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Investment strategies in the crude oil futures market - an empirical analysis of its return and its causes

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Investment Strategies in the Crude Oil Futures Market

-an Empirical Analysis of its Return and its Causes

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Master thesis in finance

UMB SCHOOL OF ECONOMICS AND BUSINESS

Contents

Abstract

We show that while a passive investment strategy going long in WTI oil futures yields an annual excess return of 8.1% between January 1985 and June 2010, an active but very simple investment strategy going long in backwardation markets (spot price *above* futures prices) and short in contango markets (spot price *below* futures prices) yields an annual excess return of 20 % for the same period. Its statistical significance is also high with a t-value of 3.36 compared to the long only strategy with a t-value of only 1.34. A supplementary investment strategy, where we leave the market for one month after a prior monthly negative return, yields an annual excess return of 22% between 1985 and 2010.

We also show that although the risk is relatively high in oil futures, investors with a perspective of more than 5 years made at least 12% annually after June 1991. Investors entering the market in 2000 and in 2005 made respectively 24.5% and 22.2 % annually.

Between 1985 and 2004, backwardation markets account for more than 66% of the months. In addition, returns are much higher during backwardation months than during contango months. After 2005, however, contango markets have become the norm in oil futures; yet, the excess return has remained high. Roll return, whether in backwardation markets or contango markets is a very stable and safe excess return and accounts for almost all the return compared to spot return.

Several explanations have been put forward regarding the drivers of the return in commodity futures. No explanation seems to fully account for the high returns. However, we do show that risk premium is connected to hedging pressure where short hedgers and long speculators are the most volatile and seem to adjust their volume according to price changes.

Key words: Crude oil futures, Term Structure, Backwardation & Contango, Risk Premium, Momentum Strategy, Roll Return, Spot Return and Hedging Pressure.

Preface

This thesis is written as a closure of my two years master degree at the UMB School of Economics and Business.

Digging into the investment world of crude oil futures has been a challenging and interesting journey. I first came over the subject when I studied the price spread between the WTI and Brent crude oils in the UMB courses *Empirical Analysis of Financial and Commodity Markets I & II*. Later I was able to increase my knowledge of how demand and supply form the futures curve and the spot price in crude oil through the course *Commodity Market Analysis*.

I hope the future will offer me the opportunity to further enhance my knowledge of the futures market for crude oil. If money suddenly should fall upon me, I will certainly invest them in oil futures based on my findings in this paper of active management as the best strategy to capture risk premium in oil futures. As Warren Buffet puts it:

"Wide diversification is only required when investors do not understand what they are doing"

I also hope that any readers, who happen to come across this thesis, may find it valuable as an introduction to investments in oil futures. On the other hand I must say, that if you are late, let's say a couple of years from today, I believe that someone might have been there and picked up the 100 dollar bill that has been laying there since 1985.

Finally I want to thank my supervisor, PhD professor Ole Gjølberg for valuable support and corrections.

UMB, January 2011

Trond Hanstveit

List of figures and tables

1. Introduction

During the last decade several academic papers have been published that have focused on how to capture returns in commodities and especially in so called backwardated commodities; commodities which normally have a term structure where the current spot price exceeds current futures prices. While most academic papers conclude that in the stock market in the long run a passive investment strategy[1] beats an active investment strategy, in commodities a lot of academic papers conclude on the opposite; active strategies beat passive strategies.

Despite these findings, a lot of investors and huge pension funds continue to invest in passively managed indexes like the Standard & Poor's GSCI based on the belief that commodity indexes offer low correlation with other asset classes, a hedge against inflation etc. The growth of inflow into commodity indexes took off particularly after the publication of one of the most influential and publicly known commodity analysis *Fact and Fantasies about Commodities,* by Gary Gorton and Geert K. Rouwenhorst and published in the Financial Journal in 2006. The publication supports a passive long only strategy in commodities.

While several academic papers explore the difference between active and passive management for a diversified portfolio of commodities, fewer papers compare these strategies for one commodity only. This paper tries to fill this gap by focusing on crude oil futures only

First, we will look at how excess returns have been in the crude oil futures market between 1985 and 2010 using strategies based on term structure signals and momentum. We will also introduce two fictitious investors, one entering the market in 2000 and the other in 2005. The first investor has a setback period of 15 years (1985 – 1999) and an investment period of almost 11 years (2000 – 2010); the second investor has a setback period of 20 years (1985 – 2004) and an investment period of almost 6 years (2005 – 2010). Both are faced with a history of data which they can use to construct several strategies to be used for their future's investments.

Second, we will look at some of the potential drivers of these returns. While the drivers of return in the equity market for single stocks have been commonly recognized as being its beta, the futures markets seem to be more complicated as commodities show low correlation with stocks and bonds. Several

[1] A passive investment strategy, both in equities and in commodities, is a financial investment strategy that doesn't try to beat the market by stock/futures picking or any use of market timing. Normally a passive strategy is tracking an externally specified index.

hypotheses have been put forward. We will not go into them all. Instead we want to particularly look at the hedging pressure as a driver of risk premium in oil futures.

There are several intriguing questions that form the basis or the "why" of this paper. First, future prospects for equity returns seem to be low in Europe and the USA which is likely to raise bullish bets on commodities. With the expectation of more than 50 billion dollars of investments in commodities in 2011[2], and most of these going into the energy sector and crude oil, an investigation of past return in crude oil futures commands a thorough analysis.

Second, can an investment strategy that trades on publicly available information like term structure and past performance succeed even though this is well known in the market?

Third, contango, where the current futures prices trade above the current spot price, is often seen as a negative term structure for investors[3]. But does this have to be so? Before 2005 the crude oil futures curve was normally in backwardation where the current futures prices trade below the current spot price, while after 2005 the normality for the futures curve has been contango. Since risk premiums in crude oil futures have been connected with backwardation, has this affected the return after 2005?

Fourth, while huge pension funds for the last decade have gone long in commodity indexes, spurred by academics and Wall Street, how has oil futures contributed to portfolios of commodities like index funds etc?

Fifth, some investors go long in crude oil futures in order to capture spot price increase[4]. But has spot price increase contributed to total return in the past?

The paper is organized as follows: In chapter 2 we introduce the reader to some basic concepts of the futures market as well as a discussion of the futures markets' role and efficiency. In chapter 3 we look at the historical returns in the futures commodity market in general as well as in the crude oil futures market. We will also include what earlier empirical analysis have found out about the reason behind risk premium in commodities In chapter 4 we will present some of the most relevant theories that can help explain the behavior of spot prices, futures prices and the relationship between them (the term structure or basis).

[2] According to the British investment bank, *Barclays Capital*'s website
[3] See Financial Times, June 30, 2005
[4] The exact reason why speculators are net long or short in futures is not easy to know without asking them. However, media often refers to long position holders as they are speculators on price rise. In *Dagens Næringsliv*, Dec.4, 2010, a graph is depicted that shows that speculators recently have increased their long positions in crude oil. This is then interpreted as if investors expect that prices will go up.

Our empirical analysis of the futures market in oil is presented in chapter 5 and 6. In chapter 7 we discuss some of the drivers of the risk premium in oil futures before in chapter 8 we wrap up and conclude.

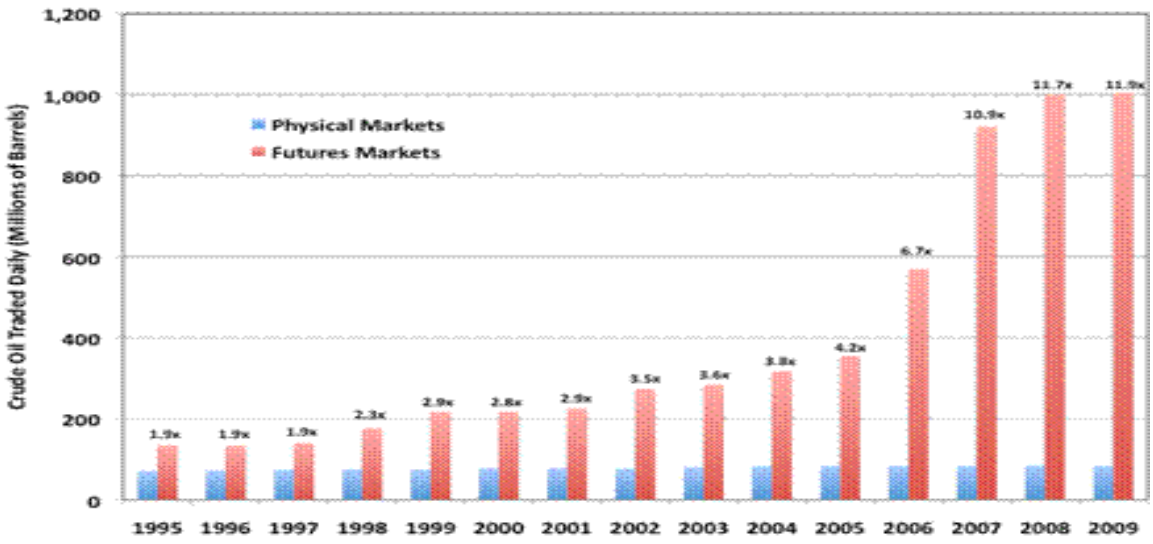
2. The futures market for crude oil

A futures contract in crude oil is an agreement between a seller and a buyer of oil to exchange a given amount of crude oil at an agreed upon price, location and at a particular date in the future. The contract used in this paper is the West Texas Intermediate (WTI) which trades at the New York Mercantile Exchange (NYMEX). This contract is an agreement to deliver or take delivery of 1000 barrels (158,970 liters) of oil in Cushing Oklahoma on whatever day in the following month of the expiration month stated in the contract. The WTI contract is listed for 9 years forward. The number of different maturity contracts per year decreases as we extend our time into the horizon. Also the trading volume of each contract decreases with the front month contract (the first contract) and the nearby contracts being the most liquid.

Since the contract is very standardized, offering no flexibility in size, time of delivery or location, most of the hedgers using oil futures to manage risk do not buy the physical contract but the equivalent financial contracts which they liquidate before expiration. For this reason, and because there are huge amounts of speculation in futures, only a small percentage of the contracts are actually aimed at being physically delivered or bought. Figure 1 shows the amount of futures traded of the two most important futures in the world, the WTI futures and the Brent futures, both traded on NYMEX. The left axis shows the number of contracts traded each day.

As Figure 1 also shows, the physical contracts are only a tiny part of the total contracts traded and are very stable at around 70 and 80 million contracts each day. The financial contract, on the other hand, has increased considerably during the last 15 years from growing slowly between 1995 and 2005 reaching almost 400 million contracts in 2005 to skyrocketing during the end of the last decade to 1 billion contracts a day. While we cannot read out of this figure why this growth has taken place, we will see later that both hedgers and speculators have increased their demand for futures along with the last decades price rise in the spot market of crude oil. From an investment perspective the high amount of daily trade is a considerable advantage. Such a high volume makes it easy to enter and leave the market. In our paper, we use the front month (first contract) and the second contract which carries the bulk of daily trades in oil futures.

Figure 1 Daily trading volume NYMEX WTI Futures + ICE WTI Futures + Brent Futures



Source: www.futuresindusty.org

The WTI crude oil is traded both on NYMEX (New York Mercantile Exchange) and on ICE Futures Europe, which is a London based futures exchange. NYMEX is the world`s largest energy futures exchange and traded along with CME Group5 3.28 billion derivatives contract in 2008 giving the CMC Group the first place in the global derivative market. Over 134 million WTI contracts were traded on NYMEX in 20086, making the WTI contracts on NYMEX the most traded energy and crude oil futures contract in the world. By contrast, ICE Futures Europe traded around 51 million WTI contracts in 20087.

The derivative market consists of contracts that are derived from an underlying asset, in our case crude oil. Crude oil is the world`s most traded energy commodity[8] and comprises over 50% of all actual trade in the world[9]. Crude oil is also the commodity that gets most attention in the news. Prices on crude oil act as a temperature on the world economy and affect the prices of other commodities, as crude oil is used in their production process and as the fuel for transportation. Crude oil comes in many different varieties and grades where API gravity and sulfur content are the most important characteristics that distinguish them from one another. The WTI (West Texas Intermediate) crude oil is the lightest of the crude oils with high API and low sulfur content. This characteristic makes it perfect for light products like petrol. The WTI is

[5] The CMC Group acquired NYMEX in 2008.
[6] www.futuresindustry.org
[7] www.futuresindustry.org
[8] www.futuresindustry.org
[9] World-production weighted according to S&P`s Global Industry Classification Standard (GICS®) as the commodities markets answer to the market capitalization idea in the equity market.

therefore the one that is priced highest. The WTI is a North-American crude oil with delivering point in Cushing Oklahoma. WTI act as the most important benchmark crude oil along with the Brent Crude.

How the futures market is organized should be, and certainly is, of importance to investors. Certain characteristics are inherent in the futures market, like low costs and a liquid trade. This will improve both the forecast and the easiness of getting in and out of the market.

In the next chapter we will look at the role of the futures market. This is not only of academic interest. As we will see later, understanding the role of the futures market may help us to understand why and what kind of risk premium investors can expect to capture in this market.

2.1. The role of the crude oil futures market

The main role of the futures market is risk management. "Commodity futures markets exist to facilitate the transfer of exceptionally expensive inventory risk….at their timing and convenience" (Eagleye 2005, p.7).The futures market helps producers of oil to share this risk with others as futures can be bought, as we saw in the previous chapter, for many years ahead. But consumers may also want to share risk, so both buyers and sellers of crude oil meet on an exchange to lock in the price for oil to be delivered in the future. As an insurance giver, the futures market is different than the bonds and equity market, as their role is to raise capital. This is important, because in theory, if there are enough hedgers so liquidity is not a problem and hedgers are even on both sides of the futures contracts, the futures market does not need any speculators. On average the futures price should then equal the expected spot price.

Another important role of the futures market is that it dampens price fluctuations by moving stocks from one period to another. Imagine a sudden drop in demand of crude oil. If no futures market existed, all the oil will flood the market and the price would drop to such a level that consumption would equal production. However, since there is a futures market with a known price, market participants can go long in physical oil and at the same time go short in oil futures. This will withdraw oil from the market and the price will not drop as much as it might have done if there were no storage possibilities. But the proposition about futures and price volatility may also have the opposite effect as speculators may bid up prices and thereby increase volatility.

Nearly related to the futures market being an allocator of recourses across time is the price discovery function of the futures market. The futures market gives individuals information and signals about future

price forecast that reflect all actors' collective thoughts about supply and demand. This will induce the participants to make *correct* judgment about production, consumption and storage.

Together these three roles (risk management, allocator across time and price discovery) lead market participants to optimize production, consumption and storage. Risk-averse participants will produce and consume *more* since they are able to lock in future prices. And since the commodity is possible to store, in bad economic times we can build up storage to be used when the economy improves, instead of consuming "more than we should" due to a too low price. In good economic times, prices will increase and storage holders would be encouraged to sell their oil reducing the prices compared to a situation with no storage.

Finally, the futures market offers risk hungry investors (speculators) the possibility to earn profits by speculating on the evolvement of futures prices. And as we will see later, this hunger has increased considerably after 2004. Yet, investment in futures is considered a risky business. We therefore need to familiarize ourselves with some basic concepts.

2.2. The term structure of crude oil futures

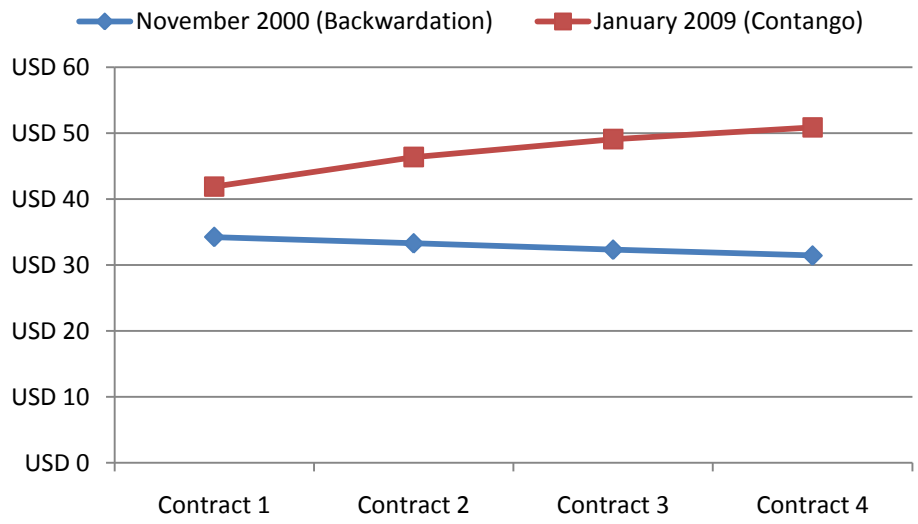
The most commonly used term structure concepts, both in the academic literature and in the news, are (normal) backwardation, (normal) contango and basis. Although academic authors differ in their use of these concepts[10], there seems to be a fairly common usage in the media and in the literature as of today.

The most commonly used concepts are those of "contango" and "backwardation" which is the difference between the current futures price and the *current* spot price. These concepts are used when we take a snapshot of the spot price and the futures prices at different maturities. This can be seen in figure 2, where we have taken two snapshots, one in January 2009 where futures prices for different maturities were above the spot price (contango) and one in November 2000 when the futures prices for different maturities were below the spot price (backwardation). The left axis shows USD per barrel of oil while the horizontal axis shows four WTI contracts expiring in four consecutive months . As we see from the figure, in November 2000 contract 4 with expiration in February 2001 was priced almost USD 10 above

[10] Pilipovic (1997 pp 80-82) & McDonald (2006 pp 170-171) define the difference between the current futures price and the *current* spot price as contango and backwardation, while Dubofsky (2003 pp 100 & 134) uses the terms "normal market" and "inverted market" respectively. The latter defines the difference between the futures price and the *expected* future spot price as contango and normal backwardation. Gorton and Rouwenhorst (2007) acknowledge this interchangeable use of the concepts. *We* find it useful to distinguish between contango and backwardation as the difference between the current futures price and the *current* spot price, and normal contango and normal backwardation as the difference between the current futures price and the *expected* spot price.

the spot price in November, compared to 2009 where the futures price for contract 4 was around USD 3 below the spot price.

Figure 2 Different term structures in WTI futures

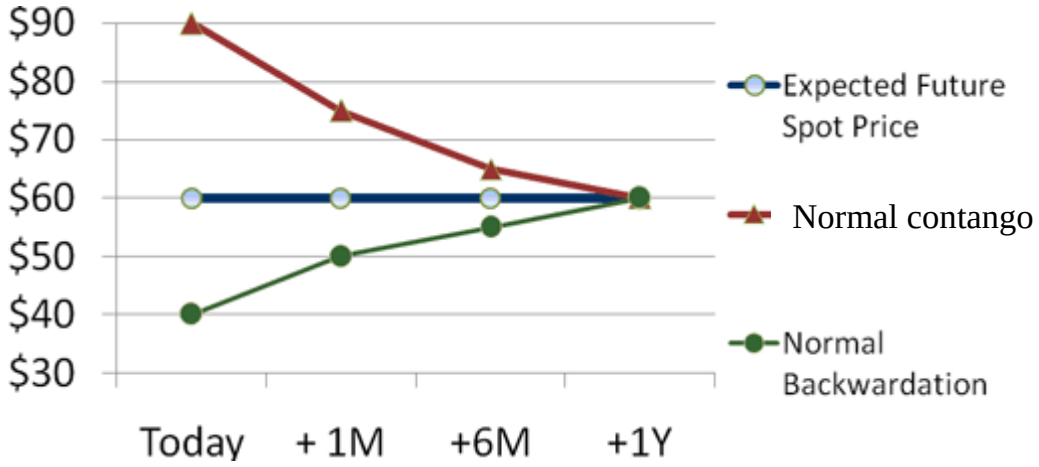


Source: www.eia.gov

Another name for term structure is the *basis*, which is normally defined as the difference between the futures price and the spot price. By this definition the basis was negative in 2000 while positive in 2009.

When we talk about *normal* contango and *normal* backwardation, which is not to be mixed with contango and backwardation, we talk about the difference between the current futures price and the *expected* spot price. Irrelevant whether the market is in contango or backwardation, the expected spot price in the future may be higher or lower than the current futures price. This is illustrated in figure 3, where we have drawn two imagined situations where on the left axis the amounts represent dollar per barrel of oil. Imagine a situation where the expected spot price for the future is USD 60 as in figures 3, and that it turns out that the actual spot price stays at this price for one year. Despite this expectation, participants in the futures market may be willing to enter agreements where the futures price is above or below that expectation. This is illustrated in figure 4 with a futures price on USD 90 and another futures price at USD 40. Both contracts must converge towards the spot price at maturity, either because of normal contango (current futures price above expected spot price) or normal backwardation (current futures price below the expected spot price) to eliminate the possibility of arbitrage. Therefore, the price in year one in Figure 3 must in all cases be USD 60 as long as the spot price is USD 60.

Figure 3 Illustration of converging futures prices of a contract due in one year



Source: www.investopedia.com

Figure 3 is important to understand as investors are rewarded for being on the buy side of the contract if the market is in normal backwardation and on the sell side if the market is in normal contango. In both cases the futures prices must *roll* towards the spot price at expiration. More on this will be explained in the next chapter

When a futures curve is in contango, it will at the same time, if the futures price is different from the expected spot price, be either in normal backwardation or in normal contango. The same applies to a contango market; it will either be in normal contango or normal backwardation under the same assumption as above. At the same time, a futures curve can contain both contango and backwardation along its curve.

What causes the futures curve to change between contango and backwardation? In chapter 3 we will outline the theoretical reason why the futures curve may change between these different market conditions and introduce some of the factors that shape the futures curve like the option theory, convenience yield and OPEC.

Being able to discern those different concepts, we now turn to discuss a closely related subject; the sources of return in the crude oil futures market.

2.3.Excess return, roll return, spot return and diversification return

When we later in this paper present our return in the crude oil market, we will break the return into different components like spot return and roll return, which combined is called excess return (return in excess of risk free rate). In addition, return in commodities may earn collateralized return and diversification return, where the last one only accrues to those who invest in more than one commodity, and by so diversify.

Since investment or speculation in futures is highly leveraged, return is normally calculated by adding a risk free rate to arrive at a total return, in order to make a meaningful comparison to other investments. The *marked-to-market* in futures requires an investor to set aside approximately 5% of the futures price to the brokerage. E.g. if the futures price is USD 100, USD 5 is put into the margin account while we calculate risk free rate on the rest (95 dollars). This comes on top of the excess return we will explain shortly. The interest earned on the cash value of the investment, or collateralized return, is often included when returns in commodities are listed up and compared with other investments. In this paper we only list the highly leveraged excess return, but when we calculate annual risk and return we assume the full futures price is invested i.e. a reward of USD 10 of holding a futures price bought at USD 100 and kept for one year is calculated as 10% even though only USD 5 was invested (set aside in the margin account).

