initial amount invested ($10,000)

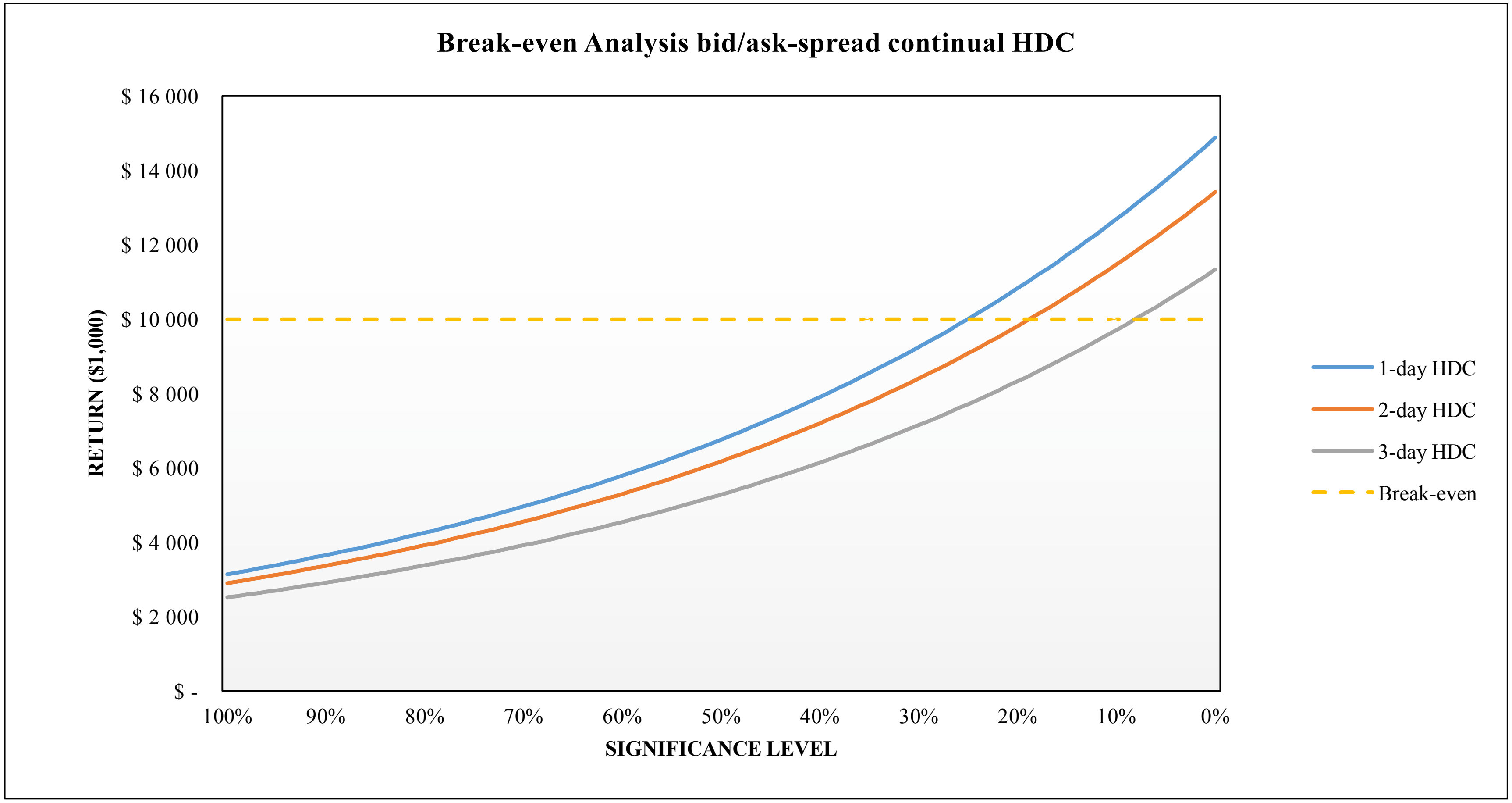

Figure 12 Break-even Analysis of bid/ask-spread of continual HDC Strategy

Sensitivity analysis conducted on interval from 100% transaction costs (quoted bid/ask) to 0% transaction costs (quoted mid) compared to break-even threshold (B.E. threshold) equal to initial amount invested ($10,000)

Delta

Deltas of all options included in the data sample are illustrated in Figure 13. The average delta[3] of the entire sample was -0.943 in 2015, -0.940 in 2016 and -0.968 in 2017. Large deviations in delta are found in the sample. Certain options such as CP (-0.586), MG (-0.560), QSR (-0.509) and SNC (-0.670) all had deltas differing significantly from a delta-neutral position at certain points throughout the sample period.

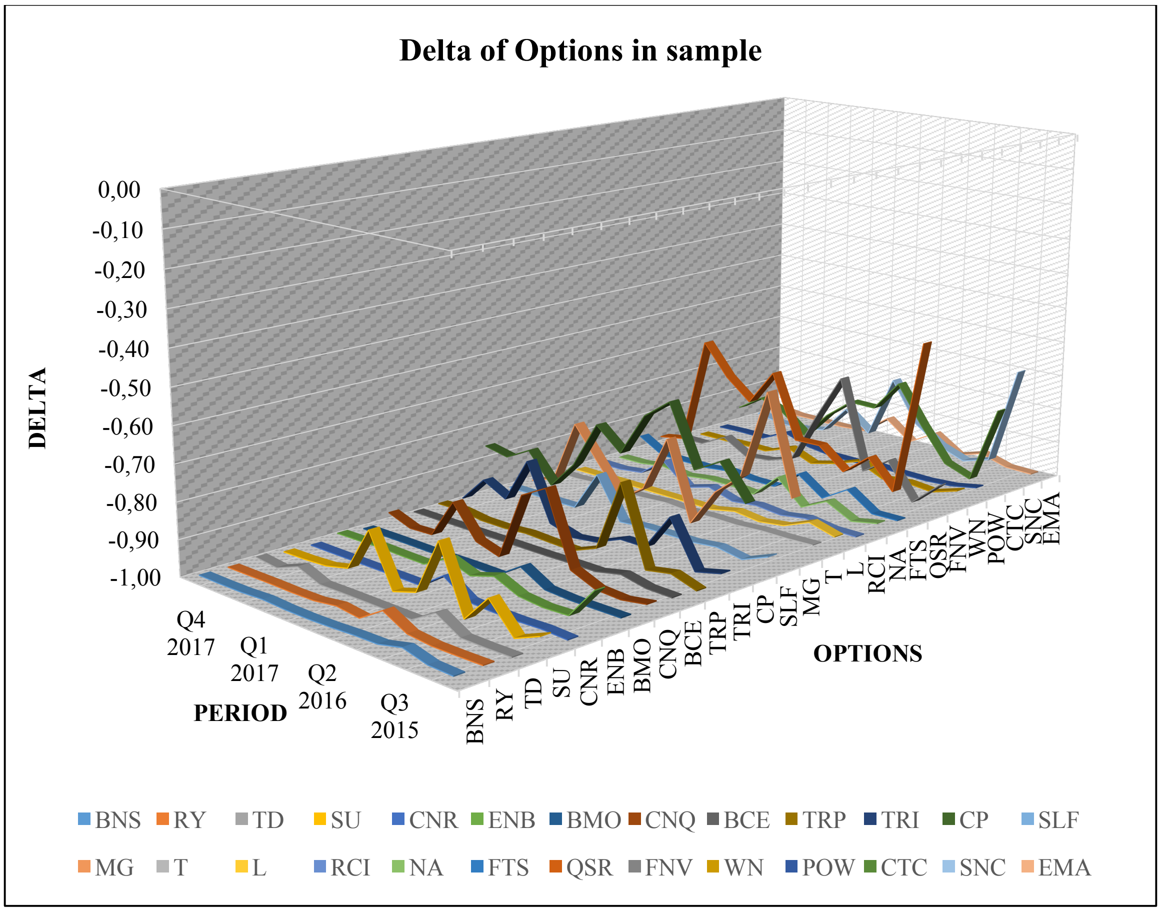

Figure 13. Delta of Options in sample

Delta calculated per dividend interval (quarter) from 2015-2017

[3] The average Greek values presented in this chapter are for illustrative purposes only. See Appendix 2-6 for a complete overview of the estimated Greek values calculated for the HDC strategy.

Beta

Betas of all options included in the data sample are illustrated in Figure 14. The average beta of all options was –0.677 in 2015, -0.612 in 2016 and -0.545 in 2017. Similar to delta, beta deviates within the data sample. Certain options had beta values lower than negative one, such as CNQ (-1.393), QSR (-1.175) and SU (-1.114), whereas other options had beta values close to zero, such as FTS (-0.067) and EMA (-0.086).

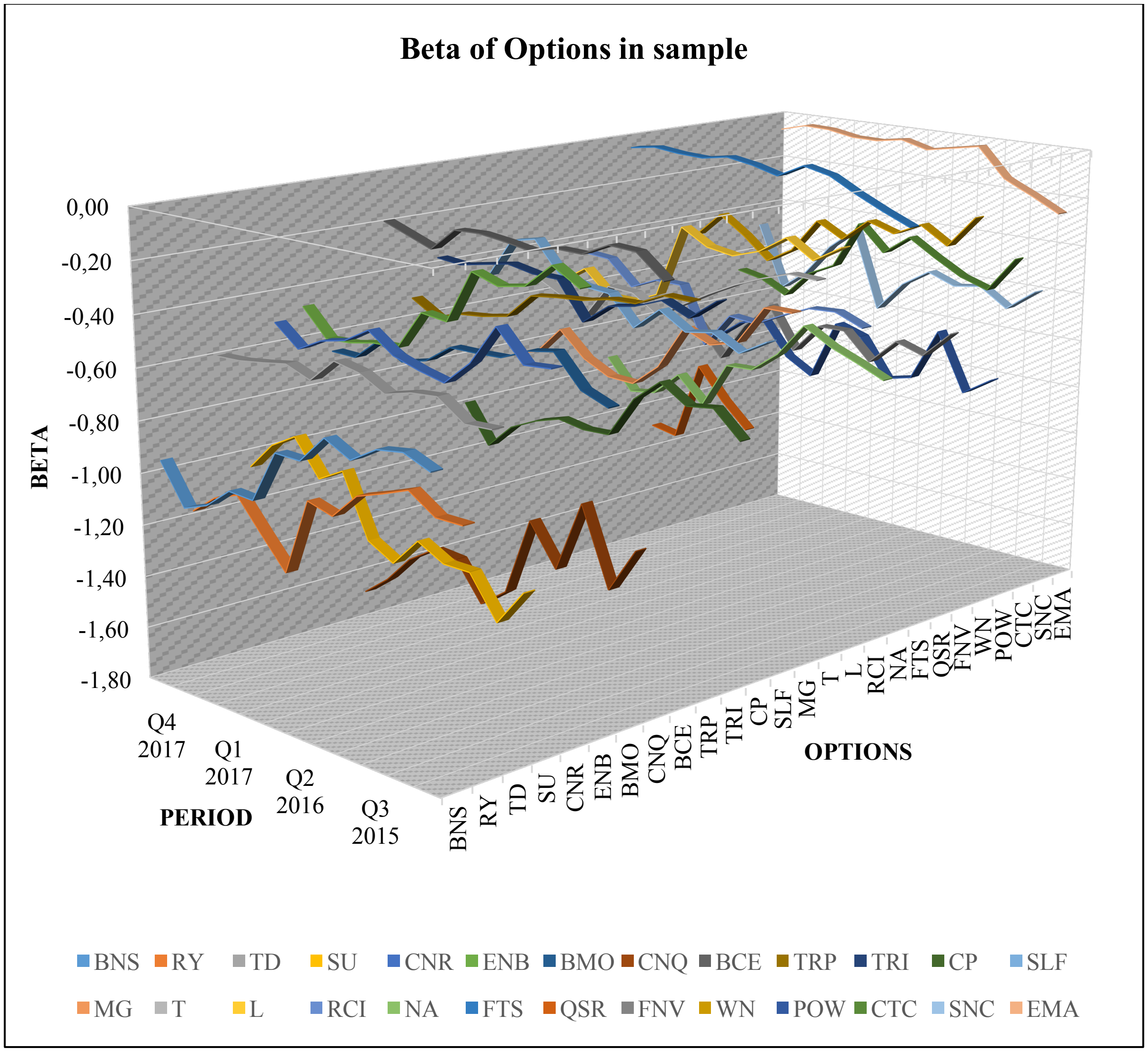

Figure 14. Beta of Options in sample

Option-beta per dividend interval (quarter) 2015-2017. Beta calculated based on five-year historical stock betas.

Gamma

Gammas of all options in the data sample are illustrated in Figure 15.[4] The average gamma of all options was 0.010 in 2015, 0.012 in 2016 and 0.007 in 2017. As for both delta and beta, gamma of the options deviated throughout the sample period where certain options, such as QSR (0.074), MG (0.066), TRI (0.063) and SNC (0.059), all had gammas significantly above the average.

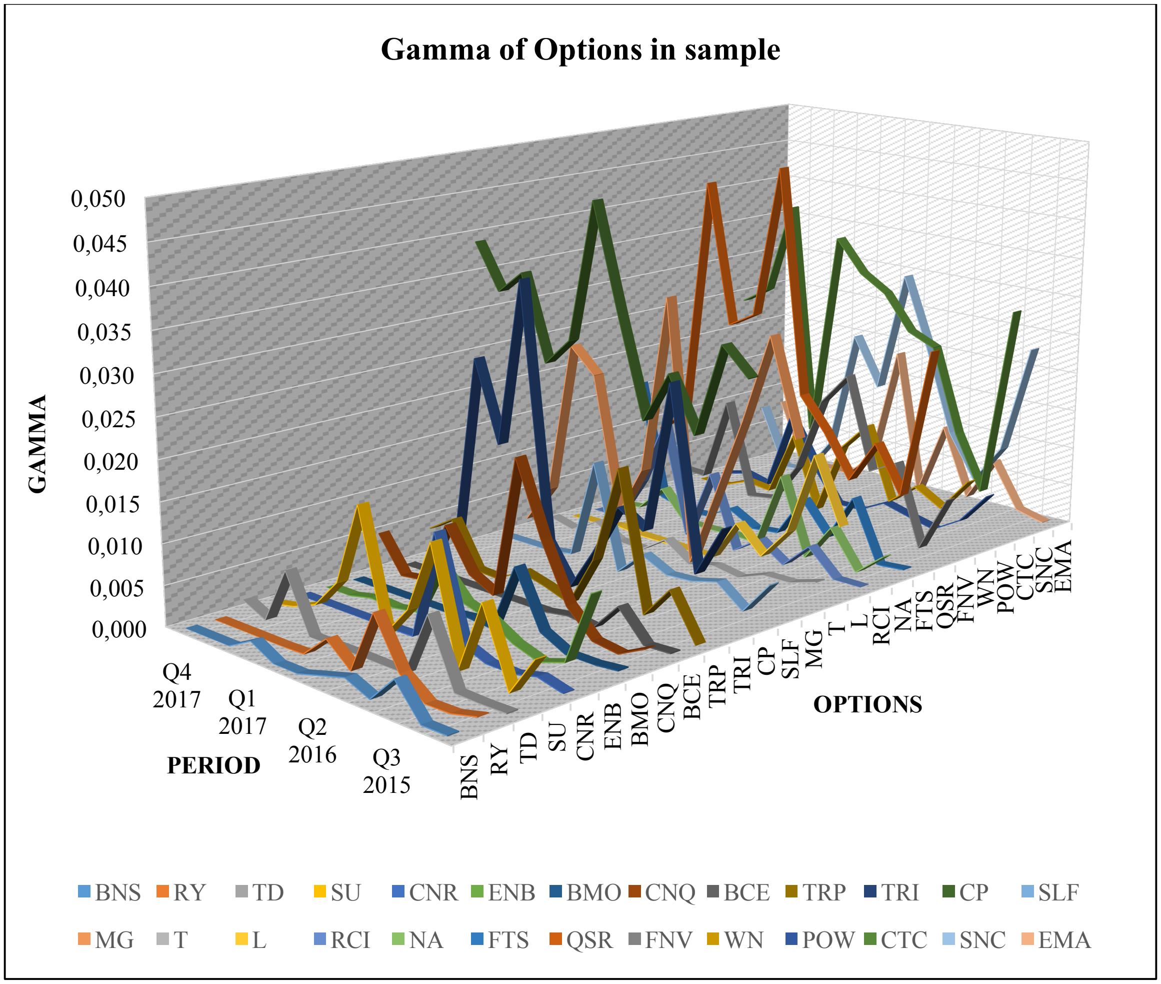

Figure 15. Gamma of Options in sample

Gamma calculated per dividend interval (quarter) from 2015-2017

[4] The Gamma presented in this section represents the GammaP defined in Chapter III

Vega

Vegas of all options included in the data sample are illustrated in Figure 16.[5] The average vega of all options was 0.028 in 2015, 0.029 in 2016 and 0.019 in 2017. Contrary to findings from the delta, beta and gamma analyses, only lesser deviations have been found in the data sample. Vega of certain options such as CP (0.331), CTC (0.164), QSR (0.159) and MG (0.170) deviated significantly from the average vega at several points throughout the sample period.

