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The Effectiveness of Hedging the Swedish Stock Markets Using Commodity Futures Index

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Abstract

It is well documented that commodity futures contracts are negatively correlated with equities. Recent years has seen a spike in trading with commodity futures contracts because of the large volume traded and the increasing interest by investors, which have reach a top of 380 billion dollar in April 2011.

Using 10 years of monthly time series data we will explore the diversification benefits of hedging equity portfolios in the Swedish stock markets using commodity futures contracts. The equity indices we are using are chosen to represent the different Swedish Markets. We also investigate how diversification gains from using commodity futures contracts in our portfolio, before, during and after the financial crisis.

The results strongly support the benefits of hedging the portfolios using commodity futures contracts. We also find that post the financial crisis, the performances of hedging the single equity indices with commodity futures contracts were greater than pre the financial crisis.

Contents

1. Introduction

We are going to use commodity futures contracts in order to hedge the portfolios in the sense of diversification. The portfolios are consisting of three equity market indices representing of different firms in the Stockholm stock exchange.

Our choice of commodity futures contracts are based on the recent decade's extreme growth of commodity investments. Through the years of trading with commodities, the general opinion has been that it has only been for the investors who trade actively. Today the volume of managed commodities traded on exchanges is about 380 billion dollars at its peak in April 2011 according to TheCityUK[1].

We use commodity futures contracts as assets in our portfolios. Commodity futures contracts are an agreement between two individuals, companies or institutions to buy or sell an amount commodity at a price agreed upon when the contract was entered (Geman, 2005).

The idea of investing in equities and commodity futures contracts is that there are two different asset classes and they are influenced differently based on macroeconomics factors and this is why we can use one to hedge the other. To diversify a portfolio the best way is to minimize the risk spread because of the different way the market is performing depending on their environment. Our opinion and many others (Geman, Hill and Rouwenhorst) is not why you should diversify your portfolio but rather how you should do it. The point of diversifying is to get a low variance for the portfolio. This is achieved by adding stocks with negative correlation to each other, which implies that if one equity price increase another might decrease and equity moving in opposite direction will decrease the risk but also reduce the opportunities for higher profit.

The rational choice behind our portfolios is based on the risk diversification from Markowitz, 1952. "A portfolio with sixty different railway securities, for example, would not be as well diversified as the same size portfolio with some railroad, some public utility, mining, various sorts of manufacturing etc". This quote illustrates the idea behind diversification were we have two assets that are negatively correlated and from that negatively correlation we get a reduction in risk.

[1] www.thecityuk.com

We examine the diversification and hedging benefits of using commodity futures contracts in our three indices. For each equity index, we combine three Buy & Hold portfolios with equal weights at the beginning of our time period, the first with Crude Oil futures contracts, the second one with the GSCI futures contracts and the third with Nordic Power futures contracts. We also combine three portfolios for each equity indices where the weights will be Yearly Managed.

We divide the total time period from 2003-2013 into two time periods, the first prior the financial crisis between December 2002 until December 2006. The second period during and after the financial crisis from January 2007 until April 2013. We investigate these time periods in order to find differences prior the financial crisis or after.

Our hypotheses states as follow:

- The equity indices hedged with commodity futures contracts will outperform the non-hedged equity indices.
- The diversification benefits of using commodity futures contracts is affected by the financial crisis.

Previous studies have investigated how hedging equity indices using commodity futures contracts impacts on the performances of portfolios in the US. So far no studies have been done about the Swedish equity markets and this is why it is relevant. It is also interesting because the GSCI futures contracts are heavily weighted with energy and one of the most traded energy contracts are Crude Oil futures contracts. Since GSCI futures contracts are energy dominated and Sweden is not an oil producing country, we will also use Nordic Power futures contracts which is electricity produced in Scandinavian countries. We contribute to the literature by exploring the effects for the Swedish markets.

The proportion of the weights for the GSCI futures contracts differs over time. We as an investor have no power of influence. We accept this and use the weights last used with no deeper analysis.

GSCI commodity futures contracts are composed mainly of oil as energy[2] therefore that is one of the limitations for our data. In order to isolate the effect of energy we will use Crude Oil

[2] Appendix A, table 1

futures contracts, which is an energy only index. We will also use Nordic Power futures contracts in order to analyse the effect of futures contracts based on a commodity produced in the same geographic area as the observed equities.

2. Related Literature

Previous literature about the benefits of commodity futures contracts as a hedging instrument includes the study by Gorton and Rouwenhorst (2005) who investigates commodity futures contracts as an asset class. They use an equally weighted index for commodity futures contracts and compare its performance to inflation and other asset classes in the US market. They find that commodity futures contracts perform better than equities in times of unexpected inflation. Commodity futures contracts also offer similar returns as the S&P 500 but with lower volatility and a negative correlation towards the chosen equity index, the S&P 500. The negative correlation increases when the holding period increases, which implies that the longer the time period the more effective is the hedge. They do find a difference in the skewness of equity returns and commodity returns. The distribution of the first is skewed to the left while the distribution of the second is skewed to the right.

Akey (2005) finds that commodity futures contracts as an asset class are very suitable for actively managed portfolios. He observes six commodity indices and finds that commodity futures contracts are a good way to hedge against weakening currencies and inflation. He also concludes that investors who consider an investment in commodity futures contracts may experience enhanced returns by investing in actively managed commodity futures contracts. In the same frame Geman and Kharoubi (2008) writes about diversifying an equity portfolio consisting of the S&P 500 with the commodity futures contracts for Crude Oil. They find that the Crude Oil futures contracts diversify the equity portfolio well in both upward and downward trending equity markets. The correlation between Crude Oil futures contracts and S&P 500 are close to zero or in many cases even negative, which makes Crude Oil futures contracts an excellent hedging instrument for equities in the US market (Geman and Kharoubi, 2008.)

Conover et.al (2010) finds in their work about the benefits of diversifying the US market by adding a commodity futures contracts in an equity portfolio, that allocating at least 10 percent

of the assets in a portfolio to commodity futures contracts significantly reduced the risk of the portfolio significantly. The portfolios consisted of equities for companies ranked in growth value large cap or small cap.

Other string of the literature finds little evidence for the benefits of hedging a portfolio using commodity futures contracts. Among previous studies that use simple passive Buy & Hold strategies Jensen et.al (2000) find that commodity futures contracts such as the GSCI on its own gives lower returns and higher risk then equities but when combining them in a portfolio the return is shown to increase. The equities used in the study are a CRSP index for the three different US equity markets NYSE, AMEX and NASDAQ. They conclude that the benefits are proven by the use of commodity futures contracts such as the GSCI in equity portfolios for the latest 25 years.

Fuertes et.al (2010) claims that first-generation commodity indices like the S&P GSCI is not optimal as a commodity investment. They claim that the indices are not rebalanced at a high enough frequency and that the indices do not take historical performance into account which has been proven to have a big effect on the price for commodity futures contracts. They reach the conclusion that GSCI has good diversification benefits when it comes to hedging away risk. Within the same frame, Demidova-Menzel et.al (2007) defines the characteristics specified for financial investable commodities such as energy, precious metals and many others. They analyze earlier work where passive investments in commodity indices such as the GSCI have been used successfully. Further on they analyze the underlying commodity futures contracts for the GSCI. They reached the conclusion that previous studies were not as convincing because of the fact that the benefits only occurs during some specific time period. They find no advantage to hedge the S&P 500 or invest in commodity indices when the portfolio is passively managed in the US market.

We identify that there are two different views about commodity futures contracts where most of them are focusing on the US market while we focus on the Swedish equity markets. That is how we contribute to the literature. Unlike what has been done in the literature before we are comparing two different portfolio strategies, one Buy and Hold and one Yearly Managed for the three Swedish equity indices OMXS30, Mid Cap and Small Cap.

3. Data description

We use equity indices from Stockholm Stock Exchange from the period December 2002 until April 2013 at monthly frequency. The equity indices are OMXS30, Mid Cap and Small Cap. OMX Stockholm 30 is the Stockholm Stock Exchanges leading share index. The index has the 30 most actively traded stocks on the Stockholm Stock Exchange. With a market cap over 1 billion Euros. Because of the limited number of participants in the OMXS30, they can guarantee that all the underlying shares have superior liquidity and that is why it is essentially constructed for derivate trading. This index only tracks equities from Sweden and the composition is revised twice a year. (Nasdaq OMX, 2013). The Mid Cap index has companies with a market cap between 150 million to 1 billion Euros. Small Cap index has companies with a market cap under 1 billion Euros. The industry breakdown for the different equity indices is shown in Appendix A[3].

We have also used time-series data for a 30-day Swedish treasury bill to calculate the risk-free rate.

For the commodity futures contracts indices we have used three different commodity futures contracts. All these commodity futures contracts are used on a monthly basis for commodity futures contracts prices.

The first use Crude Oil as the underlying asset, which Crude Oil futures contract is written upon and is traded on the New York mercantile exchange (NYMEX). It is found to be the most liquid commodity futures contract in the future contracts market (Geman and Kharoubi, 2008).

The second one is the S&P GSCI, which is traded on the Chicago mercantile exchange (CME). The S&P GSCI is the first major investable commodity index. By being both broad-based and production weighted, it is highly recognized to represent the global commodity market beta. According to Standard & Poor[4], the GSCI is a "recognized leading measurement of price movements and inflation in the world economy".

The S&P GCSI includes the following components and weights.

[3] Appendix A, table 2
[4] Standard & Poors GSCI description

Table 2. S&P GSCI composition[5].

S&P GSCI index Components and Dollar Weights (%) December 31 2012	
Energy	69,00%
Industrial Metals	6, 9%
Precious Metals	3,60%
Argicultural	15,60%
Livestock	5,00%

As we see in table 2, the GSCI is heavily weighted with energy. In order to isolate the effect of energy, we will also use Crude Oil futures contracts.

Demidova-Menzel et.al (2007) claim that the energy bias of the GSCI can be a disadvantage but points out that the magnitude of investments in the energy sector in the GSCI represents the importance of energy as a trading instrument. They also mention the importance of knowing that the proportions of the weights differ over time and that the investor has no power of influence.