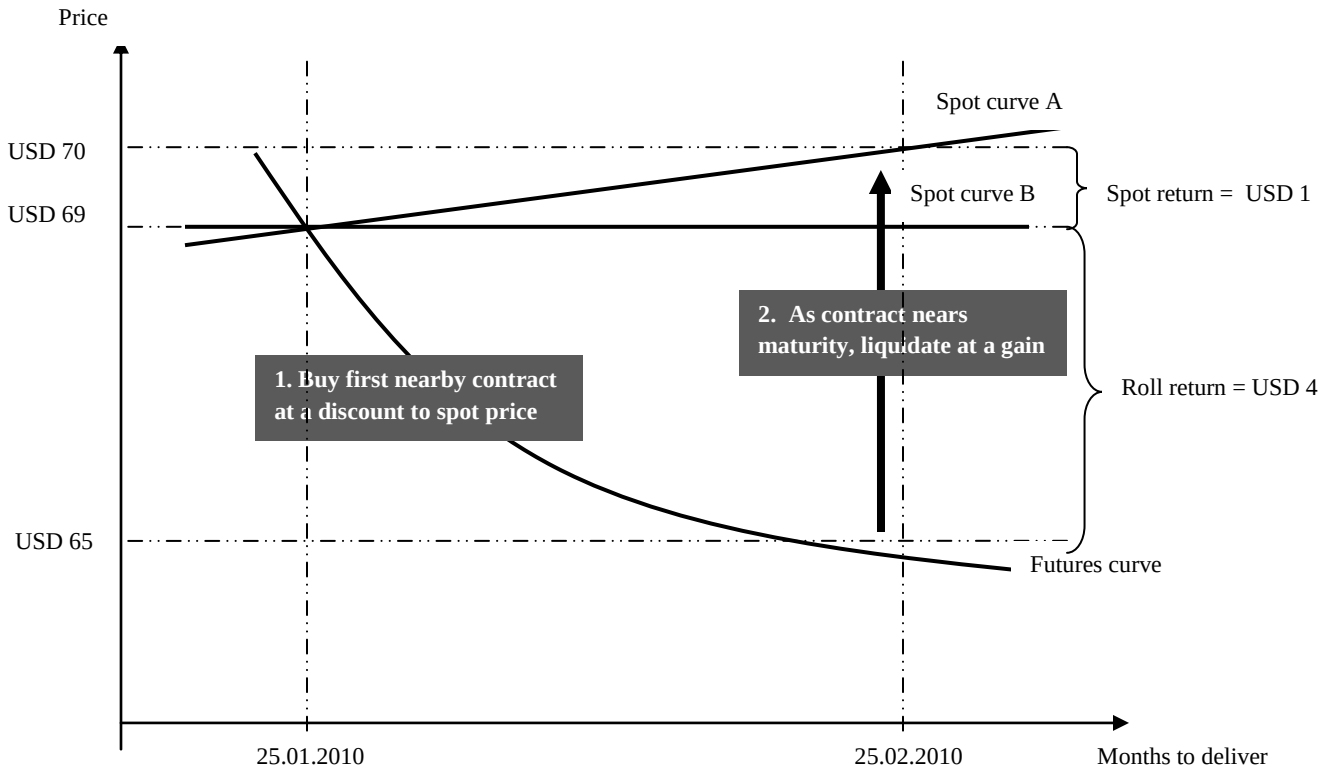
The excess return in the futures markets for a commodity can be divided into spot return and roll return (also called roll yield). This difference is important to understand. As we shall see in the next chapter, even trained investors do not seem to fully understand this difference and the effect it will have on their investments. Excess return in futures is earned when an investor goes on the buy side, as we saw in chapter 2.2, when the market is in normal backwardation and on the sell side when the market is in normal contango.

In order to explain the difference between spot return and roll return we will begin with a simple case when the spot price in a given period is constant. This is presented in Figure 4 with a horizontal line called *Spot curve A*. If on January 25 we buy oil spot, it will cost us USD 69. If we buy futures, the price depends on which contract we buy, which is shown on the curve called *Futures curve*. Since futures prices must converge towards spot price, the futures price for delivery on January 25 is USD 69 – the same as the spot price on that day. But as we go into the future, futures prices become lower and lower, shown by a downward sloping futures curve. If we buy oil futures to be delivered in March, which on the figure is shown as a futures contract with expiration date on February 25, we can buy the contract for USD 65.

In this figure the market is in backwardation. Since we have assumed that the spot price is constant between January and February, the futures price we bought in January for USD 65 must increase as we near the maturity date in February; otherwise there would be arbitrage possibilities on February 25. This is the roll return, defined as the difference between the futures price and the spot price. If the spot price in the previous example did *not* stay constant, but increased with one dollar to USD 70, futures prices on February 25 must also become USD 70. Spot return would then be USD 1 and roll return USD 4 which would total 5 USD. If, however, the spot price decreased with one dollar making the spot return *minus* 1 USD, roll return would still be USD 4 and total return would decrease to USD 3.

We have explained the difference between spot return and roll return in a backwardated market. However, the same principles hold true and the same concepts are used in a contango market as well as whether one goes short or long in either markets. But if we go short in futures, roll return will be positive if the current futures price is *above* the expected spot price. If we, however, go long in a contango market, we will earn *negative* roll yield since the current futures price is above the expected spot price.

Figure 4 Spot return and roll r**eturn**



The last source of return in the commodity market that we will shortly mention is the diversification return, a topic discussed in several academic papers, among them Booth and Fama (1992) and Erb and Harvey (2006) and seen upon as a *free lunch* that has the capability of raising a portfolio's geometric return. Erb and Harvey show that by combining Heating Oil and Copper with geometric return of respectively 5.53% and 6.71% between 1982 and 2004, combined geometric return will become 7.86%. The long-only return that many academics find to be equity-like when using a huge array of commodities with long horizons is then explained by this diversification return. Erb and Harvey (2006) also show that these equity-like returns on commodity portfolios consist of commodities that on average have zero geometric return.

So, to conclude on what we started this chapter with; we need to do an analysis of past performance of different strategies and do a breakdown of its return; if spot price is the source of return one must invest (go long) in commodities with expected spot increase in the future. If roll return is the main source of return, commodities with highest expected roll return in the future should be included in our portfolio. If one is looking for diversification return as a reliable source of return, one should include as many commodities as possible or those commodities *combined* that are expected to give highest diversification return in the future. But what can earlier empirical studies tell us about risk and return in commodities and in crude oil futures particular?

3. Earlier literature on risk and return in commodities

The most influential and cited paper about a long only strategy in commodities is the article by Gorton and Rouwenhorst (2006). Although this article is most known for the findings of equity like return in commodities, which we will look at shortly, their empirical findings also include a zero geometric average return for all commodities. Of the 36 commodities included in their study[11], 18 commodities had geometric excess return below zero and 18 commodities had geometric return above zero, with an average of zero! Despite an average of zero, the differences are large with 10.6% yearly return of oil futures performance being second best after unleaded gas futures showing 14 % yearly return. Corn, rough rice and electricity had on the other hand the most negative returns with annual returns of -7.35%, -10.11% and -55.65% respectively.

[11] The findings by Gorton and Rouwenhorst (2006) cover different periods between 1959 and 2004; e.g. oil futures were not traded before 1983.

Leaving the historical performance of single commodities, Gorton and Rouwenhorst (2006) found that the commodity futures market between 1959 and 2004 offered; (a) the same risk premium (5% excess return) as the equity market and a higher risk adjusted return (Sharpe ratio) than stocks and bonds, (b) a negative correlation with equity and bond returns, (c) a hedge against inflation, (d) positively skewed distribution of return relative to equity return (less downside-risk) and (e) the possibility of diversifying away some of the systematic component of risk as they perform different than equity during different parts of the business cycle.

Table 1, taken from the paper by Gorton and Rouwenhorst, shows why commodity investment has become so popular in the last decade. With a 24% higher Sharpe ratio of commodity futures compared to stocks and almost the double Shape ratio of bonds, the figure should speak by itself.

Table 1 Annualized risk and returns on different asset classes, July 1959 – March 2000

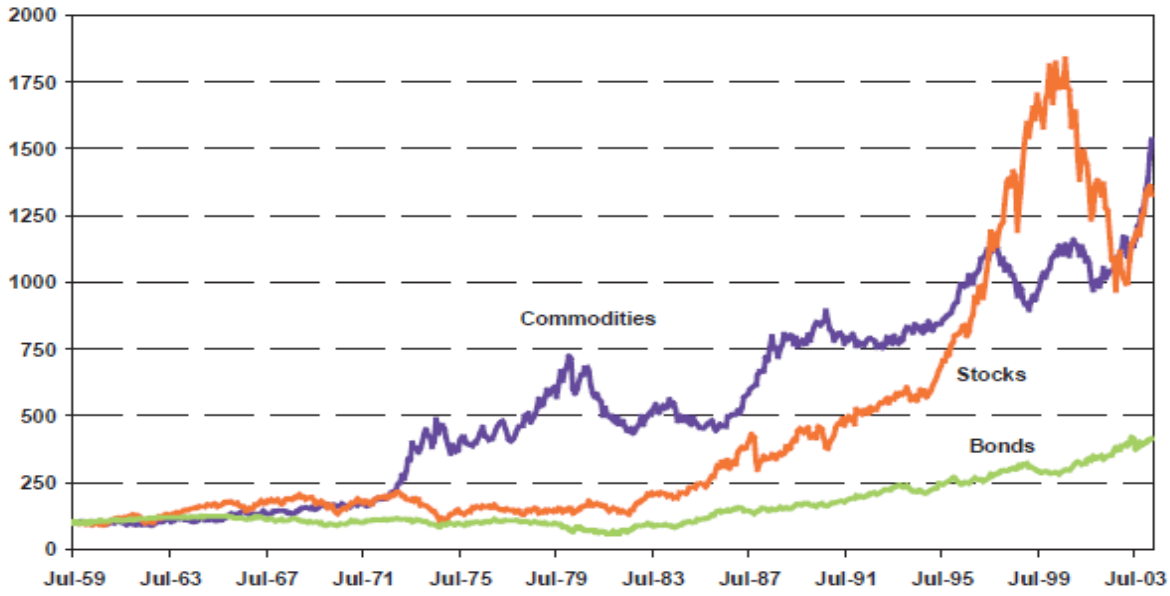
	T-bills	Stocks*	Bonds**	Commodity futures***
Mean return	5,52 %	11,02 %	7,71 %	11,02 %
Std.Dev.	0,78 %	14,90 %	8,47 %	12,12 %
Sharpe ratio	0,00	0,37	0,26	0,45

*/**/*** S&P 500/Ibbotson corporate bond index/an average of 18 commodities included in the study by Gorton and Rouwenhorst.

Source: Gorton and Rouwenhorst (2004)

The table above, however, should not mislead us as to what the historical facts tell us of a varying performance of the three assets, stocks, bonds and commodity futures. In shorter periods (but still up to 20 years) there has been a huge variety, particularly between stocks and futures, as to who performs best. As shown in Figure 5, while stocks performed best in the 60s, 80s and around the turn of the millennium, commodities performed best in the 70s and the 90s.

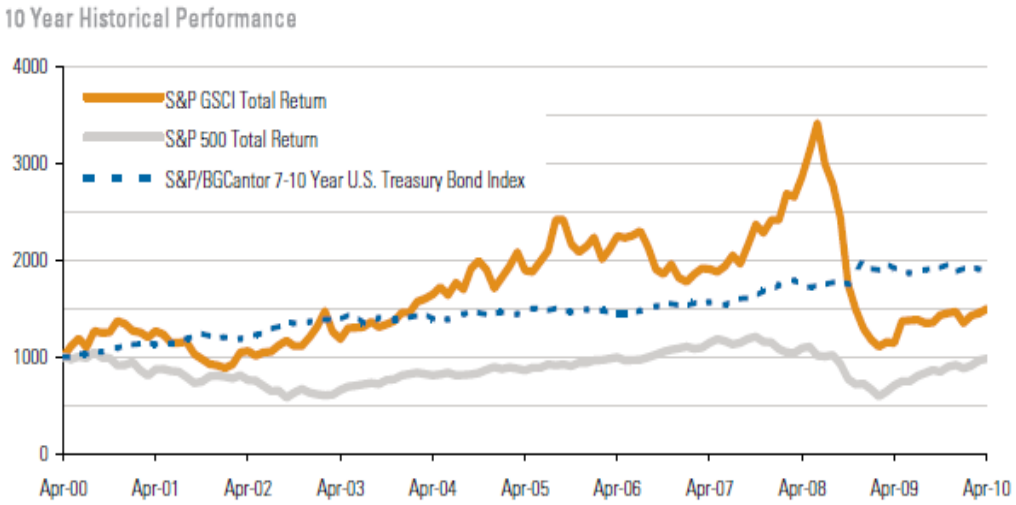
Figure 5 Stock, bonds and commodities – inflation adjusted performance, July 1959 – October 2003



Source: Gorton and Rouwenhorst (2004)

If we look at shorter period like we have shown in Figure 6 we see another example of how return in shorter periods may deviate from the long run. While commodities in this period have still outperformed stocks, U.S. Treasury Bonds have outperformed both stocks and Standard and Poor's commodity index. This is very interesting since commodities are considered much more risky than bonds. A 10 year period, which is a relatively long time, has not rewarded risky assets.

Figure 6 S&P's GSCI – inflation adjusted performance, April 2000 – April 2010



Source: Standard & Poor's website

In Table 2 , we have introduced another important passive commodity investment strategy, namely index investment. Since index investment started in 1991, with the introduction of the GSCI by Standard & Poor, the indexes have grown in number. As we can see from Table 2, the annual rates vary a lot between different indexes as different indexes use different weighing measures as to what relative weight each commodity will possess in the index. The average Sharpe ratio for this period for all indexes is not convincing as it is well below the Sharpe ratios we have seen for bonds, stocks and commodities in the long run above in Table 1.

Table 2 Annualized risk and returns for passive indexes, January 1991 – December 2004

Index	Compound annual rate*	Annualized standard deviation	Sharpe ratio
Reuters Jefferies CRB Index (RJCRB)	3,30 %	8,34 %	-0,07
DeutscheBank Liquid Commodity Index (DBLCI)	10,09 %	18,49 %	0,34
Dow Jones - AIG Total Return Index (DJ-AIG)	6,98 %	11,82 %	0,26
GSCI Total Return Index (GSCI)	5,66 %	18,06 %	0,1
Rogers International Commodity Index (RICI)	10,10 %	14,04 %	0,44
S&P Commodity Index (SPCI)	4,79 %	13,04 %	0,07
Average	**6,82 %**	**13,97 %**	**0,19**

* Compound annual rate is total rate including collateralized funds.

Source: Akey (2005)

Leaving the historical performance of passive investment strategies, active management of commodities futures has shown to generate high excess return and superior Sharpe ratios. Akey (2005, p 40) has created two benchmarks "by creating an equally weighted portfolio of all known commodity traders and all known natural resource hedge funds." Compared to the indexes in Table 2, these active strategies have without doubt outperformed passive index investment in the same period. Returns are higher, risks are lower and the Sharpe ratios are very high compared to the passive indexes.

Table 3 Annualized risk and returns for active futures traders and hedge funds, January 1991 – December 2004

Portfolio	Compound annual rate*	Annualized standard deviation	Sharpe ratio
Active commodity traders	15.89%	7,60 %	1,58
Active commodity traders & hedge funds	18,44 %	8,19 %	1,78

*Compound annual rate is total rate including collateralized funds.

Source: Akey (2005)

In addition to the historical performance of active managers, several academic papers have been written where relatively simple investment strategies have been empirically tested. There are basically two approaches used by academics trying to enhance the excess return on a commodity futures portfolio – momentum strategies and strategies based on term structure signals.

The momentum strategies evaluate past performance on one or more commodities and go long those commodities with positive return and short those commodities with negative return. Erb and Harvey (2006) shows that if you go long those commodities with 12 months' prior positive futures return and go short those with 12 months' prior negative futures return, also called a trend following portfolio, this active portfolio shows an annual excess return of 6,5% and a Sharpe ratio of 0,85 between 1982 and 2004. An equally weighted portfolio and the GSCI index for the same period show excess return of 0.80% and 4.39% respectively, and a Sharpe ratio of 0.08 and 0.25 respectively. The conclusion by Erb and Harvey that tactical asset allocation based on momentum is able to increase excess return corresponds to other academics like Miffre et al (2006).

Strategies based on term structure signals go long when the market is in backwardation and short when the market is in contango. In line with the result for the momentum strategy, Erb and Harvey (2006) also show that this one is superior to an equally weighted portfolio and the GSCI index for 12 commodities between 1982 and 2004. Miffre et al. (2006) also look at the link between these different strategies and come up with an interesting answer; the momentum strategies actually buy the high volatility backwardated contracts and short the high volatility contangoed contracts! And these findings are very strong in e.g. crude oil. Miffre et al. (2006) finds that despite the fact that the most risky strategies also are the most profitable, risk measured as correlation to S&P500 composite index, GSCI etc. shows no significant alpha. The return is therefore not only a compensation for time-varying risk. Another

interesting finding by Miffre et al. (2006) is that these strategies lose their hedge against inflation that commodities are known to provide.

Before we in the next chapter look at the most relevant theories relevant to a discussion of whether there is a risk premium and how high it can be, we will look at some of the empirical findings on these issues. Many academics have supposed that the normality in commodity futures markets is that the current futures price is set below the expected spot price (normal backwardation) and that this market rewards investors going long in futures. Among the proponents are Bodie and Rosansky (1980), Fama and French (1987) and Gorton and Rouwenhorst (2005) but also investments banks at Wall Street like the Standard and Poor. The whole idea with the S&P's GSCI is to go long in commodities. Something pensions funds, as we have seen, in the last decade have done on a huge scale.

Empirical research on cross sectional risk premiums of both live cattle and gasoline (Nash and Shrayer, 2004) shows that in both these markets there has been a "congenital (inherent) weakness" (Eagleye, 2005) on the demand side for hedging, causing these futures curve to be in backwardation most of the time, offering long-only investors risk premiums of respectively 11.0% and 18.6% between April 1983/84[12] and April 2004. Kolb (1992) also found that "normal backwardation is not normal. Also Gorton and Rouwenhorst (2004) took their findings of equity like return in commodities to be a proof of the normal backwardation. However, Erb and Harvey (2006 p 12), deny this as "just rebalancing an equally weighted portfolio can be a source of statistically significant return".

While a lot of academics have found that certain commodities reward long holders of its futures (normal backwardation), others have found commodities where short holders are rewarded (normal contango). Gjølberg and Brattestad (2010) show that in the futures market of Nord Pool the weakness is on the other side of the contract; long hedgers outnumber short hedgers so the risk premium is offered speculators going short. Basu and Miffre (2009), studying 27 commodities between 1992 and 2008, find that a portfolio based on taking the opposite position of hedgers outperforms a passive long only portfolio with between 4 and 10% depending on different sorting techniques. Gorton and Rouwenhorst (2007) contend these results stating that most papers only document a *contemporaneous* correlation between hedging pressure and futures return. According to him, the positive correlated activity of hedgers and level of risk premium may as well be that the increased volatility induces hedgers to hedge more. His empirical work does not find that hedging pressure predicts ex-ante risk premiums.

Others again have looked to other places than hedging pressure as an explanation for risk premiums. Both Pagano (2009) and Gorton and Rouwenhorst (2007) find the risk premium to be counter-cyclical. While

[12] 1985 for gasoline and 1983 for live cattle.

Gorton relates the risk premium to inventory levels, which Pagano argues could be a proxy for the business cycle, Pagano uses the degree of capacity utilization in US manufacturing as a proxy for the business cycle. Pagano also includes both indicators in the same regression and finds that the significance of the capacity utilization indicator is still intact while the inventory indicator loses its significance indicating that inventory data is spanned by the manufacturing indicator. The explanation to these results relates to the different dynamics inherent in a low-state/high-state inventory; when inventories are low, supply and demand shocks increase the volatility of both the cash and futures market and hence the volatility increases. As volatility is connected with risk, the premium for taking this risk must also increase. Hence, the risk premium is negatively correlated with inventories, which again are low during booms and high during busts. Gorton and Rouwenhorst (2006) also finds that prior futures return, prior sport price changes and the futures basis are informative about the expected futures risk premium.

To sum up; while earlier findings show that the historical geometric risk premium in commodities on average has been zero, where crude oil has been on the positive side of this average, forming these commodities into portfolio has created excess return both for an equally weighted rebalance portfolio of commodities and for passive index portfolios. These excess returns have increased even more under active management and where these portfolios have been designed based on term structure signals and momentum strategies. The empirical findings as to why there exists a risk premium are mixed. While several papers look to hedging pressure as a determinant of risk premium, others look to inventory and the business cycle. Our contribution to these papers is to analyze term structure signals and momentum strategies in light of crude oil futures *only*. In addition we want to look at hedging pressure and see how it is related to risk premium in oil futures.

But can past performance predict future performance? And what if this past performance is based on anomalies? We have come to the question of whether the market in oil futures is an efficient market or not.

4. Risk premium in crude oil futures – a theoretical introduction

The return in oil futures is simply the difference between the current futures price when entering a contract and the spot price when the contract is sold or liquidated. If the contract is liquidated close to maturity, the futures price must equal the spot price, and so, the question becomes a matter of how well the current futures price forecasts the ultimate spot price.

A lot of theories have been proposed about the predicative power of futures prices as forecast of ultimate spot prices. The simplest theory is the e*xpectation hypothesis.* This hypothesis is based on the assumption that speculators are risk neutral. If speculators don't care what risk they get in futures trading, hedgers don't have to pay them any premium for taking that risk and so the futures prices should be good predictors of ultimate spot prices. However, if any risk premium on average turns out to be zero, this does not automatically support the expectation hypothesis. Risk premium may be *time varying* due to different circumstances.

While the time varying risk premium hypotheses have been one competing explanation to the expectation hypothesis, others have tried to look for a more or less "constant" risk premium. Two of these theories are the CAPM and the *normal backwardation* hypothesis, where the latter will be explained in chapter 3.2. The capital asset pricing model (CAPM) introduced by Sharpe and Treynor stems originally from the asset market and builds on the notion that investors are paid for the systematic component of risk, represented by the beta (β). This model has later been incorporated into the commodity market by Litzenberger (1979) and Richard and Sundaresan (1981), with the idea that the commodity market offers risk premiums when they pose systematic risk. There is however some problems with the CAPM when related to the commodity market as its correlation with stocks and bonds is very low. In addition, commodities have the characteristic of actually being able to reduce systematic risk by offering counter cyclical excess return (Gorton and Rouwenhorst, 2004).

The the empirical evidence on risk premium, both whether there exist such a premium and the reason behind it is mixed. Gorton and Rouwenhorst (2004, p 32) summarize the discussion as this:

"...from the point of view of researchers, there are clearly challenges for asset pricing theory, which to date have primarily focused on equities."

Erb and Harvey (2006, p 17) put it this way:

"None of these perspectives (CAPM, hedging pressure, etc) is the final word on commodity price determination or the prospective returns from investing in commodity futures, yet they are part of the evolution of thought with regards to commodity price determination and investing".

Nonetheless, this should not discourage us to look for a cause for risk premium in crude oil futures as an understanding of its causes may give us a clue of whether there will continue to be a risk premium. We will look at two theories to have particular relevance for our study of investment strategies in the crude oil futures market, the theory of storage and the net hedging hypothesis. In addition, without going into the subject in this paper, inventory levels seem to influence the return in oil futures. According to Gorton et al (2007) investing in low inventory commodities like crude oil offers the best return and particularly when inventory levels are low in these commodities. Since low inventory levels normally correspond to backwardation market, also pointed out by Gorton et al, our strategy should take advantage of this premium.

4.1. The theory of storage

The theory of storage explains the difference between the future price and the current spot price, in the context of our earlier analysis; the theoretical reasoning behind backwardation and contango. The theory originates from Kaldor (1939), Working (1949) and Brennan (1958) and explains the difference between the futures price and the current spot price in terms of storage cost given by:

$$F(t, T) = S(t)\, e^{(r + c)(T-t)} + CY \qquad (1)$$

where F(t,T) is today's futures price (t) to be executed in the futures (T denotes the forward expiry date) , S (t) is the spot price of today and $e^{(r + c)(T-t)}$ is the continuously compounded interest rate $^{(r)}$ and storage cost $^{(c)}$. CY is convenience yield which is the benefit of holding stocks.

The model is called the cash-and-carry arbitrage or the cost-of-carry model because if the left side (futures price) of the equation is higher than the right side (spot price and storage costs), then arbitrage exists and an arbitrager will be able to buy the commodity cash and short futures and earn a riskless profit. Opposite; if the future price is below the spot price and storage costs, the arbitrager may be able to short in the cash market (sell the underlying asset) and go long in futures (buy futures contract) and cash in a riskless profit. Therefore the spot price should equal the futures price when the cost of carrying the commodity is included. Any deviation will soon bring arbitragers on the arena.