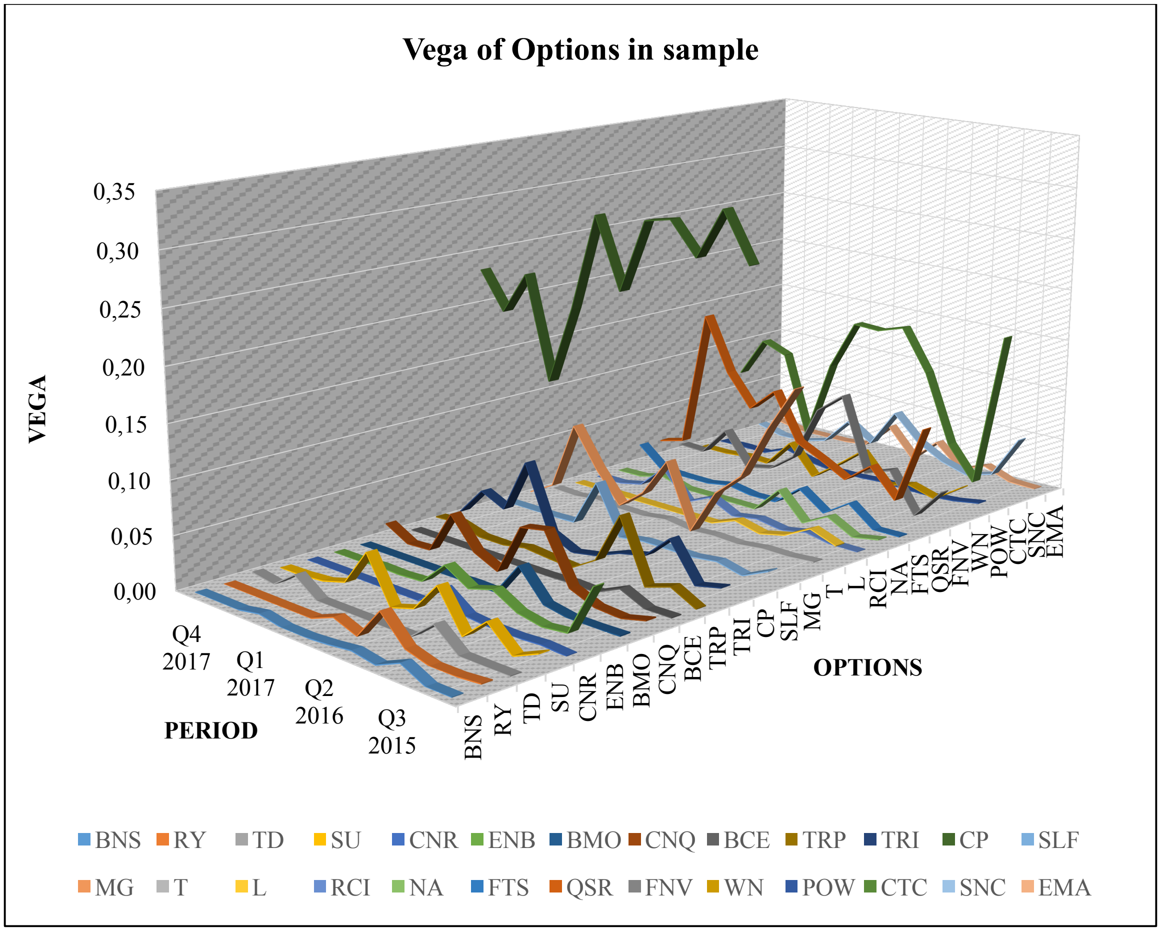

Figure 16. Vega of Options in sample

Vega calculated per dividend interval (quarter) from 2015-2017

[5] The Vega presented in this section represents the GammaP defined in Chapter III

DdeltaDvol

The DdeltaDvol of all options included in the data sample are illustrated in Figure 17. The average DdeltaDvol of all options was 0.36 in 2015, 0.45 in 2016 and 0.36 in 2017. Similar to findings presented above, significant deviations in DdeltaDvol exist between the individual options in the data sample. The DdeltaDvol of certain options such as CTC (2.60), CP (1.93) and FTS (1.41) deviated significantly from the average DdeltaDvol at several points throughout the sample period.

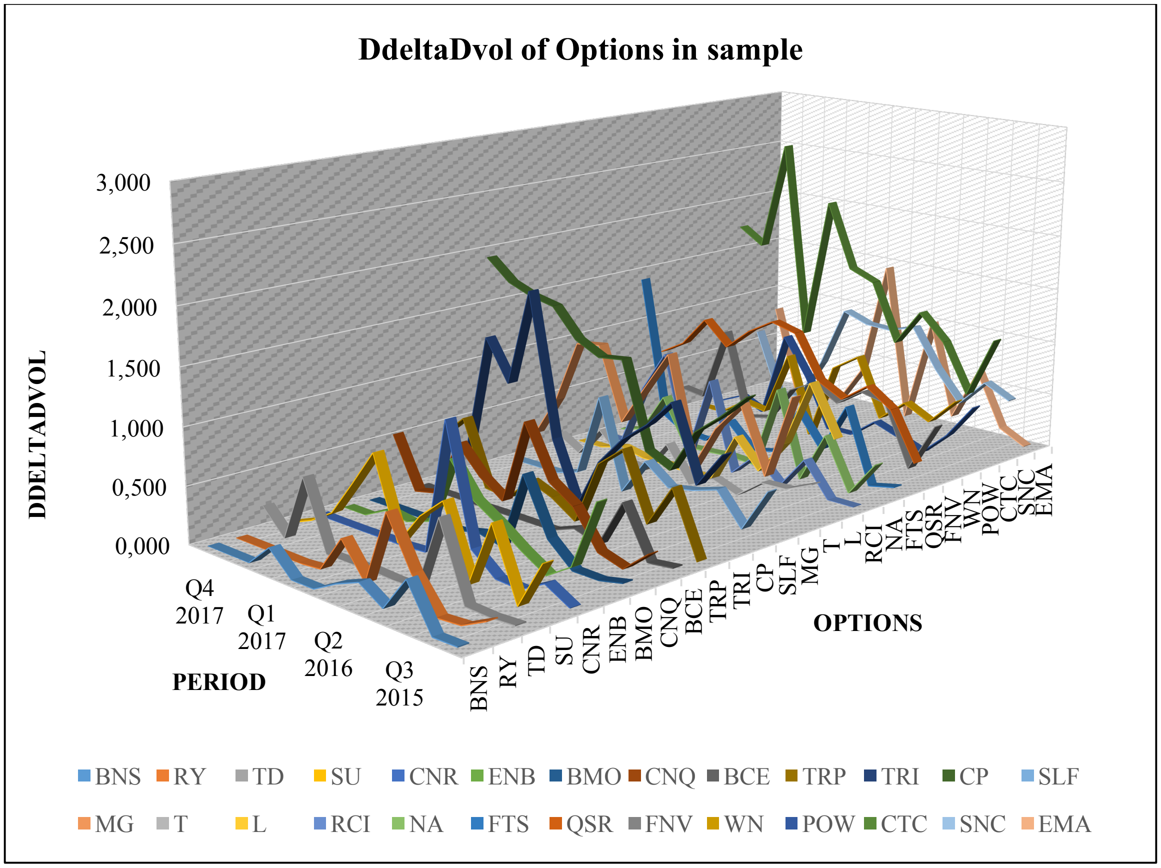

Figure 17. DdeltaDvol of Options in sample

DdeltaDvol calculated per dividend interval (quarter) from 2015-2017

As illustrated above, certain options have deltas far away from negative one, implying that the investor would, by investing in the HDC strategy, face the risk of not being fully delta hedged throughout the sample period. Moreover, the beta of the put-options applied in the HDC strategy illustrate the negative variation in market risk for the individual put-options included in the data sample. To further analyze this, the beta of the HDC strategy is illustrated in Appendix 7. As the beta illustrates, throughout the sample period the HDC strategy was positively exposed to market risk. Over the entire sample period the average beta of the HDC strategy equaled 0.18, which may raise a question as to whether the returns generated from the HDC strategy could simply be attributed to the market moving in a favorable direction.

Furthermore, based on the variation in Gamma across the data sample demonstrated above, an argument could be made as to how well the data sample is equipped to cope with the HDC strategy. As defined in Chapter III, Gamma expresses the sensitivity in delta due to small changes in the underlying asset price. The options in the sample with high Gamma therefore pose a risk of the deltas changing significantly from the cum-dividend date to the ex-dividend date. This could be an argument for maintaining a dynamic delta hedge throughout the holding period. This will be discussed in more detail in the final chapter.

As the options applied to the HDC strategy are deep in-the-money, low Vega should, in theory, be expected (Hull 2011 p. 395). As emphasized above, only a few of the options in the sample have high Vega, indicating a low sensitivity in the option price relative to volatility. However, DdeltaDvol demonstrates that a large part of the data sample expresses sensitivity in delta from small changes in volatility levels. Even though the options may have small Vega, this illustrates that the options applied to the HDC strategy have delta sensitivity in relation to changes in volatility, which, based on the findings in this section, further raises the argument for dynamically hedging the HDC strategy.

MVaR & MSR

The MVaR for the in-and-out HDC strategy and the continual HDC strategy is illustrated in Figures 18 and 19. Based on previously discussed literature, the maximum significance level has been set at four percent. The MVaR is calculated according to an initial investment of $10 million. At a four percent significance level the MVaR for the in-and-out HDC strategy equals -$927,05 (-9.27%), -$1 224,89 (-12.25%) and -$1 327,05 (-13.27%) for the three holding periods. Similarly, the MVaR for the continual HDC strategy is lower than that calculated for the in-and-out HDC strategy. At a four percent significance level the MVaR for the continual HDC strategy is –$510,12 (-5.10%), -$643,41 (-6.43%) and -$670,03 (-6.70%) for the three holding periods.

In addition to MVaR, the MSR of the HDC strategy has been calculated. These results are illustrated in Appendix 8.[6] When applying MSR as a risk measure, the HDC strategy performed better for the one-day than the two- and three-day holding periods for both the in-and-out and the continual HDC strategy.

As discussed above, the Omega ratio ranked the holding periods quite similarly in terms of risk-adjusted performance. However, based on the MVaR and MSR presented above, it can be concluded that the one-day holding period outperformed the two- and three-day holding periods. Moreover, the two-day holding period outperformed the three-day holding period for the continual HDC strategy, while the three-day holding period performed better than the two-day holding period for the in-and-out HDC strategy.

[6] It should be noted that the MSR is fairly large due to the high excess returns generated from the HDC Strategy. The ratio should therefore be interpreted as a ranking instrument between the different holding periods throughout the sample period.

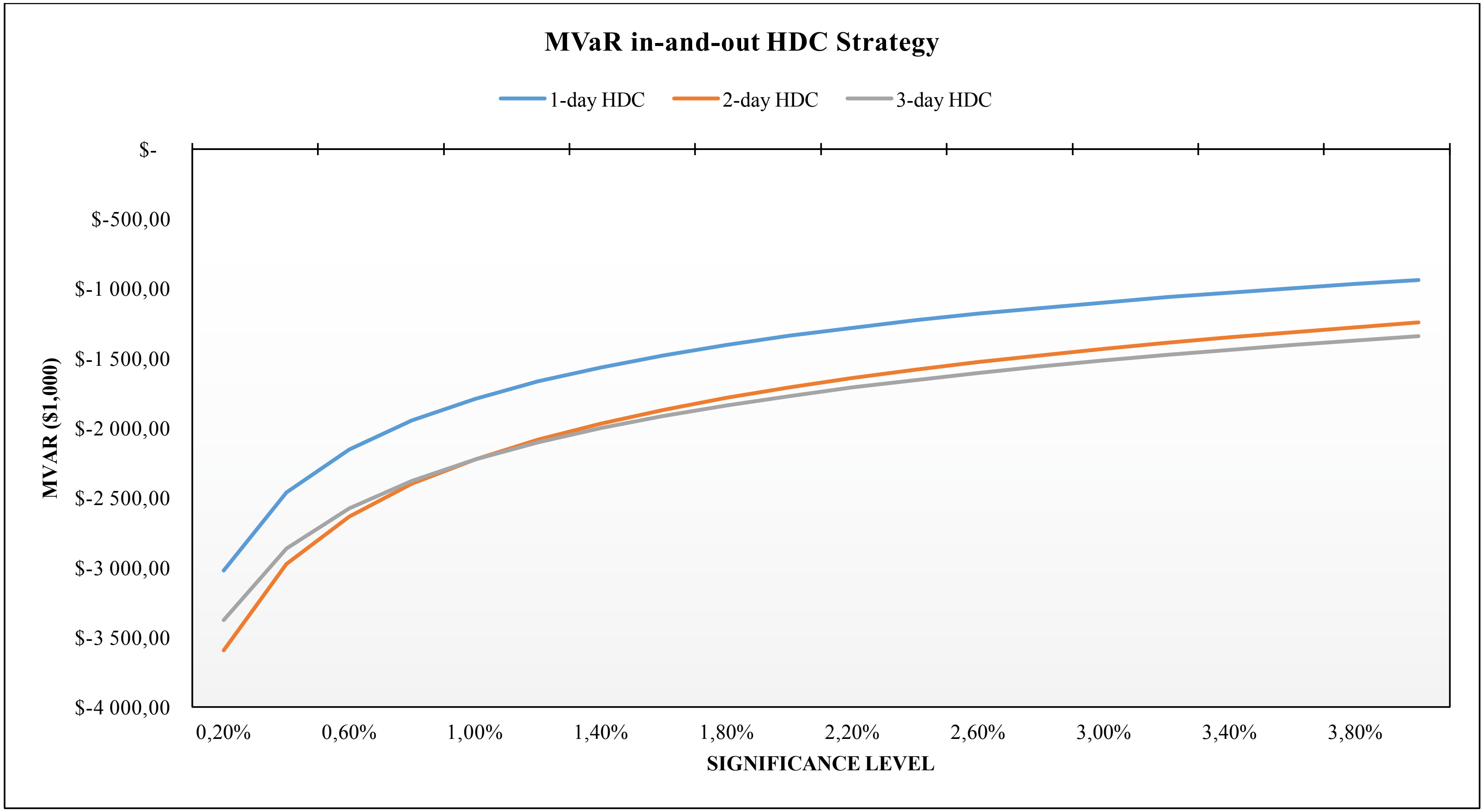

Figure 18. MVaR for the in-and-out HDC Strategy

MVaR conducted at several significance levels ranging from 0.20 percent to 4 percent. Calculations in $ million. Based on initial investment of $10 million