The third commodity futures contract is Nordic Power which is traded on the NASDAQ OMX commodities financial market. Nordic Power futures contracts are based the reference price for Nordic electricity, calculated by the Nord Pool Spot[6].

To be able to explore the returns of our indices and portfolios we must investigate the skewness and kurtosis, due to that we suspect the returns to be not normally distributed. Below we present the descriptive statistics for the returns of our indices.

Table 3 Descriptive Statistics.

	N	Mean	Std. Deviation	Variance	Skewness	Std. Error	Kurtosis	Std. Error
OMXS30	125	0,0074	0,0524	0,003	-0,518	0,217	0,708	0,430
MidCap	125	0,0111	0,0553	0,003	-0,147	0,217	1,214	0,430
SmallCap	125	0,0109	0,0561	0,003	-0,309	0,217	0,284	0,430
LightCrudeOil	125	0,0111	0,0842	0,007	-0,408	0,217	0,281	0,430
GSCI	125	0,0079	0,0595	0,004	-0,398	0,217	0,577	0,430
NordicPower	125	0,0059	0,0794	0,006	0,263	0,217	0,605	0,430

[5] Standard & Poor GSCI factsheet
[6] http://www.nordpoolspot.com/How-does-it-work/Financial-market/

Our returns have positive kurtosis. Small Cap and Light Crude Oil have the lowest value of kurtosis at 0,284 and 0,281 while Mid Cap has the highest value of kurtosis at 1,214. All our indices are negatively skewed except for Nordic Power that is positively skewed.

4 Methodology

For our three equity indices we will construct three portfolios each. The first hedged with Crude Oil futures contracts, the second with GSCI futures contracts and the third with Nordic Power futures contracts.

We will use two types of portfolio strategies. The first strategy is a Buy & Hold strategy with no active portfolio management. The weights will be equal for the two assets during the whole time period.

The second strategy will be a Yearly Managed portfolio, which is based on what according to Bodie et.al (2011) is known as the Optimal Risky Portfolio. We will calculate the weights in order to maximize the Sharpe ratio for the specific year and after each year rebalance the weights in order to maximize the Sharpe ratio the upcoming year.

$$Optimal\ Risky\ Portfolio: W_D = \frac{E(R_D)\sigma_E^2 - E(R_E)Cov(R_D, R_E)}{E(R_D)\sigma_E^2 + E(R_E)\sigma_D^2 - [E(R_D) + E(R_E)]Cov(R_D, R_E)}$$

Where W_D equals the percentage amount invested in asset D.

$W_E = 1 - W_D$ is the weight in percent that should be invested in asset E.

We use the average monthly returns for each asset as our expected return and the variance-covariance matrix for the same year. The reason for this strategy is to observe the optimal portfolio for the selected period of time and from that data, conclude for which equity market diversification with commodity futures contracts is the most effective and also which commodity futures contract is best used. The return on the indices is calculated by using the following formula:

$$R_P = \sum_{i=1}^{n} W_i R_i$$

Where i = index, W_i = Weight of the index i, R_i = Return of index i and n= the number of indexes we have in our portfolio and in our case we have only two indexes.

By using the Yearly Managed portfolio strategy, we investigate the hedging effect of commodity futures contracts in the optimal portfolios. In the Yearly Managed portfolios the weights[7] are adjusted to benefit from potential temporary spikes that occur in commodity futures contracts[8].

According to Conover et.al, (2010) allocating at least 10 % of the portfolios assets to commodity futures contracts will reduce the risk significantly, therefore we will investigate the effect of allocating 50 % to commodity futures contracts. We expect the Yearly Managed strategy to outperform the Buy & Hold strategy.

We are hedging the portfolios in the diversification sense based on Markowitz portfolio theory. We compare the Yearly Managed portfolio performances when they were hedged separately with Crude Oil futures contracts, GSCI futures contracts and Nordic Power futures contracts with the Buy & Hold portfolios and the single equity indices.

We want to see if hedging is effective or not and test the hypotheses which states if the effect of the diversification benefits will be affected by the financial crisis or not. In order to evaluate that, we compare the portfolios in terms of the returns, volatility and Sharpe ratio. The variance is the most common measure of variability or dispersion. The risk is measured as the portfolio variance in the portfolios. It is a measurement of our assets and how the actual returns are fluctuating. The portfolio variance includes the correlation coefficient and the covariance for all the assets in our portfolios. The lower the covariance properties between our assets the lower the portfolio return variance will end up (Bodie et.al 2011). The portfolio variance is calculated using following equation:

$$\sigma_p^2 = w_D^2\sigma_D^2 + W_E^2\sigma_E^2 + 2w_D w_E \sigma_D \sigma_E \rho_{DE}$$

Where ρ_{DE} = is the correlation coefficient between the returns on assets D and E and $\sigma_D\sigma_E$ is the standard deviation for the two assets.

[7] Appendix A, table 4
[8] Appendix B, figure 1 & 2

One of the most important measures when diversification is made for the portfolios is the covariance. The covariance measures how much two assets move in relations to each other for a given period of time. A new asset adds different importance to the variability to the portfolio, but the importance part is not the separate asset variance; it is the result of all the covariances of the assets in the portfolio (Markowitz, 1992). The covariance between the returns of two assets is calculated by using the following formula:

$$Cov(r_D, r_E) = \rho_{DE}\sigma_D\sigma_E$$

When we are computing the weights of our portfolios for our different time periods, pre the financial crisis and post the financial crisis we use a covariance matrix[9], in order to calculate the maximum Sharpe ratio and the return for the portfolios.

Below we present the covariance for our total observed time period.

Table 6: Variance-Covariance matrix 2002-2013.

Covariance	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	0,00273					
Mid Cap	0,00225	0,00303				
Small Cap	0,00208	0,00275	0,00313			
Light Crude Oil	0,00066	0,00119	0,00125	0,00703		
GSCI	0,00045	0,00086	0,00092	0,00457	0,00351	
Nordic Power	0,00065	0,00078	0,00047	0,00301	0,00235	0,00626

In order to explore any linear relationship between commodity futures contracts and the equity indices we use the correlation coefficient. The formula used is:

$$Corr(r_D, r_E) = \frac{Cov(r_D, r_E)}{\sqrt{var(r_D)}var(r_E)} = \frac{\sigma_{DE}}{\sigma_D\sigma_E}$$

The correlation coefficient is a ratio of the covariance with the variance, which helps us to compare the results to previous literature that found negative correlation between commodity futures contracts and equities. Usually a perfect hedge is when the correlation or covariance is -1. Diversification will not reduce the portfolio risk if two assets are positive correlated, but if the assets returns are negatively correlated, then the diversification can reduce the risk but not eliminate it. In general we assume that the returns on asset would be more correlated with

[9] Appendix A, table 5.

assets in the same industries compared to other industries. The businesses in the same industry tend to move in the same direction on the equity markets. To reduce the risk, it is important to choose assets in the portfolio that are not highly correlated with each other (Markowitz, 1992).

Alternately we use another portfolio performance, which is the Sharpe ratio. It is a reward to volatility measurement. The Sharpe ratio describes if the portfolio returns is due to the investors intelligent investment decisions or due to the risky assets the investor have chosen. It calculates the excess return divided by the standard deviation for the same period (Bodie et.al 2011). The greater the Sharpe ratio, the better its risk-adjusted performance will be. The Sharpe ratio formula is presented below:

$$S_p = \frac{\bar{r}_p - \bar{r}_f}{\sigma_p}$$

Where $\bar{r}_p$ is the expected return, $\bar{r}_f$ is the risk free rate and σ_p is the portfolio standard deviation.

We will test our data series for Skewness and Kurtosis. It provides a measure of the weight in the tails of a probability density function. If the observations are not symmetrically distributed on the both side of the center of a normal distribution curve, it can be positively skewed, which means that it has a tail that extends farther to the right. A skewed left distribution is called negatively skewed. If skewness is zero or close to zero it means that the distribution is symmetric. A negative value means that the distribution is skewed to the left and a positive value means that it is skewed to the right, (Newbold et. al, 2013). Skewness formula is presented below:

$$Skewness = \frac{1}{n}\frac{\sum_{i=1}^{n}(x_i - \bar{x})^3}{s^3}$$

Where i= index, $\bar{X}$= is the mean, s =is the standard deviation and n =the number of data points.

Kurtosis is a measure of whether the selected data are peaked or flat relative to a normal distribution. It provides a measure of the weight in the tails of a probability density function. It is known that for the normal distribution, the population is 3 (Newbold et. al, 2013). Kurtosis equation is presented below:

$$Kurtosis = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^4}{ns^4}$$

5. Empirical Results and Analysis

In table 7 below we present the descriptive statistics for our Buy & Hold and Yearly Managed portfolios:

Table 7: Descriptve Statistics for the portfolios

	N	Mean	Std. Deviation	Variance	Skewness	Std. Error	Kurtosis	Std. Error
Buy and Hold								
OMXS30+Oil	125	0,0092	0,0529	0,003	-0,811	0,217	1,583	0,430
OMXS30+GSCI	125	0,0076	0,0424	0,002	-0,839	0,217	1,591	0,430
OMXS30+ Nordic	125	0,0066	0,0509	0,003	-0,183	0,217	1,011	0,430
Mid Cap+Oil	125	0,0111	0,0560	0,003	-0,760	0,217	1,308	0,430
Mid Cap+GSCI	125	0,0095	0,0456	0,002	-0,706	0,217	1,319	0,430
Mid Cap+Nordic	125	0,0085	0,0523	0,003	-0,394	0,217	1,425	0,430
Small Cap+Oil	125	0,0110	0,0565	0,003	-0,838	0,217	1,781	0,430
Small Cap+GSCI	125	0,0094	0,0462	0,002	-0,855	0,217	1,861	0,430
Small Cap+Nordic	125	0,0084	0,0510	0,003	-0,560	0,217	1,285	0,430
Yearly Managed								
OMXS30+Oil	125	0,0126	0,0618	0,004	-0,991	0,217	3,485	0,430
OMXS30+GSCI	125	0,0131	0,0510	0,003	-0,803	0,217	1,961	0,430
OMXS30+Nordic	125	0,0134	0,0654	0,004	-0,741	0,217	1,759	0,430
Mid Cap+Oil	125	0,0179	0,0610	0,004	-1,036	0,217	4,308	0,430
Mid Cap+GSCI	125	0,0170	0,0499	0,002	-0,658	0,217	2,729	0,430
Mid Cap+Nordic	125	0,0163	0,0589	0,003	-0,538	0,217	2,694	0,430
Small Cap+Oil	125	0,0178	0,0632	0,004	-0,955	0,217	3,160	0,430
Small Cap+GSCI	125	0,0167	0,0520	0,003	-0,651	0,217	1,505	0,430
Small Cap+Nordic	125	0,0150	0,0587	0,003	-0,691	0,217	1,780	0,430

The returns for all the portfolios have positive kurtosis and negative skewness, which means that they are not normally distributed. The negative skewness for our portfolio means that they have a distribution skewed to the left. Kurtosis below 3 means leptokurtic distribution, which tells us that the distribution is thin and high. The values are concentrated around the

mean and have thicker tails, which implies high probability for extreme values (Newbold et.al 2013).