While for financial assets this theory is able to exactly predict the futures price in period (t) from the spot price in period (t-1), for commodities this theory might be violated. There are two reasons for this: physical crude oil is both difficult to store and to short. Crude oil is not a financial paper with only interest as its alternative cost from period 1 to period 2. Imagine how it would be if crude oil should always give risk free rate by buying it, storing it and sell it later at an earlier agreed upon futures price: as risk free rate in the long run has been on average similar to the inflation rate, crude oil prices, with its additional storage costs, must have risen faster than inflation in the long run in order to induce storage. But it is hard to see that this could have happened in the long run. In addition, oil rich countries can save the oil in the ground for later use for free! And since crude oil is not possible to short in the cash market, there is no theoretical lower bound for the futures prices compared to the spot price.

These theoretical and practical difficulties with physical crude oil as well as its history of being backwardated most of the time have given birth to what has been called convenience yield. As those who have crude oil in storage do not want to sell oil because they need it in their daily business and because there is always a risk of running out of oil, the spot price must rise above the futures prices until enough oil is released into the market. Backwardation is therefore related to tightness in supply of oil due to either a sudden rise in demand or because war or other disruptions have limited supply. And since supply is inelastic (it takes time for countries to increase production), storage holders are induced to sell oil today with a higher spot price than the backwardated futures prices

Even though crude oil is costly to store it is *possible* to store it. This predicts the upper bound of the futures curve. Since if the futures prices rise enough above the spot price, riskless profit is possible to earn by going long in the cash market (buy physical oil) and short in futures. But even the upper bound is a bit flexible since storage capability is not made available necessarily in an hour or a day. We might therefore see shorter periods when the upper bound is violated.

Many academics have found investments backwardated commodities very fruitful. The thing these commodities have in common is the characteristic of being difficult to store and short cash, and therefore being in backwardation. But backwardation in itself does not give excess return since backwardation only tells that the spot price is above the futures price. Excess return is earned because the *expected* spot price is above the futures price (normal backwardation) and earned when an investor goes long or when the expected spot price is below the futures price (normal contango) and earned because an investor goes short. But what causes this deviation? Let's look at one explanation; the net hedging pressure hypothesis.

4.2.Hedging pressure

The first and most simple theory that was postulated on hedging pressure and risk premium was the theory of normal backwardation which dates back to Keynes (1930) and Hicks (1939). According to them the short sellers of futures are the ones seeking to insure their future price risk offering the speculators some reward for taking the opposite position. This reward can then be captured by going long as the futures price in set at a discount to the expected spot price, but will rise over the life of the contract until it reaches maturity. Although widely recognized as a plausible and an important contribution to the subject of risk premiums, it has been criticized for being an idea of pre historic modern portfolio theory where modern portfolio theory is based on systematic risk and not on total risk (Bodie et al (2008) p 781). Therefore, the net hedging hypothesis has become and more recent and advanced evolvement of the normal backwardation hypothesis.

The net-hedging hypothesis is something similar to the normal backwardation theory of Keynes in that it tries to explain the risk premium due to hedging pressure. However, this theory extends the ideas of Keynes to include also the effect when the natural hedgers are *the purchasers* of any commodity (going long) and therefore outnumbers the sellers in this category. Any commodity should have both natural long hedgers (*buyers* of the commodity wanting to lock in the future price) and natural short hedger (*sellers* of the commodity wanting to lock in the futures price). Whether hedgers are net long or net short, they are willing to offer the other part compensation (risk premium) in order to obtain insurance against future price risk.

There are several proponents of these ideas, among the earlier are Cootner (1960/67), Stoll (1979) and Hirshleifer (1989, 1990). According to Cootner (1960/67), commercial market participants are well aware of the risk premium and the continuing persistence of these risk premiums is evidence that the benefit of offering them outweigh the cost. Later on, several models have been outlined based on the risk premium being cross sectional or inter-temporally based on the net demand of hedgers.

After having looked at both the theory of storage and the net hedging hypotheses, what can these theories teach us about futures investment in oil futures? How can we combine them into a bigger picture? Since some commodities exhibit characteristics that allow the spot parity theorem to deviate from its "financial" alike futures price, this gives also room for hedging pressure as riskless profit is still not possible to reach.

What can the theory of storage teach and hedging pressure teach us about investment in crude oil futures? First, as we have touched upon earlier in this chapter, we can enter the physical market for crude oil when

the futures price is higher than the current spot price plus storage costs. If we use crude oil as an example you can buy crude oil today, store it and sell it later, making gains or losses depending on the increase/decrease in the spot price. For a normal investor this is practical impossible, but in 2008 when the difference between the spot price and the 3 month futures price was as much as seven dollars, cargo ships actually used this strategy, filled up their ships with crude oil and waited off shore to deliver the oil later on for the agreed upon futures price. In addition, several hedge funds as well as financial institutions as Goldman Sachs and Morgan Stanley have expanded their investment into physical ownership in commodities like power stations, oil refineries and oil tank[13]s. While part of the reason behind this strategy is to get information and knowledge into the industry, another reason could be, especially when it comes to oil tankers, to benefit from a violation of the spot parity theorem.

4.3. Crude oil futures – an efficient market?

Is it possible that our investment strategies will be able to beat the market in the long run? According to the *efficient market hypothesis* (EMH), formulated by Eugene Fama in 1970, it is not. Because asset prices, in our case oil futures, fully reflect all available information, they are priced correctly and no (statistically significant) arbitrage or anomaly[14] exists that investors can take advantage of.

According to the efficient market hypothesis it is common to distinguish between three different versions of efficiency; weak-form, semi-strong and strong-form depending on what is meant by "all available information". Without discussing the differences further, in our case the weak-strong is most relevant as it says that no history of past prices, volume, term structure or trend analysis or whatever from the past, should be able to predict for the future, a better return than a passive strategy. What constitutes a passive strategy, however, is not as obvious in the futures market as it is e.g. the equity market. While some may define this as a random pick of futures contracts other may say a strategy where an investor goes long all the time is a passive strategy. But what then about an investor going short all the time? We will look at market efficiency from three angles or three areas that may constitute the market for oil futures.

First, market efficiency might be evaluated in relation to the asset market in general like stocks and bonds. However, the correlation between commodities and stocks and bonds is low and even negative

[13] Financial times, From trading to owning commodities, October 29, 2007
[14] Arbitrage means that assets are mispriced in such a way that risk-free profits can be earned by exploiting these assets. Anomalies, on the other hand, are results that seem to oppose common accepted theories of how return should be consistent with and asset pricing models.

according to Gorton and Rouwenhorst (2004). Risk adjustment of any commodity futures return for comparison with stocks is therefore difficult as its beta (β) is low.

Second, market efficiency might be evaluated within a confined investment world of only commodities. Still, we face the same problem as above since the correlation *between* commodities is also low. In addition we have the problem of what constitutes the market. In the stock market, a passive strategy is normally linked to an index of stocks where the index is made up of the relative importance of each stock in the market the index is linked to. The relative importance is a measure of relative market size in money terms, a so called *market-value-weighted-index* like e.g. the S&P 500 which consists of 500 companies from different sectors of the US economy. In the futures market the relative weight is not as obvious since the price of the contract times the number of outstanding contracts do not reflect any total market value of each commodity. Different commodity indices have therefore used different measures and up with different relative weighting of each commodity. As we saw in chapter 3, of the 18 commodities included in the Gorton and Rouwenhorst study, half of them offered lower return than zero while half of them offered higher returns than zero. Is it then possible to pick the best based on some predefined criteria? Gorton and Rouwenhorst (2004) tried such an alternative investment strategy and "invested" in backwardated commodities between 1959 and 2004 as they were said to have higher returns than other commodities. Their conclusion was that backwardated commodities did not offer a statistically significant better return, which they concluded was consistent with the efficient market hypothesis. In addition, when they divided their past historical return performance between 1959 and 2004 into two separate periods, several commodities that performed well in the first period did not perform well in the second period. Crude oil, however, performed well during both periods.

Third, market efficiency might be evaluated within oil futures alone where as in (1) in chapter 4.1 the upper or lower bound of the futures prices is decided by the theory of storage. Any break of this bound, on the upside or on the downside, is therefore irreconcilable with market efficiency. Yet, the theory is difficult to evaluate, at least the lower bound. Convenience yield is difficult to measure as the each company has its own parameters for valuing the benefits of oil in storage. In practice, therefore, researchers have focused on what is called the *speculative market efficiency* test where the current futures prices is expected to equal, at least in the long run, the expected future spot prices. A reference to this idea was made by Philippe Comer, head of commodity investor structuring at Barclays Capital when he commented:

"*Investing in futures or investing in the physical over time should be roughly similar…otherwise there is an arbitrage opportunity"*[15]

The statement has certainly an important point for the upper bound of oil futures prices; current futures price should not exceed the cost of carry. If they do, investors with physical storage capacity are able to lock in a riskless profit (arbitrage) by storing the commodity (going long in cash) while going short in futures. According to an article from Reuters[16] the cost in 2010 for storing oil amounts to approximately USD 1 per month, where the best companies/investors are able to store for around 70-80 cents per month. In this respect, the market was not efficient for several months in 2010 and especially in May 2010 as the spread between the front month and second contract was USD 2.8. With respect to the lower bound, the comment by Mr. Comer does not apply, as the difficulty of going short in the cash market does not let anyone lock in any riskless profit. How much return is then "allowed" in a backwardated market or in commodities in general before we can talk of a violation of the efficient market hypothesis since backwardation markets do not have a theoretical limit? A simple answer may be that this is determined by speculators and how much return their demand for a certain amount or risk. But for the upper bound, if we assume that prices do not rise in nominal terms and the price of a barrel of oil is USD 80 with a possible roll return of USD 1, yearly return of going short should be maximum 15%[17]

Although arbitrage may have existed in the oil futures market and speculators in futures may gain from this, investors only buying or selling futures do not have the possibility of arbitrage. Instead we may talk of investments strategies that earn money on what someone may look upon as anomalies. History has shown that so called market efficiencies also called anomalies have persisted for long enough time to make the become statistically significant. Several articles have been written that show that anomalies have existed. Eagerly and Till (2005), however, state that "superior investment strategies have historically been quite fleeting" by showing to two publications where the return on a simple investment strategy was highlighted, one being that high-beta stocks beat low-beta stocks and the other being that high book value stocks beat low book value stocks. Later research on these investment strategies showed that the return was either diminished or gone. But, Eagerly and Till also show to so called publications about market inefficiencies that despite publication did not disappear like the liquidity premium in US long-maturities bonds published by Hick (1939).

Market inefficiency or biased future prices have sometimes been explained due to immature markets where asymmetric information may exist which cause the one part of the hedge to offer a too high risk premium to the other part. According to Gjølberg and Brattestad (2010) this may explain some of the

[15] The Financial Times, October 17, 2010 "Questions marks hang over base metal ETPs".
[16] hwww.reuters.com/article/idUSTRE62A29U20100311
[17] (USD 1/ USD 80)*12 months

negative roll yield (expected spot price lower than current futures price) in electricity prices at Nord Pool. But the futures crude oil market is one of the most liquid commodity futures markets with thousands of participants all over the world constantly looking for return. According to Chernenko et al. (2004 pp 19) huge hedge funds and other large participants in the oil market that are constantly looking for profit opportunities. We are therefore inclined to conclude that any risk premium in oil futures is there because it has not been competed away. This again tells us that the level of return is what investors claim to receive based on the inherent risk and that they are not willing to lower this return or Sharpe ratio any more.

On the other hand, it might also be that investors are not well informed on the possible increase in return of being more active in the market. According to Jeremy Charlesworth, chief investment officer of the London based Moonraker Fund Management, "even"sophisticated" investors …failed to understand that in contango markets they are not able to capture the spot increase in a commodity"[18]. If this lack of knowledge exists among managers of investment funds which are a huge participant in commodities and futures, they may also not be aware of the issues that we have shown in this paper: the expected futures price tend to overshot the current futures price in contango markets but undershoot the current futures price in backwardation markets rewarding an active approach to commodity investments.

It's time to look at our data series of monthly crude oil prices, spot and futures.

5. Stylized facts on the WTI crude oil spot price, futures prices, term structure and forecasting error, 1985 – 2010

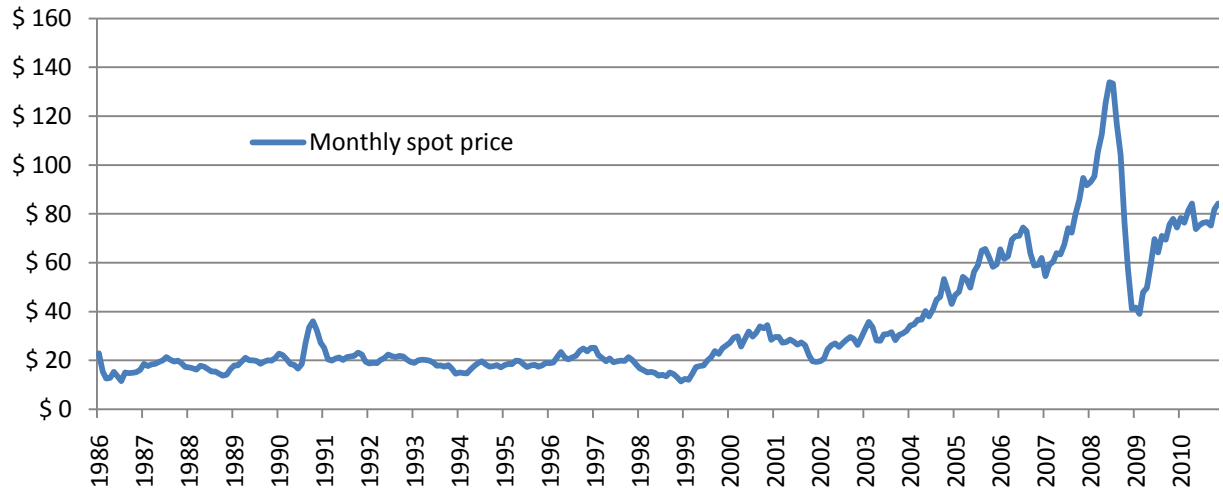
We have obtained our futures prices (NYMEX) and spot prices of WTI crude oil from the U.S Energy Information Administration (EIA)[19]. We use monthly futures price from January 1985 to September 2010 and monthly spot prices from January 1986 to September 2010. According to EIA, monthly prices are calculated by taking an unweighted average of the daily closing spot prices for a given product over the specified time period. When measure the forecasting errors between spot and futures prices we use the front month contract as the spot price[20]

In Figure 7 we see how the spot price has evolved for the last almost 3 decades. The years between 1986 and the beginning of 2004 was a relatively stable price period. The highest price in that period was

[18] Financial Times, March 21, 2010, Alarm over commodity ETP returns.
[19] www.eia.doe.gov/
[20] More about this will be explained in chapter 6.

reached in October 1990 with USD 36.04 and the lowest price was reached in 1998 with USD 11.35. After 2004, the figure tells a very different story. Around 2004 prices started to put pressure on the historical price band set by OPEC in order to e.g. prevent competing energy sources. At the end of 2007 the price reached its historical record with monthly average spot price at USD 133.88 in June 2008. Since 2004, prices have remained high.

Figure 7 Monthly spot price WTI crude oil, USD/bbl., 1986 (01) – 2010 (09)

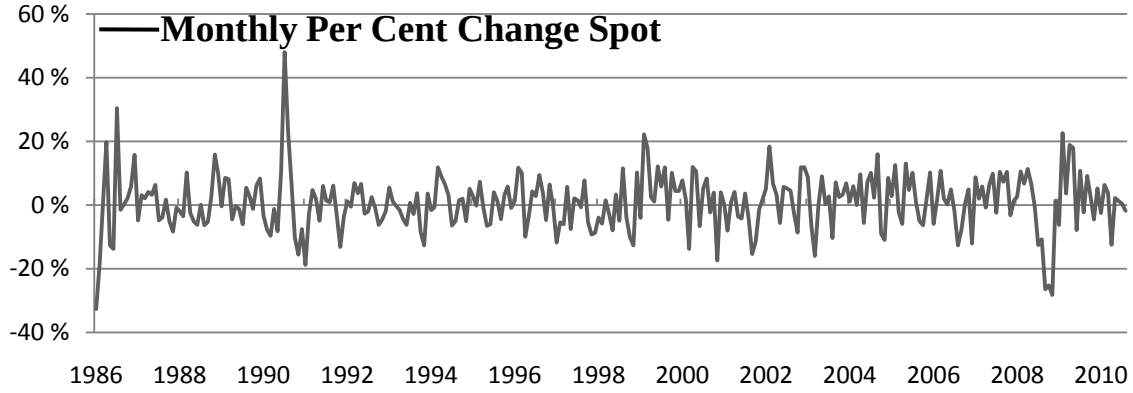


Source: www.eia.gov

Figure 7 tells a story of a commodity responsive to war or threats of war, speculation, OPEC and a rising demand from emerging economies. While these subjects are far too large for this paper to elaborate on, some comments should be made from the figure. The price in October 1990 of USD 36 was a double of the price in July the same year and was due to the Iraq-Kuwait war, however this price spike was small compared to earlier crisis in the oil rich Middle East in the 70s. The price bottomed in 1998 due to increase oil quotas by OPEC and the economic crisis in Asia. Asia was much of the reason why the price spike happened in 2008 with an increased demand for petroleum products and the fear by many (including speculators) the world could run out of oil. All in all, for investors with money in crude oil futures, these historical events will also form the degree of excess return in crude oil futures in the future. And as we have seen, shorter periods may show great variation in spot prices but in the long run (except for the last 5 years), spot return has not been a reason for being in crude oil futures. This also holds true if we go longer back in history (not shown in Figure 7).

If we look at the monthly volatility in Figure 8 we see that except high volatility in 1986, during the gulf war in 1990 and the financial crisis around 2008, volatility has been high but relatively stable in this 25 years period.

Figure 8 Monthly spot price volatility, WTI crude oil, 1986 (Jan) – 2010 (Sept).



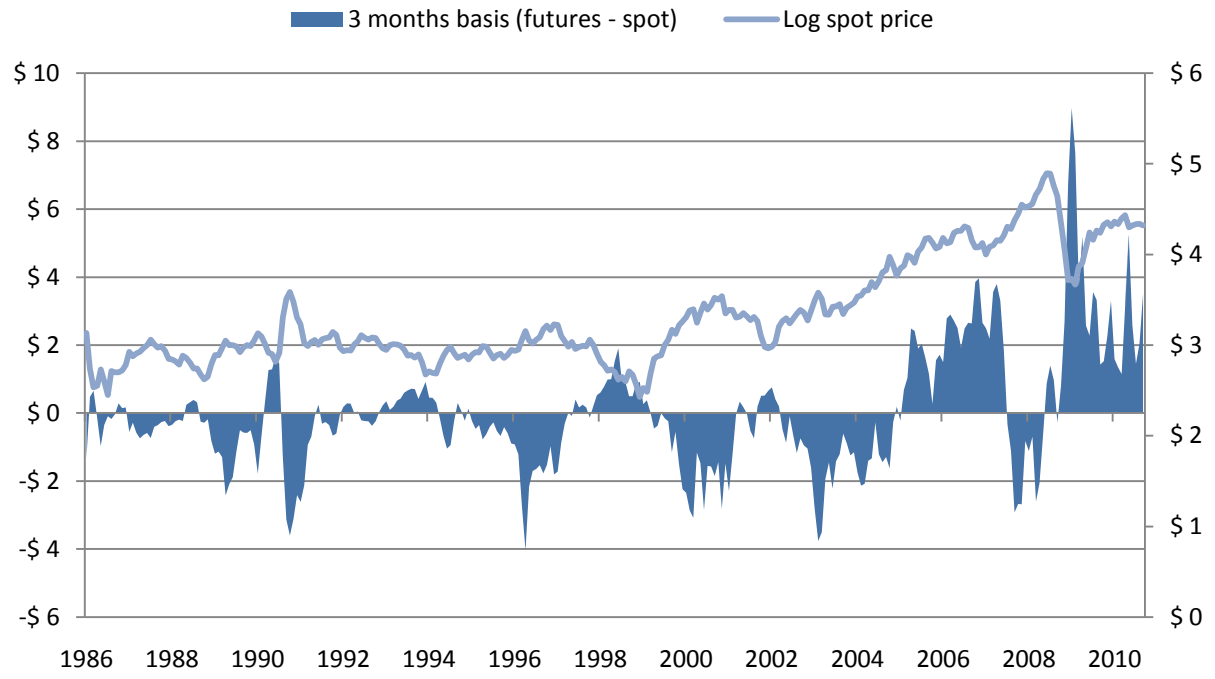
Source: www.eia.gov

As noted by Akey et al (2005, p 4), discussing the reason for high volatility in the commodity market; "with limited intervention capabilities and slow production responses, the market has basically one response to short term supply/demand disruption: Price." Demand and supply is inelastic in the crude oil market, making disruption in supply or shift in demand very effectible on prices.

5.1. A backwardated market

As mentioned earlier, a futures curve is backwardated if the current spot price exceeds the current futures prices and in contango if the current spot price is below current futures prices. Figure 9 shows the 3 months basis i.e. (F_t^3-S_t) between 1986 and until today. Two trends stand out; first, before 2005 backwardation was the norm in the crude oil futures market and the size of the basis reached more than minus USD 2 in several months while the contango never exceeded USD 2. Second, after 2005, contango has become the norm in the futures market for crude oil and, compared to earlier contango periods, the size of the contango has exceeded USD 2 on several occasions and reached as much as USD 9 in January 2009.

Figure 9 WTI crude oil futures 3 months basis and log spot price, 1985 (Jan) – 2010 (Sept).



Source: www.eia.gov

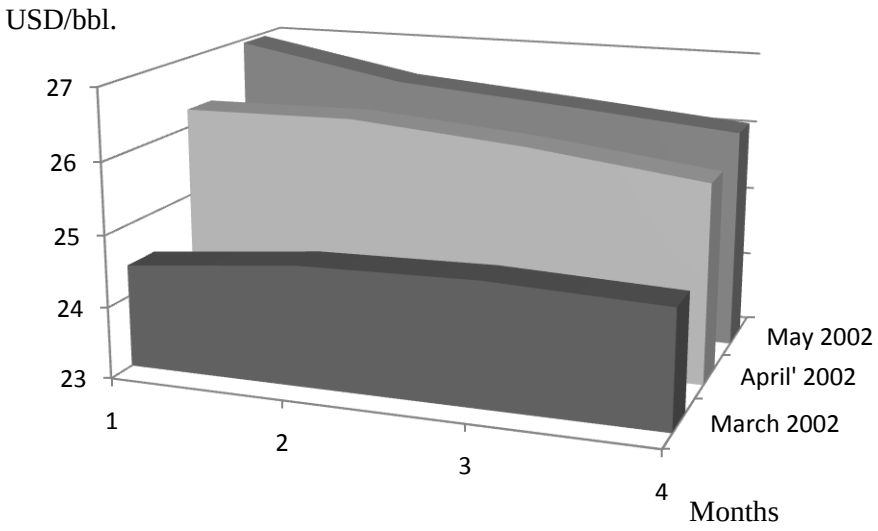
Table 4 present the findings from Figure 9 in actual percentage but adds the first and the second contract as well. By including different contract lengths we also get a clear picture of another characteristic of the futures curve for oil futures; namely that a longer contract has a higher likelihood of backwardation than a short contract. In other words forward curve where the nearby contract(s) shows contango while the contract(s) further out shows backwardation. While a contango in the front month contract and backwardation further out may signal tightness in the near futures, others blame the huge amount of pension funds and other funds for the contango between the first and second contract as they are known for buying that contract.