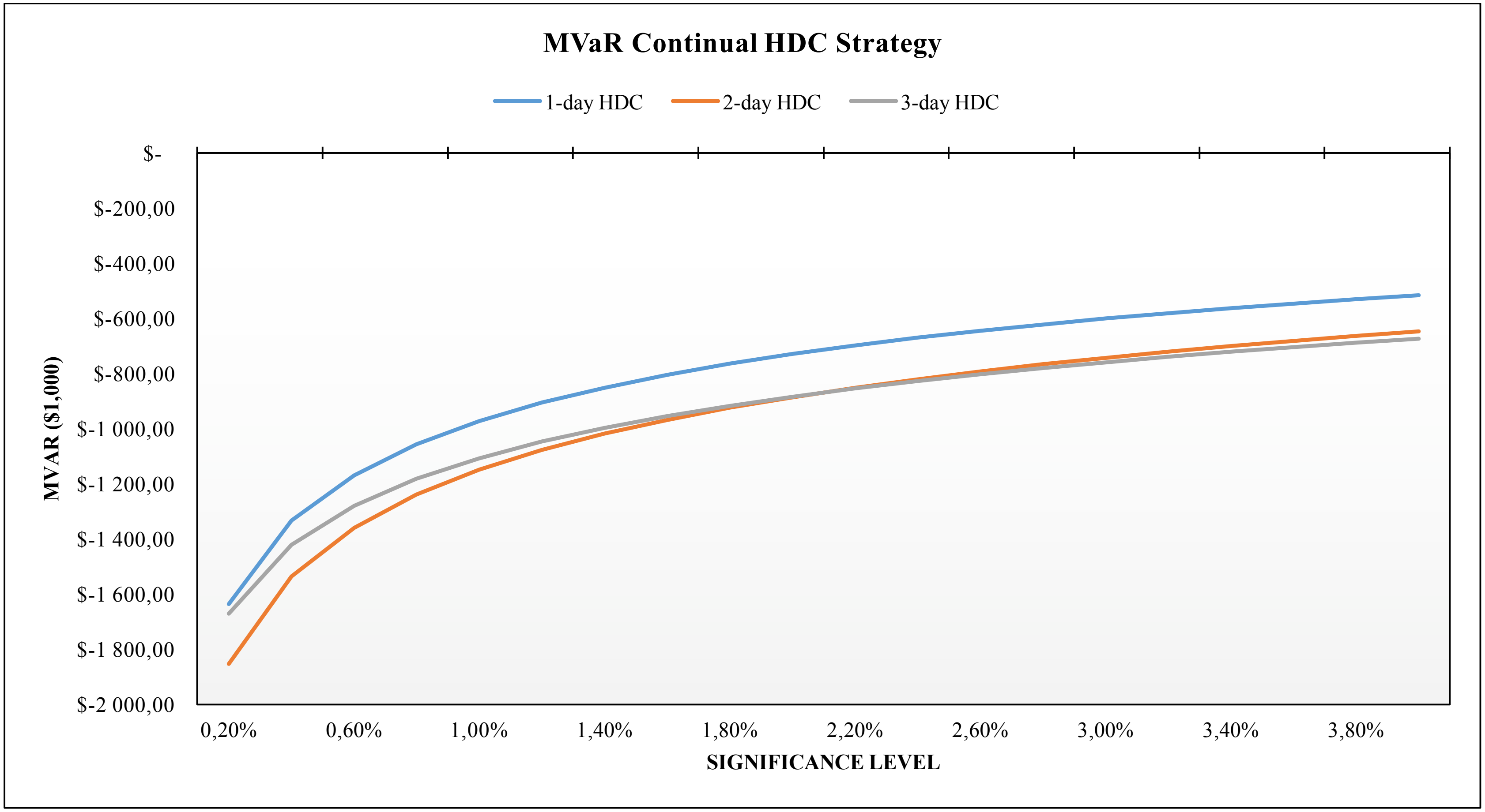

Figure 19. MVaR for the continual HDC Strategy

MVaR conducted at several significance levels ranging from 0.20 percent to 4 percent. Calculations in $ million. Based on initial investment of $10 million

Delta Hedge: A Case Study

Up until this point in the research it has been assumed that applying deep in-the-money put-options would sufficiently secure a fully delta-hedged position. However, as demonstrated above, certain options included in the sample have at several points throughout the sample period had delta values far from a delta-neutral position. In addition, high Gamma is demonstrated in several of the options in the sample. As a consequence, this may not be a reasonable assumption. Therefore, a case study[7] has been conducted on the HDC strategy by applying a static delta hedge to the options in the sample with the highest delta (upper quartile) and the lowest delta (lower quartile).[8] Applying a static delta hedge implies delta hedging the position at the initiation date and never adjusting the position during the holding period (Hull 2011 p. 381). The static delta hedge has been conducted on all three holding periods for the in-and-out HDC strategy, without considering the effects of transaction costs, over the entire sample period.[9] It is assumed that the static delta-hedged position is initiated by investing $10 million at the beginning of the sample period while re-investing any proceeds generated from the strategy. The findings from the case study are illustrated in Table 7 and Figures 20 and 21.

The returns generated by applying a static delta hedge to the upper quartiles of the HDC strategy were 20.09% ($2,008.72),[10] 12.76% ($1,275.76) and -7.45% (-$744.89) for the one-, two- and three-day holding periods. For the lower quartiles, the returns generated

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[7] It should be noted that this is not a precise case study but rather an experiment to further research some of the assumptions underlying this paper.
[8] See Appendix 9 for a complete overview of the options included in the case study.
[9] The case study has not been conducted on the continual HDC strategy as it generates the same returns as the in-and-out strategy less the risk-free rate. The static delta hedge should therefore yield similar results for both strategies.
[10] Numbers in $1,000

by applying a static delta hedge were 30.90% ($2,948.73), 36.30% ($3,446.40), and 15.31% ($1,439.70). By applying a static hedge to the HDC strategy throughout the sample period, the investor would significantly improve the profitability of the HDC strategy compared to a 1:1 hedge. This is especially true for the upper quartile, where a static delta hedge would improve the returns from the strategy by approximately 28.11% ($2,810.98) and 26.24% ($2,623.92) percent for the one- and two-day holding periods. For the three-day holding period, there was no difference in returns by applying a static hedge compared to a 1:1 hedge. Moreover, the returns generated from the lower quartile improved by 11.32% ($1,118.27) and 11.80% ($1,162.50) for the one- and two-day holding periods. For the three-day holding period, and similar to the upper quartile, there was no difference in returns by applying a static hedge compared to a 1:1 hedge.

Based on the returns generated by the static delta hedge, the one-day holding period is more profitable than the two- and three-day holding periods for the upper quartile. For the lower quartile, the two-day holding period is more profitable than the one- and three-day holding periods. The Sharpe ratios of the upper quartile support this view, with the three holding periods presenting Sharpe ratios of 1.25, 0.57, and -0.30. Furthermore, the Sharpe ratios of the lower quartile contribute to this view, with the one-day holding period (10.09) performing better than the two- (9.53) and three-day periods (3.07). This is in line with previous findings (see Table 3) ranking the one-day holding period (based on the Sharpe ratio) as more profitable for both the in-and-out HDC strategy and the continual HDC strategy. However, based on the Omega ratios of the three holding periods, the two-day holding period is more successful than the one- and three-day holding periods for the lower quartile. For the upper quartile, the Omega ratios of the one- (0.59) and two-day

(0.52) holding periods are quite similar. In conclusion, the one-day holding period performs better based on Gaussian risk measures. When applying risk-adjusted measures, however, the two-day period performs better for the lower quartile, and quite similar for the upper quartile.

The most interesting finding from this case study is arrived at by analyzing the change in risk of the HDC strategy between the static hedge and the 1:1 hedge. By only comparing the rate of change in standard deviation between the static hedge and 1:1 hedge, the static hedge does not notably affect the risk of the strategy. However, when analyzing risk by accounting for higher information in the return distribution of the static hedge, this view changes. This is especially evident for the upper quartile, where for instance, the two-day holding period MVaR is reduced from -2.65% to -2.15%, equaling a $50.90 reduction in MVaR. Similar results are found for the one-day holding period and the results can also be witnessed on a smaller scale for the lower quartile. For the three-day holding period, the change in risk is minimal, both when analyzing the standard deviation and the MVaR, for both quartiles. The results presented above illustrate that the investor would, based on this case study, reduce tail risk by applying a static hedge to the HDC strategy for the one- and two-day holding periods, while at the same time improving returns compared to a 1:1 hedge.

In conclusion, the findings in this case study should be viewed as nothing more than an indication that there is a difference between applying a static delta hedge compared to a 1:1 delta hedge. The data material applied to the case study is relatively small, and the results cannot be generalized to a high degree. Moreover, during the sample period, the general market level, as represented by the S&P TSX Composite Index, increased by approximately 10 percent, as illustrated in Appendix 10. Bearing the previous discussions on beta in mind, this fact might be an explanation for the entire improvement in returns generated by the static delta hedge and one should therefore consider the findings from the case study with a degree of caution.

Table 7. Descriptive Statistics of Case Study

	Static Delta Hedge			**1:1 Hedge**		
	1-day	**2-days**	**3-days**	**1-day**	**2-days**	**3-days**
Upper Quartile:						
Return (%)*	20.09	12.76	-7.45	-8.02	-13.48	-7.44
Return ($)*	2,008.72	1,275.76	-744.89	-802.26	-1,348.16	-744.29
Std. dev**	15.59	21.39	26.54	15.67	21.37	26.42
Sharpe***	1.25	0.57	-0.30	-0.55	-0.65	-0.30
Omega	0.59	0.52	0.36	0.18	0.22	0.35
MVaR (%)****	-1.73	-2.15	-2.98	-1.97	-2.65	-2.96
MVaR ($)*****	-172.81	-214.59	-297.72	-197.49	-265.49	-296.27
Lower Quartile:						
Return (%)	30.90	36.30	15.31	19.58	24.50	15.17
Return ($)	2,948.73	3,446.40	1,439.70	1,830.46	2,283.90	1,426.38
Std. dev	21.85	30.28	29.54	21.04	30.03	29.41
Sharpe	10.09	9.53	3.07	5.61	5.48	3.05
Omega	0.89	1.02	0.67	0.66	0.82	0.67
MVaR (%)	-1.83	-2.60	-2.52	-1.98	-2.78	-2.51
MVaR ($)	-182.91	-259.86	-251.67	-197.97	-278.15	-251.14

* *Cumulative return calculated according to on an initial investment of $10 million*
** *Standard deviation in annual terms*
*** *Calculated according to annualized returns*
*****MVaR calculated based on 4% confidence interval*
***** *MVaR in $1,000*

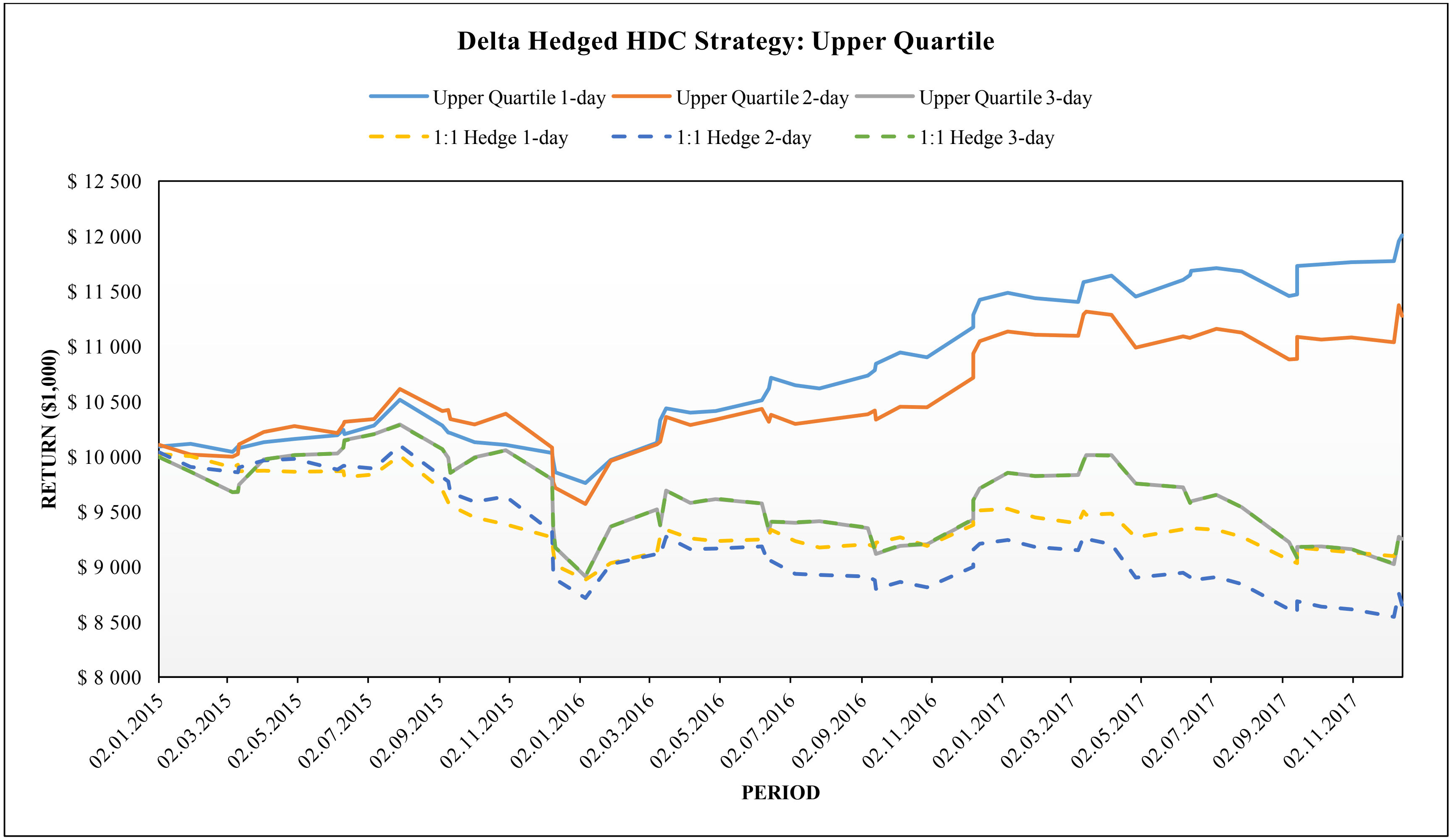

Figure 20. Upper Quartile Delta Hedged Strategy

Static delta hedged upper quartile options compared to 1:1 hedged upper quartile options