In order to spot any macroeconomic shocks or effects for the observed period of time, we have in figure 1 constructed a rolling return index that starts at 100% for all indices. We can conclude from that figure, that the observed time period starts with a slightly upward trend for all our equity indices. The trend continues until the middle of 2007, when it starts to decline. This can be explained by the fact that our observed time period starts post the internet bubble that occurred in 2000 to 2001 and had a negative effect on the equity markets worldwide. This tells us that our time period begins by recovering from a previous crash.

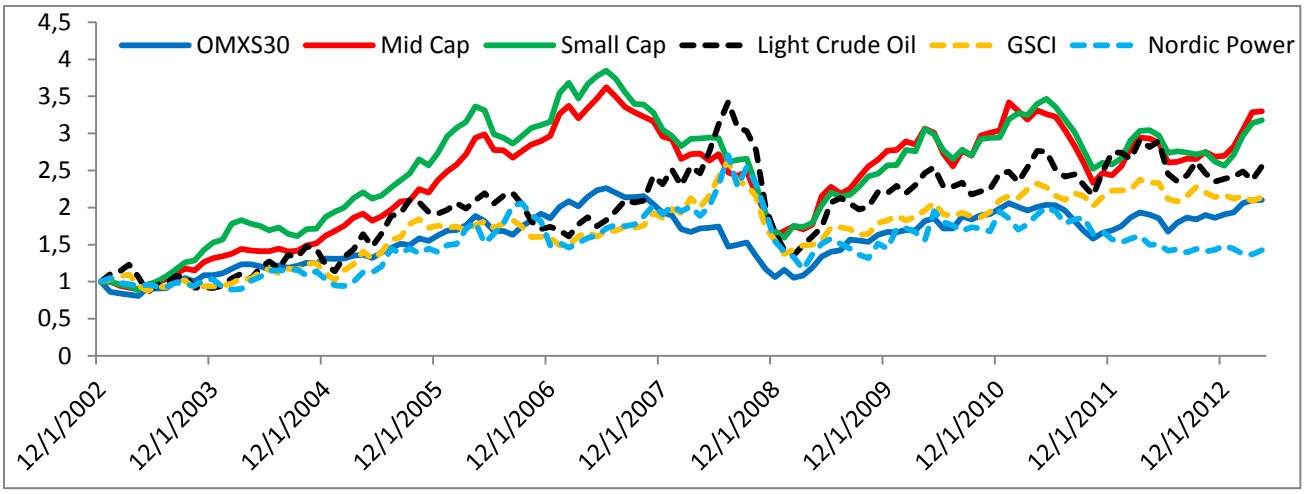
After the middle of 2007 the equity indices start to fall and this negative trend continues until the beginning of 2009. This is explained by the financial crisis between 2007 and 2009, which was an effect of the credit situation started by the mortgage associations Fannie Mae and Freddie Mac. The crisis burst after the bankruptcy of the investment bank Lehman Brothers in late 2008. In the beginning of 2009 the equity indices starts to recover after the crisis and the upward trend continuous until the beginning of 2011 at which point the indices are almost fully recovered after the crisis. In 2011 the equity indices begins to fall again, this time due of the financial situation in Greece and southern Europe.

The patterns of the commodity futures contracts differ compared to the equity indices. We can observe in figure 1 that pre crisis in the late 2008, commodity futures contracts and equity indices in Sweden, have moved in different directions and showed a negative correlation, this is in line with Gorton and Rouwenhorst (2005). We also find some specific time periods where commodity futures contracts will work as an excellent hedging instrument to equity indices. Among those time periods we find the years 2004 and 2007 that show negative correlation for our commodity futures contracts to all equity indices. The yearly correlations are showed in appendix A[10], a negative correlation between the assets is in line with Geman and Kharoubis (2008) work.

In figure 1 below, we conclude some major hedging opportunities prior to the financial crisis in 2008. As described earlier we conclude that our observed time period have experienced both financial crisis and financial booms.

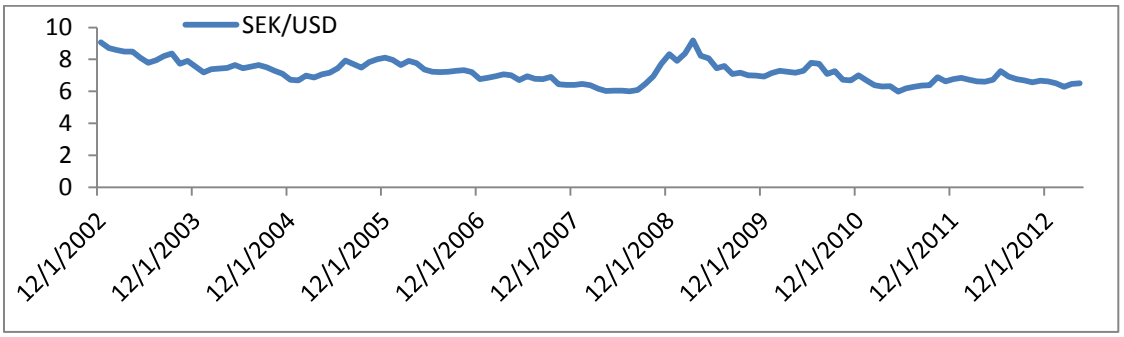
[10] Appendix A, Table 9

Figure 1: Cumulative returns starting at 1 = 100%



When trading with assets in different currency than the domestic, there is always some risk that needs to be taken into accounting. Our observed commodity futures contracts are traded on US exchanges and by that traded in US dollars. Since our equity indices are traded on the Swedish markets in Swedish kronor, we need to be aware of the currency risk and the effects of using the commodity futures contracts in SEK instead of USD. As we see in appendix B[11], converting Crude Oil futures contracts and GSCI from USD to SEK, reduces the volatility for both of our commodity futures contracts. The reduced correlation is supported by table 8 below, in which we see that the Standard deviation decreases with more than 1 % as an effect of the converted currency. This can be explained by looking at figure 2, which shows the SEK/USD exchange rate for the total period of time. We see that the USD has depreciated in value against the SEK.

Figure 2: SEK/USD exchange rate for the total time period



[11] Appendix B, figure 4 & 5

Table 8: Variance and Standard Deviation for Commodity futures contracts based on monthly returns

	Light Crude Oil	Light Crude Oil	GSCI	GSCI
Currency	SEK	USD	SEK	USD
Variance	**0,0071**	0,0092	**0,0035**	0,0052
Std. Dev	**0,0842**	0,0961	**0,0595**	0,0719

5.2 Portfolio Performance, Total time period

In order for commodities to work as a good hedge in our portfolios we need them to correlate negatively. A negative correlation between two assets would imply that the assets are moving in opposite direction which would reduce the volatility for a portfolio significantly. A correlation close to zero implies that there is no linear relationship at all between the assets. As seen in table 9, OMXS30 have almost the same correlation to Crude Oil, the GSCI and Nordic Power. The correlation implies that there is a weak linear relationship between the two assets.

Mid Cap and Small Cap shows a slightly higher correlation to both Crude oil and GSCI futures contracts than to the OMXS30. The correlation between Nordic Power and the equity indices are almost the same for the three equity indices. The correlation tells us that there is a weak positive linear relationship between the observed equities and commodity futures contracts during the total observed time period.

We see that we have a positive correlation between all our equity indices and all our commodity futures contracts for the total time period. This is the opposite of what Gorton and Rouwenhorst (2005) find when looking at correlations for longer time periods. To further investigate the correlation between our equities and commodity futures contracts see Appendix A, table 10.

Table 9: Correlation matrix for monthly asset returns over total time 2002-2013

Correlation	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1					
Mid Cap	0,78131	1				
Small Cap	0,71084	0,89387	1			
Light Crude Oil	0,15167	0,25766	0,26591	1		
GSCI	0,14406	0,26335	0,27667	0,91950	1	
Nordic Power	0,15830	0,17815	0,10522	0,45300	0,50217	1

In table 10, we observe the results for the portfolio over the total time period. We can see that for OMXS30, the best portfolio strategy is the Yearly Managed portfolios. When the OMXS30 is hedged with GSCI futures contracts it provides the highest return and the highest Sharpe ratio. The return is tripled and the Sharpe ratio is doubled in comparison to the single OMXS30. The Yearly Managed portfolio hedged with Nordic Power futures contracts provides the highest monthly average return. When hedged with Crude Oil futures contracts or Nordic Power futures contracts, we get a lower total return and a higher risk than when hedged with the GSCI futures contracts. To get the lowest possible risk for the OMXS30 we need to combine it with the GSCI futures contracts in a Buy & Hold portfolio. We can see that OMXS30 benefits from being hedged for the total time period. Both the return and the Sharpe ratio are higher for all portfolios than for the single OMXS30 index.