Table 4 Percent of time backwardated (1, 2 and 3 months futures)

Time Period	1 Month	2 Months	3 Months
1986 (01) - 2004(09)	66 %	68 %	70 %
2004 (10) - 2010 (09)	17 %	17 %	20 %

In Figure 10 we see how the futures curve may change within a couple of months. In March 2002 the futures curve was slightly in contango with spot price around USD 24-25, before it turns into a combination in April. In May the curve is in backwardation in all the 4 consecutive months.

Figure 10 From contango to backwardation



Source: www.eia.gov

Understanding the term structure and its characteristics is not only of academic interst. As we have seen in this chapter, a futures curve can suddenly change from backwardation to contango which as we shall see in the next chapter is caused by changes in spot price. And as changes in spot price can be volatile, its change, whether postive or negative, will affect our investment in oil futures. Let us then turn to an analysis of how the spot price is connected with the term structure.

5.2. Term structure and spot price change

If we go back and look at Figure 9 we can how increase in oil prices are connected with backwardation and decrease in the price of oil with contango. This can be seen clearly e.g. at the end of 1990 when the price went from around 17 USD (log 2.8) in June to 36 USD (log 3.6) in October. At the same time the basis went from a positive 1.66 in June (the highest basis between 1985 and 1998), turning negative in August, before it reached -3.6 in October. The spot price was then at its highest level at that time. After this, a gradual reversion occurred both for the spot and the basis. All in all these events show that the sudden increase in spot price made the term structure more from contango to backwardation with a

gradual reversion thereafter. We also see this trend around 1994 and 1998. This line of events materialized in most of the cases in Figure 9 where the basis exceeded a negative amount of -2. In January 2009 the decline in the oil price was accompanied by the tallest contango ever in history reaching almost 9 USD.

Another interesting thing about the period around 2009 is that the basis around the price spike in the summer 2008 where the basis where circling around zero (from -0.62 to 1.4). According to history, such a period with high prices should be accompanied by a high backwardation signaling a reverse price trend in the near futures. However, the basis showed that market participants did not expect a reversed trend immediately. All in all we can say from these observations that in several instances the basis and the futures prices have given correct signals about futures prices.

In Table 5 we have measured the average percentage change in spot price during periods of contango and periods of backwardation to reinforce what we saw in Figure 9 earlier. We have in the first column of both contango and backwardation measured the contemporaneous spot price change while in the second columns respectively measured the spot price change prior to a contango or a backwardation month. When we later in this paper look at different investment strategies we will also look at the contemporaneous spot price change connected with the term structure. The point here is to see the difference between spot price changes in contango markets and backwardation markets.

As Table 5 shows, in our history of data backwardation has been connected with a spot price increase. Contango has been connected with a decrease in the spot price, at least prior to a contango months as we see in the third column. However; this relationship has weakened, especially in the last two years where we see a high spot price increase both in front of and at the same time with a contango market.

There are many suggestions to why this has happened, one being that the pressure from investors wanting to go long in oil futures has pressed the futures price above the spot price causing a backwardated market (tightness in supply and demand) with rising prices to be connected with contango.

Table 5 Contango, backwardation and monthly percentage spot price change

Time Period	Contango*	Contango**	Backwardation*	Backwardation**
1985 (01) - 1999(12)	0,2 %	-2,8 %	-0,3 %	1,4 %
2000 (01) - 2004 (12)	1,0 %	-1,7 %	1,1 %	2,0 %
2005 (01) - 2010 (09)	0,4 %	0,0 %	2,9 %	3,7 %
2009 (03) - 2010 (09)	2,5 %	3,7 %	***	***

*/** Spot price change one month after the identification a of futures curve as either backwardated of contangoed/Spot price changes one month preceding the identification of a futures curve as either backwardated of contangoed.*** No backwardation in this period.

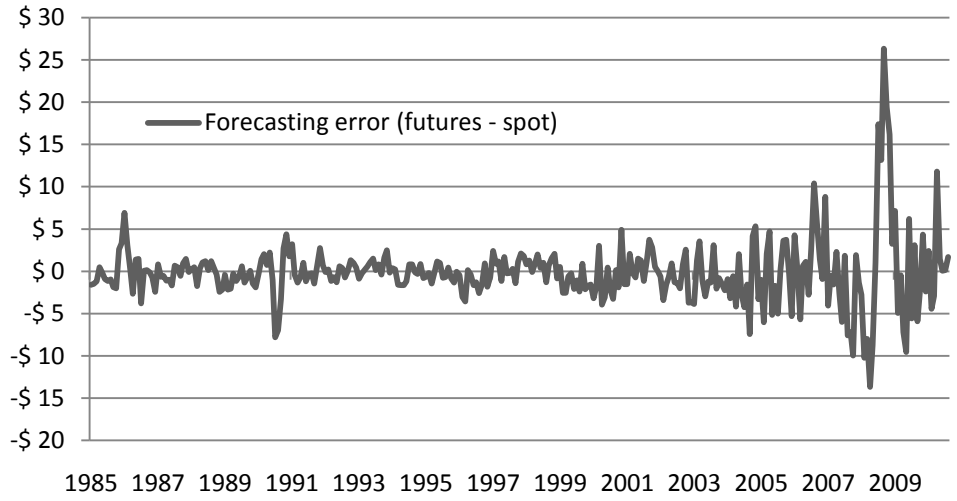
How is the analysis in this chapter relevant for investment in futures? First of all because the excess return in oil futures is dependent on the change in spot price as futures prices must converge towards the spot price at maturity. And as we will see in chapter 6, when we go short in contango markets, the spot price increase "eats" into our excess return as short strategy benefits from a *decrease* in spot price.

5.3.Forecasting error

In Figure 11we see that the one month forecasting error between 1985 and 2005 has been within +/- 5 USD all the time except two times. The first one was in 1986 under the Iran/Iraq war and the other one when the US invaded Iraq in 1990. After 2005 the forecasting error has exceeded USD 5 several times with USD 26.31 as the highest one month forecasting error between September and October 2008 (the start of the financial crisis) when the price went from USD 103.03 to USD 76.72. The second highest was some months before, between April and May 2008 when the price *increased* with almost USD 14.

As forecasting errors are dependent on the evolvement of the spot price, the form of Figure 11 resembles Figure 7 we saw earlier about spot prices between 1985 and 2010. Threats of war and the GDP are two very important factors that are likely to affect the price of oil and change the yield of a position, long or short, between two periods.

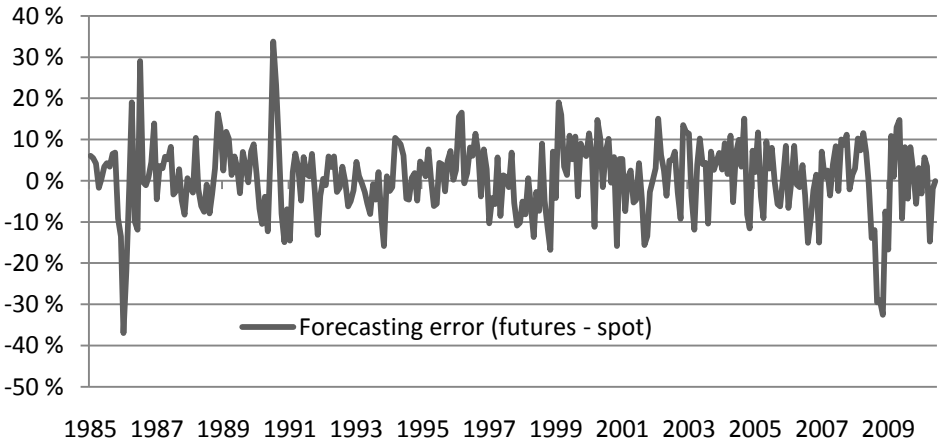
Figure 11 Monthly forecasting error WTI oil futures, USD/bbl., 1985 (01) – 2010 (09).



Source: www.eia.gov

Despite the increase in *absolute* volatility in the years after 2005, this period cannot be described as a period with more *relative* volatility as shown in Figure 12 where the monthly percentage forecasting errors have been measured in log terms. The forecasting errors in percentage have been within 20% except in the three periods we have mentioned earlier. The risk within crude oil futures is certainly there and as we see from Figure 12, an initial set-aside margin account of 5%-1%5 will soon be erased by monthly forecasting errors of up to 20%.

Figure 12 Monthly percentage forecasting errors, WTI log, 1985 (01) – 2010 (09)



Source: www.eia.gov

Finally in Table 6 we have shown a comparison of forecasting errors between our general forecasting error presented above and the forecasting error in months where the futures curve is either in backwardation or contango. The percentage forecasting errors for backwardation and contango are presented as an average of those months *only* where the futures curve is in either backwardation or contango.

Table 6 Monthly forecasting error different futures curves, WTI futures 2nd contract, 1985 - 2010

Term structure	Forecasting error	Standard deviaton	T-value
Backwardation	2,1 %	8,5 %	3,23
Contango	-1,2 %	9,2 %	1,47
General (both backwardation and contango)	0,7 %	8,8 %	1,34

According to Table 6 it looks like we have a time varying forecasting error in oil futures. Backwardation has a statistically significant monthly forecasting error far above the general forecasting error. Contango, on the other hand, has a negative forecasting error. Put together, this makes the forecasting error on average to be positive with 0.7%. Take also note of the strong statistical significance of the forecasting error in backwardation months. It's time to look at the historical returns in the crude oil futures market with different strategies that try to capture this variation in forecasting errors.

6. Historical returns in crude oil futures, 1985 – 2010 – an empirical analysis

In this chapter we will explore the historical returns in the crude oil futures market. We will start with showing risk and returns in a passive investment strategy where we go long all the time, before we look at investment strategies based on term structure signals like backwardation and contango where we change between going long and going short. We will look at both contango and backwardation separately in order to easier explore the characteristics of both of these conditions. We will then combine them into one strategy where we also look at a momentum strategy.

The relevance of the different strategies we will look at differs. While the long only strategy probably is the most utilized, since those who commit funds to track a commodity index normally goes long, I have not heard of any consequently going short. A backwardation strategy, on the other hand, is more relevant. More and more have become aware of the roll yield supposed to be earned from backwardated commodities[21]. Finally, our long backwardation short contango strategy, with our without momentum, seems to be a hidden treasure in the jungle of different investments strategies. Although the strategy is not new within academic circles, we have not been aware of anyone who has consistently been trading according to this strategy.

When calculating returns we will calculate geometric means[22] based on the formula:

$$LN(F_{t+2}/F_{t+1}) \quad (1)$$

where F_{t+2} represent the second month's contract and F_{t+1} represent the front contract (first contract). We will present our yearly return according to Compound Annual Growth Rate (CAGR) which is simply the monthly return times twelve. Our data consists of high volatility; arithmetic average would significantly overestimate the monthly returns.

Since our data are downloaded on the 15 of each month and the first contract is soon to expire[23]we do not measure the return on this contract. Instead we use this contract to measure the return on the second contract with the following example; e.g. on January 15 we go long/short on the second contract (March contract) that expires "on the third business day prior to the 25th calendar day of the month preceding the

[21] This belief is certainly there despite the findings of Gorton and Rouwenhorst (2006) that backwardated commodities do not offer statistically better return than other commodities.
22 Another way to do this is simply to use the formula ((Ft+1/Ft)/ Ft) +1 and then use the geometric function in excel. This yields the same result.
[23]According to NYMEX (www.cmegroup.com) expiration day is on the third business day prior to the twenty-fifth calendar day of the month preceding the delivery month.

delivery month"[24] which in this case is the end of February for this March contract. Instead of holding this contract until the expiration day, we "sell" it on February 15 and buy a new one (April contract).

In a long only strategy we simply go on the *buy side* of the contract and hope that the spot price has increased as the contract reaches maturity so we can sell/liquidate the contract with a gain. When we go short we go on the *sell side* of the contract and hope that the spot price has decreased until we sell it.

Our annual percentage returns are all based on a fully collateralized position, whether long or short. How this is done has been explained in chapter 3.2. Through the next chapters we will therefore use excess return - return in excess of the risk free rate, as a measure of return. Transactions costs are not included.

As we have seen earlier, a term structure may consist of both backwardation and contango along the futures curve. Since we are occupied with the first two contracts only, our futures curve will be either in contango or in backwardation.

6.1.Long only strategy

A long only strategy is the simplest strategy we follow in this paper, but very much used by pension funds and other investment funds. If these funds invest in commodity indexes like i.e. the Standard and Poor's commodity index, they will be exposed to a long only strategy in crude oil futures and gain approximately what we show in this paper. While the purposes of investments funds are, as we mentioned before, to get equity-like return with low correlation, hedge against inflation etc, many investors go long because they speculate in a rise in the spot price. It is therefore of interest to see how crude oil futures have contributed as a part of a passive commodity index as well as for speculators who bet on increased spot prices.

Table 7 shows the historical return by going long in WTI futures between 1985 and 2010. With an average of 8.10% annual excess return for the whole period it should be able to compete with a lot of other investments. Yet, standard deviations are high so it certainly involves a great deal of risk to trade in futures.

As we see in Table 7, investors entering the market in 2000 were able to approximately match the previous years' return. For the 2005 investors, returns have been dismal. No wonder some commodity experts have cautioned a too heavy exposure towards commodities in the last years as contango has made its way into the commodity futures curve. With the current futures price above the expected spot prices,

[24] The sentence is collected from EIA's definition of futures expiration days.

the last 5 years have actually shown a *negative* roll yield as futures prices have rolled towards the lower spot price at maturity.

Table 7 Annual risk and excess returns, long only strategy WTI futures 2nd contract, 1985 – 2010

Annual	Mean	St.dev.	Sharpe	T-value
1985(01)-1999(12)	8,7 %	30 %	0,29	1,13
2000(01)-2010(06)	7,3 %	32 %	0,23	0,74
2005(01)-2010(06)	-8,8 %	35 %	-0,25	-0,60
1985(01)-2010(06)	8,10 %	31 %	0,26	1,34

A comparison of the return of oil futures with the passive indexes we saw in chapter 3 (Table 2) shows that by only investing in oil futures an investor would have gained 12.2% return (not shown in the figure here) between January 1991 and December 2004. This is more than 5% better than the average of the passive commodity indexes. The Sharpe ratio for this period for oil futures is 0.47 which is also better than all the commodity indexes shown in Table 2. Compared to this, U.S. large stocks between 1981 and 2005, shows a Sharpe ratio of 0.42 (Bodie et al (2009 p 137)). Oil futures have therefore been a good contributor to the passive long only indexes with a relatively high risk adjusted return.

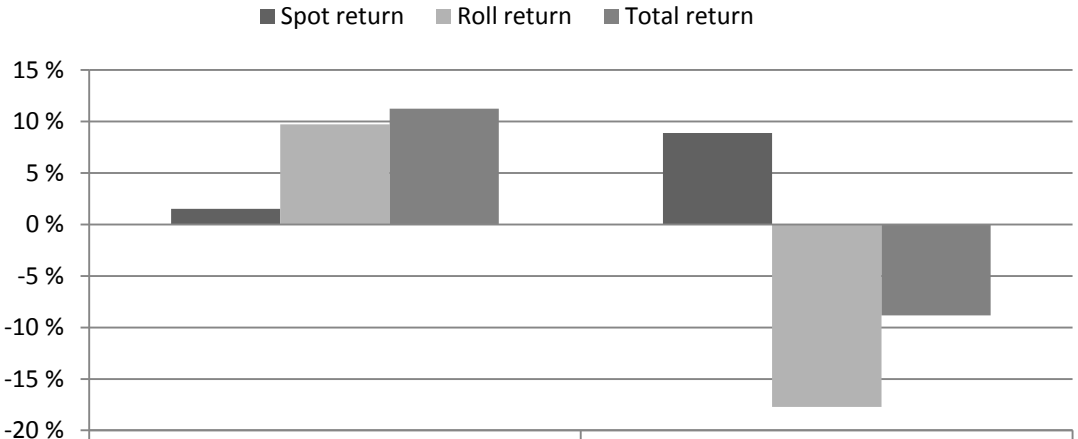
How should we interpret the lack of statistical significance in Table 7? Well, first as a sign of oil futures being a risky business. But, the improved t-value for the whole period may as well be interpreted as if we continue to invest and calculate t-values we will reach statistical significance in the end. A test, however, reveals that in order to reach the 5% critical t-value of 1.96 we need 35 years more of history to tell with 95% confidence that this was not pure luck. On the other hand, an investor who entered the market in 2005 didn't have to wait for 35 years. If we calculate the t-value up to 2004 (not shown in any figure), we are able to say with 95% confidence that these returns are not pure luck. The "sad" thing was that after 2005 the WTI crude oil market, as we have seen, went into a period of prolonged contango. And as we will explore more in the next chapter, contango markets do not reward long only holders of WTI oil futures. It didn't reward our statistical evidence either as our t-value fell to 1.34 for the whole period.

In Figure 13 we see what has contributed to the return in our long only strategy. Until 2004 the roll return was the main source of return in WTI oil futures with an annual return of 9.7%. The spot return in this

period was only 1.5% annually but nevertheless adds up to a pleasant total return of 11.2%. This shows that the return from a long only strategy in oil futures has mainly come from the futures price being below both the current *and* expected spot price when the contract is bought, but rolls up as it nears maturity. The roll return is also highly statistical significant with a t-value of 6.0 (not shown in the figure). The spot return on the other side does not show any statistical significance.

Figure 13 reinforces what we have seen about why a long only strategy has not paid off for the last years. After the market went into long periods of contango after 2004, the roll return has been negative with almost -18% annually. Investors who have been speculating in spot price increase after 2004 have been rewarded with a yearly spot price increase of 9.3%, but the negative roll return has "eaten up" more than the spot gain so total return has been negative. In other words; history shows that a long only strategy is rewarded dependent on the form of the futures curve, where backwardation is a necessary condition for excess return.

Figure 13 Breakdown of excess returns on long only strategy, WTI futures 2nd contract, 1985 (01) – 2010 (08)

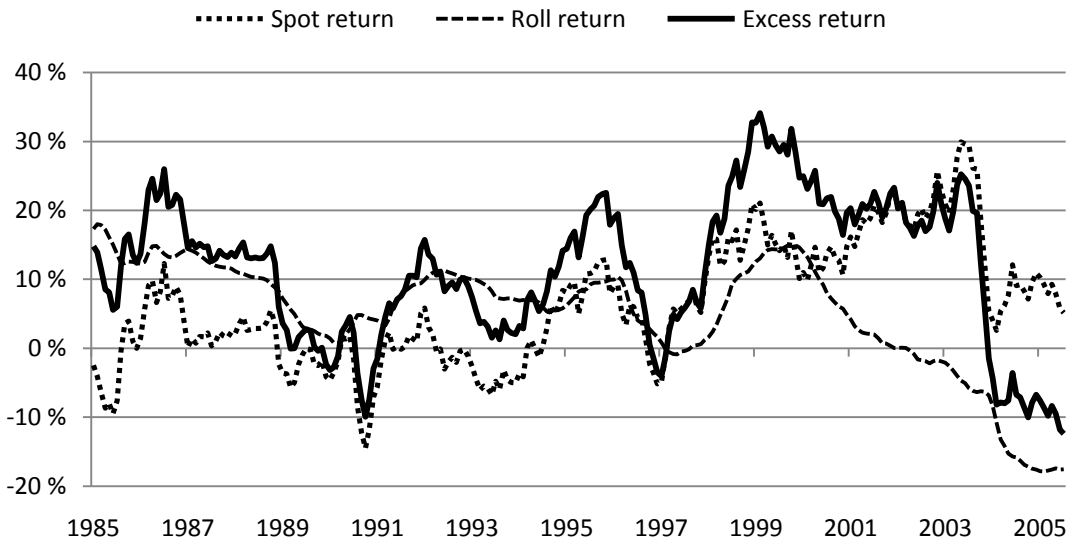


	1985-2003	2004-2010
Spot return	1,5 %	8,9 %
Roll return	9,7 %	-17,7 %
Total return	11,2 %	-8,8 %

Finally, we will show what this strategy has offered in a 5 years rolling perspective. In Figure 14 we have calculated *average* annual return for all time periods of 5 years between January 1985 and July 2010. This means that on every point on the graph the left axis shows the average annual return 5 years ahead. E.g. in 1999 the graph is at its highest with more than 30% which means that between January 1999 and December 2003 average annual return was more than 30%. Both 1991 and 2005 was a bad time for investors holding long positions in oil futures for 5 years.

The high 5 years moving average returns between 1998 and 2003 may explain why a long only strategy in commodities (provided that also other commodities also performed well in this period) became so popular at the beginning of the last decade.

Figure 14 Annual 5 years moving excess return, long only strategy, WTI 2nd contract, 1985 – 2005*



*The last 5 years period is from July 2005 until June 2010.

To sum up our empirical findings about a long only strategy in crude oil WTI futures between 1985 and 2010:

- A passive long only strategy, where we go long in oil futures all the time has offered an annual excess return of 8.1% between 1985 and 2010.

- Until 2004 roll return was the main contributor to our excess return. After 2004, the market went into contango with a considerable negative roll yield for a long only strategy.

- A long only investment strategy in crude oil futures requires a long term horizon as roll return, spot return and excess returns are highly volatile.

6.2. Long backwardation and short contango strategies

In this chapter we will look at two different strategies. The first strategy goes long when the current futures price (2^{nd} contract) is below the current spot price (1^{st} contract). The second strategy goes short when the current futures price (2^{nd} contract) is above the current spot price (1^{st} contract).

Second, since we only invest those months that according to our theory give excess return, our funds will in certain months be idle (only invested in t-bills). We will therefore present our monthly results *both* as an average of only those months where we invested our funds in futures *and* as an average over the whole investment period. Let's say that e.g. in the year 2004 we had backwardation for the first six months and contango for the last six months. According to our backwardation strategy we would then only invest for 6 months. If the average monthly excess return was 2% during those 6 backwardation months, where the total return for the six months was approximately 12%, we will only present this as a 12% annual return. For the monthly returns we will present *both* the 2% return on those months where we actually did invest and the average monthly returns of 1% (12%/12 months).This makes sense if we want to make a comparison to the long-only strategy or any other investment strategy. At the same time it is interesting to see how much return we earned in those months *only* where our funds were active.

Table 8 reveals some interesting findings. First, over the whole period, if an investor only picked those 1-months futures where all the four contracts showed a negative basis (backwardation), he would have earned an annual excess return of 14,2%, which is more 6% more than an investor going long for the whole period. Second, investors who discovered this strategy in 2000 were able to beat past performance.

If we compare the risk in the backwardation strategies with risk in the previous long-only strategy, we are able to see that standard deviations have decreased. Together with a higher return this has again made higher Sharpe ratios and a higher statistical significance for the backwardation strategy. We also see from Table 8 that after 2000, fewer months have been in backwardation. However, the monthly return of those months only when the futures curve was in backwardation has increased from 1.62% to 3.16%.