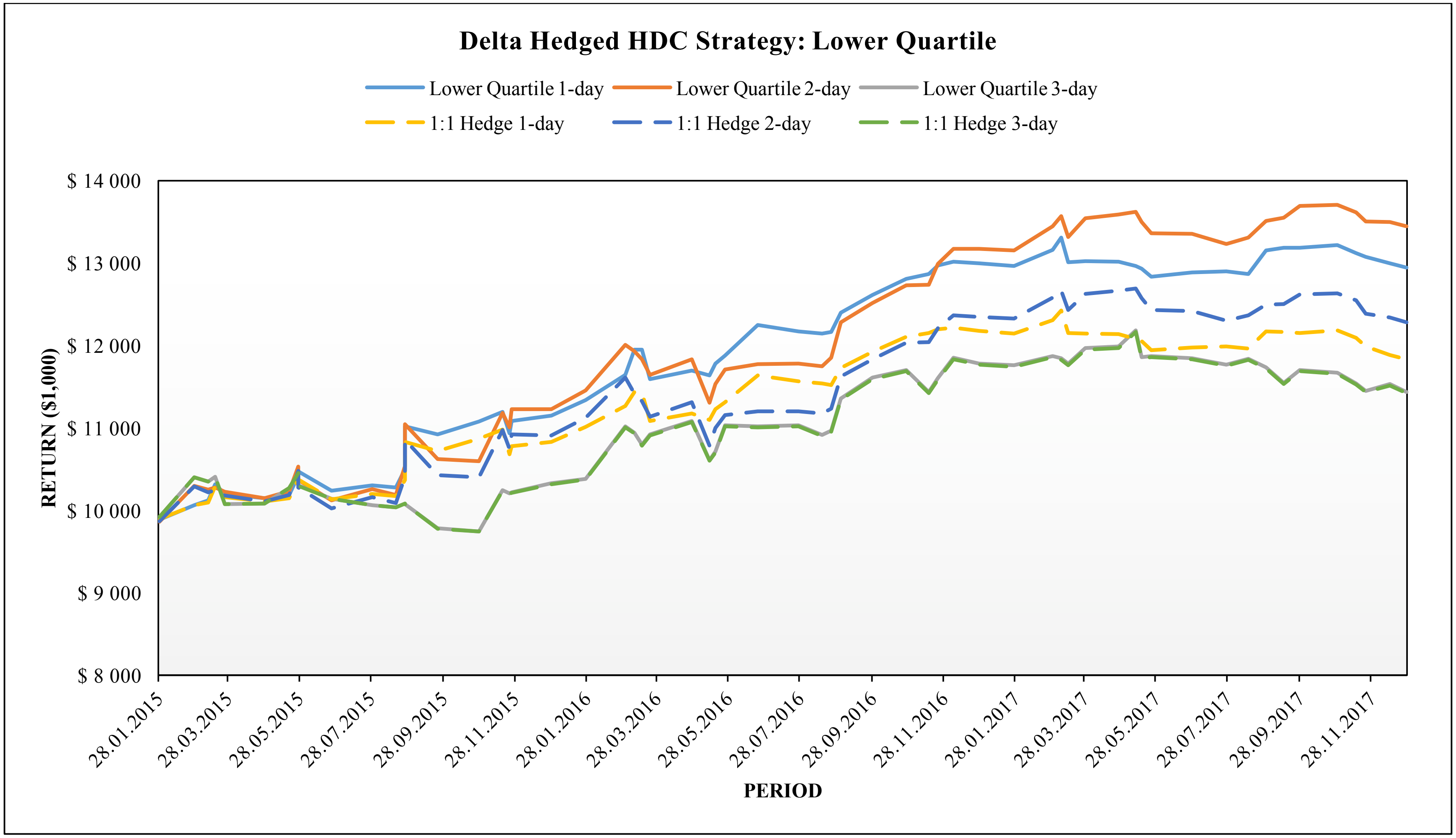

Figure 21. Lower Quartile Delta Hedged HDC Strategy

Static delta hedged lower quartile options compared to 1:1 hedged lower quartile options

Kurtosis and Skewness

An argument could be made regarding the validity of the Omega ratio, MVaR and MSR as a risk measure that captures the tail risk previously demonstrated to exist in the return distribution of the HDC strategy. The Omega ratio assumes constant kurtosis throughout the sample period, while MVaR and MSR make the same assumption regarding both kurtosis and skew. Figures 22 and 23 illustrate the one- and three-year rolling kurtosis and skewness of the options with the highest and lowest recorded values of kurtosis and skew found throughout the sample period.[11] As the figures illustrate, kurtosis and skewness are far from constant throughout the sample period.

When kurtosis and skewness are not constant, the question is raised as to how much better the ratios defined above describe the risk of the HDC strategy compared to Gaussian-based risk measures. Research regarding tail risk and criticism of Gaussian return distributions in relation to financial assets dates back to Mandelbrot (1963). Mandelbrot, as retold by Pazarbasi in his *Tail Risk Literature Review* (2013 p. 19), "challenged the usual assumption of Gaussian return distribution by applying the power law to describe the unconditional tail distributions of financial returns". Mandelbrot's work gained support from others such as Fama (1963), who claimed that certain markets showed price behaviors not consistent with price behaviors expected from normally distributed returns. Over more recent decades, several measures have been implemented as a tool to capture tail risk in financial assets, such as Modified Value at Risk, Conditional Value-at-Risk and Extreme Value Theory models, and in more recent years, Copula Theory (Pazarbasi 2013).

[11] See Appendix 11-14 for a complete overview of the rolling kurtosis and skewness of all options in the sample.

In contrast to the views presented above, other studies have been conducted to determine whether risk-adjusted performance measures implementing information from the higher moments of the return distribution led to significantly different performance results compared to traditional Gaussian-based risk measures (Pedersen and Rudholm-Alfvin 2003; Eling and Schuhmacher 2007). These studies find a high correlation between ranking performance of investments by applying both risk-adjusted measures and traditional Gaussian-based risk measures and conclude that there is not a significant difference between applying the two sets of risk measures. Although acknowledging the different viewpoints and discussions presented above, this paper has applied risk-adjusted performance measures to analyze the risk of the HDC strategy. By analyzing returns from the HDC strategy with respect to normally distributed performance measures, such as the Sharpe ratio, different conclusions have been reached with respect to the performance of the HDC strategy compared to applying risk-adjusted performance measures, such as the Omega ratio. Given that this difference in performance measurement is found in the data sample between the ranking of the two sets of risk measures, it is found that it is better to include the higher moments of the return distribution through the risk-adjusted measurements, and the ratios defined above have therefore been applied in this paper. However, when considering MVaR and MSR as a performance measure, the shape of the return distribution must be considered closely. When returns are leptokurtic (as for the one- and two-day HDC strategy), MVaR will underestimate losses compared to Gaussian-based VaR. On the other hand, when returns are platykurtic (as for the three-day HDC strategy), the MVaR will overestimate losses compared to Gaussian-based VaR (Aktas & Sjöstrand

2011). Furthermore, an argument could be made as to how relevant tail risk actually is for the HDC strategy as the sample consists of options that are deep-in-the-money.

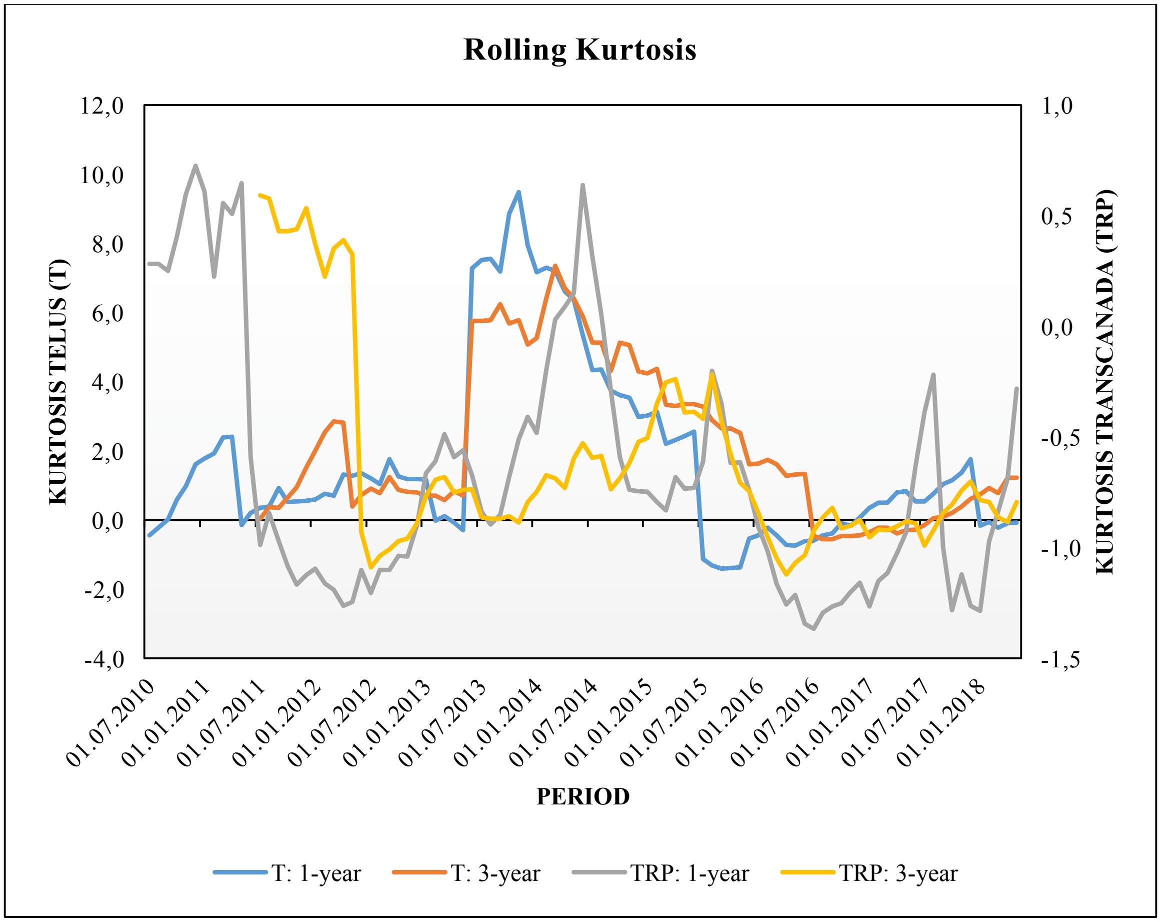

Figure 22. One- and three-year Rolling Kurtosis

One- and three-year rolling kurtosis calculated based on daily sample stock returns of TELUS (T) and TransCanada Corporation (TRP) over the period 2008-2018. TELUS (T) kurtosis on the left vertical axis. TransCanada Corp (TRP) on the right vertical axis.

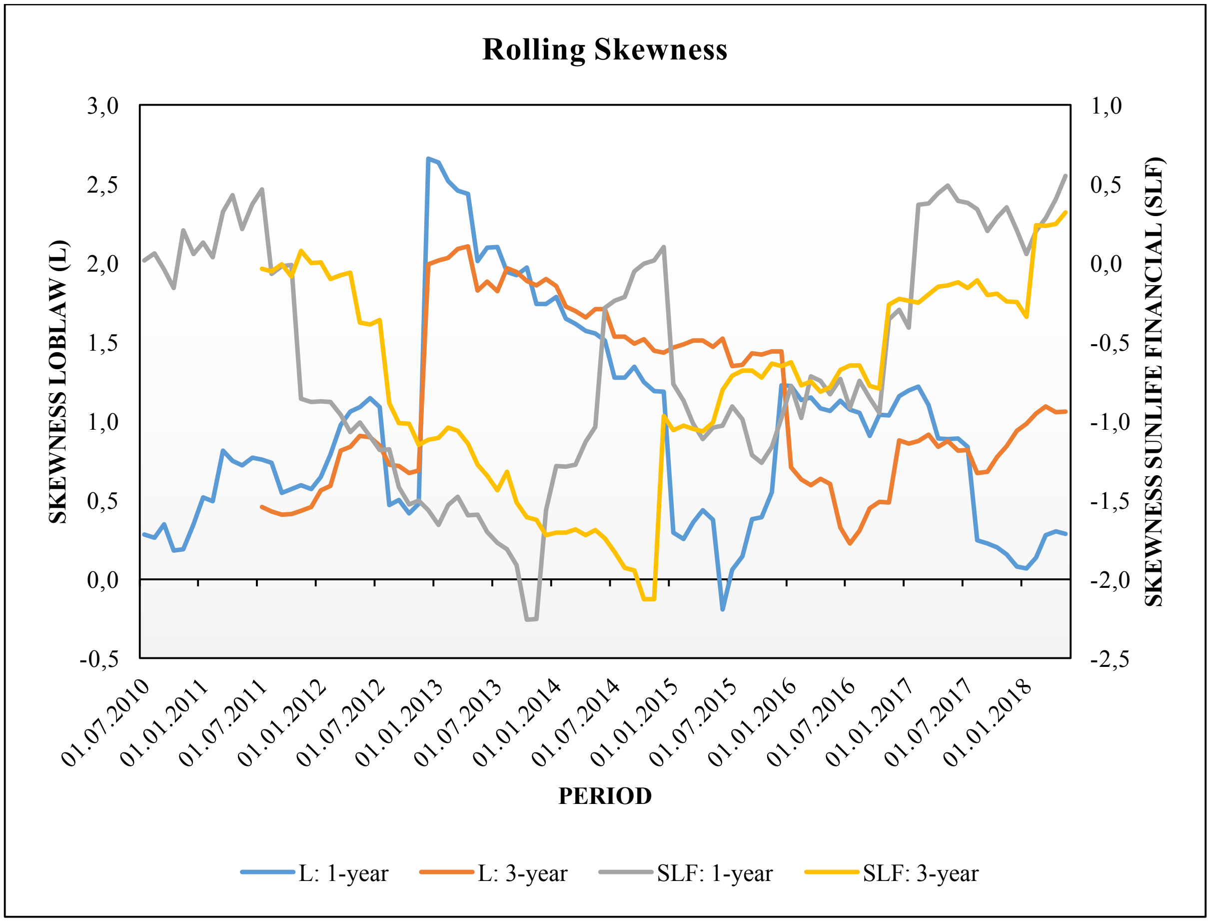

Figure 23. One- and three-year Rolling Skewness

One- and three-year rolling skewness calculated according to daily sample stock returns over the period 2008-2018. Loblaw (L) skewness is illustrated on the left vertical axis. Sun Life Financial (SLF) skewness is illustrated on the right vertical axis.