Mid Cap performs best when added in a Yearly Managed portfolio. The highest return shows for the portfolio hedged with Crude Oil futures contracts. The return is lower when hedged with GSCI futures contracts or Nordic Power futures contracts. Because of the lower risk we see that Mid Cap combined with the GSCI provides the highest Sharpe Ratio. The lowest provided risk for a Mid Cap portfolio is achieved by using the Buy & Hold strategy and hedge Mid Cap with GSCI futures contracts. Hedging Mid Cap is effective in the measure of Sharpe ratio for all portfolios except the Buy & Hold portfolios with Crude Oil futures contracts and Nordic Power futures contracts.

For Small Cap we find the best performing portfolios being the Yearly Managed. The highest return is presented when we hedge Small Cap with Crude Oil future contracts. Small Cap hedged with GSCI futures contracts will give a lower return and a lower risk and by the reduced risk the highest Sharpe ratio. The lowest risk is shown in the Buy & Hold portfolio hedged with GSCI futures contracts. Small Cap benefits from being hedged in all portfolios except the Buy & Hold combined with Nordic Power. This is measured by looking at the Sharpe ratio.

When comparing the portfolios we can conclude that Crude Oil future contracts and Nordic Power futures contracts increased the risk for all Yearly Managed portfolios while the GSCI reduced the risk for all portfolios. This is explained by the fact that Crude Oil future contracts are more volatile than the GSCI futures contracts. This is supported by what Demidova-Menzel et.al (2007) found. The same applies for Nordic Power futures contracts.

The effectiveness of hedging away risk with GSCI futures contracts is supported by Fuertes et.al (2010), who reaches the same conclusion. For the total time period we conclude that hedging an equity index with commodity futures contracts will improve the results. The best performing portfolio was the Yearly Managed Mid Cap hedged with GSCI. All portfolio performances are showed in figures, see Appendix B[12].

Table 10: Portfolio and index values for the total time period

YM Hedged with Light crude oil	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	1,26	**1,79**	**1,78**
Total return %	276,17	**627,70**	**602,09**
Std. Deviation	0,0618	0,0610	0,0632
Sharp-Ratio	0,1765	0,2655	0,2539
YM Hedged with Nordic Power	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	**1,34**	1,63	1,50
Total return %	304,27	506,49	421,69
Std. Deviation	0,0654	0,0589	0,0587
Sharp-Ratio	0,1789	0,2472	0,2271
YM Hedged with GSCI	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	1,31	1,70	1,67
Total return %	**333,33**	604,21	567,97
Std. Deviation	0,0510	0,0499	0,0520
Sharp-Ratio	**0,2235**	**0,3059**	**0,2877**
B&H Hedged with Light crude oil	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	0,92	1,11	1,10
Total return %	154,68	214,33	207,00
Std. Deviation	0,0529	0,0560	0,0565
Sharp-Ratio	0,1425	0,1681	0,1645
B&H Hedged with Nordic Power	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	0,66	0,85	0,84
Total return %	94,81	143,72	141,81
Std. Deviation	0,0509	0,0523	0,0510
Sharp-Ratio	0,0967	0,1303	0,1311
B&H Hedged with GSCI	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	0,76	0,95	0,94
Total return %	127,81	182,28	175,69
Std. Deviation	**0,0424**	**0,0456**	**0,0462**

[12] Appendix B, Figure 6-11

Sharp-Ratio	0,1392	0,1706	0,1658
Stock indexes	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	0,74	1,11	1,09
Total return %	110,43	230,12	217,96
Std. Deviation	0,0524	0,0553	0,0561
Sharp-Ratio	0,1076	0,1701	0,1631

5.3 Portfolio performance between 2002/12 and 2006/12

When observing the time period prior the financial crisis in 2007, we can see in table 11 that OMXS30 has a negative correlation to Crude Oil futures contracts and a correlation close to zero for Nordic Power futures contracts and GSCI futures contracts. This indicates good hedging opportunities in the observed time period, since there is a small negative relationship to Crude Oil futures contracts and no linear relationship to GSCI and Nordic Power. This can also be strengthened by Appendix B[13]. Mid Cap and Small Cap have for the observed time period low and close to zero correlation to Crude Oil futures contracts and a slightly positive correlation to GSCI futures contracts. Nordic Power futures contracts have a negative correlation to both Mid Cap and Small Cap which should provide some good hedging opportunities.

The low correlation to Crude Oil futures contracts is in line with Geman and Kharoubi (2008).

Table 11: Correlation matrix for monthly asset returns between years 2002-2007

Correlation	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1					
Mid Cap	0,74896	1				
Small Cap	0,69094	0,86648	1			
Light Crude Oil	-0,15901	0,06496	0,07555	1		
GSCI	0,02435	0,18861	0,15986	0,92017	1	
Nordic Power	0,01598	-0,05653	-0,10381	0,23058	0,31057	1

For the time period prior to the financial crisis we can see in figure 1 presented earlier, that all equity indices experienced a solid upward trend while the commodity futures contracts increased with a slightly upward trend. We can by looking at table 12 see that our equity indices performed well with no hedging.

[13] Appendix B, figure 1-3

For OMXS30, the Yearly Managed portfolio strategy showed the best results. The greatest return was given for the portfolio hedged with Crude Oil futures contracts. The same portfolio also showed the highest Sharpe ratio. The portfolio hedged with GSCI futures contracts showed slightly lower return and a slightly higher risk. The lowest risk was found in the Buy & Hold portfolio hedged with GSCI futures contracts. All portfolios except the ones hedged with Nordic Power outperformed the non-hedged index, when measured in Sharpe ratio.

The best performing Mid Cap portfolio was the Yearly Managed hedged with Crude Oil futures contracts. It showed the greatest return, the lowest risk and the highest Sharpe ratio. When hedged with GSCI futures contracts the portfolio showed almost the same risk as with Crude Oil futures contracts, but with lower return. The lowest risk for Mid Cap is given in the Yearly Managed portfolio hedged with Nordic Power. The Buy & Hold portfolios where outperformed by the non-hedged Mid Cap index.

Small Cap performed best in the Yearly Managed portfolios. The optimal portfolio was hedged with Crude Oil futures contracts, which showed the highest Sharpe ratio and the highest average monthly return. The greatest return was provided by the non-hedged Small Cap index. The lowest risk was experienced when hedged with Nordic Power futures contracts. All Buy & Hold portfolios where outperformed by the non-hedged equity index.

Comparing the portfolios we can conclude that OMXS30 benefitted from being hedged in all portfolios except the ones with Nordic Power futures contracts. Mid Cap and Small Cap only benefitted from the Yearly Managed portfolios but with all commodity futures contracts. This can be explained by observing figure 1, where both Mid Cap and Small Cap experienced financial booms. The best performing portfolio was the Yearly Managed Mid Cap with Crude Oil futures contracts. OMXS30 increased its performance in all portfolios which implies that it is the best index to hedge with a commodity futures contract for this period of time.

Table 12: All portfolios and index values for time period 2002-2007

YM Hedged with Light crude oil	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	**1,58**	**2,38**	**2,60**
Total return %	**105,13**	206,93	235,42
Std. Deviation	0,0467	0,0375	0,0456
Sharp-Ratio	**0,2976**	**0,5833**	**0,5276**
YM Hedged with Nordic Power	OMXS30	Mid Cap	Small Cap

Avarage return (monthly) %		1,55	2,18	2,32
Total return %		91,96	180,22	196,35
Std. Deviation		0,0646	**0,0344**	**0,0406**
Sharp-Ratio		0,2102	0,5774	0,5246
YM Hedged with GSCI	OMXS30		Mid Cap	Small Cap
Avarage return (monthly) %		**1,58**	2,34	2,38
Total return %		104,94	200,16	203,52
Std. Deviation		0,0471	0,0375	0,0429
Sharp-Ratio		0,2952	0,5712	0,5096
B&H Hedged with Light crude oil	OMXS30		Mid Cap	Small Cap
Avarage return (monthly) %		1,45	1,92	2,00
Total return %		93,86	134,89	144,48
Std. Deviation		0,0464	0,0491	0,0517
Sharp-Ratio		0,2704	0,3509	0,3496
B&H Hedged with Nordic Power	OMXS30		Mid Cap	Small Cap
Avarage return (monthly) %		1,24	1,70	1,79
Total return %		74,20	120,02	128,73
Std. Deviation		0,0446	0,0412	0,0425
Sharp-Ratio		0,2338	0,3662	0,3753
B&H Hedged with GSCI	OMXS30		Mid Cap	Small Cap
Avarage return (monthly) %		1,27	1,74	1,82
Total return %		81,93	121,75	130,96
Std. Deviation		**0,0399**	0,0401	0,0429
Sharp-Ratio		0,2695	0,3850	0,3800
Stock indexes	OMXS30		Mid Cap	Small Cap
Avarage return (monthly) %		1,38	2,31	2,49
Total return %		100,99	**226,43**	**254,62**
Std. Deviation		0,0465	0,0382	0,0482
Sharp-Ratio		0,2542	0,5552	0,4759

5.4 Portfolio performance between 2007/1 and 2013/04

We can observe in table 13 below, that the correlation after the financial crisis in 2007-2009 has increased dramatically by comparing to table 11 above. For our time-period 2007-2013, we notice the correlation between our three equity indices and our three commodity futures contracts are quite similar. The correlations differ from positive 0, 19 to positive 0, 37 which is a much smaller range then compared for the other time-periods. We notice a positive linear relationship between the two asset classes. When investigating the correlation further we can

see in appendix B[14], that just before the crisis on 2008, we notice some great hedging opportunities. From the time the financial crisis bursts in late 2008, due to the collapse of Lehman Brothers, we can see that commodity futures contracts and equities have moved with almost the same patterns, which implies that hedging will not be as effective as prior to and during the crisis. This observed time period starts as we can see in appendix A[15], with a strong negatively correlation for all indices towards both the commodity futures contracts. This tells us that the hedged portfolios would perform well in the beginning of this time period. We also need to know that our observed time period starts pre the crisis.