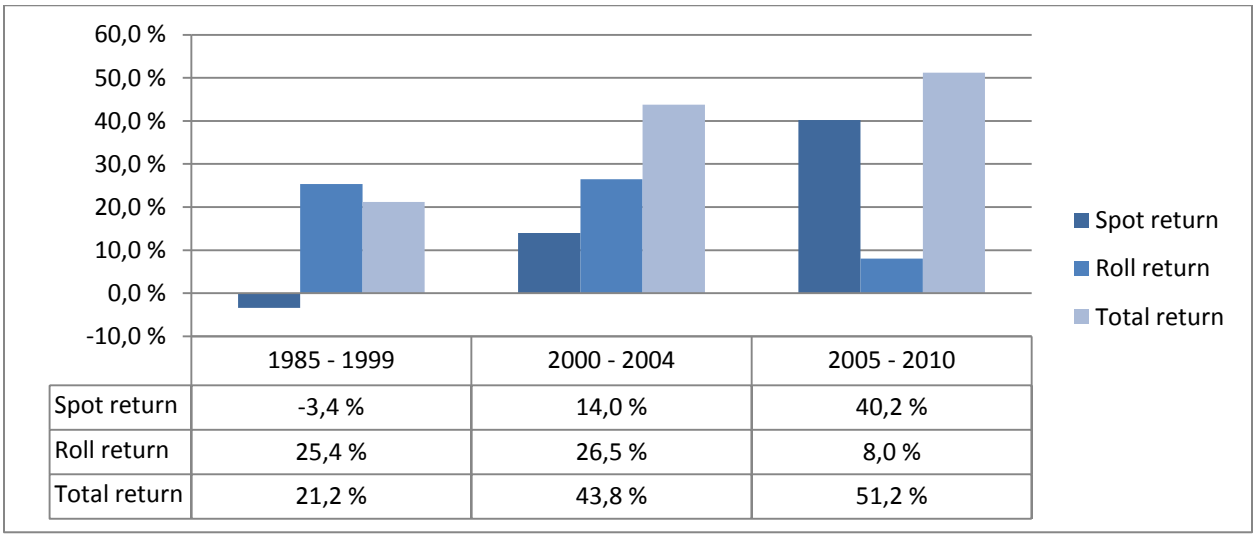
Table 8 Annual risk and excess returns, long backwardation strategy WTI futures 2nd contract, 1985 – 2010

1985(01)-1999(12)	Mean	St.dev.	Sharpe	T-value
Annual (112/180)*	14,20 %	23 %	0,62	2,04
Monthly average**	1,01 %			
Monthly average***	1,62 %			
2000(01)-2010(12)	Mean	St.dev.	Sharpe	T-value
Annual (54/126)*	16,30 %	20 %	0,80	2,59
Monthly average**	1,35 %			
Monthly average***	3,16 %			

* Number of months out of total where investment took place due to backwardation. E.g. 112/180 means that this period contains 180 months, but investment took place only during 112 months.
** Monthly average including months were return was zero due to no investment in futures.
*** Monthly average on those months ONLY where investment in futures were done due to backwardation

If we look at the breakdown of return in the different periods, shown in Figure 15, we see that the source of the backwardation return until 2000 was the roll return; the return earned because the futures price rolls towards the spot price at expiration. In the beginning of the last decade spot return began to pick up while roll return was constant. In the last period, however, the roll return slowed down while the spot return increased to just above 40%

Figure 15 Breakdown of excess returns on backwardation strategy, WTI futures 2nd contract, 1985 – 2010*



	1985 - 1999	2000 - 2004	2005 - 2010
Spot return	-3,4 %	14,0 %	40,2 %
Roll return	25,4 %	26,5 %	8,0 %
Total return	21,2 %	43,8 %	51,2 %

*The return is made up of average return *in **only** those months where the term structure was in backwardation*. This means that the total return, when all the months of not investing are included, is smaller. This return in considerable smaller in the last period (2005-2010) since that period was marked with contango most of the time.

If we take a closer look at spot price changes in backwardation market in Table 9, we see that the average spot return in months marked with backwardation is positive in the same month. The figure shows the annual spot returns in backwardation months one month before (-1), one month after (1) and the same month (0) as a backwardation month. Our data sample therefore shows that during the last 25 years the spot price has increased with 1.6% in those months where the term structure was in backwardation. If we instead measure the spot increase one month before a backwardation month, the spot increase is considerable higher. This tells us that backwardation markets come after a high positive spot price change.

Table 9 Spot return one month before, at the same time and after a backwardation month

	Month	Month	Month
1985(01)-2010(12)	-1	0	1
Spot return	11,2 %	1,6 %	-1,1 %

Table 10 shows the excess return of only investing in months where the term structure was in contango. If we compare it to the backwardation strategy we see both differences and similarities. The difference is first that the contango strategy yields less return and Sharpe ratio than the backwardation strategy. The second difference is that skewness is now positive, while in backwardation this was negative. This is natural since shorting causes negative deviations to become positive since a decrease in the spot price is a gain in shorting. In addition, the returns are less normal distributed than the backwardation strategy. The similarity between the two strategies is that return factors have increased in the last decade and risk factors have decreased.

Table 10 Annual risk and excess returns, short contango strategy WTI futures 2nd contract, 1985 – 2010

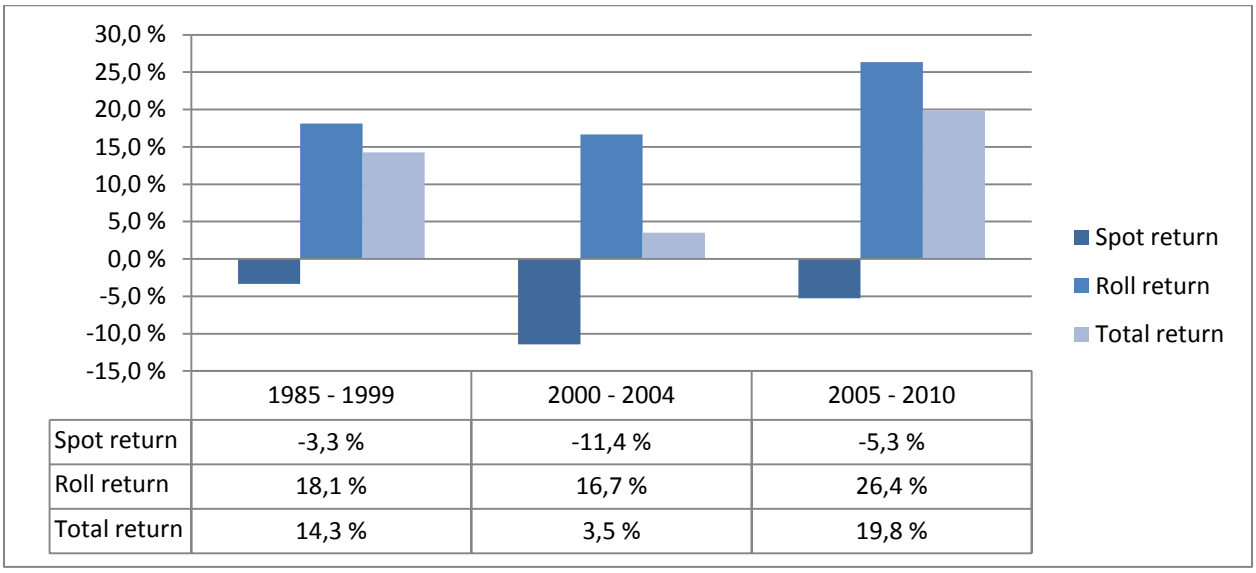
1985(01)-1999(12)	Mean	St.dev.	Sharpe	T-value	Skewness	Excess Kurtosis	Normality Test
Annual (112/180)*	4,64 %	18 %	0,26	0,97	0,5	6,2	506
Monthly average**	0,38 %						
Monthly average***	1,12 %						

2000(01)-2010(12)	Mean	St.dev.	Sharpe	T-value	Skewness	Excess Kurtosis	Normality Test
Annual (54/126)*	8,23 %	23 %	0,35	1,10	1,6	3,0	99
Monthly average**	0,66 %						
Monthly average***	1,32 %						

* Number of months out of total where investment took place due to contango. E.g. 112/180 means that this period contains 180 months, but investment took place only during 112 months.
** Monthly average including months were return was zero due to no investment in futures.
*** Monthly average on those months ONLY where investment in futures were done due to contango.

If we compare the spot and roll return in the contango strategy in Figure 16 with the spot and roll return in the backwardation strategy in Figure 15, again we find interesting differences and similarities. Like in the backwardation strategy, the roll return has been, although lower in the contango strategy than in the backwardation strategy on average, very similar in the 2 first periods. In the last period, however, both strategies have shown a roll return with a large deviation from earlier periods. This also holds true if we divide the first period from 1985 to 1999 into several 5 years periods (not shown here).

Figure 16 Breakdown of excess returns on short contango strategy, WTI futures 2nd contract, 1985 – 2010



	1985 - 1999	2000 - 2004	2005 - 2010
Spot return	-3,3 %	-11,4 %	-5,3 %
Roll return	18,1 %	16,7 %	26,4 %
Total return	14,3 %	3,5 %	19,8 %

In Table 11we see that the total spot return in our contango strategy from 1985 to 2010 is negative with 4.8%. This means that there is a contemporaneous spot *increase* in contango periods that *eats into* our roll return. (Remember that when you short, a positive spot price change yields a negative return). However, if we instead measure the spot price change one month prior to a contango month we see that the spot price on average decreased, which would have given (if predicted) a spot return of almost 20%. We also see that if we invest one month after a contango month, our spot return decreases. If we compare this to the findings in Figure 15 in the backwardation analysis, we can conclude that backwardation is connected with spot decrease while backwardation is connected with spot increase, at least on month prior to the event of backwardation/contango.

Table 11 Return one month before, at the same time and after a contango month

1985(01)-2010(06)	-1	0	1
Spot return	19,7 %	-4,8 %	-8,8 %

To sum up our empirical findings in this chapter about contango and backwardation strategies we can conclude on the following:

I. Backwardation strategy has offered a better rate of return than a contango strategy.

II. After 2000 and especially after 2005, spot return explains more of the excess return than roll return, while the opposite has happened in the contango strategy; roll return has become more important as spot return has increased its negative impact. Both strategies have given best return in the last 5 years.

III. Backwardation periods are linked to an increase in the spot price while contango periods are linked to a decrease in the spot price. However, the main spot price change takes place in front of a change from backwardation to contango or the opposite.

IV. Backwardation strategies, most likely due to a higher number of months than contango, give a positive statistical significant return while contango strategies do not.

In the next chapter we will look at risk and return when we combine backwardation and contango strategies.

6.3. Combined long backwardation short contango strategy

A long backwardation short contango strategy is a strategy where we go long in backwardation markets and short in contango markets. In those months where the futures curve shows a combination of backwardation and contango we have chosen to go long. A test on whether an opposite strategy works better on those futures curves that consist of both backwardation and contango, shows that there is no significant difference between the two methods for our whole investment period. This means that our funds in this strategy are invested 100% of the time.

According to Table 12 this strategy has rewarded our investors coming into the market in 2000 and 2005 with a higher average than the period from 1985 - 1999. In light of all the focus in the financial news about contango periods as bad for investors, these findings are worth noticing. Despite a market trading in contango most of the time after 2005, our strategy has given investors an annual excess return of 20%. It might look like our strategy does not depend on any specific term structure to succeed. The t-value is low

for this short period; however, Table 12 shows that this strategy is able to offer statistically significant returns in within a 10 year horizon.

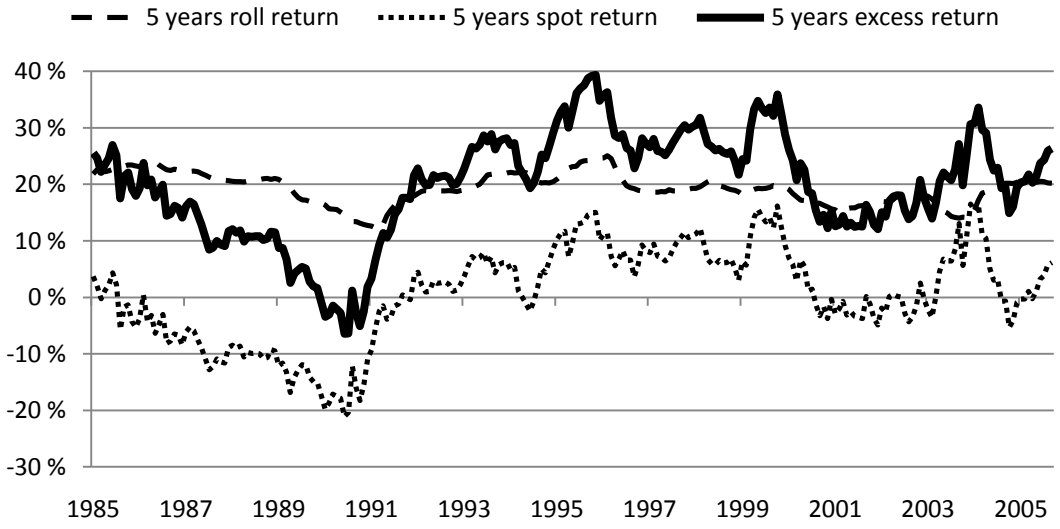
Table 12 Annual risk and excess returns, long backwardation short contango strategy, WTI futures 2nd contract, 1985 – 2010

Annual	Mean	St.dev.	Sharpe	T-value
1985(01)-1999(12)	18 %	29 %	0,60	2,337
2000(01)-2010(06)	23 %	31 %	0,74	2,428
2005(01)-2010(06)	20 %	34 %	0,60	1,428

In Figure 17 we have calculated the annual excess return on our long backwardation short contango strategy if an investor has been in the market for 5 years. Note that the roll return is very constant in all these periods and is regulated up or down according to any positive or negative spot return. Only the years around 1990 did investors have negative return over a 5 years period.

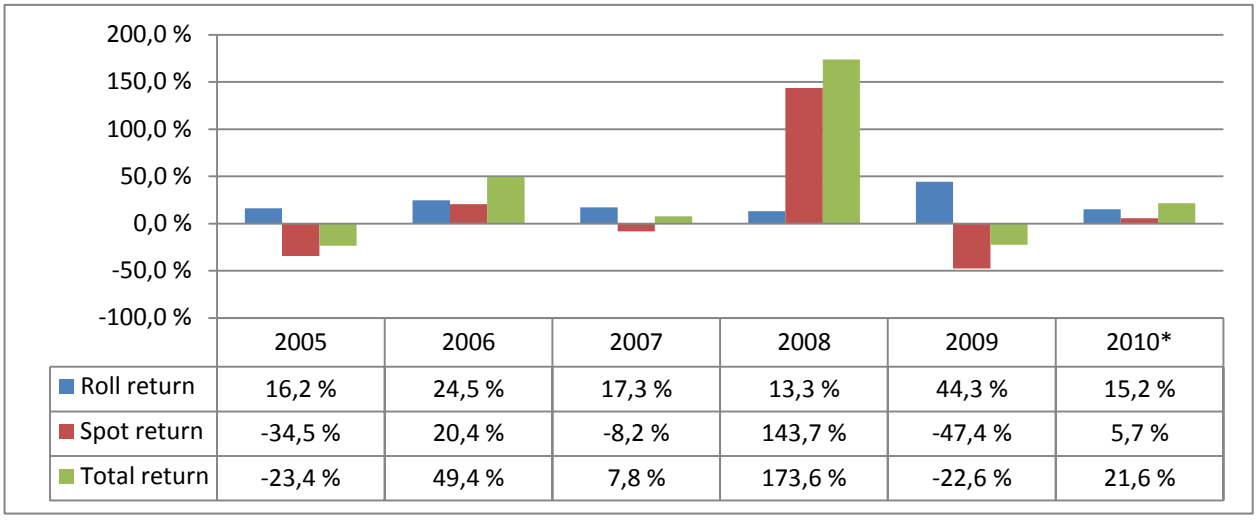
An interesting finding is that during our 25 years return period, roll return accounted for more than 98% of total return. This means that excess return is the same as roll return.

Figure 17 Moving average 5 years roll return, spot return and excess return



Another interesting finding is that if you divide the second of those so called two 5-years stable periods in the last decade, we see a much higher diversity. First, the basis shows much higher variation from a "low" 15.2% in 2010 to 44.3% in 2009. Second, the spot return between 2008 and 2009 shows an even higher variation. So, in general, total return does show a great yearly variation in these years. Third, the basis was a really bad predictor of total return in these 5 years – and again, 2008 and 2009 stand out as bad examples. The figure is by the way a good example of how the spot return and roll return can point in the same direction[25] (year 2006, 2008 and 2010) or where spot return can take away some (year 2007) or more than all (year 2005 and 2009) the roll return.

Figure 18 Annual breakdown of excess returns on long backwardation short contango strategy, WTI futures 2nd contract, 2005 – 2010



	2005	2006	2007	2008	2009	2010*
Roll return	16,2 %	24,5 %	17,3 %	13,3 %	44,3 %	15,2 %
Spot return	-34,5 %	20,4 %	-8,2 %	143,7 %	-47,4 %	5,7 %
Total return	-23,4 %	49,4 %	7,8 %	173,6 %	-22,6 %	21,6 %

*For 2010 the average return is for 8 months. The average for all these 6 years will therefor not match the 6-years annual retun calculated in figure XX.

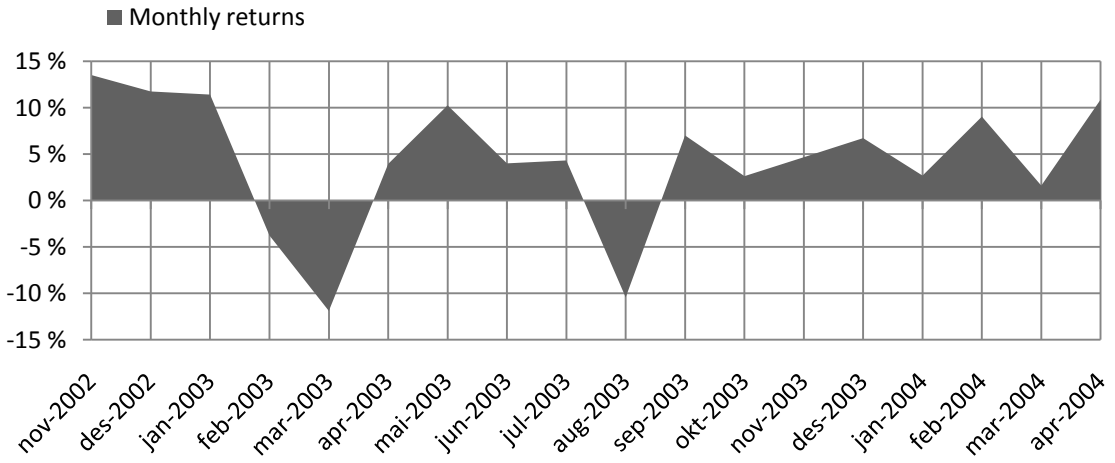
An analysis of whether it is backwardation or contango that contribute to the excess return on this strategy between 1985 and 2010, we find that 26% is due to backwardation and 16% is due to contango. And this relationship also holds when we look at all our four sub-periods.

[25] Roll return in our strategy can never be negative since we go long backwardated futures curves and short contango futures curves, so if they work in the same direction it must be positive.

6.4.Momentum strategy

Finally we will try a momentum strategy on the long backwardation short contango strategy. If we take a look at Figure 19 we see that monthly returns, whether negative of positive, are not random but seem to pervade through several months. We want to utilize this by the following strategy: Every month we look at the last month's futures return; if it is positive we also invest in futures this month, if it is negative we stop buying until return is positive again. In addition, if the month after a negative return changes term structure from backwardation to contango or the opposite, we do invest despite prior negative return in the previous month. The reason for this is that we see changes in term structure as a signal of changing market conditions and therefore a break in momentum. Since this strategy comes on top of our long backwardation short contango strategy, we, like before, go long if futures prices exceed spot price and short if futures prices is below spot price.

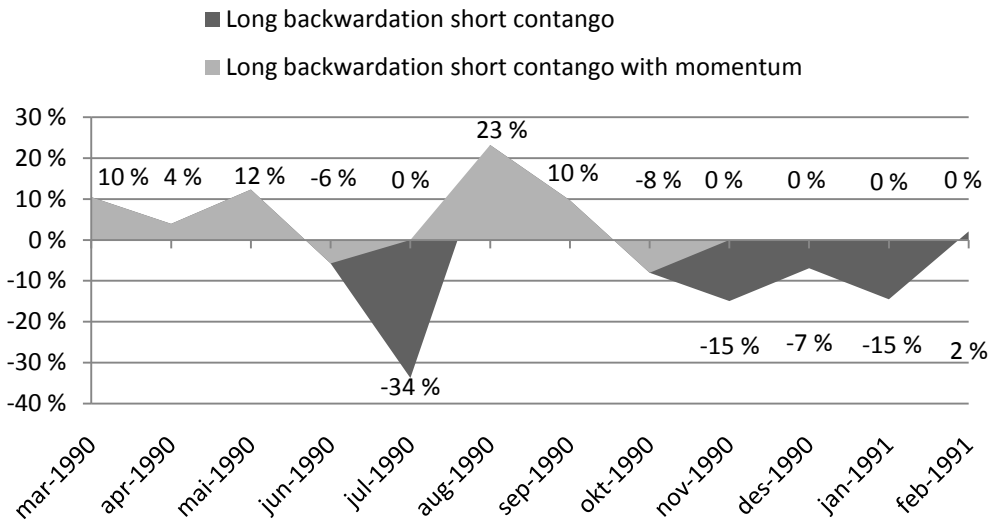
Figure 19 Monthly returns, long backwardation short contango strategy WTI futures 2nd contract, 2002(11) – 2004(04)



To look more closely at yet another period, in Figure 20 we see how this strategy worked between March 1990 and February 1991 where the long backwardation short contango strategy had a monthly loss of -2% while the momentum gained 4%. On the left axis is the monthly percentage return. All our returns on the momentum strategy are shown on the upper part (positive side) of Figure 20 while the 4 monthly returns that we lost in this period are shown on the negative side of the figure. The figure shows that from March until June 1990 we invested in futures due to prior month positive futures return, however since the return was negative in May with- 6% we did not invest in June. The long backwardation short contango therefore lost 34% in July while the momentum did not invest and therefore return was zero. In August

we did invest although negative return in July because in August the market went into backwardation from contango in August. Take note of the 4 last months on Figure 20. Since return was negative in October, we left the market for 4 consecutive months with an average negative return of -12% for the first 3 of these months, but lost only the positive return in February 1991.

Figure 20 Comparison long backwardation short contango strategy versus momentum strategy, 1990(3) -1991(7)



If we look at the whole period from 1985 to 2010 in Table 13, we see that the momentum strategy has yielded an annual excess return of 22% which is 2% better than our strategy of going long in backwardation markets and short in contango markets. We don't find these two returns to be statistically different from one another, nevertheless, by investing only approximately two third of the time[26] we have increased return and reduced our risk with skewness and been paid off with a considerably better risk/return ratio.

[26] By leaving the market for one month every time the return was negative in a month we have not invested approximately 100 out of 308 months.

Table 13 Annual risk and returns, long backwardation short contango versus momentum strategy, 1985 – 2010

1985(01)-2010(06)	Mean	St.dev.	Sharpe	T-value
Long backwardation short contango	20 %	30 %	0,66	3,36
Long backwardation short contango including momentum	22 %	24 %	0,93	4,71

To sum up our empirical findings in this chapter:

I. If we include in our long backwardation short contango strategy a momentum strategy, where we only invest in a month's futures if the previous month was positive, and with the exception that we always invest the first month after a change in term structure, we have increased return and reduce risk.

II. The result is not statistically significant, however, our sharp ration has increased with almost 50% from 0.66 to 0.93.

6.5. "Super" contango and investment strategy

We have earlier seen how contango markets in crude oil futures have been connected with decreased demand/ increased supply of oil causing oil prices to go down in contango periods. We have also seen how this relationship has weakened lately, and actually has been reversed so that contango markets, and especially in 2009-2010, have been accompanied with a rise in oil prices (Table 5).

Since an increase in the spot price during contango markets "eats" into our short strategy[27] we have tried to look for a sign that may help us to reduce the loss from the highest spot price increases under these market conditions. As we saw in Figure 16, the negative spot return can be considerable.

[27] Remember that when you short futures, returns are made on a *decrease* in futures prices. An increase in the spot price will therefore reduce our return.

If we look again at the basis in Figure 9, we see that in January 2009 the basis was at its highest ever, reaching as much as USD 9. This market condition was reported in several new agencies as a *super* contango[28]. Tank ships filled up their ships with crude oil and went short in futures and cashed in huge amounts because total storage cost was much less than the price spread between spot and futures prices, making riskless arbitrage possible for those with storage capacity. There might be several explanations to this situation, among them a strong belief in futures demand of oil or that the pensions funds appetite for commodity investment caused pressure on futures prices.