Conclusion

The aim of this study, as defined in the introduction, was to determine whether the HDC strategy, from a risk-reward perspective, was profitable. The findings in this study have shown that in terms of risk-reward, the HDC strategy has performed better compared to a UHDC strategy. Furthermore, from a risk-reward perspective, the one-day holding period has been found to be more profitable based on generated return, standard deviation and Sharpe ratio than the two- and three-day holding period. However, based on the Omega ratio, this finding is only true for the in-and-out HDC strategy, as the two-day holding period performs better than the two other holding periods for the continual HDC strategy.

However, these findings were arrived at by assuming that quoted mid-prices fully reflect the relevant transaction costs for the investor. When applying quoted bid/ask-prices as a proxy for transaction costs, on the other hand, the HDC strategy becomes highly unprofitable, which, in isolation, indicates that the Canadian derivatives market is priced efficiently. Moreover, these results should be considered in relation to what the investor's relevant transaction costs are. It was found that an investor who is able to trade approximately 19 percent above the quoted mid for the in-and-out HDC strategy, and 10 percent above the quoted mid for the continual HDC strategy, might be able to make a profit.

By analyzing the risk of the HDC strategy it was found that the one-day holding period outperformed the two- and three-day holding periods based on MVaR and MSR for both the in-and-out and the continual HDC strategy. However, the validity of the tail-risk measures is questionable due to kurtosis and skew being non-constant over the sample period, as well as the options applied to the HDC strategy being deep in-the-money.

Furthermore, it was found that delta, gamma and DdeltaDvol of the options may have had implications for how well the options in the sample fully delta-hedged the investor using the HDC strategy. These implications were addressed by applying a static delta hedge to the HDC strategy. The findings from this analysis show that from a risk-reward perspective, the investor achieved greater results compared to a 1:1 hedge. However, the sample period of the analysis is short and the results, as for the research overall, could simply be attributed to the market moving in a favorable direction. The results should therefore be considered with a certain degree of caution.

All in all, it has been found that from a risk-reward perspective the HDC strategy is most likely not profitable for the investor. However, the profitability will be determined by the investor's relevant transaction costs at which he/she can initiate trades. This finding indicates that the Canadian derivatives market has been priced efficiently in relation to dividends. Moreover, based on the sample period in this research, it has been found that even though the HDC strategy implements options that are deep in-the-money, the investor faces the risk of not being fully delta hedged throughout the period.

Shortcomings and Recommendations for Future Studies

Several assumptions made in this paper point the way to other interesting areas of research. Firstly, the time-frame of the data sample is short. In addition to this, the sample itself is rather small, with only a total of 25 options. As discussed above, only high dividend-yielding stocks have been included in the sample. The options included are mostly large cap, high-volume stocks. An interesting extension to this research would therefore be to look at a larger sample over a longer period of time, comparing the performance across stocks of different market size and volume. In addition to this, as briefly mentioned above, the success of the HDC strategy (when applying quoted mid-prices) could simply be due to the market moving in a favorable direction. Therefore, an interesting extension to this study would be to analyze the strategy only on days where the market moves in an unfavorable direction.

Secondly, the data material is based on daily close prices. As mentioned above, this could result in the findings obtained from the analysis in this research not reflecting the dividend payment itself, but rather being down to favorable market moves over the days in question. As a future extension of this study, research could be conducted on intraday data, for instance by initiating the HDC strategy right before the close on the cum-dividend date and liquidating the position at the open of the ex-dividend date.

Thirdly, this research applies a protective put to the HDC strategy. As shown above, previous research has analyzed the HDC strategy by applying different variations of covered call strategies and index options, in addition to other derivatives, such as futures contracts. One additional strategy which could be of interest for a future study would be to apply a long strangle[12] to the HDC strategy. By applying a strangle to dividend-yielding stocks the investor could potentially exploit the price behavior of dividend-paying stocks ex-dividend without being dependent on the dividend payment itself.

Lastly, the HDC strategy is not *strictly* delta hedged. This assumption has been addressed by applying a case study to the HDC strategy to test the effects of implementing a static hedge. However, the case study has been conducted on a fairly small sample of the

[12] Combination of a long put-option and long call-option with the same expiration date and different strike prices (Hull 2011 p. 247)

total number of options included in the data sample, and a future study could be based on a static hedge on a larger sample. In addition, this research does not look into the effects of applying a dynamic hedge to the HDC strategy. Not applying a dynamic hedge might increase risk for investors engaged in the HDC strategy due to the high Gamma found in certain options in the sample. In the discussions above, it has been assumed that the HDC strategy might be most suitable for smaller investors due to the low volume shown to exist in the option contracts applied to this research. The increased costs of applying a dynamic delta hedge may result in extra costs for investors who are employing the HDC strategy, and in essence make the strategy unprofitable. On the other hand, dynamically delta hedging the HDC strategy could ensure that the investor maintains a fully delta-hedged position throughout the sample period and in essence reduces price risk compared to the hedge conducted in this research. Researching the HDC strategy with respect to a dynamic delta hedge could therefore be an interesting topic for a future study.

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Appendix

Appendix 1

VBA Code

The following shows the VBA code applied to estimate the Greek values in this paper. The code is based on work from Haug (2003; 2007).

```
Function CalcDOne(S, K, sigma, r, q, tau)
CalcDOne = (Log(S / K) + (r - q + (sigma * sigma) / 2) * tau) / (sigma * Sqr(tau))
End Function

Function CalcDelta(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
CalcDelta = -Exp(-q * tau) * CDF(-d1)
End Function

Function CalcVega(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
CalcVega = S * Exp(-q * tau) * PDF(d1) * Sqr(tau)
End Function

Function CalcVegaP(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
CalcVegaP = sigma * 0.1 * S * Exp(-q * tau) * PDF(d1) * Sqr(tau)
End Function

Function CalcGamma(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
CalcGamma = Exp(-q * tau) * PDF(d1) / (S * sigma * Sqr(tau))
End Function

Function CalcGammaP(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
CalcGammaP = Exp(-q * tau) / (100 * sigma * Sqr(tau)) * PDF(d1)
End Function

Function CalcVanna(S, K, sigma, r, q, tau)
d1 = CalcDOne(S, K, sigma, r, q, tau)
d2 = d1 - (sigma * Sqr(tau))
CalcVanna = -Exp(-q * tau) * PDF(d1) * d2 / sigma
End Function

Function PDF(x)
PDF = WorksheetFunction.NormDist(x, 0, 1, False)
End Function

Function CDF(x)
CDF = WorksheetFunction.NormSDist(x)
End Function
```

Appendix 2

Delta of Options in Sample

The tables below illustrate the delta for all options included in the data sample throughout the period for each option dividend-quarter from 2015-2017. The average delta of the entire sample was -0.943 in 2015, -0.940 in 2016, and -0.968 in 2017. As the tables illustrate, the delta deviates significantly during the sample period; certain options, such as CP (-0.586), MG (-0.560), QSR (-0.509), and SNC (-0.670), all had deltas differing significantly from a delta-neutral position at certain points throughout the sample period.

Period	**BNS**	**RY**	**TD**	**SU**	**CNR**	**ENB**	**BMO**	**CNQ**	**BCE**	**TRP**	**TRI**	**CP**
Q4 2017	-0.9906	-0.9913	-0.9856	-0.9930	-0.9957	-0.9838	-0.9920	-0.9666	-0.9848	-0.9813	-0.9857	-0.8516
Q3 2017	-0.9912	-0.9910	-0.9931	-0.9917	-0.9959	-0.9829	-0.9913	-0.9904	-0.9848	-0.9798	-0.9135	-0.8652
Q2 2017	-0.9904	-0.9905	-0.9679	-0.9877	-0.9959	-0.9807	-0.9911	-0.9876	-0.9843	-0.9890	-0.9481	-0.8279
Q1 2017	-0.9866	-0.9912	-0.9933	-0.9721	-0.9958	-0.9824	-0.9918	-0.8771	-0.9841	-0.9894	-0.8219	-0.9080
Q4 2016	-0.9896	-0.9898	-0.9923	-0.8490	-0.9952	-0.9830	-0.9908	-0.9641	-0.9835	-0.9841	-0.9768	-0.8308
Q3 2016	-0.9897	-0.9803	-0.9922	-0.9890	-0.9955	-0.9462	-0.9899	-0.9843	-0.9835	-0.9874	-0.9962	-0.7012
Q2 2016	-0.9873	-0.9885	-0.9923	-0.9681	-0.9476	-0.9699	-0.9906	-0.7978	-0.9832	-0.9895	-0.9874	-0.7606
Q1 2016	-0.9834	-0.9456	-0.9922	-0.8139	-0.9916	-0.9489	-0.9455	-0.7599	-0.9813	-0.9614	-0.9582	-0.6411
Q4 2015	-0.9819	-0.9805	-0.9516	-0.9910	-0.9952	-0.9782	-0.9841	-0.9548	-0.9812	-0.7642	-0.9582	-0.5864
Q3 2015	-0.9656	-0.9870	-0.9907	-0.9144	-0.9953	-0.9849	-0.9883	-0.9834	-0.9660	-0.9769	-0.8565	-0.7498
Q2 2015	-0.9835	-0.9863	-0.9912	-0.9919	-0.9926	-0.9818	-0.9884	-0.9877	-0.9811	-0.9642	-0.9815	-0.7087
Q1 2015	-0.9854	-0.9847	-0.9897	-0.9627	-0.9959	-0.8949	-0.9879	-0.9764	-0.9825	-0.9875	-0.9644	-0.8005
Avg. Delta	**-0.9854**	**-0.9839**	**-0.9860**	**-0.9520**	**-0.9910**	**-0.9681**	**-0.9860**	**-0.9358**	**-0.9817**	**-0.9629**	**-0.9457**	**-0.7693**

SLF	MG	T	L	RCI	NA	FTS	QSR	FNV	WN	POW	CTC	SNC	EMA
-0.9930	-0.9919	-0.9842	-0.9977	-0.9950	-0.9973	-0.9501	-0.9695	-0.9906	-0.9976	-0.9925	-0.9470	-0.9837	-0.9823
-0.9929	-0.9674	-0.9853	-0.9977	-0.9957	-0.9967	-0.9895	-0.9570	-0.9912	-0.9976	-0.9907	-0.8997	-0.9974	-0.9911
-0.9929	-0.7884	-0.9812	-0.9971	-0.9872	-0.9867	-0.9907	-0.6454	-0.9538	-0.9958	-0.9923	-0.9280	-0.9969	-0.9910
-0.9918	-0.8790	-0.9846	-0.9974	-0.9339	-0.9972	-0.9907	-0.7335	-0.9946	-0.9964	-0.9574	-0.9839	-0.9838	-0.9917
-0.8788	-0.9667	-0.9833	-0.9977	-0.9932	-0.9876	-0.9827	-0.7914	-0.9874	-0.9691	-0.9821	-0.9023	-0.9015	-0.9867
-0.9932	-0.9174	-0.9783	-0.9978	-0.9727	-0.9874	-0.9903	-0.6898	-0.9636	-0.9976	-0.9923	-0.8440	-0.9582	-0.9311
-0.9879	-0.7595	-0.9834	-0.9981	-0.9946	-0.9935	-0.9901	-0.8707	-0.8207	-0.9792	-0.9934	-0.8450	-0.7770	-0.9859
-0.9875	-0.9759	-0.9810	-0.9837	-0.9869	-0.9248	-0.9346	-0.8689	-0.6896	-0.9535	-0.9879	-0.7550	-0.8936	-0.9428
-0.9874	-0.8686	-0.9818	-0.9926	-0.9941	-0.9917	-0.9855	-0.9273	-0.9448	-0.9868	-0.9913	-0.8635	-0.9441	-0.9906
-0.9797	-0.8060	-0.9771	-0.9835	-0.9834	-0.9551	-0.9411	-0.8672	-0.8948	-0.9798	-0.9928	-0.9598	-0.9711	-0.9674
-0.9925	-0.5603	-0.9771	-0.9535	-0.9941	-0.9917	-0.9905	-0.9471	-0.9973	-0.9872	-0.9884	-0.9874	-0.9484	-0.9901
-0.9636	-0.8274	-0.9747	-0.9735	-0.9941	-0.9773	-0.9899	-0.5090	-0.9307	-0.9643	-0.9750	-0.7675	-0.6703	-0.9925
-0.9784	**-0.8590**	**-0.9810**	**-0.9892**	**-0.9854**	**-0.9823**	**-0.9771**	**-0.8147**	**-0.9299**	**-0.9837**	**-0.9864**	**-0.8903**	**-0.9188**	**-0.9786**

Appendix 3

Beta of Options in Sample

The tables below illustrate the beta for all options included in the data sample throughout the period for each option dividend-quarter from 2015-2017. The average beta of all options was –0.677 in 2015, -0.612 in 2016, and -0.545 in 2017. As the tables illustrate, the beta deviates significantly during the sample period; certain options having beta lower than negative one, such as CNQ (-1.393), QSR (-1.175), and SU (-1.114), and other options having beta close to zero, such as FTS (-0.067) and EMA (-0.086).