Table 13, Correlation matrix for monthly asset returns between years 2007-2013

Correlation	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1					
Mid Cap	0,79952	1				
Small Cap	0,71671	0,90695	1			
Light Crude Oil	0,32630	0,34627	0,37208	1		
GSCI	0,21121	0,30416	0,34301	0,91919	1	
Nordic Power	0,22192	0,25712	0,19284	0,59294	0,62957	1

Investigating the performance of the indices and portfolios in table 14 for the observed time period, we see that the financial crisis had a major negative effect. This time period is observing the financial crisis and the time after. We can see the impact of the crisis.

The best performing portfolio for OMXS30 was the Yearly Managed hedged with GSCI futures contracts. It showed the greatest return and the highest Sharpe ratio. The lowest risk was found in the Buy & Hold portfolio combined with GSCI futures contracts. All portfolios except the Buy & Hold portfolio hedged with Nordic Power futures contracst outperformed the non-hedged OMXS30 index in both Sharpe ratio and return.

Mid Cap in a Yearly Managed portfolio hedged with GSCI futures contracts was the best portfolio according to the Sharpe ratio and the total return. The greatest average return was found in the portfolio hedged with Crude Oil futures contracts. The lowest possible risk was found in the B&H portfolio hedged with GSCI futures contracts. As in OMXS30, all portfolios except the Buy & Hold with Nordic Power futures contracts performed better than the non-hedged Mid Cap index.

[14] Appendix B, Figure 1-3
[15] Appendix A, Table 9, year 2007

The Yearly Managed portfolio for Small Cap hedged with GSCI futures contracts showed the greatest total return together with the highest Sharpe ratio. The greatest average return was found for the portfolio with Crude Oil futures contracts. The Buy & Hold portfolio combined with GSCI futures contracts experienced the lowest risk. The Small Cap equity index and the Buy & Hold combined with Nordic Power futures contracts was the only portfolios in our observed time periods that showed a negative return. A hedge in Small Cap using commodity futures contracts would improve for all the portfolios.

When comparing our portfolios we observe that the Yearly Managed portfolios performed best. They showed the highest returns and highest Sharpe ratios. The lowest risk where found in the Buy & Hold portfolios consisting GSCI futures contracts. This is supported by Fuertes et.al (2010) who concluded that GSCI is used effectively to hedging away risk. The reason that the Buy & Hold portfolios provide low risk is because they are equally weighted in two assets, which reduces the risk more than when the majority is invested in one asset. In order to investigate which index benefitted the most from being hedged, the Sharpe ratio tells us that Mid Cap combined with GSCI in a Yearly Managed portfolio showed the best Sharpe ratio.

Small Cap showed the greatest improvement in the same kind of portfolio as Mid Cap. For this observed time period, the positively effects of hedging using commodity futures contracts, can be explained by the fact of highly negatively correlations, as seen in appendix A[16]. The hedging benefits is supported by Conover et.al (2010) and is in opposite of Demidova-Menzel et.al (2007).

Table 14: Indices and portfolios values for time period 2007-2013

YM Hedged with Light crude oil	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	1,06	**1,41**	**1,24**
Total return %	77,81	135,84	110,09
Std. Deviation	0,0701	0,0723	0,0721
Sharp-Ratio	0,1282	0,1735	0,1508
YM Hedged with Nordic Power	OMXS30	Mid Cap	Small Cap
Avarage return (monthly) %	**1,21**	1,27	0,98
Total return %	105,69	111,40	71,94
Std. Deviation	0,0664	0,0703	0,0676

[16] Appendix A, table 9

Sharp-Ratio		0,1583		0,1582	0,1214
YM Hedged with GSCI	OMXS30		Mid Cap		Small Cap	
Avarage return (monthly) %		1,14		1,29	1,21
Total return %		**113,93**		**143,46**	**130,99**
Std. Deviation		0,0536		0,0564	0,0568
Sharp-Ratio		**0,1826**		**0,2006**	**0,1845**
B&H Hedged with Light crude oil	OMXS30		Mid Cap		Small Cap	
Avarage return (monthly) %		0,59		0,59	0,52
Total return %		20,88		32,46	31,22
Std. Deviation		0,0567		0,0598	0,0589
Sharp-Ratio		0,0759		0,0732	0,0614
B&H Hedged with Nordic Power	OMXS30		Mid Cap		Small Cap	
Avarage return (monthly) %		0,30		0,30	0,23
Total return %		6,19		4,27	-1,52
Std. Deviation		0,0546		0,0579	0,0552
Sharp-Ratio		0,0254		0,0252	0,0127
B&H Hedged with GSCI	OMXS30		Mid Cap		Small Cap	
Avarage return (monthly) %		0,43		0,44	0,37
Total return %		17,93		27,52	26,05
Std. Deviation		**0,0439**		**0,0484**	**0,0476**
Sharp-Ratio		0,0632		0,0588	0,0439
Stock indexes	OMXS30		Mid Cap		Small Cap	
Avarage return (monthly) %		0,32		0,34	0,18
Total return %		4,70		1,13	-10,34
Std. Deviation		0,0558		0,0629	0,0593
Sharp-Ratio		0,0295		0,0285	0,0047

6. Conclusion

We illustrate the benefits of hedging the Swedish equity markets: OMXS30, Mid Cap and Small Cap with commodity futures contracts, by diversifying based on Markowitz portfolio theory. The thesis concludes that when hedging the Swedish equity indices using commodity futures contracts, the portfolio outperforms the single equity indices when performances measures in Sharpe ratio.

For all the observed time periods investigated, we found the best performing portfolios using the Sharpe ratio, being the Yearly Managed portfolios.

The preferred commodity futures contracts differed for our time periods. During the total time period and the period post 2007, the portfolios hedged with GSCI futures contracts performed the best for all equity indices.

For the period pre 2007 the portfolios hedged with Crude Oil futures contracts performed the best. The results are supported by what Jensen et.al (2000) concluded; that adding commodity futures contracts in portfolios increases the return. It is also in line with Gorton and Rouwenhorst (2005), who finds that commodity futures contracts as an asset class provides a good hedge for a long holding period of a portfolio.

Nordic Power futures contracts provide the lowest risk in the Yearly Managed portfolios for Mid Cap and Small Cap, prior to 2007. This is based on the negative correlation to both Small Cap and Mid Cap which strengthens the fact that negative correlation implies lower risk.

We cannot reject the hypotheses that the diversification benefits is affected by the financial crisis, since our results states that a hedge prior the financial crisis only increased the Sharpe ratio while the returns for most of the portfolios were lower than for the single equity indices.

The best portfolios pre the crisis also where hedged with Crude Oil futures contracts while the other observed time periods used GSCI futures contracts. This can be explained from the fact that the pre-crisis time period shows a recovery period for the equity indices from the internet bubble in 2000/2001. The upward trending equities will then benefit more from the volatile Crude Oil futures contracts than from the GSCI futures contracts or the Nordic Power futures contracts which are less volatile.

During and post the financial crisis we can conclude the greatest benefits of hedging a portfolio. The returns for all the portfolios increased and the increased Sharpe ratio tells us that all hedged portfolios outperformed the indices.

Observing the correlations for our time period we conclude that some years with strong negative correlations between equities and commodity futures contracts as seen in appendix A[17]. We also find that the positive correlation is higher for years during and after the financial crisis then pre the crisis. This tells us that during the years with high correlation the hedge will be less effective which is in opposite of our findings. We conclude that hedging an equity index using a commodity futures contract is more effective in volatile time-periods then for upward trending markets.
For the return figures of all the portfolios we refer to Appendix B[18].

[17] Appendix A, table 9
[18] Appendix B, table 5-10

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8. Appendix A, Tables

Table 1. S&P GSCI composition

S&P GSCI index Components and Dollar Weights (%) December 31 2012	
Energy	69,00%
Industrial Metals	6, 9%
Precious Metals	3,60%
Argicultural	15,60%
Livestock	5,00%

Table 2: Industry breakdown for indices on the Stockholm stock exchange (Nasdaq OMX, 2013)

Indices	OMXS30	Mid Cap	Small Cap
Trade date	5/25-2013	5/25-2013	5/25-2013
Basic materials	1,22%	8,00%	3,71%
Consumer goods	6,87%	14,26%	7,76%
Consumer services	11,81%	15,18%	4,27%
Financials	30,11%	27,19%	4,45%
Health care	3,27%	8,10%	14,96%
Industrials	29,59%	22,58%	41,57%
Oil & Gas	1,48%	2,29%	1,62%
Technology	7,96%	2,39%	18,72%
Telecommunications	7,70%	-	1,60%
Utilities	-	-	1,35%

Table 4: Weights for Yearly Managed portfolios

Year	OMXS30	Light Crude Oil	OMXS30	GSCI	OMXS30	Nordic Power
2003	1,00	0,00	1,00	0,00	1,00	0,00
2004	0,77	0,23	0,70	0,30	0,76	0,24
2005	0,77	0,23	0,64	0,36	0,77	0,23
2006	1,00	0,00	1,00	0,00	0,89	0,11
2007	0,45	0,55	0,37	0,63	0,00	1,00
2008	0,00	1,00	0,00	1,00	0,00	1,00
2009	0,83	0,17	0,68	0,32	1,00	0,00
2010	1,00	0,00	0,72	0,28	0,66	0,34
2011	0,00	1,00	0,00	1,00	1,00	0,00
2012	1,00	0,00	1,00	0,00	1,00	0,00
2013	0,79	0,21	0,97	0,03	0,77	0,23
Year	Mid Cap	Light Crude Oil	Mid Cap	GSCI	Mid Cap	Nordic Power
2003	1,00	0,00	1,00	0,00	1,00	0,00
2004	0,82	0,18	0,77	0,23	0,79	0,21