What can this tell us about investments in crude oil futures? As futures prices rise more than the spot price and arbitragers are able to lock in a riskless profit, crude oil is removed from the market into storage which again drives up spot prices. Let's assume that the term structure is in equilibrium in a contango market and suddenly one or more participants enter the long side of the contract thereby increasing the demand for participants going short. From a demand/supply equilibrium point of view, this situation has two possible outcomes; price increase or increase demand on the other side of the contract. Immediately this will increase the futures price if this demand is not met. However, the arbitragers will enter the market. We therefore expect the price to rise if the basis reach such an amount that makes is attractable to engage in this business. We therefore decide to leave the market in the aftermath of a steep contango curve.

In Table 14 we see the results of our strategy. The strategy to leave the market after a steep contango increases our monthly return from 1.2% to 2.1% per month. While the first contango strategy was not significant, this strategy is. The Sharpe ratio is also better. However, we cannot tell that the strategies are statistically different so it might also have been pure luck!

Table 14 Annual risk and returns, long backwardation short contango versus momentum strategy, 1985 – 2010

1985(01)-2010(08)	Mean	St.dev.	Sharpe	T-value
Short contango original	1,2 %	9,2 %	0,13	1,47
Short contango advanced *	2,1 %	8,6 %	0,24	2,55

* This strategy entails that we leave the market *for* two months and two months *after* we spot a contango market e.g. if on the 15th of January the futures curve is in contango alone its whole futures curve, we leave the market between March 15 and Mai 15.

[28] www.dn.no/forsiden/borsMarked/article1591195.ece, http://www.marketwatch.com/story/crude-super-contango-puts-more-oil-in-storage-signals-price-rise

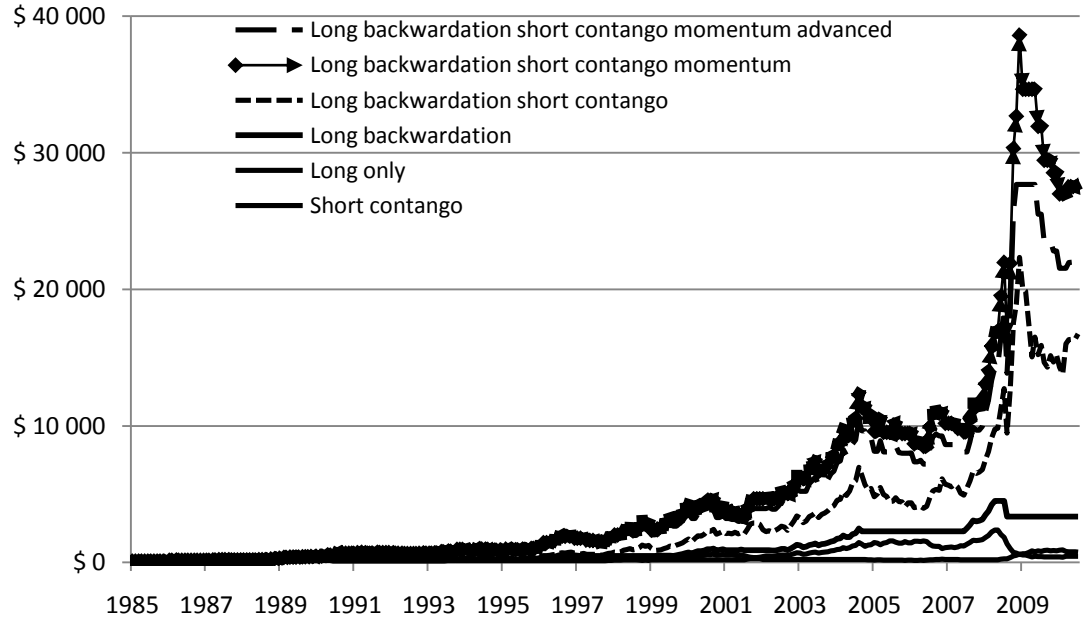
6.6. Comparison of our different investment strategies

Finally we want to show how much 100 USD invested in January 1985 would have grown to by September 2010 if invested according to our different strategies analyzed in this paper[29].

It doesn't come as a surprise that the worst strategy has been the short contango strategy. Contango has been rare in the oil futures market, and our 100 USD was still at around 200 USD in July 2008 before it reached USD 466 in September 2010. If we look at the long only strategy, the result is better reaching USD 770 by the end of our investment period. This is what all pension funds have received during the last 25 years if they have invested in a commodity index with crude oil as one of the commodities. The result is not bad compared to the equity though, but bad compared to what our a little more advanced, but still simple, strategies show.

If we had only invested in backwardated oil futures we would have made USD 3 363. A long backwardation short contango strategy, however, would have made our money grow to 16 739 USD in our period under investigation and finally, adding some momentum into it would have made us USD 28 212. And that even before any interest on the collateralized funds are calculated.

Figure 21 Excess return on our different strategies, 1985 - 2010



[29] Transactions costs are not included.

We should also note that our advanced strategy performed better than a long backwardation short contango strategy, but a closer look at the return series (not shown in any figure) reveals that our momentum strategy also removes the negative returns that the advanced strategy takes away, so then we are better off with the momentum strategy.

It is also interesting to notice the reduction in risk in our different strategies presented In Table 15. The long backwardation strategy and short contango strategy are far from normally distributed due to particularly high excess kurtosis. But when we compare the long only strategy to the long backwardation short contango strategy we see that the latter offer higher Sharpe ratio and T-value. With momentum the data are even better. Also skewness and kurtosis are on the right side of zero for this strategy.

Table 15 Annual risk and return, different strategies, WTI 2nd contract, 1985 - 2010.

1985(01)-2010(08)	Mean	St.dev.	Sharpe	T-value	Skewness	Excess Kurtosis	Normality Test
Short contango	6 %	20 %	0,29	1,5	0,5	6,3	520
Long only	8 %	31 %	0,26	1,3	-0,5	-0,8	18
Long backwardation	14 %	22 %	0,63	3,2	-0,6	4,4	265
Long backwardation short contango	20 %	30 %	0,67	3,4	-0,3	-0,5	7
Long backwardation short contango included momentum	22 %	24 %	0,92	4,7	0,5	0,3	12

If we compare the best Sharpe ratio in Table 15 with the Sharpe ratios we saw in chapter 3 this confirms what we have seen before: active strategies beat passive strategies. The passive indexes we saw in Table 2 had an average Sharpe ratio of 0.19 between 1991 and 2004. A test on our best strategy in Table 15 reveals that the Sharpe ratio of this strategy between 1991 and 2004 (not shown in any figure) is 0.84. Still, we need more knowledge (or luck?) to reach the Sharpe ratios of 1.58 and 1.78 shown in Table 3 in chapter 3.

7. What explains the risk premium?

In the previous chapter we saw that a strategy that going long when the market is in backwardation and short when the market is in contango combined with a momentum strategy, is the best tactical investment strategy in crude oil futures. A simple conclusion may then be to accept this and hope that what happened in the past will prevail in future. However, a study on what caused the returns in the past may help us to gauge whether this past will continue in the future or not. Investment is a too serious business to be left to a decision of pure luck. According to Erb and Harvey (2006, pp 2), "past return will only be a guide to the future if the future return drivers are the same as in the past". What have been the drivers of return in oil futures?

If we try to combine what has been found earlier in academic papers about risk premium in commodities, as we saw in chapter 3 in light of theoretical discussion in chapter 4, we may see that all the theories have something to contribute to a better understanding of the issue.

The expectation hypothesis**,** which says that current futures prices should equal expected future spot prices, is true according to Gorton and Rouwenhorst (2005), when calculated on average of the 18 commodities included in their study. This seems like a reasonable conclusion as the futures market does not, per se, exist in order to raise capital, compared to the stock and bond markets. And if it does not need inflow of speculative capital, it does neither have to induce investors with reward. This means that if there is an even number of hedgers wanting to go short as there are hedgers wanting to go long, and both sides have the same benefit of entering a futures agreement, the futures price should on average not be different than the expected future spot price and the expectation hypothesis should hold.

Between 1986 and 2004 we saw that crude oil prices in nominal terms did not rise. If we then assume that the participants in the futures market are rational and risk neutral, this should also support the expectation hypotheses to be a valid explanation in the oil futures market. Instead, as we saw in Table 4, the period has seen backwardation in 66% of the months in the front month contract. Nevertheless, market participants have pressed the futures prices down below the spot price in backwardated markets and up above the spot price in contango markets, making it possible for participants aware of this to achieve considerable excess return by going long in the backwardated markets and short in contangoed markets.

While the expectation hypothesis may help us understand why some commodities have offered no return, and the average of the 18 commodities in the Gorton and Rouwenhorst study has been zero, it does not fully account for what we have seen in actively managed portfolios of commodity futures and in some particular commodities like crude oil.

The net hedging hypothesis therefore tries to answer the question of what happens when, on the other hand, the number of sellers and buyers does not balance. The futures price will, based on fundamental demand and supply of hedgers and speculators, reach equilibrium like any other asset. If the insurance demand from sellers of oil is higher than the insurance demand from buyers of oil then it is natural to think that the sellers will bid down the price in order to induce more buyers of oil to hedge or speculators to speculate According to Eagleye and Till (2005) a key to understanding the structural return in the futures market of commodities is to see the profits, losses and risks in a wider perspective. For hedgers, the incentive to enter the futures market is to insure them of any price change in the future, which again affects their decision to invest because volatility in prices increases a company's exposure to risk. In this respect, and according to Eagleye and Till (2005), the futures market is *not* a zero-sum game like the equity market where for every winner there must be a looser. In the commodity market, even though hedgers pay a risk premium to speculators, the gains and losses must be put into a wider perspective that makes all winners.

If we assume that participants in the oil market are risk averse we open up for the insurance perspective of the futures market we discussed in chapter 2.1. Oil related companies are willing to accept the cost of transferring risk to other participants in the market. And if there are more buyers of oil (long holders of crude oil) who want insurance than sellers of oil (short holders of crude oil) or the opposite, the characteristic of the oil futures market allows the futures price to deviate from the expected future spot price since this deviation does not open up for riskless arbitrage profit who brings the futures price back in line with the spot-parity-theorem. According to Till (2006, p 5)

"…commodity futures markets allow producers, merchandisers, and marketers the benefit of laying off inventory price risk at their timing and convenience. For this, commercial participants will tolerate paying a premium so long as this cost does not overwhelm the overall profits of their business enterprise.

Applied to our findings we could say that this last conclusion may seem reasonable in light of the stable roll return, while the spot return in one way might be said to have winners and losers because it was not taken into account.

Opening up for the possibility of net hedging demand as a determinant of risk premium does not, however, by itself pave the way for risk premium per se. As we saw in chapter 4, storing costs, convenience yield and the difficulty of going short in the cash market make some commodities open for great deviation between spot and futures prices from the spot-parity-theorem. Backwardation only opens up for greater risk premium for long holders since a contango commodity does not have the same leeway on the long side. As we saw in chapter 3, backwardated commodities do not show any statistical

significant difference in return compared to commodities that normally trade in contango. We are therefore left to an analysis of the actual market condition of hedgers and speculators within a specific futures market, in our case oil futures.

According to Verleger (2010), the oil commodity market exhibits a persistent lack of longs. He compares gasoline to the heating oil and gas where consumers have been more willing to bet on futures prices for their heating. However, for gasoline, the situation is different because e.g. consumers patronize different petrol stations as they don't want to bind themselves to a certain station or retail chain. And because there is a weak link between distributors of oil and retailers, it is difficult to lock in futures prices. The reasoning seems logical in light of the findings by Gjølberg and Brattestad (2010), who found that in the Nordic electricity market there is lack of shorts as consumers prefer to lock in futures prices. Also in Norway we can see that many customers hedge their electricity demand but no one hedges their patrol. A further analysis of the risk premium in the crude oil futures market commands a look at the participants in the market; hedgers and speculators.

What could be the rationale behind momentum in oil futures? First, although recognized as being pure luck or inefficient markets by many academics, momentum has been explained by that of investors being not rational and instead investors have followed trends or "horde" like behavior. But according to this explanation the bubble should burst sooner or later and investors should not be able to get out of the market in time. Another and better explanation could therefore be that since high risk premium often are connected with low inventory commodities, returns are often correlated in consecutive months because inventory continue to be low for a certain period since inventory takes time to pick up. This may also support our earlier argument of having an exception to the strategy rule above when the market change from one condition to another.

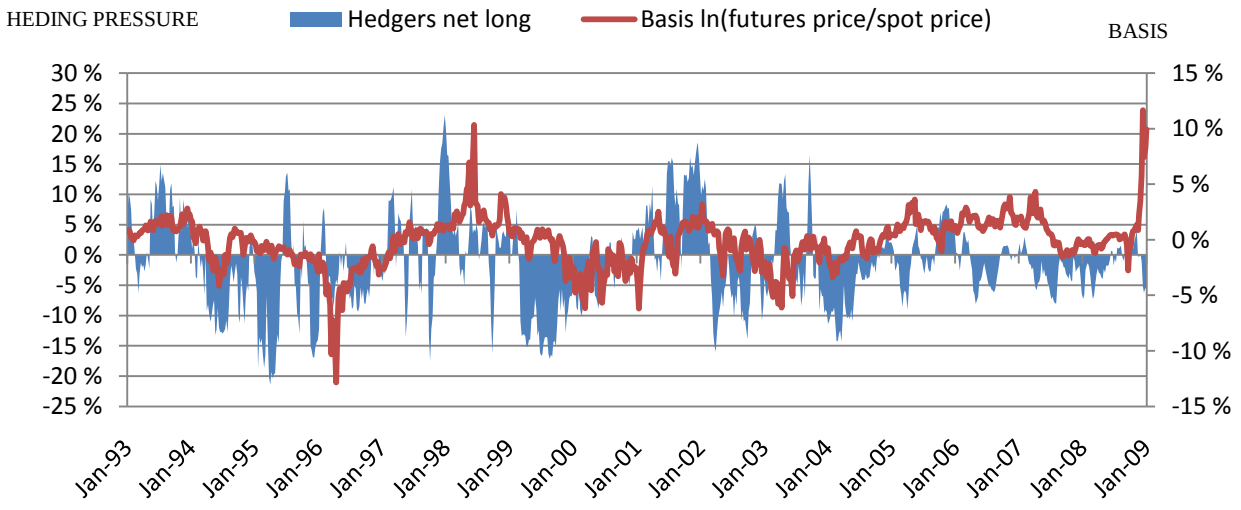
7.1.Risk premium and hedgers

The *hedging pressure*, defined as the relative size of the positions taken by hedgers, is possible to measure based on data downloaded from the *Commodity Futures Trading Commission* (CFTC). While the exact definition of traders may be blurred and even less the purpose of their trade is hard to determine, it has become customary in academic literature to use their data to measure correlation between hedgers' position and risk premium or the term structure of futures markets. According to CFTC traders are categorized in 3 groups where:

"*Commercial traders are those who use futures or option contracts in a given commodity for hedging purposes, as defined in CFTC regulations. Commercial traders hold positions in both the underlying commodity and in the futures (or options) contracts on that commodity. By contrast, non-commercial traders do not own the underlying asset or its financial equivalent; they hold only positions in futures (or options) contracts. Finally, non-reportable positions are those held by traders who do not meet the reporting thresholds set by the CFTC (usually small traders)*[30]

In Figure 22 we have compared the weekly hedging pressure of commercial traders and the 1 week's relative percentage basis where hedging pressure is measured on the left axis and percentage basis on the right axis. Hedging pressure is calculated as hedgers' *net long positions* by subtracting number of short positions hold by hedgers from number of long positions hold by the same group. We then arrive at net long positions which will be positive if long positions outnumber short position and negative if short positions outnumber long position. The net position numbers for every week have then been calculated as a percentage of total open interest for the same week over the whole period. The basis is the current futures price minus current spot price, which is also the difference between the first and the second contract as we as earlier use the nearest futures price as spot price when measuring basis. The hedging pressure data is reported on average 3 days prior to the basis data. The two data sets have a correlation of 0.18 (not shown in any figure) which increase to its highest correlation of 0.33 when basis is compared with 5 months prior hedging pressure.

Figure 22 Weekly hedging pressure versus weekly basis (%), WTI futures, 1993 (01)-2009 (12)



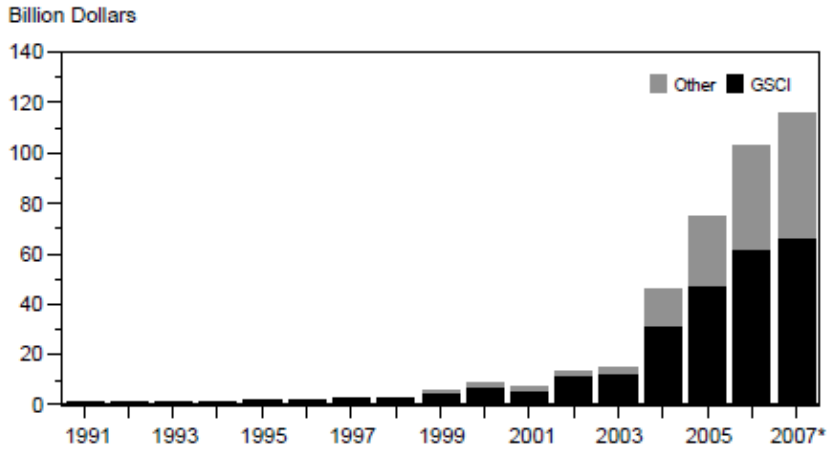
Source: www.cftc.gov/

[30] www.cftc.gov/

Although the correlation between hedging pressure and basis is low and only 0.18 in Figure 22, we are able to see that there exists a correlation, particularly up to 2004. (The correlation increases to 0.24 if we look at the years between 1993 and 2004). To illustrate what the figure is able to tell us we can look at the period between January 1998 and January 2001. In January 1998 hedgers are 21% net long[31] and some months after the futures price is USD 10 higher than the spot price. Between 1999 and 2000 hedgers start becomes net short up to -15% while the basis in the months after become negative. While we should not conclude that hedging pressure *predicts* risk premium, (it might also be the opposite; hedgers adjust their positions as risk premium increase or decrease), a more formal test is necessary to conclude on any granger causality. However, without concluding on any granger causality, we are able to see from the figure that speculators are normally short in contango markets and long in backwardation markets.

One more comment should be made from Figure 22. As we just have seen, before 2004 there is seemingly a correlation between hedging pressure from commercial traders and risk premium, but after 2005 Figure 22 reveals that this proposition may not hold (a more formal correlation test reveals that after 2005 correlation is down to - 0.02). And since hedgers are net short in that period, speculators are net long. According to Verleger (2007b) this change from backwardation to long periods of contango is due to passive investors entering the market, pushing the futures curve into contango as according to him, the global futures market is not big enough to accommodate such a large inflow of money. In chapter 6.5 we saw how we, as investor, can profit from these market conditions with active management.

Figure 23 Global growth in global commodity investment, 1990 - 2007



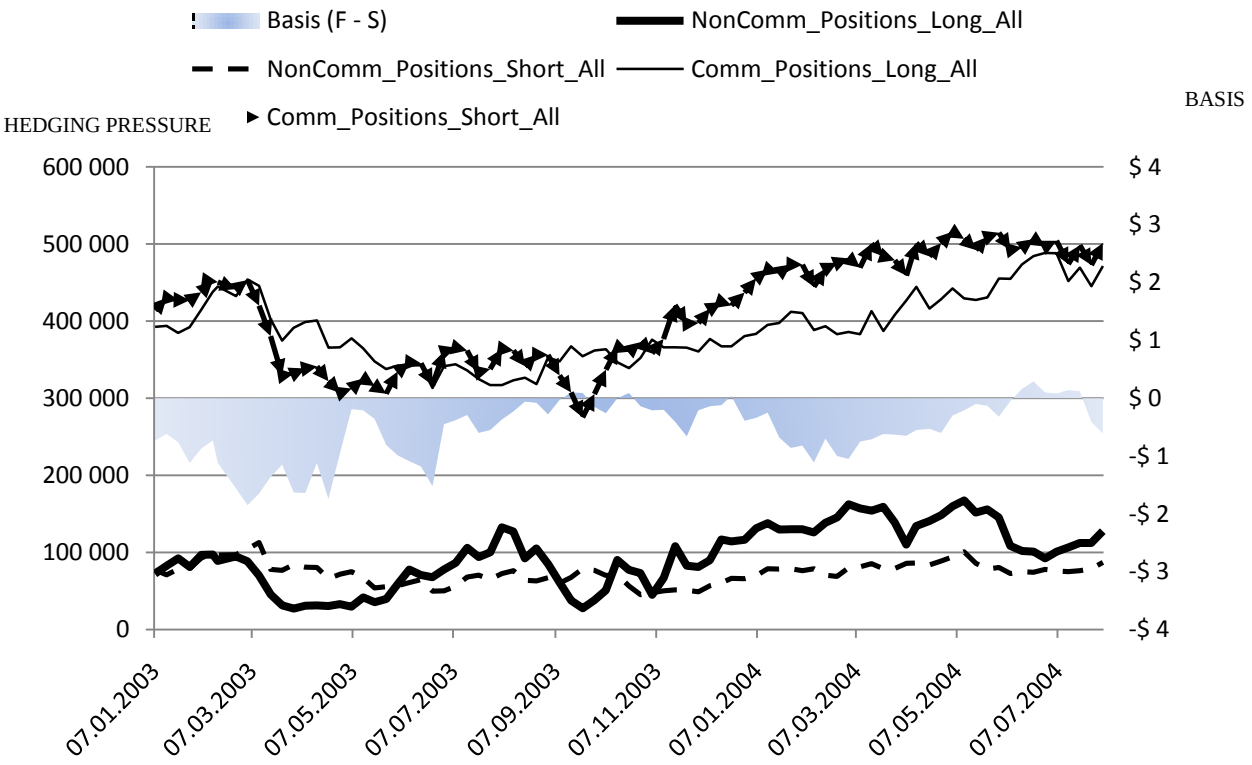
Source: Verleger (2007b)

[31] To illustrate our calculations: 299 814 hedgers went long this week while 214 460 went short. Net hedging were therefore 85 354 divided by total open interest of 414 134 which makes 21%.

The arguments by Verleger and the arguments we put forward in chapter 6.5 may be relevant. As we saw in Figure 16, the roll return from the period between 2005 and 2010 amounted to as much as over 26% compared to around 16-18% in previous periods. In Table 4 we also saw how the contango months have changed from a negative spot price change to a positive the last 5-10 years.

If we dig into a shorter time period we might be able to see things more clearly. In Figure 24 we see how the basis (F-S) shown on the right axis in USD terms is linked to the different positions taken by both hedgers and speculators given its total weekly contracts bought or sold on the left axis. Several things should be noted from the figures; first, and as we saw in Figure 23 participants adjust their positions in correlation to the basis. Second, short hedgers and long speculators seem to be more volatile in their behavior than their counterparts. If we look at the period around September 2003 we see a sudden drop in the hedgers demand for short positions as the futures curve goes into contango. While this connection between the futures curve and the hedging demand in this case is easy to see, other periods do not have such an apparent connection like e.g. the time around July 2004.