Period	**BNS**	**RY**	**TD**	**SU**	**CNR**	**ENB**	**BMO**	**CNQ**	**BCE**	**TRP**	**TRI**	**CP**
Q4 2017	-0.9448	-1.1674	-0.5942	-1.0487	-0.5081	-0.4664	-0.6642	-1.6734	-0.1882	-0.5140	-0.3703	-0.9895
Q3 2017	-1.1003	-1.0895	-0.5894	-0.9384	-0.5895	-0.5713	-0.6660	-1.5911	-0.2251	-0.5723	-0.3803	-1.1439
Q2 2017	-1.0620	-1.0505	-0.5746	-0.8799	-0.5366	-0.5652	-0.5813	-1.4783	-0.2622	-0.5377	-0.3593	-1.0432
Q1 2017	-0.9808	-1.1714	-0.5568	-1.0158	-0.5136	-0.5440	-0.6395	-1.4106	-0.1714	-0.5263	-0.3394	-0.9932
Q4 2016	-0.9872	-1.2878	-0.5938	-0.9593	-0.4532	-0.5402	-0.6122	-1.4197	-0.1669	-0.5051	-0.3589	-0.9600
Q3 2016	-0.7868	-0.9888	-0.5015	-1.1957	-0.5264	-0.3885	-0.5398	-1.5652	-0.1793	-0.4059	-0.3610	-0.9780
Q2 2016	-0.7887	-1.0173	-0.5213	-1.2513	-0.5577	-0.4008	-0.5384	-1.4855	-0.1963	-0.3915	-0.5065	-0.9728
Q1 2016	-0.6816	-0.9161	-0.5746	-1.1388	-0.5809	-0.1982	-0.5334	-1.1778	-0.1700	-0.3826	-0.4256	-0.8073
Q4 2015	-0.7336	-0.8797	-0.5463	-1.1933	-0.4870	-0.2318	-0.4873	-1.3357	-0.1719	-0.3590	-0.4049	-0.7175
Q3 2015	-0.6708	-0.8394	-0.5360	-1.1938	-0.3343	-0.2116	-0.4673	-1.0560	-0.1210	-0.3546	-0.3628	-0.7869
Q2 2015	-0.6544	-0.9081	-0.6075	-1.3468	-0.4481	-0.1192	-0.5845	-1.3528	-0.1270	-0.3049	-0.4082	-0.7711
Q1 2015	-0.6957	-0.9078	-0.6021	-1.2070	-0.4386	-0.1813	-0.6247	-1.1758	-0.2151	-0.3071	-0.3263	-0.8730
Avg. Beta	**-0.8406**	**-1.0187**	**-0.5665**	**-1.1140**	**-0.4978**	**-0.3682**	**-0.5782**	**-1.3935**	**-0.1829**	**-0.4301**	**-0.3836**	**-0.9197**

SLF	MG	T	L	RCI	NA	FTS	QSR	FNV	WN	POW	CTC	SNC	EMA
-0.4803	-0.8283	-0.5285	-0.5597	-0.4592	-0.9333	-0.0449	-1.2842	-0.7762	-0.4693	-0.9475	-0.6661	-0.4790	-0.0627
-0.3193	-0.7971	-0.5825	-0.4905	-0.4680	-1.0591	-0.0285	-1.3055	-0.8333	-0.3655	-0.8655	-0.6877	-0.7441	-0.0335
-0.2958	-0.6845	-0.6502	-0.5865	-0.5668	-1.0421	-0.0403	-0.9739	-0.9581	-0.4396	-0.8390	-0.7407	-0.6591	-0.0372
-0.4188	-0.7833	-0.5069	-0.5865	-0.5197	-0.9426	-0.0447	-1.1033	-0.7957	-0.5308	-0.9758	-0.6252	-0.5256	-0.0567
-0.4479	-0.8349	-0.5137	-0.5396	-0.5205	-1.0472	-0.0256	-1.2061	-0.6873	-0.4663	-1.0378	-0.5710	-0.4348	-0.0580
-0.4557	-0.8389	-0.5824	-0.2471	-0.7472	-0.8572	-0.0435	*n.a*	-0.8593	-0.3255	-0.7882	-0.3721	-0.7598	-0.0395
-0.5713	-0.7487	-0.5200	-0.3087	-0.6082	-0.8515	-0.0724	*n.a*	-0.7352	-0.3847	-0.8229	-0.4783	-0.6335	-0.0685
-0.4800	-0.5735	-0.4581	-0.3258	-0.6185	-0.7650	0.0167	*n.a*	-0.7329	-0.2914	-0.9807	-0.3952	-0.5621	-0.0474
-0.5455	-0.6175	-0.4027	-0.2896	-0.5645	-0.6279	-0.0412	*n.a*	-0.8411	-0.3263	-0.9535	-0.4633	-0.6029	-0.0258
-0.5265	-0.5874	-0.3584	-0.2186	-0.5162	-0.6906	-0.0992	*n.a*	-0.7350	-0.2722	-0.7363	-0.5247	-0.5852	-0.1460
-0.5839	-0.4321	-0.3224	-0.2888	-0.5092	-0.7338	-0.1505	*n.a*	-0.7706	-0.3412	-0.9716	-0.5605	-0.6586	-0.2005
-0.5203	-0.4315	-0.3278	-0.2218	-0.5528	-0.7815	-0.1969	*n.a*	-0.6615	-0.2095	-0.8974	-0.4140	-0.5702	-0.2617
-0.4704	**-0.6798**	**-0.4795**	**-0.3886**	**-0.5542**	**-0.8610**	**-0.0528**	**-1.1746**	**-0.7822**	**-0.3685**	**-0.9013**	**-0.5416**	**-0.6012**	**-0.0747**

Appendix 4

Gamma of Options in Sample

The tables below illustrate the gamma for all options included in the data sample throughout the period for each option dividend-quarter from 2015-2017. The average gamma of all options was 0.010 in 2015, 0.012 in 2016, and 0.007 in 2017. As the tables illustrate, the gamma deviates significantly during the sample period; certain options, such as QSR (0.074), MG (0.066), and SNC (0.059), all having gamma significantly above the average.

Period	**BNS**	**RY**	**TD**	**SU**	**CNR**	**ENB**	**BMO**	**CNQ**	**BCE**	**TRP**	**TRI**	**CP**
Q4 2017	0.0000	0.0000	0.0014	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0038	0.0017	0.0390
Q3 2017	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0005	0.0000	0.0059	0.0256	0.0334
Q2 2017	0.0000	0.0000	0.0070	0.0019	0.0000	0.0007	0.0000	0.0009	0.0000	0.0003	0.0155	0.0363
Q1 2017	0.0016	0.0000	0.0000	0.0055	0.0000	0.0005	0.0000	0.0088	0.0000	0.0001	0.0367	0.0257
Q4 2016	0.0000	0.0001	0.0000	0.0157	0.0000	0.0010	0.0000	0.0036	0.0000	0.0020	0.0048	0.0292
Q3 2016	0.0000	0.0030	0.0001	0.0014	0.0001	0.0075	0.0003	0.0020	0.0000	0.0012	0.0000	0.0467
Q2 2016	0.0009	0.0003	0.0000	0.0053	0.0134	0.0041	0.0000	0.0196	0.0000	0.0001	0.0055	0.0337
Q1 2016	0.0018	0.0081	0.0001	0.0141	0.0013	0.0031	0.0084	0.0107	0.0005	0.0063	0.0119	0.0216
Q4 2015	0.0006	0.0023	0.0079	0.0003	0.0001	0.0013	0.0017	0.0037	0.0001	0.0183	0.0099	0.0280
Q3 2015	0.0039	0.0000	0.0001	0.0092	0.0000	0.0002	0.0000	0.0006	0.0037	0.0017	0.0284	0.0214
Q2 2015	0.0001	0.0001	0.0000	0.0001	0.0008	0.0013	0.0000	0.0001	0.0000	0.0056	0.0066	0.0328
Q1 2015	0.0001	0.0009	0.0001	0.0049	0.0000	0.0102	0.0003	0.0018	0.0002	0.0000	0.0129	0.0296
Avg. Gamma	**0.0007**	**0.0012**	**0.0014**	**0.0049**	**0.0013**	**0.0025**	**0.0009**	**0.0048**	**0.0004**	**0.0038**	**0.0133**	**0.0314**

SLF	MG	T	L	RCI	NA	FTS	QSR	FNV	WN	POW	CTC	SNC	EMA
0.0000	0.0015	0.0008	0.0000	0.0000	0.0000	0.0159	0.0089	0.0024	0.0000	0.0000	0.0241	0.0079	0.0080
0.0000	0.0064	0.0000	0.0000	0.0000	0.0004	0.0010	0.0116	0.0022	0.0000	0.0008	0.0262	0.0002	0.0001
0.0000	0.0258	0.0019	0.0005	0.0055	0.0037	0.0001	0.0434	0.0131	0.0014	0.0000	0.0381	0.0004	0.0000
0.0005	0.0227	0.0003	0.0001	0.0139	0.0000	0.0000	0.0252	0.0011	0.0010	0.0102	0.0080	0.0050	0.0000
0.0131	0.0055	0.0001	0.0001	0.0003	0.0001	0.0019	0.0272	0.0016	0.0094	0.0046	0.0350	0.0209	0.0031
0.0001	0.0122	0.0023	0.0000	0.0091	0.0002	0.0001	0.0467	0.0066	0.0000	0.0000	0.0308	0.0147	0.0185
0.0032	0.0345	0.0000	0.0000	0.0000	0.0001	0.0005	0.0179	0.0163	0.0093	0.0000	0.0287	0.0304	0.0001
0.0016	0.0023	0.0008	0.0053	0.0023	0.0097	0.0058	0.0138	0.0204	0.0130	0.0018	0.0243	0.0212	0.0098
0.0018	0.0119	0.0003	0.0021	0.0000	0.0000	0.0017	0.0084	0.0087	0.0038	0.0009	0.0228	0.0106	0.0009
0.0027	0.0215	0.0015	0.0061	0.0033	0.0048	0.0077	0.0139	0.0106	0.0066	0.0000	0.0120	0.0050	0.0066
0.0001	0.0325	0.0016	0.0165	0.0000	0.0000	0.0000	0.0080	0.0003	0.0047	0.0021	0.0051	0.0100	0.0009
0.0042	0.0209	0.0026	0.0085	0.0000	0.0029	0.0003	0.0271	0.0074	0.0089	0.0062	0.0295	0.0239	0.0000
0.0023	**0.0165**	**0.0010**	**0.0033**	**0.0029**	**0.0018**	**0.0029**	**0.0210**	**0.0076**	**0.0048**	**0.0022**	**0.0237**	**0.0125**	**0.0040**

Appendix 5

Vega of Options in Sample

The tables below illustrate the vega for all options included in the data sample throughout the period for each option dividend-quarter from 2015-2017. The average vega of all options was 0.028 in 2015, 0.029 in 2016, and 0.019 in 2017. As the tables illustrate, the vega of certain options, such as CP (0.331), CTC (0.164), QSR (0.159), and MG (0.170), deviated significantly from the average vega throughout the sample period.

Period	**BNS**	**RY**	**TD**	**SU**	**CNR**	**ENB**	**BMO**	**CNQ**	**BCE**	**TRP**	**TRI**	**CP**
Q4 2017	0.0000	0.0000	0.0044	0.0000	0.0000	0.0000	0.0000	0.0307	0.0000	0.0085	0.0096	0.3102
Q3 2017	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0022	0.0000	0.0075	0.0534	0.2889
Q2 2017	0.0000	0.0000	0.0328	0.0053	0.0000	0.0029	0.0000	0.0068	0.0000	0.0008	0.0382	0.3709
Q1 2017	0.0069	0.0000	0.0000	0.0189	0.0001	0.0019	0.0000	0.1870	0.0000	0.0002	0.1017	0.2022
Q4 2016	0.0000	0.0002	0.0000	0.1389	0.0001	0.0045	0.0000	0.0485	0.0000	0.0079	0.0167	0.4135
Q3 2016	0.0001	0.0158	0.0001	0.0035	0.0002	0.0528	0.0009	0.0093	0.0000	0.0029	0.0000	0.5030
Q2 2016	0.0034	0.0010	0.0000	0.0236	0.0276	0.0231	0.0000	0.1427	0.0000	0.0001	0.0054	0.4609
Q1 2016	0.0112	0.0733	0.0001	0.1617	0.0040	0.0938	0.0796	0.3128	0.0018	0.0329	0.0289	1.1004
Q4 2015	0.0020	0.0108	0.0455	0.0013	0.0002	0.0164	0.0079	0.0423	0.0003	0.2211	0.0295	0.9600
Q3 2015	0.0288	0.0000	0.0002	0.0804	0.0000	0.0013	0.0001	0.0082	0.0215	0.0169	0.0920	0.8801
Q2 2015	0.0002	0.0003	0.0000	0.0002	0.0033	0.0058	0.0000	0.0003	0.0000	0.0245	0.0097	0.7190
Q1 2015	0.0002	0.0041	0.0005	0.0334	0.0000	0.1596	0.0012	0.0229	0.0007	0.0001	0.0191	0.6015
Avg. Vega	**0.0044**	**0.0088**	**0.0070**	**0.0390**	**0.0030**	**0.0302**	**0.0075**	**0.0678**	**0.0020**	**0.0269**	**0.0337**	**0.5675**

SLF	MG	T	L	RCI	NA	FTS	QSR	FNV	WN	POW	CTC	SNC	EMA
0.0000	0.0082	0.0011	0.0000	0.0000	0.0000	0.0231	0.0378	0.0194	0.0000	0.0000	0.0702	0.0090	0.0040
0.0000	0.0415	0.0000	0.0000	0.0000	0.0007	0.0011	0.0515	0.0190	0.0000	0.0012	0.1602	0.0003	0.0000
0.0000	0.1906	0.0031	0.0006	0.0049	0.0113	0.0001	0.2561	0.0661	0.0027	0.0000	0.0766	0.0007	0.0000
0.0020	0.0994	0.0006	0.0002	0.0584	0.0001	0.0000	0.3095	0.0106	0.0013	0.0183	0.0198	0.0124	0.0000
0.1474	0.0448	0.0002	0.0002	0.0006	0.0001	0.0095	0.1911	0.0375	0.0519	0.0047	0.1063	0.0774	0.0028
0.0002	0.0919	0.0042	0.0000	0.0154	0.0004	0.0002	0.1675	0.0824	0.0001	0.0000	0.2495	0.0278	0.0363
0.0045	0.1445	0.0001	0.0000	0.0000	0.0003	0.0010	0.1247	0.3683	0.0256	0.0000	0.2640	0.1495	0.0001
0.0090	0.0516	0.0030	0.0175	0.0100	0.0671	0.0802	0.1548	0.4945	0.0742	0.0040	0.4359	0.0717	0.0383
0.0055	0.2211	0.0011	0.0072	0.0000	0.0000	0.0058	0.1044	0.0869	0.0231	0.0019	0.2360	0.0463	0.0015
0.0164	0.2204	0.0063	0.0151	0.0108	0.0377	0.0530	0.1668	0.1698	0.0321	0.0001	0.0686	0.0283	0.0214
0.0001	0.3434	0.0055	0.0337	0.0000	0.0000	0.0000	0.0647	0.0013	0.0168	0.0027	0.0147	0.0446	0.0019
0.0396	0.4039	0.0097	0.0233	0.0000	0.0087	0.0006	0.3226	0.1347	0.0608	0.0103	0.3728	0.2411	0.0000
0.0187	**0.1551**	**0.0029**	**0.0081**	**0.0083**	**0.0105**	**0.0146**	**0.1626**	**0.1242**	**0.0240**	**0.0036**	**0.1729**	**0.0591**	**0,0089**

Appendix 6

DdeltaDvol of Options in Sample

The tables below illustrate the DdeltaDvol for all options included in the data sample throughout the period for each option dividend-quarter from 2015-2017. The average DdeltaDvol of all options was 0.36 in 2015, 0.45 in 2016, and 0.36 in 2017. As the tables illustrate, significant deviations in DdeltaDvol exist between the individual options in the data sample, with certain options, such as CTC (2.60), CP (1.93), and FTS (1.41) deviating significantly from the average at several points throughout the sample period.