2005	0,91	0,09	0,85	0,15	0,82	0,18
2006	1,00	0,00	1,00	0,00	0,87	0,13
2007	0,25	0,75	0,18	0,82	0,00	1,00
2008	0,00	1,00	0,00	1,00	0,00	1,00
2009	0,82	0,18	0,81	0,19	1,00	0,00
2010	0,35	0,65	0,14	0,86	0,56	0,44
2011	0,00	1,00	0,00	1,00	0,00	1,00
2012	1,00	0,00	1,00	0,00	1,00	0,00
2013	0,63	0,37	0,68	0,32	0,61	0,39
Year	Small Cap	Light Crude Oil	Small Cap	GSCI	Small Cap	Nordic Power
2003	1,00	0,00	1,00	0,00	1,00	0,00
2004	0,63	0,37	0,55	0,45	0,65	0,35
2005	0,93	0,07	0,90	0,10	0,84	0,16
2006	1,00	0,00	1,00	0,00	0,88	0,12
2007	0,16	0,84	0,11	0,89	0,00	1,00
2008	0,00	1,00	0,00	1,00	0,00	1,00
2009	0,94	0,06	1,00	0,00	1,00	0,00
2010	0,61	0,39	0,35	0,65	0,58	0,42
2011	0,00	1,00	0,00	1,00	0,00	1,00
2012	1,00	0,00	1,00	0,00	1,00	0,00
2013	0,73	0,27	0,98	0,02	0,55	0,45

Table 5. Variance - Covariance matrix pre and post the financial crisis

2002-2007	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	0,00212					
Mid Cap	0,00130	0,00143				
Small Cap	0,00152	0,00156	0,00227			
Light Crude Oil	-0,00064	0,00021	0,00031	0,00758		
GSCI	0,00007	0,00045	0,00048	0,00505	0,00397	
Nordic Power	0,00005	-0,00016	-0,00037	0,00150	0,00146	0,00555

2007-2013	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	0,00308					
Mid Cap	0,00277	0,00391				
Small Cap	0,00234	0,00334	0,00347			
Light Crude Oil	0,00148	0,00177	0,00179	0,00666		
GSCI	0,00066	0,00107	0,00114	0,00424	0,00319	
Nordic Power	0,00101	0,00131	0,00093	0,00396	0,00291	0,00669

Table 9: Yearly Correlations

2003	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,732	1,000				
Small Cap	0,663	0,938	1,000			
Light Crude Oil	-0,304	-0,026	0,053	1,000		
GSCI	0,043	0,252	0,336	0,908	1,000	
Nordic Power	0,271	0,638	0,569	0,177	0,294	1,000
2004	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,799	1,000				
Small Cap	0,813	0,776	1,000			
Light Crude Oil	-0,408	-0,346	-0,154	1,000		
GSCI	-0,381	-0,299	-0,241	0,920	1,000	
Nordic Power	-0,631	-0,659	-0,669	0,048	0,227	1,000
2005	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,838	1,000				
Small Cap	0,745	0,934	1,000			
Light Crude Oil	0,314	0,337	0,367	1,000		
GSCI	0,339	0,377	0,471	0,963	1,000	
Nordic Power	0,053	-0,124	-0,050	0,626	0,585	1,000
2006	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,787	1,000				
Small Cap	0,813	0,924	1,000			
Light Crude Oil	-0,201	0,207	0,160	1,000		
GSCI	-0,154	0,095	0,018	0,891	1,000	
Nordic Power	0,125	-0,149	-0,083	0,042	0,059	1,000
2007	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,924	1,000				
Small Cap	0,935	0,969	1,000			
Light Crude Oil	-0,478	-0,350	-0,357	1,000		
GSCI	-0,472	-0,388	-0,438	0,874	1,000	
Nordic Power	0,065	0,175	0,142	0,617	0,543	1,000
2008	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,851	1,000				
Small Cap	0,884	0,898	1,000			
Light Crude Oil	0,407	0,644	0,630	1,000		
GSCI	0,270	0,542	0,535	0,974	1,000	
Nordic Power	0,205	0,557	0,417	0,852	0,861	1,000
2009	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power

OMXS30	1,000					
Mid Cap	0,359	1,000				
Small Cap	-0,194	0,724	1,000			
Light Crude Oil	0,192	0,088	0,341	1,000		
GSCI	-0,119	0,102	0,533	0,851	1,000	
Nordic Power	0,464	0,425	0,357	0,535	0,459	1,000
2010	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,828	1,000				
Small Cap	0,740	0,929	1,000			
Light Crude Oil	0,679	0,474	0,396	1,000		
GSCI	0,633	0,378	0,257	0,925	1,000	
Nordic Power	0,035	-0,093	-0,211	0,378	0,532	1,000
2011	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,879	1,000				
Small Cap	0,849	0,903	1,000			
Light Crude Oil	0,600	0,478	0,489	1,000		
GSCI	0,417	0,485	0,501	0,881	1,000	
Nordic Power	0,216	0,231	0,280	0,467	0,526	1,000
2012	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,854	1,000				
Small Cap	0,791	0,958	1,000			
Light Crude Oil	0,408	0,461	0,397	1,000		
GSCI	0,515	0,565	0,507	0,971	1,000	
Nordic Power	0,439	0,393	0,325	0,523	0,552	1,000
2013	OMXS30	Mid Cap	Small Cap	Light Crude Oil	GSCI	Nordic Power
OMXS30	1,000					
Mid Cap	0,740	1,000				
Small Cap	0,928	0,876	1,000			
Light Crude Oil	-0,140	-0,770	-0,409	1,000		
GSCI	0,240	-0,446	-0,110	0,882	1,000	
Nordic Power	-0,799	-0,763	-0,946	0,362	0,203	1,000