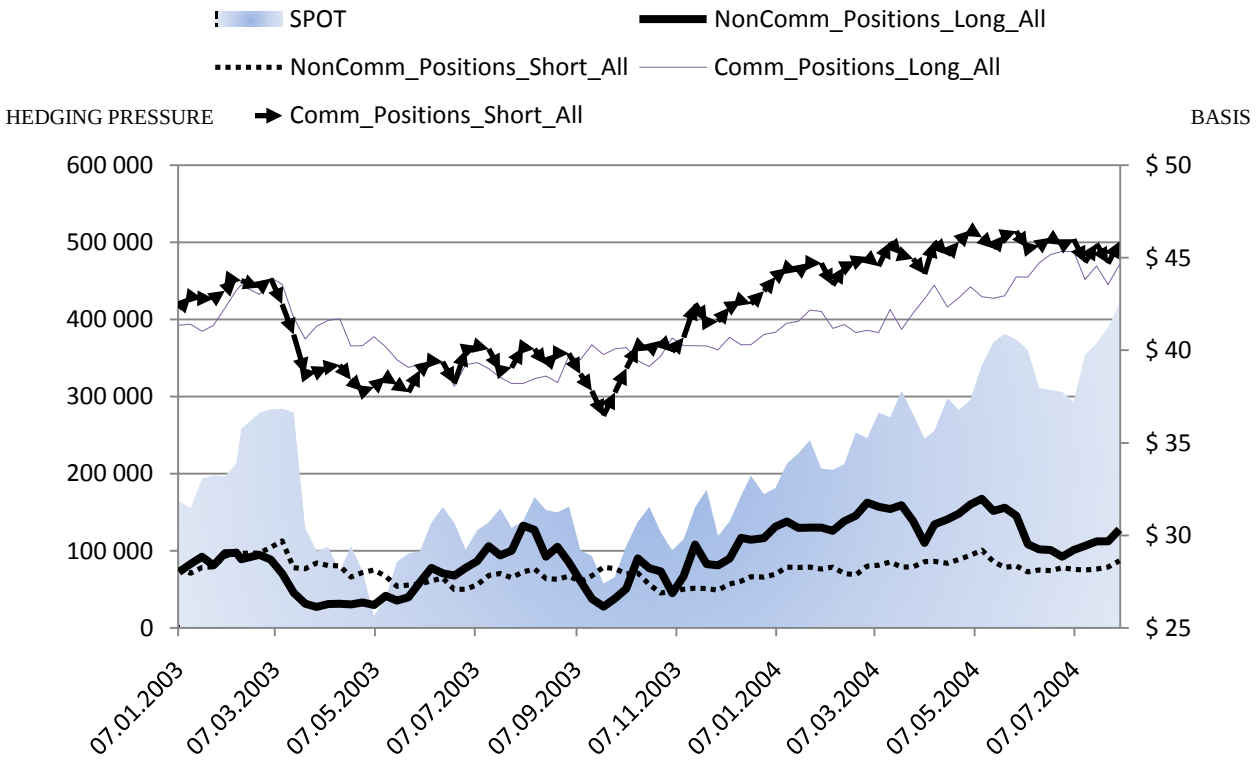
Figure 24 Weekly hedging pressure versus 1 week basis, WTI futures 1st and 2nd contract, 1993 (02) - 1994 (12)



Source: www.cftc.gov/

Why do hedgers and speculators act this way? As Figure 25 shows, hedgers may have incentive to increase their net short position as prices rise. A reversion may be damaging to their heavy investment in new oil production facilities. Speculators, on the other hand, may think prices will continue to rise in the futures and increase their net long positions. The close connection of the change in spot price and the change in long position demand by speculators is interesting from an investment perspective, as we have seen, investors are not in the long run rewarded for speculating on the spot price but trading based on the term structure.

Figure 25 Weekly hedging pressure versus 1 week spot price change, WTI futures, 1993 (02) - 1994 (12)



Source: www.cftc.gov/

If we look at the Table 16 we see two things; First, long speculation is more volatile than short speculation, where for hedgers it is the opposite. Second, speculators relative difference between long and short is higher than the relative difference between hedgers

Table 16 Weekly standard deviations of positions of traders on WTI futures NYMEX, 1993 - 2009

	Long hedgers	Short hedgers	Long speculators	Short speculators
Weekly st.dev. (number of contracts)	168 095	178 802	70 322	58 174

Source: www.cftc.gov/

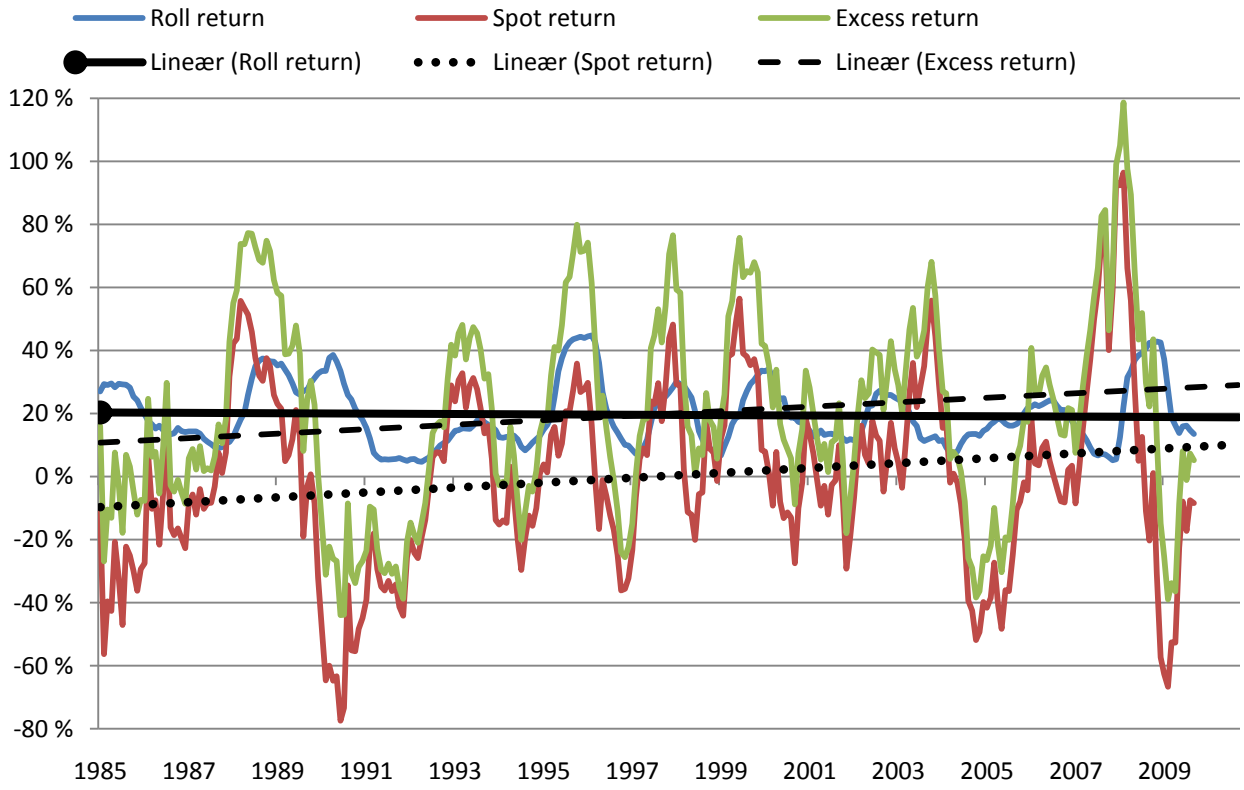
Having looked at figures above we see that the futures market does not only consist of hedgers wanting to share risk and speculators wanting to buy risk for a premium. Both hedgers and speculators have very different reasons for buying futures and they use different market signals to change positions. By so, a future risk premium may be decided by both hedgers' and speculators' thoughts and beliefs about futures prices both spot and futures and future risk premium. However, it may look like speculators are more active on the long side, while hedgers are more active on the short side adjusting their positions more often. And they do so particularly based on spot prices and less according to basis, where the latter is the most reliable source of return. In addition, investors wanting to include commodities in their portfolios for diversification may also affect prices and risk premium.

The famous Nobel Laureate and Stanford professor William Sharpe reminded us that "Although it is always perilous to assume that the future will be like the past, it is at least instructive to find out what the past was like" But is oil futures the right basket to put the eggs in for the years ahead?

7.2. Continued risk premium in crude oil futures?

Figure 26 shows the one year moving average for spot, roll and excess return for oil futures between January 1985 and September 2010. If we were to forecast future performance based on past trends, the future looks bright; spot return shows an upward trend which together with a stable roll return makes an upward trend for the excess return for the period. Again we see that the roll return is a very stable and safe source of return where the one year moving average roll return of 20% very exact equals our annual excess return of 20% as we earlier saw in Table 12. Given this compelling historical record, and a belief that the futures will be like the past, we only have to look at the futures curve when allocating our funds for the years to come.

Figure 26 One year moving average on long backwardation short contango excess return, spot return and roll return, January 1985 – September 2010



However, a positive past trend is no guarantee for future performance. As we have seen earlier, the great return in crude oil futures for the last 25 years has been a contribution from both backwardation and contango markets, where a complete cutback in one of the two markets would at least have halved the final absolute money return (see Figure 21). So when talking about futures prospect in oil futures we must also have an idea of what market, backwardation or contango, we believe the oil futures market will exhibit in the years ahead and if the risk premium is likely to continue in those two markets. The answer may be the same for both of them, but it might also differ.

From a theoretical perspective backwardation markets do seem to have more room for roll return and hence excess return since, as we have seen, the violation of the spot-parity-theorem gives most leeway downwards. In addition, long backwardation has also given better spot return since, in contrast to shorting, going long benefits from spot increases. Contango markets, on the other hand, have not offered the same degree of roll return and, despite their long contango periods for the last 5 years, contango markets have only contributed to the total return in small periods. And, if Verleger (2005) is correct, and

the roll return in the last contango period is due to all the index investment then it might disappear. Others might also argue that the roll return in backwardation might disappear since it has gone down for the last 5 years (see Figure 15) signaling less return in backwardation markets. This argument is however weak since backwardation markets only accounted for 17% of the time in the last 5 years so one should exert caution when this period is interpreted.

Different trends in backwardation and contango markets may signal changing market conditions in demand and supply of futures contracts. And in the end, it is these market conditions that will decide the futures curve and the amount of roll return. Changes may occur in the market structure of oil producing companies that alter the demand for hedging. Opec will certainly try to get the futures curve back in backwardation and the risk aversion of both speculators and hedgers may change. All these factors and several more will decide on the form of the futures curve and how strong the roll return will be in the future.

There might also be psychological reasons for the risk premium. According to Erb and Harvey (2006 pp 49) many investors are not interested in tactical allocation because "long only investors want to know that they always have a well defined long exposure to the commodities market. Tactical strategies which can allocate amongst commodities, or go long or short commodity futures, will naturally leave these investors wondering about what sort of portfolio exposure they happen to have at any point in time". It is, however, questionable how long this passive approach to commodity investments will survive.

More and more investors are becoming aware of the returns they are missing by only being passive. If these investors suddenly find out they want to become active, and more and more large investment banks decide to promote more active indices, we may see the futures prices more in line with the expected spot price and returns diminished. Investors changing side on the futures bet will both reduce long holders and increase short holders at the same time. Compared to new investors entering the market, the effect of investors changing side has a double effect. According to John Kemp, Senior Market Analyst, Commodities and Energy at Reuters;

"*The major index operators have responded by promoting variants which try to minimize roll losses. They roll less frequently, shift positions further forward along the curve (where contango is smaller), or re-allocate investments towards commodity markets with the smallest contango or biggest backwardation."* [32]

[32] http://blogs.reuters.com/great-debate/2010/07/15/short-side-of-commodity-market-becomes-crowded/

According to the Commodities Research Index launched, by Barclays Capital (a British investment bank), 43% chose active management while only 7% expected to use index swaps when asked how they plan to invest in commodities over the next 12 months. In addition, the respondents said that their primary motivation for commodity investing was absolute return, which was twice as many as those citing portfolio diversification or inflation hedge[33] And according to Kevin Norrish, Managing Director, Barclays Capital commodities research:

"The challenge for them is to find the right strategy to achieve those returns, and it is clear that active strategies are increasingly coming into favor."[34]

According to Neale Wilson, a director of Asia-Pacific sales structuring at Barclays in Singapore;

"Investors are clearly becoming more aware of the impact of negative roll yield and the associated crowding-out effects that results from there being an enormous amount of passive money rolling over at predetermined periods in time …Historically, investors were more willing to invest in standard benchmark indexes. However, as a result of losses suffered due to contango, investors are showing a strong preference for enhanced indexes."[35]

All these statements above do signal a possible change in how commodity investment will look like in the future and certainly also affect the size of the roll yield.

Roll return will also depend on Opec and their decisions. Hassan Qabazard, Opec's head of research, told the Financial Times strong backwardation in the oil futures curve was one reason why Opec chose to increase supply" and "For Opec the (important thing) is that backwardation signals a tight oil market."[36] And in the same article " Ali Aissaoui, chief economist at the Arab Petroleum Investments Corporation in Damman, Saudi Arabia, said in a report in advance of Opec's meeting that Opec did not want to allow passive commodity investors and speculators to push up oil prices.

Finally, one issue that may have prevented the risk premium from being competed away or considerably reduced might be the difficulty of small investors to enter the market. According to the United States Department of Agriculture, the possibility of small investors to enter the market is limited. As the smallest contract for crude oil futures on the exchanges is 1000 barrel, this would require a margin of at least USD 5000 with today's prices. In addition, intermediaries do not offer any other choices except indexes.

[33] www.commodities-now.com
[34] www.barcap.com
[35] www.risk.net/asia
[36] The Financial Times, September 12, 2007, Commodity traders brace for Opec's boost to oil output

8. Summary and conclusions

In this paper we have investigated risk and return for investments in crude oil futures for the last 25 years. The conclusion is unequivocal; active management, which means going long when the futures curve is in backwardation and going short when the futures curve is in contango, has rewarded investors in crude oil futures with an additional 12% annual excess return compared to a passive strategy where we go long all the time. While the passive strategy between 1985 and 2010 has given an annual excess return of 8.10 %, our active strategy has offered an annual excess return of 20% with a Sharpe ratio of 0.66 and a t-value of 3.54. This is far better than US bonds, the S&P 500 and any passive commodity index for the same period. In addition we have shown that it has been possible to increase this return by 2% to an annual excess return of 22% by leaving the market every month that the last month's return was negative. This gives us in addition a much lower risk and the Sharpe ratio increase to 0.93. We cannot, however, conclude that this return is significantly different from the 20% annual excess return.

Up until 2004 the crude oil futures curve normally traded in backwardation, where the current futures prices were set below the current spot price. In that period oil prices in nominal terms did not rise and returns were earned because futures price "rolled" towards the spot price at expiration date. In contango markets the roll return was negative as current futures prices were set above the current spot price, but rolled *downwards* towards the general lower spot price. Since our investment strategy involves short position during times of contango, the negative roll return became a positive return for our strategy. The roll return has shown to be a significant and reliable return over the whole investment period except for when the futures curve was in backwardation or contango. After 2005, crude oil futures have traded in contango most of the time. Despite this change, our investment strategy has not performed worse. And we have no indication that this return is about to be competed away as crude oil futures up to the last months have offered excellent returns.

Investment in crude oil futures may be risky in the short run as standard deviations of going long in backwardated markets and short in contango markets have been relatively high with yearly losses of up to 45%. However, investors have never lost money in these 25 years if they have been in the market for more than 6 consecutive years at a time. In addition, investors staying in the market for at least 5 years have been rewarded with an annual 10% return or more for the last 20 years.

Our findings in this paper that active management of oil futures offers better risk and return than passive management, should not come as a surprise to investors, as several academic papers have showed the benefits of active management, not only in crude oil but in commodities in general. Yet, many investors

seem to prefer a long only strategy and invest in commodity indexes, either as a means to speculate on future tightness in the physical markets and thereby increase in spot prices or as part of a diversification strategy and hedge against inflation.

The reason for the return in crude oil futures is complex and we have only touched upon some of the factors that may have contributed to this stable return for the last 25 years. Hedgers have normally been short in futures pressing down the current futures price and rewarded speculators willing to share the risk for a premium. While hedgers may have had incentives to hedge because oil production is costly and prices are volatile, it may be harder to understand why hedgers generally become net long during contango periods. While particular commercial hedgers were the source of return before 2004, after 2005 passive commodity investments may have brought the futures prices over its expected spot price and rewarded our active strategy. Finally, OPEC may have contributed to roll yield since it has been in their interest to see tightness in the spot market and higher spot prices.

Our findings also show that passive investors, like short hedgers, are more volatile and adjust their positions more in accordance to price changes. This again affects the size of the spread between current futures prices and current spot prices.

Although the reasons for the high returns of oil futures may be complex, capturing it has been relatively easy. In efficient markets easy pickings have normally been picked long before it is possible to earn a substantially amount of money on it over time. Oil futures for the last 25 years have challenged this statement. Most likely, the interest for commodity futures and specially oil futures will not disappear in the near future. Only the history, written in the future, will conclude whether 2011 was a good year to continue with or redefine our investment strategy.

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ATTACHMENT 1 – Monthly return data

Monthly futures prices roll return, spot return and excess return on Long Backwardation Short Contango strategy.

Date	Cushing, OK Crude Oil Future Contract 1 (Dollars per Barrel)	Cushing, OK Crude Oil Future Contract 2 (Dollars per Barrel)	Cushing, OK Crude Oil Future Contract 3 (Dollars per Barrel)	Cushing, OK Crude Oil Future Contract 4 (Dollars per Barrel)	roll return	spot return	excess return
jan-1985	25,64	25,55	25,43	25,36	0,35 %	5,69 %	6,04 %
feb-1985	27,14	26,62	26,22	26,01	1,93 %	3,55 %	5,48 %
mar-1985	28,12	27,54	27,2	26,97	2,08 %	2,08 %	4,16 %
apr-1985	28,71	28,06	27,71	27,52	2,29 %	-4,02 %	-1,73 %
mai-1985	27,58	26,98	26,67	26,55	2,20 %	-1,79 %	0,41 %
jun-1985	27,09	26,35	25,92	25,66	2,77 %	0,66 %	3,43 %
jul-1985	27,27	26,58	26,06	25,72	2,56 %	1,71 %	4,27 %
aug-1985	27,74	27,27	26,95	26,69	1,71 %	1,72 %	3,42 %
sep-1985	28,22	27,63	27,11	26,77	2,11 %	4,37 %	6,48 %
okt-1985	29,48	28,7	28,04	27,5	2,68 %	4,15 %	6,83 %
nov-1985	30,73	29,75	28,95	28,25	3,24 %	-12,39 %	-9,15 %
des-1985	27,15	26,31	25,61	25,09	3,14 %	-16,68 %	-13,53 %
jan-1986	22,98	22,37	21,94	21,66	2,69 %	-39,64 %	-36,95 %
feb-1986	15,46	15,71	15,83	15,94	1,60 %	20,30 %	21,90 %
mar-1986	12,62	12,95	13,12	13,28	2,58 %	-1,02 %	1,56 %
apr-1986	12,75	12,62	12,57	12,62	1,02 %	17,97 %	19,00 %
mai-1986	15,26	14,76	14,44	14,29	3,33 %	-13,15 %	-9,82 %
jun-1986	13,38	13,04	13,01	13,04	2,57 %	-14,45 %	-11,87 %
jul-1986	11,58	11,3	11,35	11,49	2,45 %	26,61 %	29,06 %
aug-1986	15,11	14,99	14,96	14,94	0,80 %	-1,13 %	-0,33 %
sep-1986	14,94	15,05	15,02	14,91	-0,73 %	-0,34 %	-1,07 %
okt-1986	14,89	15,11	15,18	15,18	1,47 %	-2,26 %	-0,79 %
nov-1986	15,23	15,38	15,41	15,38	0,98 %	-5,49 %	-4,51 %
des-1986	16,09	16,25	16,28	16,26	0,99 %	-14,87 %	-13,88 %
jan-1987	18,67	18,55	18,35	18,12	0,64 %	-5,17 %	-4,52 %
feb-1987	17,73	17,64	17,55	17,45	0,51 %	3,05 %	3,56 %
mar-1987	18,28	18,05	17,86	17,7	1,27 %	1,74 %	3,00 %
apr-1987	18,6	18,24	17,99	17,86	1,95 %	3,85 %	5,80 %
mai-1987	19,33	18,98	18,8	18,69	1,83 %	3,36 %	5,18 %
jun-1987	19,99	19,64	19,49	19,41	1,77 %	6,49 %	8,25 %
jul-1987	21,33	20,92	20,71	20,6	1,94 %	-5,29 %	-3,35 %
aug-1987	20,23	20	19,89	19,83	1,14 %	-3,57 %	-2,43 %
sep-1987	19,52	19,32	19,22	19,17	1,03 %	1,73 %	2,76 %
okt-1987	19,86	19,77	19,68	19,6	0,45 %	-5,22 %	-4,77 %
nov-1987	18,85	18,74	18,67	18,62	0,59 %	-8,81 %	-8,23 %
des-1987	17,26	17,05	16,93	16,88	1,22 %	-0,64 %	0,58 %

jan-1988	17,15	17,03	16,91	16,81	0,70 %	-2,30 %	-1,60 %
feb-1988	16,76	16,69	16,62	16,53	0,42 %	-3,34 %	-2,92 %
mar-1988	16,21	16,12	16,06	16,02	0,56 %	9,81 %	10,36 %
apr-1988	17,88	17,82	17,73	17,65	0,34 %	-2,43 %	-2,10 %
mai-1988	17,45	17,61	17,68	17,7	0,91 %	5,23 %	6,15 %
jun-1988	16,56	16,72	16,81	16,88	0,96 %	6,55 %	7,51 %
jul-1988	15,51	15,68	15,79	15,9	1,09 %	-0,13 %	0,96 %
aug-1988	15,53	15,65	15,75	15,85	0,77 %	7,14 %	7,91 %
sep-1988	14,46	14,26	14,21	14,21	1,39 %	-4,67 %	-3,28 %
okt-1988	13,8	13,58	13,51	13,52	1,61 %	1,30 %	2,90 %
nov-1988	13,98	13,83	13,78	13,8	1,08 %	15,23 %	16,31 %
des-1988	16,28	15,81	15,58	15,46	2,93 %	9,93 %	12,86 %
jan-1989	17,98	17,39	17,02	16,79	3,34 %	-0,89 %	2,44 %
feb-1989	17,82	17,27	16,94	16,69	3,14 %	8,70 %	11,84 %
mar-1989	19,44	18,9	18,49	18,15	2,82 %	7,43 %	10,25 %
apr-1989	20,94	19,75	19,04	18,52	5,85 %	-4,44 %	1,41 %
mai-1989	20,03	18,84	18,28	17,94	6,12 %	-0,20 %	5,92 %
jun-1989	19,99	19,02	18,46	18,11	4,97 %	-1,66 %	3,31 %
jul-1989	19,66	19,13	18,77	18,53	2,73 %	-5,81 %	-3,08 %
aug-1989	18,55	18,27	18,14	18,05	1,52 %	5,45 %	6,98 %
sep-1989	19,59	19,37	19,19	19,02	1,13 %	2,57 %	3,70 %
okt-1989	20,1	19,91	19,69	19,52	0,95 %	-1,35 %	-0,40 %
nov-1989	19,83	19,64	19,48	19,33	0,96 %	6,16 %	7,12 %
des-1989	21,09	20,72	20,42	20,16	1,77 %	7,09 %	8,86 %
jan-1990	22,64	21,78	21,27	20,86	3,87 %	-2,37 %	1,50 %
feb-1990	22,11	21,84	21,65	21,4	1,23 %	-8,00 %	-6,77 %
mar-1990	20,41	20,63	20,74	20,72	1,07 %	9,39 %	10,47 %
apr-1990	18,58	19,2	19,59	19,85	3,28 %	0,65 %	3,93 %
mai-1990	18,46	19,07	19,45	19,75	3,25 %	9,07 %	12,32 %
jun-1990	16,86	17,6	18,11	18,52	4,30 %	-10,04 %	-5,74 %
jul-1990	18,64	19,39	19,82	20,1	3,94 %	-37,72 %	-33,77 %
aug-1990	27,18	26,71	26,31	25,92	1,74 %	21,47 %	23,22 %
sep-1990	33,69	32,6	31,56	30,56	3,29 %	6,41 %	9,70 %
okt-1990	35,92	35	33,58	32,32	2,59 %	-10,62 %	-8,03 %
nov-1990	32,3	31,54	30,35	29,19	2,38 %	-17,33 %	-14,95 %
des-1990	27,16	26,47	25,59	24,75	2,57 %	-9,49 %	-6,92 %
jan-1991	24,7	23,75	22,77	22,09	3,92 %	-18,44 %	-14,52 %
feb-1991	20,54	19,47	18,81	18,41	5,35 %	-3,27 %	2,08 %
mar-1991	19,88	19,49	19,17	18,95	1,98 %	4,62 %	6,60 %
apr-1991	20,82	20,56	20,3	20,13	1,26 %	2,04 %	3,30 %
mai-1991	21,25	21,2	21,19	21,18	0,24 %	-5,07 %	-4,83 %
jun-1991	20,2	20,24	20,34	20,45	0,20 %	-5,91 %	-5,71 %
jul-1991	21,43	21,34	21,22	21,12	0,42 %	1,16 %	1,58 %
aug-1991	21,68	21,62	21,53	21,42	0,28 %	0,83 %	1,10 %
sep-1991	21,86	21,77	21,66	21,51	0,41 %	6,08 %	6,49 %
okt-1991	23,23	23,06	22,83	22,57	0,73 %	-3,50 %	-2,77 %
nov-1991	22,43	22,28	22,05	21,83	0,67 %	-13,84 %	-13,17 %
des-1991	19,53	19,52	19,5	19,49	0,05 %	-3,70 %	-3,65 %
jan-1992	18,82	18,92	18,99	19,01	0,53 %	-1,00 %	-0,47 %
feb-1992	19,01	19,16	19,26	19,3	0,79 %	0,32 %	1,10 %