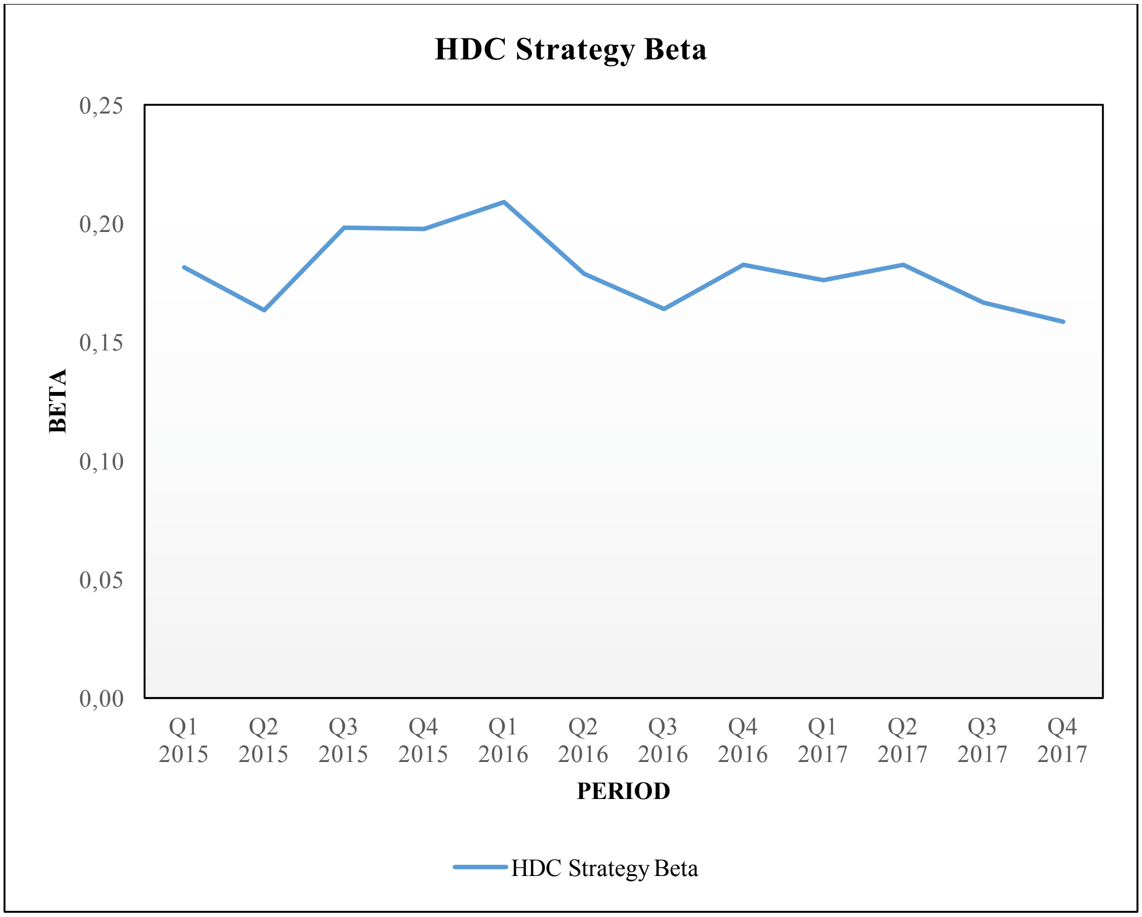
Period	BNS	RY	TD	SU	CNR	ENB	BMO	CNQ	BCE	TRP	TRI	CP
Q4 2017	0.0000	0.0000	0.2138	0.0014	0.0029	0.0020	0.0000	0.5361	0.0000	0.4164	0.2276	1.9360
Q3 2017	0.0001	0.0010	0.0001	0.0873	0.0001	0.0000	0.0000	0.0836	0.0000	0.6207	1.3027	1.7554
Q2 2017	0.0007	0.0004	0.5902	0.2214	0.0001	0.1071	0.0001	0.1305	0.0001	0.0479	0.9399	1.6748
Q1 2017	0.1977	0.0000	0.0000	0.5321	0.0052	0.0760	0.0000	0.6331	0.0000	0.0227	1.8105	1.6300
Q4 2016	0.0020	0.0212	0.0000	0.8547	0.0049	0.1474	0.0001	0.4049	0.0028	0.2396	0.5534	1.3837
Q3 2016	0.0044	0.3430	0.0094	0.1693	0.0208	0.7448	0.0513	0.2561	0.0018	0.1548	0.0000	1.2786
Q2 2016	0.1200	0.0541	0.0004	0.4599	1.1892	0.4569	0.0025	0.9952	0.0008	0.0122	0.4682	1.3090
Q1 2016	0.2065	0.6948	0.0090	0.6505	0.1868	0.3231	0.6770	0.5516	0.0838	0.5765	0.7300	0.5639
Q4 2015	0.0772	0.2755	0.6515	0.0390	0.0128	0.1692	0.1995	0.4050	0.0151	0.7629	0.9122	0.4592
Q3 2015	0.3772	0.0029	0.0135	0.6070	0.0000	0.0385	0.0053	0.0882	0.4379	0.1896	1.1595	0.8510
Q2 2015	0.0101	0.0211	0.0055	0.0166	0.1207	0.1817	0.0010	0.0209	0.0000	0.5618	0.5205	1.0386
Q1 2015	0.0148	0.1308	0.0199	0.4265	0.0000	0.7737	0.0504	0.2139	0.0273	0.0053	0.8376	1.2573
Avg. DdeltaDvol	**0.0842**	**0.1287**	**0.1261**	**0.3388**	**0.1286**	**0.2517**	**0.0823**	**0.3599**	**0.0475**	**0.3009**	**0.7885**	**1.2615**

SLF	MG	T	L	RCI	NA	FTS	QSR	FNV	WN	POW	CTC	SNC	EMA
0.0000	0.1961	0.1299	0.0000	0.0000	0.0000	1.4247	0.6658	0.2481	0.0001	0.0000	1.7396	0.6168	0.8065
0.0017	0.5728	0.0030	0.0000	0.0000	0.0581	0.1587	0.7993	0.2159	0.0000	0.1038	1.5945	0.0220	0.0138
0.0004	1.1465	0.2799	0.0611	0.5659	0.4241	0.0227	1.0739	0.9045	0.1583	0.0018	2.6099	0.0505	0.0000
0.0685	1.1809	0.0527	0.0146	0.9429	0.0055	0.0032	0.8641	0.1182	0.1204	0.8100	0.8003	0.4487	0.0016
0.8114	0.5325	0.0222	0.0132	0.0385	0.0148	0.2469	1.0640	0.1694	0.7191	0.4619	2.1269	1.0192	0.3626
0.0181	0.8981	0.3243	0.0000	0.7961	0.0313	0.0259	1.2026	0.4984	0.0061	0.0000	1.5318	0.9370	1.4482
0.3488	1.2502	0.0099	0.0000	0.0000	0.0168	0.0765	1.1431	0.6221	0.7101	0.0000	1.4388	0.9273	0.0137
0.1783	0.2783	0.1289	0.4500	0.2221	0.7712	0.5143	0.7493	0.4814	0.8656	0.1818	0.9069	1.0032	0.9943
0.2180	0.7027	0.0475	0.2032	0.0006	0.0000	0.2155	0.6303	0.6413	0.3370	0.0971	1.2402	0.6420	0.1263
0.2878	0.9705	0.2204	0.5093	0.2991	0.4607	0.6678	0.8019	0.5903	0.5362	0.0060	1.0092	0.3668	0.6148
0.0108	0.4058	0.2282	1.1037	0.0001	0.0000	0.0017	0.6418	0.0390	0.4185	0.2280	0.5660	0.6183	0.1242
0.3993	1.1459	0.3320	0.6677	0.0000	0.3155	0.0509	0.2068	0.4850	0.6588	0.5476	1.1211	0.5025	0.0018
0.1953	**0.7734**	**0.1482**	**0.2519**	**0.2388**	**0.1748**	**0.2841**	**0.8202**	**0.4178**	**0.3775**	**0.2032**	**1.3904**	**0.5962**	**0.3757**

Appendix 7

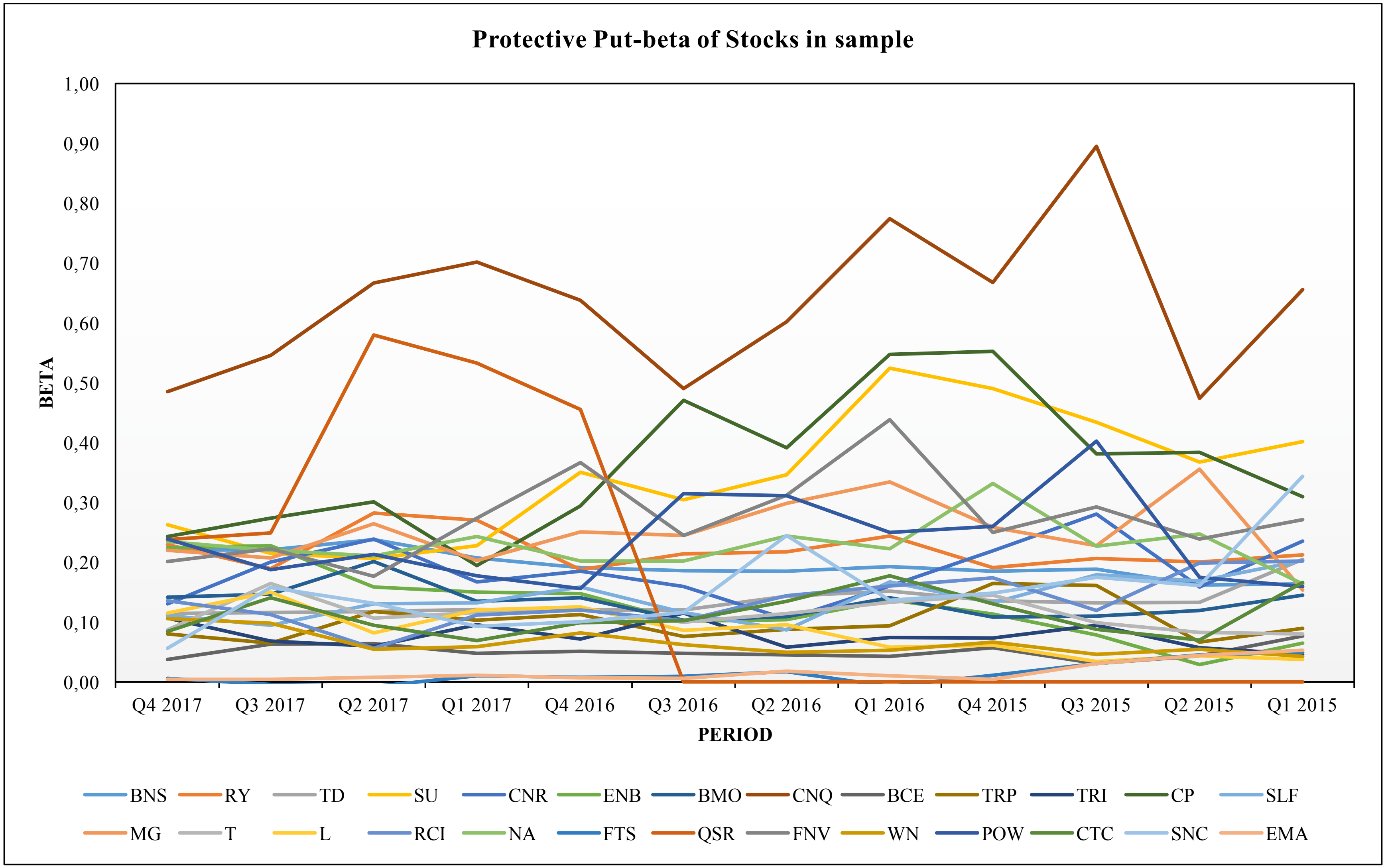
HDC Strategy Beta

The figure below illustrates the beta of the entire HDC strategy, computed as the sum of the individual protective put betas (calculated as the sum of the underlying stock beta and the put-option beta).[13]



Additionally, the figure below illustrates the protective put-beta of each individual stock in the data sample. The stock betas have been calculated according to 30-day historical volatility collected from the historical database of the Montreal Exchange.

[13] Calculated according to the formula for portfolio beta: $\beta_P = \sum_{i=1}^{n} w_i \beta_i$ where β_P equals the portfolio beta, β_i equals the beta of the individual assets and w_i equals the portfolio weights of each individual asset. In this paper, due to the 1:1 hedge, w_i equals one.


Protective Put-beta of Stocks in sample
BETA
1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0,00
Q4 2017
Q3 2017
Q2 2017
Q1 2017
Q4 2016
Q3 2016
Q2 2016
Q1 2016
Q4 2015
Q3 2015
Q2 2015
Q1 2015
PERIOD
BNS
RY
TD
SU
CNR
ENB
BMO
CNQ
BCE
TRP
TRI
CP
SLF
MG
T
L
RCI
NA
FTS
QSR
FNV
WN
POW
CTC
SNC
EMA

Appendix 8

Modified Sharpe Ratio

The table below illustrates the Modified Sharpe ratio for the different holding periods of the in-and-out and continual HDC strategy.

Modified Sharpe Ratio	**In-and-out HDC Strategy**			**Continual HDC Strategy**		
	1 day	**1 day**	**2 days**	**1 days**	**2 days**	**3 days**
Excess Return (%)	227	50.48	34.48	16.48	166	213
MVAR (%)	-9.27	-12.25	-13.27	-5.10	-6.43	-6.70
MSR	24.36	13.56	15.49	9.80	5.28	2.14

Appendix 9

Stocks Included in Case Study

The table below illustrates the return from applying a static delta hedge for the different holding periods of the HDC strategy compared to a 1:1 hedge for the upper and lower quartile options.