Appendix B, Figures

Figure 1: Monthly Returns for Equity indices and Light Crude Oil

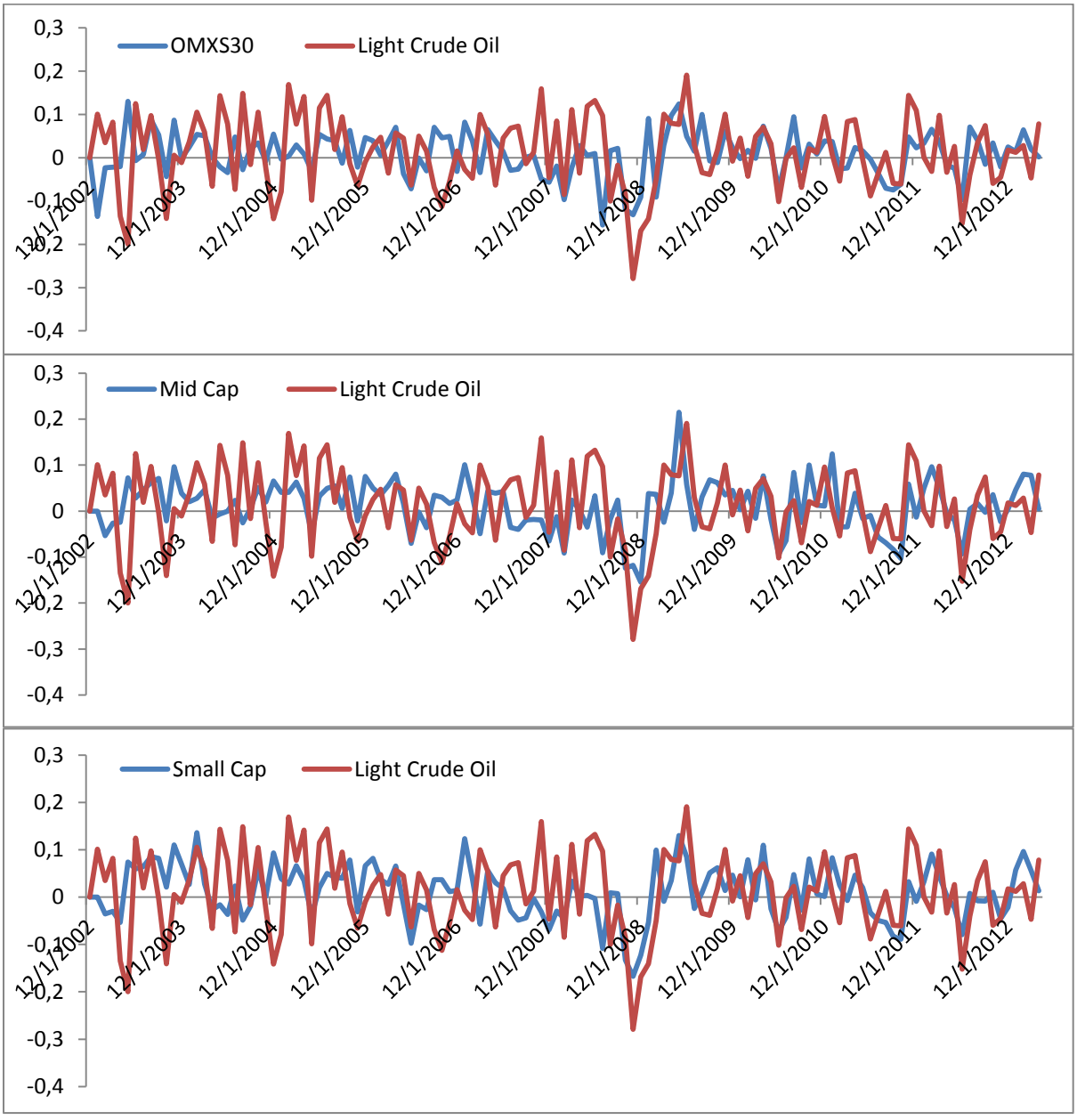

Figure 2: Monthly returns for equity indices and the GSCI

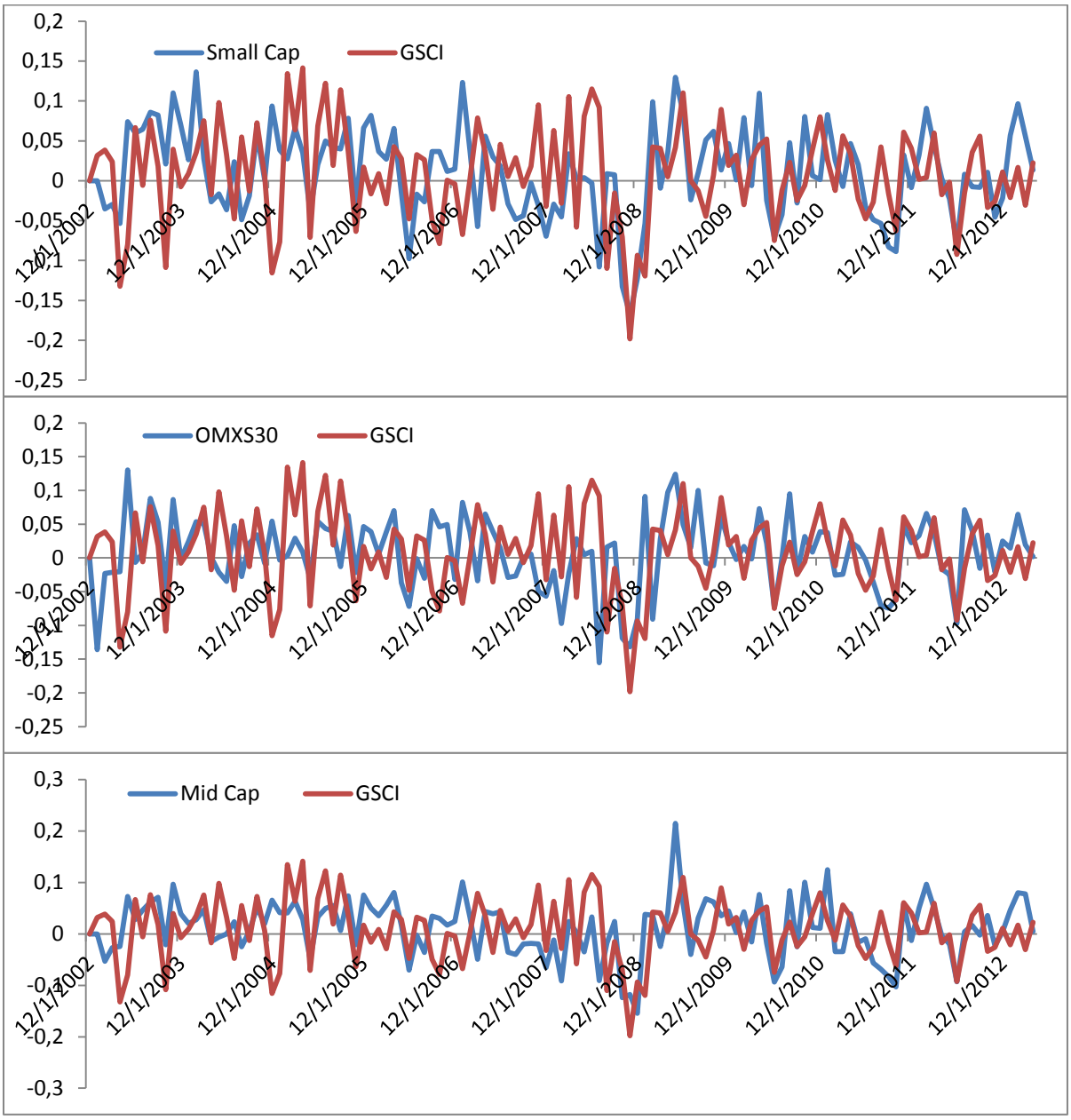

Figure 3: Monthly returns for equity indices and the Nordic Power

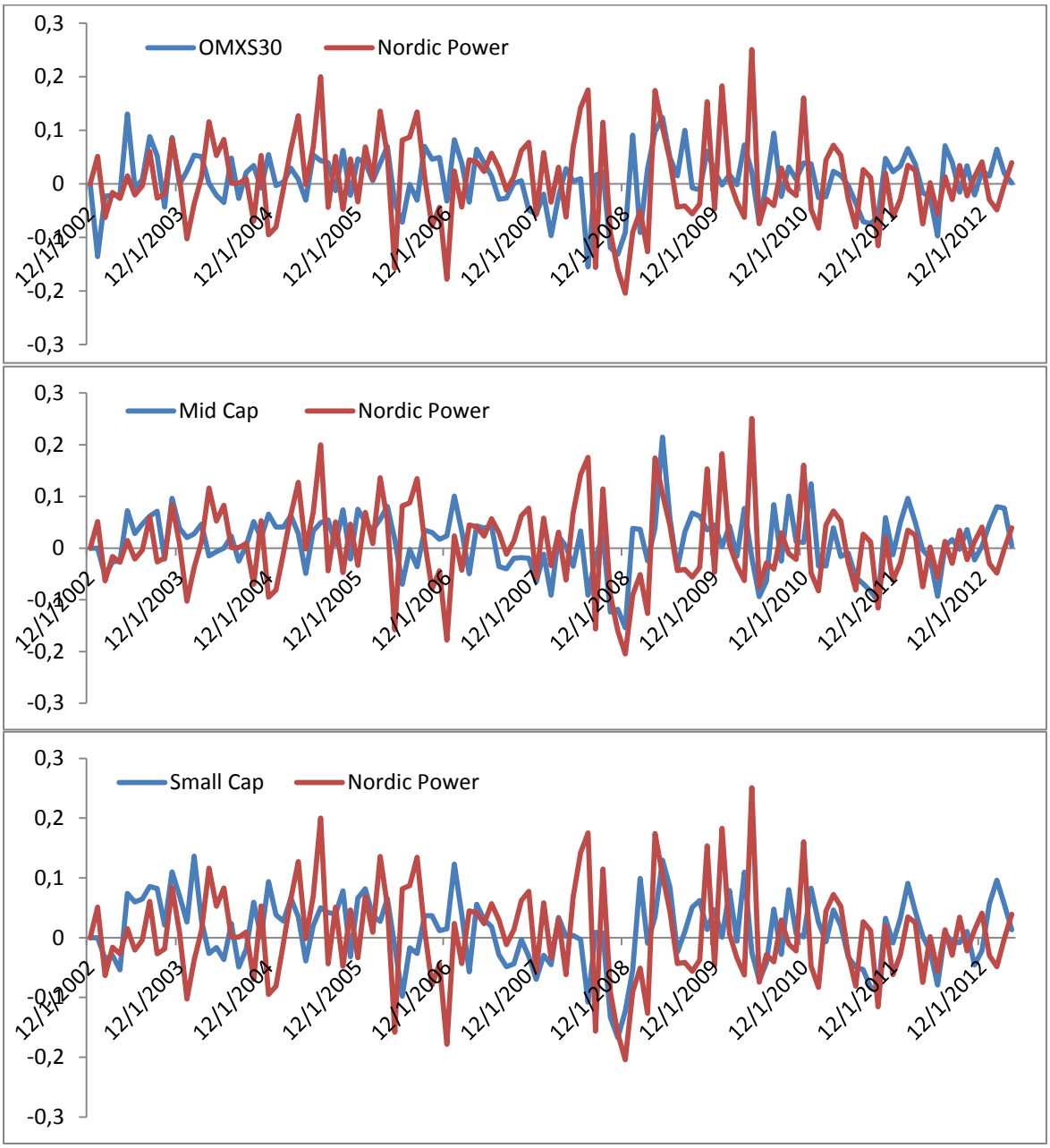

Figure 4: Cumulative return for Light Crude Oil in SEK and USD starting at 100%.

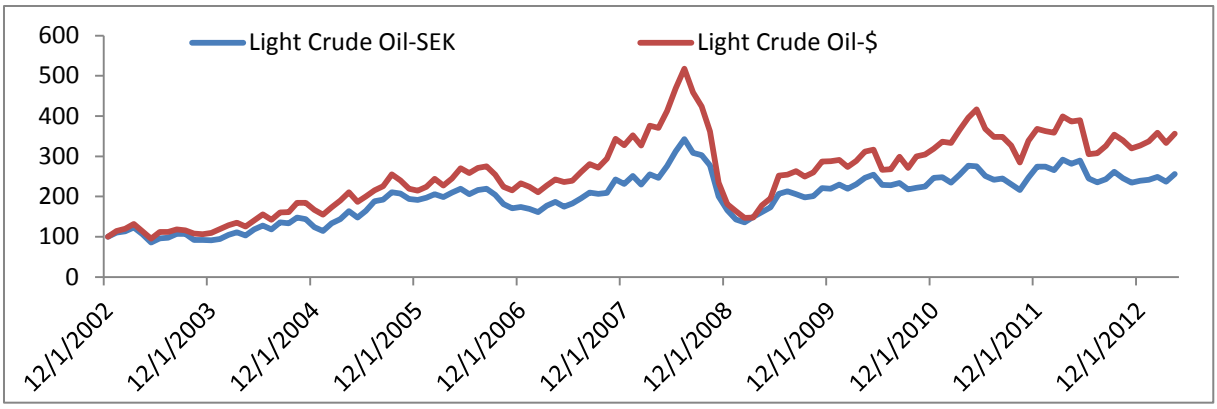

Figure 5: Cumulative return for GSCI in SEK and USD starting at 100%.