mar-1992	18,95	19,1	19,19	19,23	0,79 %	-6,68 %	-5,90 %
apr-1992	20,26	20,32	20,31	20,27	0,30 %	-3,59 %	-3,29 %
mai-1992	21	21,08	21,1	21,05	0,38 %	-6,28 %	-5,89 %
jun-1992	22,36	22,34	22,24	22,15	0,09 %	-2,81 %	-2,72 %
jul-1992	21,74	21,64	21,57	21,51	0,46 %	-2,09 %	-1,63 %
aug-1992	21,29	21,19	21,12	21,05	0,47 %	2,92 %	3,39 %
sep-1992	21,92	21,77	21,67	21,55	0,69 %	-0,96 %	-0,28 %
okt-1992	21,71	21,66	21,58	21,47	0,23 %	-6,42 %	-6,19 %
nov-1992	20,36	20,4	20,41	20,39	0,20 %	4,78 %	4,97 %
des-1992	19,41	19,52	19,57	19,64	0,57 %	1,77 %	2,33 %
jan-1993	19,07	19,19	19,32	19,42	0,63 %	-5,16 %	-4,53 %
feb-1993	20,08	20,11	20,14	20,18	0,15 %	-1,34 %	-1,19 %
mar-1993	20,35	20,46	20,51	20,54	0,54 %	0,10 %	0,64 %
apr-1993	20,33	20,53	20,64	20,7	0,98 %	1,74 %	2,72 %
mai-1993	19,98	20,21	20,34	20,41	1,14 %	4,35 %	5,49 %
jun-1993	19,13	19,41	19,61	19,73	1,45 %	6,65 %	8,10 %
jul-1993	17,9	18,17	18,39	18,57	1,50 %	-0,61 %	0,88 %
aug-1993	18,01	18,34	18,57	18,73	1,82 %	2,76 %	4,57 %
sep-1993	17,52	17,79	18,04	18,23	1,53 %	-3,64 %	-2,11 %
okt-1993	18,17	18,34	18,48	18,59	0,93 %	8,20 %	9,13 %
nov-1993	16,74	17,02	17,24	17,41	1,66 %	14,16 %	15,82 %
des-1993	14,53	14,86	15,18	15,45	2,25 %	-3,32 %	-1,07 %
jan-1994	15,02	15,15	15,31	15,48	0,86 %	1,61 %	2,47 %
feb-1994	14,78	14,88	15,04	15,23	0,67 %	0,88 %	1,56 %
mar-1994	14,65	14,72	14,82	14,96	0,48 %	-10,86 %	-10,38 %
apr-1994	16,33	16,19	16,16	16,18	0,86 %	8,79 %	9,65 %
mai-1994	17,83	17,45	17,27	17,17	2,15 %	6,72 %	8,88 %
jun-1994	19,07	18,49	18,2	18,03	3,09 %	3,05 %	6,14 %
jul-1994	19,66	19,2	18,91	18,72	2,37 %	-6,73 %	-4,36 %
aug-1994	18,38	18,29	18,22	18,15	0,49 %	-5,08 %	-4,59 %
sep-1994	17,47	17,59	17,71	17,77	0,68 %	-1,36 %	-0,68 %
okt-1994	17,71	17,77	17,79	17,78	0,34 %	-2,18 %	-1,84 %
nov-1994	18,1	18,01	17,93	17,88	0,50 %	-5,33 %	-4,83 %
des-1994	17,16	17,17	17,23	17,29	0,06 %	-4,72 %	-4,67 %
jan-1995	17,99	17,88	17,81	17,76	0,61 %	2,96 %	3,57 %
feb-1995	18,53	18,35	18,19	18,07	0,98 %	0,11 %	1,08 %
mar-1995	18,55	18,44	18,32	18,2	0,59 %	6,97 %	7,57 %
apr-1995	19,89	19,65	19,38	19,12	1,21 %	-0,76 %	0,46 %
mai-1995	19,74	19,57	19,34	19,12	0,86 %	-7,03 %	-6,16 %
jun-1995	18,4	18,25	18,1	18	0,82 %	-6,40 %	-5,58 %
jul-1995	17,26	17,06	16,99	16,99	1,17 %	3,14 %	4,30 %
aug-1995	17,81	17,51	17,35	17,28	1,70 %	2,22 %	3,92 %
sep-1995	18,21	17,85	17,66	17,54	2,00 %	-4,55 %	-2,55 %
okt-1995	17,4	17,16	17,04	16,99	1,39 %	3,39 %	4,78 %
nov-1995	18	17,72	17,54	17,41	1,57 %	5,62 %	7,18 %
des-1995	19,04	18,66	18,36	18,15	2,02 %	-1,80 %	0,21 %
jan-1996	18,7	18,31	18	17,78	2,11 %	0,43 %	2,53 %
feb-1996	18,78	18,14	17,8	17,57	3,47 %	12,03 %	15,49 %
mar-1996	21,18	19,75	18,92	18,44	6,99 %	9,54 %	16,53 %
apr-1996	23,3	21,22	19,99	19,26	9,35 %	-9,97 %	-0,61 %

mai-1996	21,09	20,06	19,39	18,93	5,01 %	-3,18 %	1,83 %
jun-1996	20,43	19,61	19,08	18,73	4,10 %	3,94 %	8,03 %
jul-1996	21,25	20,62	20,05	19,61	3,01 %	3,06 %	6,07 %
aug-1996	21,91	21,35	20,84	20,38	2,59 %	8,82 %	11,41 %
sep-1996	23,93	23,35	22,75	22,16	2,45 %	3,97 %	6,43 %
okt-1996	24,9	24,47	23,95	23,38	1,74 %	-5,57 %	-3,83 %
nov-1996	23,55	23,28	22,95	22,58	1,15 %	6,45 %	7,61 %
des-1996	25,12	24,49	23,9	23,32	2,54 %	0,24 %	2,78 %
jan-1997	25,18	24,58	24,01	23,46	2,41 %	-12,73 %	-10,32 %
feb-1997	22,17	21,87	21,57	21,3	1,36 %	-5,56 %	-4,20 %
mar-1997	20,97	20,88	20,78	20,67	0,43 %	-6,10 %	-5,67 %
apr-1997	19,73	19,73	19,73	19,74	0,00 %	5,62 %	5,62 %
mai-1997	20,87	20,93	20,87	20,79	-0,29 %	-8,24 %	-8,52 %
jun-1997	19,22	19,41	19,53	19,62	0,98 %	-2,26 %	-1,28 %
jul-1997	19,66	19,76	19,8	19,83	0,51 %	-1,46 %	-0,96 %
aug-1997	19,95	20,09	20,17	20,2	0,70 %	0,86 %	1,56 %
sep-1997	19,78	19,88	19,93	19,95	0,50 %	-7,31 %	-6,81 %
okt-1997	21,28	21,33	21,26	21,15	-0,23 %	-5,11 %	-5,34 %
nov-1997	20,22	20,42	20,46	20,43	0,98 %	9,87 %	10,85 %
des-1997	18,32	18,53	18,7	18,85	1,14 %	9,08 %	10,22 %
jan-1998	16,73	16,92	17,13	17,34	1,13 %	3,96 %	5,09 %
feb-1998	16,08	16,32	16,6	16,86	1,48 %	6,69 %	8,17 %
mar-1998	15,04	15,37	15,7	16,03	2,17 %	-2,75 %	-0,58 %
apr-1998	15,46	15,88	16,21	16,46	2,68 %	3,49 %	6,17 %
mai-1998	14,93	15,68	16,13	16,46	4,90 %	8,82 %	13,72 %
jun-1998	13,67	14,48	15,1	15,58	5,76 %	-3,03 %	2,73 %
jul-1998	14,09	14,4	14,72	15,02	2,18 %	5,17 %	7,35 %
aug-1998	13,38	13,68	14	14,29	2,22 %	-11,23 %	-9,01 %
sep-1998	14,97	15,13	15,3	15,47	1,06 %	3,74 %	4,81 %
okt-1998	14,42	14,57	14,75	14,92	1,03 %	10,06 %	11,09 %
nov-1998	13,04	13,38	13,66	13,91	2,57 %	14,23 %	16,81 %
des-1998	11,31	11,64	11,95	12,23	2,88 %	-9,92 %	-7,05 %
jan-1999	12,49	12,54	12,64	12,76	0,40 %	3,84 %	4,24 %
feb-1999	12,02	12,14	12,27	12,4	0,99 %	-19,99 %	-19,00 %
mar-1999	14,68	14,74	14,72	14,7	0,41 %	-16,42 %	-16,01 %
apr-1999	17,3	17,17	17,03	16,85	0,75 %	2,68 %	3,43 %
mai-1999	17,77	17,67	17,54	17,4	0,56 %	0,84 %	1,40 %
jun-1999	17,92	18,02	18,01	17,92	-0,56 %	11,48 %	10,92 %
jul-1999	20,1	20,2	20,13	19,95	-0,50 %	5,70 %	5,21 %
aug-1999	21,28	21,38	21,31	21,04	-0,47 %	11,15 %	10,68 %
sep-1999	23,79	23,55	23,14	22,64	1,01 %	-4,82 %	-3,81 %
okt-1999	22,67	22,64	22,45	22,12	0,13 %	8,86 %	8,99 %
nov-1999	24,77	24,39	23,86	23,27	1,55 %	5,19 %	6,74 %
des-1999	26,09	25,45	24,63	23,85	2,48 %	3,47 %	5,95 %
jan-2000	27,01	26,12	25,36	24,67	3,35 %	8,14 %	11,49 %
feb-2000	29,3	28,19	27,22	26,44	3,86 %	1,99 %	5,86 %
mar-2000	29,89	28,57	27,56	26,81	4,52 %	-15,73 %	-11,21 %
apr-2000	25,54	24,87	24,6	24,38	2,66 %	12,05 %	14,71 %
mai-2000	28,81	28,46	27,89	27,34	1,22 %	9,02 %	10,24 %
jun-2000	31,53	30,18	29,31	28,68	4,38 %	-5,91 %	-1,54 %

jul-2000	29,72	29,01	28,56	28,17	2,42 %	4,67 %	7,09 %
aug-2000	31,14	30,59	30,07	29,57	1,78 %	8,40 %	10,19 %
sep-2000	33,87	33,08	32,54	32,02	2,36 %	-2,81 %	-0,45 %
okt-2000	32,93	32,36	31,89	31,49	1,75 %	3,96 %	5,71 %
nov-2000	34,26	33,29	32,33	31,45	2,87 %	-18,76 %	-15,89 %
des-2000	28,4	27,75	27,29	26,92	2,32 %	2,98 %	5,30 %
jan-2001	29,26	28,12	27,46	26,97	3,97 %	1,29 %	5,26 %
feb-2001	29,64	29,36	28,91	28,44	0,95 %	-8,33 %	-7,38 %
mar-2001	27,27	27,43	27,4	27,25	-0,59 %	1,28 %	0,69 %
apr-2001	27,62	27,97	28,08	27,96	1,26 %	-3,77 %	-2,51 %
mai-2001	28,68	29,09	29,13	28,86	1,42 %	3,87 %	5,29 %
jun-2001	27,59	27,73	27,7	27,58	-0,51 %	-4,14 %	-4,65 %
jul-2001	26,47	26,17	26,03	25,95	1,14 %	3,12 %	4,26 %
aug-2001	27,31	26,84	26,77	26,57	1,74 %	-6,12 %	-4,38 %
sep-2001	25,69	25,96	26,06	25,89	1,05 %	14,56 %	15,60 %
okt-2001	22,21	22,51	22,64	22,72	1,34 %	12,14 %	13,49 %
nov-2001	19,67	19,93	20,08	20,19	1,31 %	1,38 %	2,70 %
des-2001	19,4	19,71	19,9	20,06	1,59 %	-1,69 %	-0,10 %
jan-2002	19,73	20,14	20,37	20,49	2,06 %	-5,09 %	-3,03 %
feb-2002	20,76	21,02	21,15	21,17	1,24 %	-16,32 %	-15,07 %
mar-2002	24,44	24,68	24,73	24,64	0,98 %	-7,18 %	-6,21 %
apr-2002	26,26	26,29	26,08	25,78	-0,11 %	2,59 %	2,48 %
mai-2002	26,95	26,5	26,3	26,08	1,68 %	-5,33 %	-3,65 %
jun-2002	25,55	25,65	25,56	25,46	-0,39 %	5,30 %	4,91 %
jul-2002	26,94	26,79	26,51	26,29	0,56 %	4,57 %	5,13 %
aug-2002	28,2	27,65	27,32	27,03	1,97 %	5,08 %	7,05 %
sep-2002	29,67	29,68	29,41	28,93	-0,03 %	-2,77 %	-2,80 %
okt-2002	28,86	28,74	28,35	27,91	0,42 %	-9,71 %	-9,29 %
nov-2002	26,19	25,67	25,39	25,15	2,01 %	11,53 %	13,53 %
des-2002	29,39	29,07	28,4	27,78	1,09 %	10,67 %	11,77 %
jan-2003	32,7	31,87	30,87	29,89	2,57 %	8,86 %	11,43 %
feb-2003	35,73	34,43	33,16	31,97	3,71 %	-7,46 %	-3,76 %
mar-2003	33,16	31,69	30,48	29,66	4,53 %	-16,42 %	-11,88 %
apr-2003	28,14	26,98	26,52	26,21	4,21 %	-0,25 %	3,96 %
mai-2003	28,07	27,54	27,03	26,62	1,91 %	8,37 %	10,27 %
jun-2003	30,52	29,49	28,85	28,3	3,43 %	0,59 %	4,02 %
jul-2003	30,7	30,26	29,75	29,29	1,44 %	2,89 %	4,33 %
aug-2003	31,6	31,42	30,96	30,39	0,57 %	-10,99 %	-10,42 %
sep-2003	28,31	28,29	28	27,71	0,07 %	6,96 %	7,03 %
okt-2003	30,35	30,25	29,88	29,46	0,33 %	2,31 %	2,64 %
nov-2003	31,06	30,67	30,27	29,82	1,26 %	3,42 %	4,68 %
des-2003	32,14	31,99	31,51	30,99	0,47 %	6,27 %	6,74 %
jan-2004	34,22	33,58	33,04	32,48	1,89 %	0,81 %	2,70 %
feb-2004	34,5	33,54	32,91	32,37	2,82 %	6,24 %	9,06 %
mar-2004	36,72	36,03	35,27	34,64	1,90 %	-0,27 %	1,62 %
apr-2004	36,62	36,12	35,7	35,22	1,37 %	9,53 %	10,90 %
mai-2004	40,28	40,09	39,57	38,95	0,47 %	-5,70 %	-5,22 %
jun-2004	38,05	38,18	38,05	37,78	-0,34 %	7,00 %	6,66 %
jul-2004	40,81	40,63	40	39,6	0,44 %	9,51 %	9,95 %
aug-2004	44,88	44,39	43,96	43,44	1,10 %	2,33 %	3,43 %

sep-2004	45,94	45,68	45,18	44,65	0,57 %	14,47 %	15,03 %
okt-2004	53,09	52,63	52,1	51,47	0,87 %	-9,08 %	-8,21 %
nov-2004	48,48	48,58	48,5	48,22	-0,21 %	-11,39 %	-11,60 %
des-2004	43,26	43,56	43,62	43,45	0,69 %	-7,97 %	-7,28 %
jan-2005	46,85	47,05	46,92	46,63	-0,43 %	2,53 %	2,10 %
feb-2005	48,05	48,59	48,81	48,74	1,12 %	-12,83 %	-11,72 %
mar-2005	54,63	55,31	55,61	55,67	1,24 %	2,61 %	3,85 %
apr-2005	53,22	54,6	55,37	55,71	2,56 %	6,50 %	9,06 %
mai-2005	49,87	51,27	51,91	52,29	2,77 %	-12,34 %	-9,57 %
jun-2005	56,42	57,32	57,94	58,32	1,58 %	-4,52 %	-2,94 %
jul-2005	59,03	60	60,65	61,07	1,63 %	-9,62 %	-7,99 %
aug-2005	64,99	65,73	66,26	66,62	1,13 %	-0,86 %	0,27 %
sep-2005	65,55	65,91	66,35	66,71	0,55 %	5,13 %	5,68 %
okt-2005	62,27	62,08	62,33	62,54	0,31 %	-6,52 %	-6,21 %
nov-2005	58,34	59,14	59,61	59,9	1,36 %	-1,88 %	-0,52 %
des-2005	59,45	60,24	60,8	61,17	1,32 %	-9,75 %	-8,43 %
jan-2006	65,54	66,19	66,68	67,04	0,99 %	5,67 %	6,65 %
feb-2006	61,93	63,15	64,04	64,72	1,95 %	-1,67 %	0,29 %
mar-2006	62,97	64,46	65,3	65,87	2,34 %	-10,81 %	-8,47 %
apr-2006	70,16	71,61	72,43	72,88	2,05 %	-1,13 %	0,91 %
mai-2006	70,96	72,08	72,88	73,47	1,57 %	-0,01 %	1,55 %
jun-2006	70,97	71,69	72,37	72,9	1,01 %	-4,80 %	-3,79 %
jul-2006	74,46	75,71	76,44	76,95	1,66 %	1,87 %	3,54 %
aug-2006	73,08	74,28	75,11	75,74	1,63 %	13,42 %	15,05 %
sep-2006	63,9	64,84	65,75	66,54	1,46 %	7,74 %	9,20 %
okt-2006	59,14	60,83	62,07	63	2,82 %	-0,44 %	2,38 %
nov-2006	59,4	61,18	62,42	63,37	2,95 %	-4,43 %	-1,48 %
des-2006	62,09	63,16	64,06	64,75	1,71 %	13,31 %	15,02 %
jan-2007	54,35	55,34	56,16	56,85	1,81 %	-8,87 %	-7,06 %
feb-2007	59,39	60,2	60,96	61,58	1,35 %	-2,25 %	-0,89 %
mar-2007	60,74	62,49	63,54	64,31	2,84 %	-5,29 %	-2,45 %
apr-2007	64,04	65,84	67,07	67,84	2,77 %	0,80 %	3,57 %
mai-2007	63,53	64,92	66,02	66,84	2,16 %	-6,11 %	-3,94 %
jun-2007	67,53	68,18	68,85	69,37	0,96 %	-9,35 %	-8,39 %
jul-2007	74,15	74,2	74	73,83	-0,07 %	-2,44 %	-2,51 %
aug-2007	72,36	72,06	71,66	71,25	0,42 %	9,57 %	9,99 %
sep-2007	79,63	78,47	77,45	76,71	1,47 %	7,30 %	8,77 %
okt-2007	85,66	84,66	83,77	82,99	1,17 %	9,96 %	11,13 %
nov-2007	94,63	93,67	92,77	91,95	1,02 %	-3,10 %	-2,08 %
des-2007	91,74	91,59	91,29	90,92	0,16 %	1,29 %	1,45 %
jan-2008	92,93	92,59	92,19	91,82	0,37 %	2,57 %	2,94 %
feb-2008	95,35	95,19	94,93	94,66	0,17 %	10,04 %	10,21 %
mar-2008	105,42	104,47	103,58	102,82	0,91 %	6,46 %	7,37 %
apr-2008	112,46	111,8	111,09	110,41	0,59 %	10,94 %	11,53 %
mai-2008	125,46	125,31	125,08	124,84	0,12 %	6,60 %	6,72 %
jun-2008	134,02	134,52	134,78	134,89	0,37 %	0,40 %	0,78 %
jul-2008	133,48	134,09	134,52	134,88	0,46 %	13,44 %	13,90 %
aug-2008	116,69	116,92	117,31	117,66	0,20 %	11,74 %	11,94 %
sep-2008	103,76	103,03	103,21	103,48	0,71 %	-30,19 %	-29,49 %
okt-2008	76,72	76,83	77,14	77,52	0,14 %	28,94 %	29,09 %

nov-2008	57,44	58,22	59,16	60,12	1,35 %	31,21 %	32,56 %
des-2008	42,04	45,16	47,2	48,78	7,16 %	0,29 %	7,44 %
jan-2009	41,92	46,39	49,11	50,9	10,13 %	6,56 %	16,69 %
feb-2009	39,26	43,13	45,47	46,92	9,40 %	-20,22 %	-10,82 %
mar-2009	48,06	49,5	50,75	51,78	2,95 %	-3,86 %	-0,90 %
apr-2009	49,95	52,01	53,82	55,15	4,04 %	-17,01 %	-12,97 %
mai-2009	59,21	60,14	61	61,79	1,56 %	-16,31 %	-14,75 %
jun-2009	69,7	70,47	71,29	71,98	1,10 %	8,08 %	9,18 %
jul-2009	64,29	65,57	66,82	67,85	1,97 %	-10,12 %	-8,15 %
aug-2009	71,14	72,57	73,67	74,47	1,99 %	2,38 %	4,37 %
sep-2009	69,47	69,91	70,4	70,9	0,63 %	-8,75 %	-8,12 %
okt-2009	75,82	76,29	76,83	77,35	0,62 %	-3,03 %	-2,41 %
nov-2009	78,15	78,93	79,71	80,43	0,99 %	4,65 %	5,64 %
des-2009	74,6	76	77,08	77,91	1,86 %	-4,97 %	-3,11 %
jan-2010	78,4	78,85	79,41	79,99	0,57 %	2,52 %	3,09 %
feb-2010	76,45	76,84	77,32	77,8	0,51 %	-6,14 %	-5,63 %
mar-2010	81,29	81,66	82,06	82,44	0,45 %	-3,97 %	-3,51 %
apr-2010	84,58	85,92	87,05	87,77	1,57 %	13,20 %	14,77 %
mai-2010	74,12	76,89	78,41	79,35	3,67 %	-1,73 %	1,94 %
jun-2010	75,41	76,43	77,28	78	1,34 %	-1,28 %	0,07 %
jul-2010	76,38	76,82	77,29	77,83	0,57 %	-0,38 %	0,20 %
aug-2010	76,67	77,26	78,02	78,72	0,77 %	1,47 %	2,24 %
sep-2010	75,55	76,82	78,08	79,06	1,67 %	-8,13 %	-6,46 %
okt-2010	81,95	82,71	83,41	83,98			

"You'll always be much more than a commodity to me."