Options		**Return Static Hedge**			**Return 1:1 Hedge**		
	Delta*	**1 day****	**2 days**	**3 days**	**1 day**	**2 days**	**3 days**
Upper Quartile:							
CNR	-0.991	0.50	0.56	0.36	0.09	0.13	0.35
BMO	-0.986	0.17	0.40	0.17	-0.27	-0.04	0.16
L	-0.989	0.70	0.18	-0.59	0.27	-0.23	-0.59
POW	-0.986	0.04	-0.18	-0.75	-0.46	-0.68	-0.75
TD	-0.986	0.15	0.10	0.25	-0.30	-0.35	0.25
Lower Quartile:							
CP	-0.769	-0.16	-0.29	-0.17	-0.28	-0.41	-0.17
CTC	-0.890	0.50	0.47	0.02	0.33	0.30	0.01
MG	-0.859	1.10	1.02	0.35	0.73	0.65	0.35
QSR	-0.815	0.84	1.19	1.02	0.57	0.92	1.02
SNC	-0.919	0.38	0.64	-0.01	0.09	0.34	-0.01

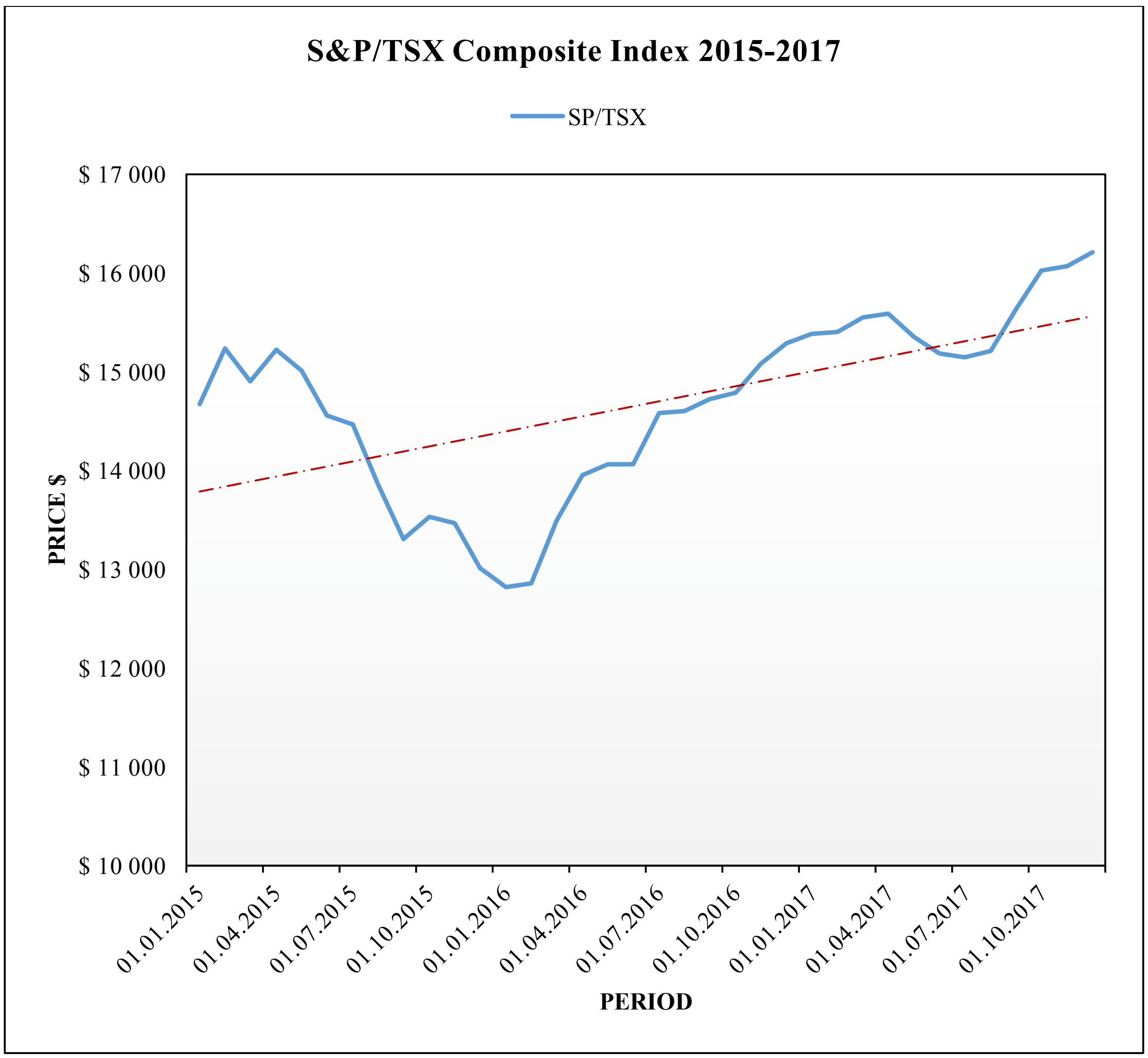
**Average delta throughout the sample period*

*** Average returns generated over the sample period*

Appendix 10

S&P/TSX Composite Index

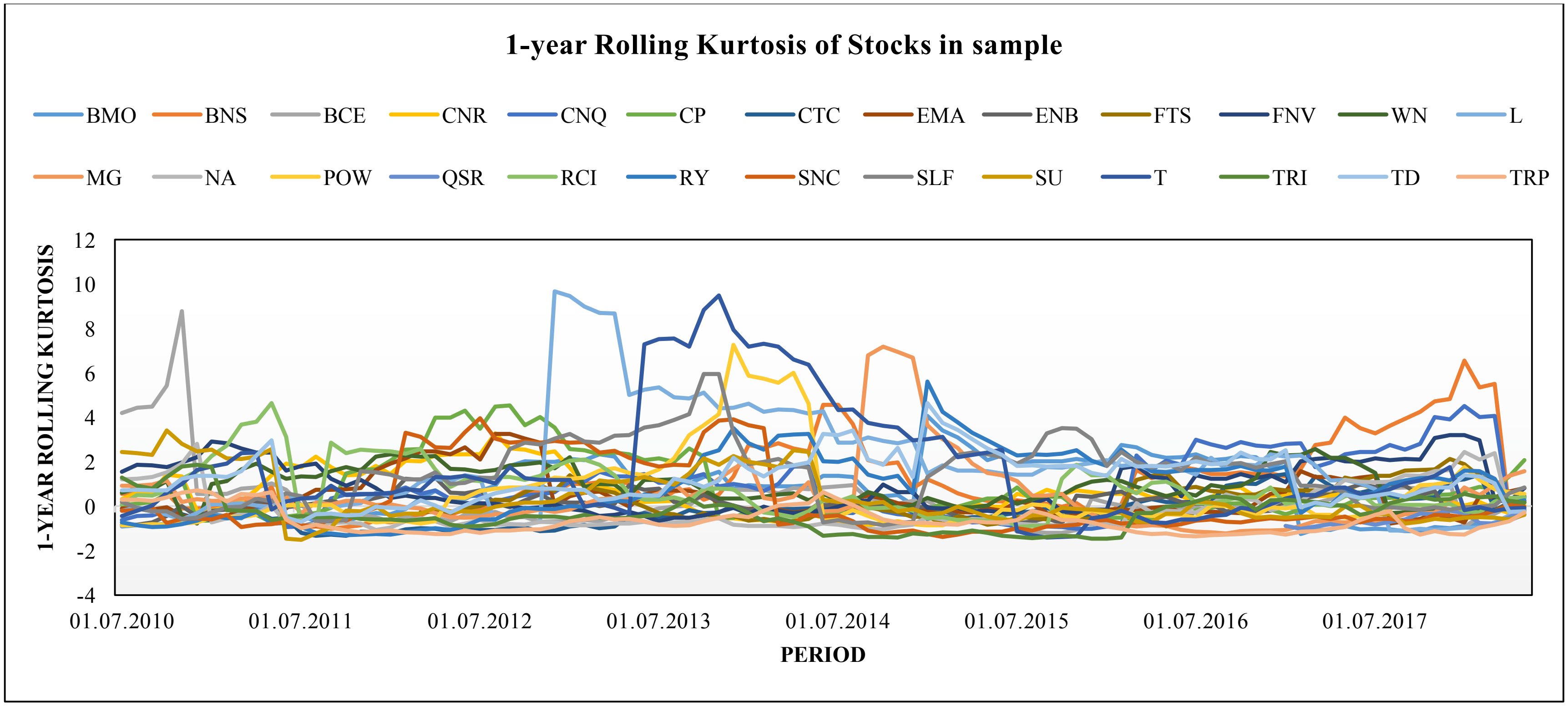
The figure below shows the price development in the S&P/TSX Composite Index throughout the sample period that applies to this research (2015-2017). The data have been collected from Yahoo Finance. The S&P/TSX is compared to a trend-line illustrating the average growth rate of the S&P/TSX Composite Index throughout the period. Over the entire sample period, the cumulative growth of the market was approximately 10.47 percent.



Appendix 11

One-year Rolling Kurtosis of Stocks in Sample

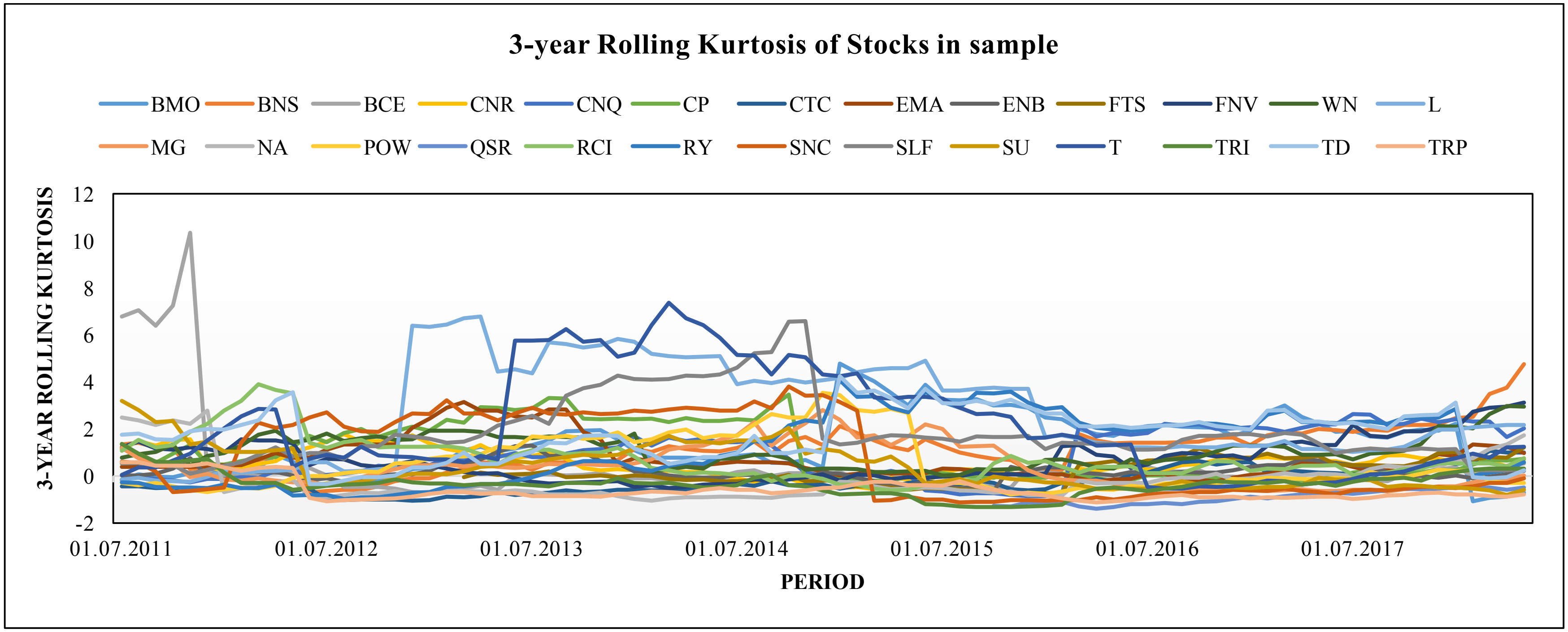
The figure below illustrates the one-year rolling kurtosis of all the stocks in the sample. The one-year rolling kurtosis is calculated according to daily sample stock returns over the period 2008-2018. As the figure illustrates, several of the stocks in the sample had one-year kurtosis that fluctuated significantly during the sample period, such as Loblaw (L), Telus (T), Magna (MG), and BCE.



Appendix 12

Three-year Rolling Kurtosis of Stocks in Sample

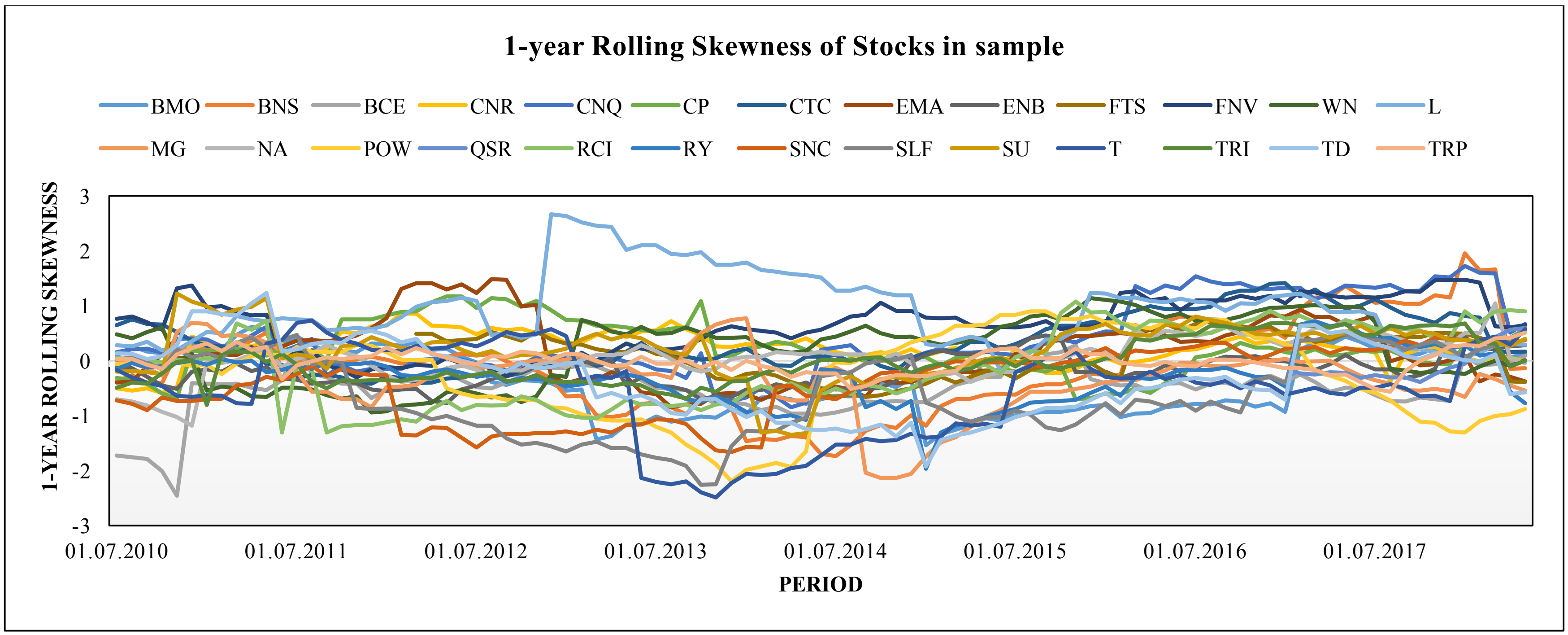
The figure below illustrates the three-year rolling kurtosis of all the stocks in the sample. The three-year rolling kurtosis is calculated according to daily sample stock returns over the period 2008-2018. As the figure illustrates, several of the stocks in the sample had three-year kurtosis that fluctuated significantly during the sample period, such as Loblaw (L), Telus (T), Sun Life (SLF), and BCE.



Appendix 13

One-year Rolling Skewness of Stocks in Sample

The figure below illustrates the one-year rolling skewness of all the stocks in the sample. The one-year rolling skewness is calculated according to daily sample stock returns over the period 2008-2018. As the figure illustrates, several of the stocks in the sample had one-year skewness that fluctuated significantly during the sample period, such as Loblaw (L), Bank of Nova Scotia (BNS), Canadian Natural Resources (CNQ), and Emera (EMA).



Appendix 14

Three-year Rolling Skewness of Stocks in Sample

The figure below illustrates the three-year rolling skewness of all the stocks in the sample. The three-year rolling skewness is calculated according to daily sample stock returns over the period 2008-2018. As the figure illustrates, several of the stocks in the sample had three-year skewness that fluctuated significantly during the sample period, such as Loblaw (L), Canadian Natural Resources (CNQ), France Nevada Corp (FNV), and Emera (EMA).