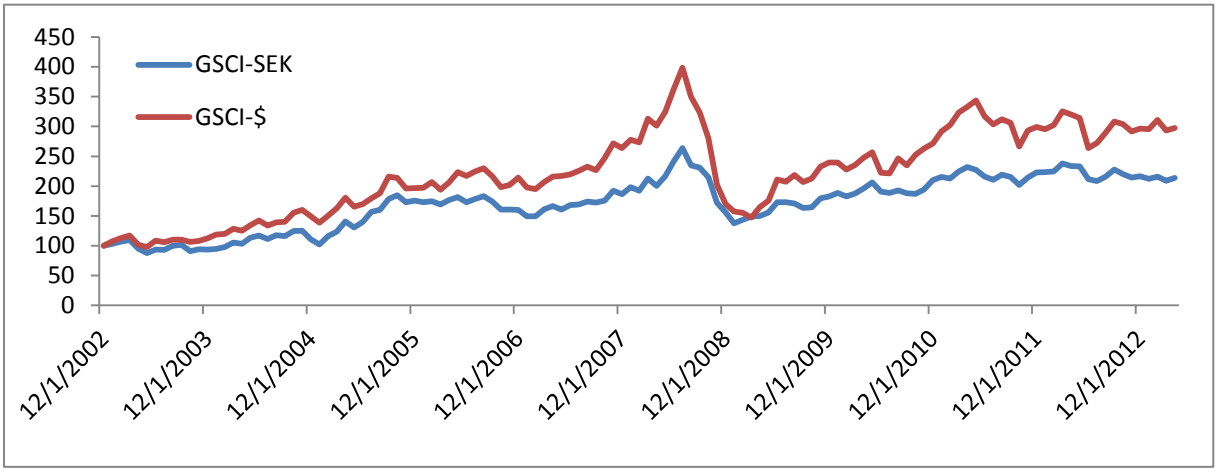

Figure 6: Cumulative return Buy & Hold portfolios hedged with Light Crude Oil, starting at 100%

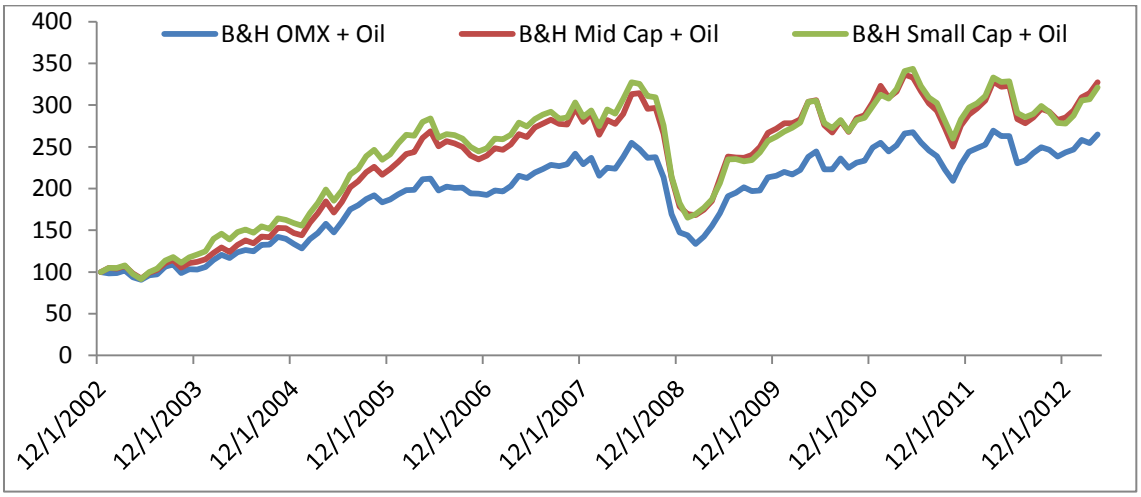

Figure 7: Cumulative return Buy & Hold portfolios hedged with GSCI, starting at 100%

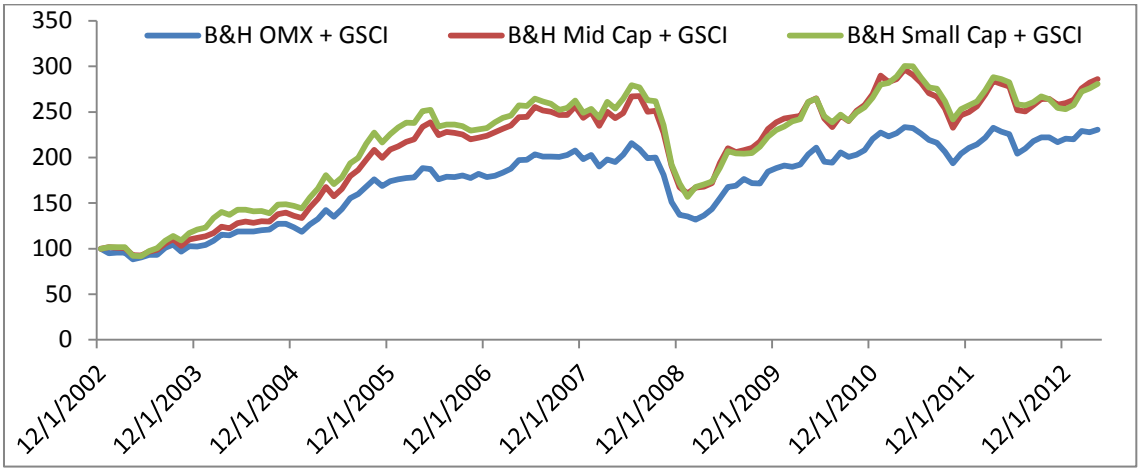

Figure 8: Cumulative return Buy & Hold portfolios hedged with Nordic Power, starting at 100%

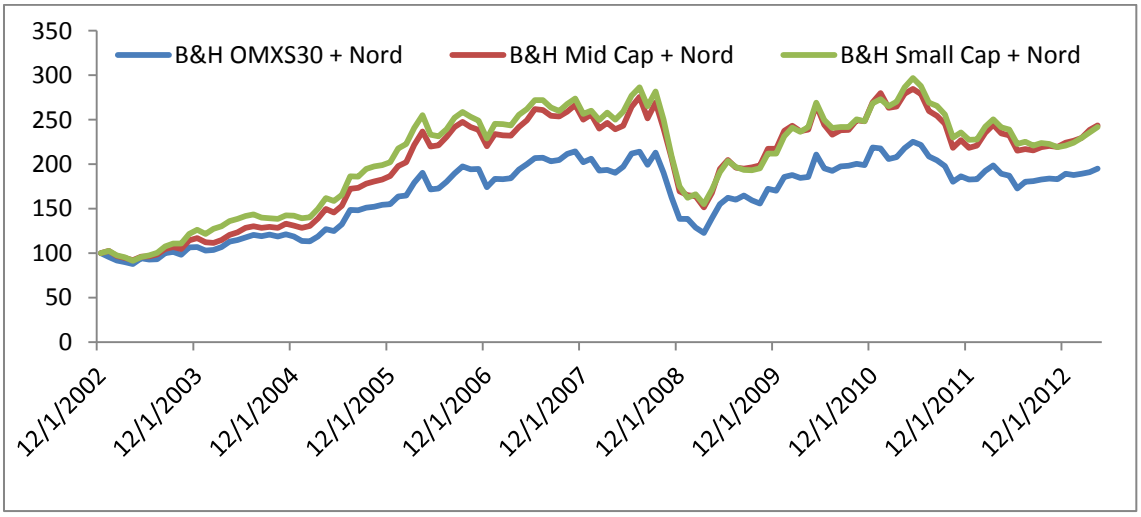

Figure 9: Cumulative return Yearly Managed portfolios hedged with GSCI, starting at 100%

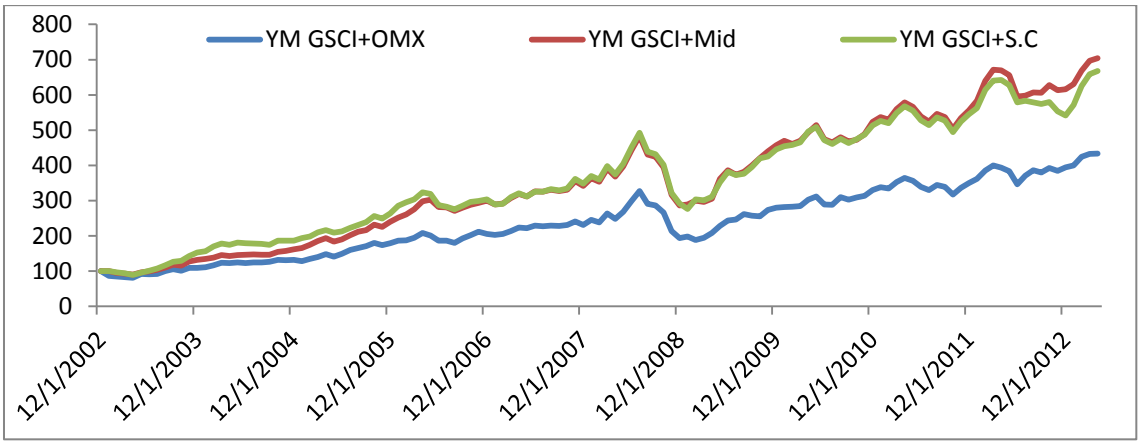

Figure 10: Cumulative return Yearly Managed portfolios hedged with Light Crude Oil, starting at 100%

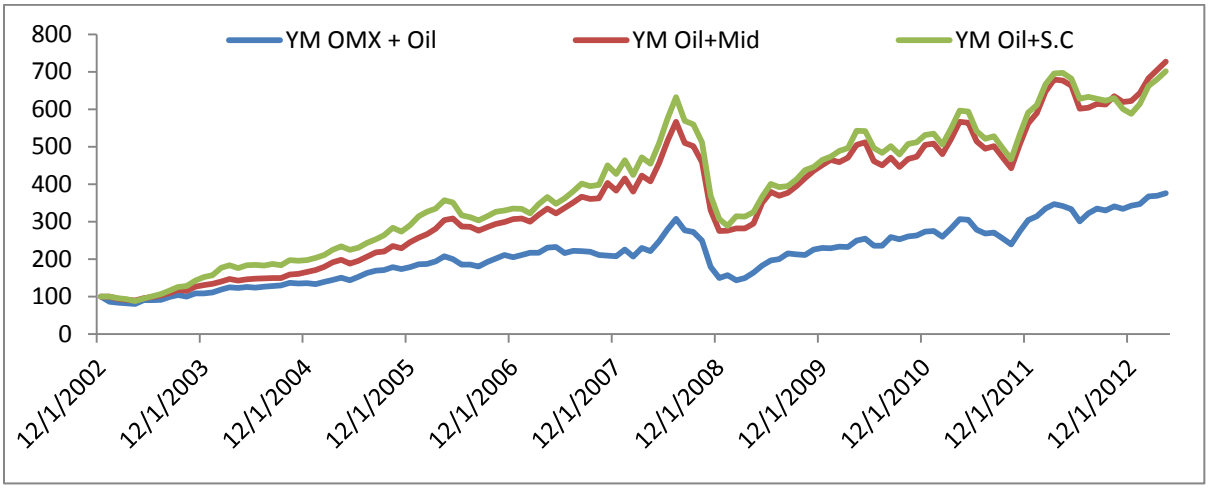

Figure 11: Cumulative return Yearly Managed portfolios hedged with Nordic Power, starting at 100%