UNIVERSITY OF PIRAEUS

DEPARTMENT OF BANKING

& FINANCIAL MANAGEMENT

"HEDGING PRESSURE AND INVENTORIES AS DETERMINANTS OF COMMODITY FUTURE RETURNS"

SEPTEMBER 2013

ΟΝΟΜΑΤΕΠΩΝΥΜΟ ΦΟΙΤΗΤΗ: ΧΡΥΣΙΚΟΣ ΔΗΜΗΤΡΗΣ

ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ: ΕΠΙΚ. ΚΑΘΗΓΗΤΗΣ Ν. ΚΟΥΡΟΓΕΝΗΣ

ΜΕΛΗ ΕΠΙΤΡΟΠΗΣ: ΚΑΘΗΓΗΤΗΣ Ν. ΠΙΤΤΗΣ, ΕΠΙΚ. ΚΑΘΗΓΗΤΡΙΑ Χ. ΧΡΙΣΤΟΥ.

ABSTRACT

Commodity futures have been expanding rapidly during the last years and represent a very important investment instrument. Investors use commodity futures for hedging and speculative purposes. A lot of theories have been developed to assess the determinants of futures returns. By detecting the factors that cause a backwarded or a contango market we can explain why futures deviate from their fair value. The latter reflects the expected spot price. In the current analysis we are going to develop the normal backwardation theory, the theory of storage and the hedging pressure theory which refer to the relation between spot and futures prices.

Key words: spot market, futures market, hedging, basis risk, risk premium, inventories, long positions, short positions, futures excess returns

CONTENTS

1. INTRODUCTION

Commodities refer to products such as oil, gold, silver, natural gas, corn, wheat, iron e.t.c. These kinds of goods are usually used as inputs for the production of other goods. The quality of a commodity might differ amongst producers but the corresponding differences are not significant.

Economic agents engage in daily activities concerning the transaction of commodities. A gold miner for instance will sell gold to an industry that uses the specific commodity as an input. The prices of commodities are determined by supply and demand. When demand is higher than supply the price of the commodity will rise while if supply is higher than demand prices will obviously drop. Since these transactions take place in cash the corresponding market is defined as the spot market (Sheffrin, 2003)

The prices of commodities in the spot markets and in turn in the futures market are influenced by many unpredictable factors such as political turmoil, weather conditions, change in consumer preferences, government intervention , taxes. If for instance there is a political turmoil the price of oil will rise or if a new goldmine is discovered the price of gold will drop. Therefore taking into consideration that these factors constantly change commodities prices will fluctuate.

The prices of commodities and futures contracts as well depend on the business cycle. Gorton and Rouwenhorst (2004) demonstrated that commodity futures perform relatively well in the early stages of a recession and relatively bad in the later stages of a recession. When the economy experiences a stage of expansion commodity futures perform better in the later stages than what they do in the earlier stages.

Buyers and sellers in order to effectively tackle with any source of unpredictability have created the futures market. A futures contract is an agreement between two parties to buy or sell an asset (commodity in our case) at a certain time in the future for a certain price. Unlike forward contracts futures contracts are traded on an exchange (Hull, 1997).

To make trading possible the exchange specifies certain standardized features of the contract. As the two parties to the contract do not necessarily know each other the exchange also provides a mechanism which gives the two parties a guarantee that the contract will be honored.

There are three types' traders activating in the futures market such as hedgers speculators and arbitrageurs. The primary objective of a hedge is to lock in a price of the commodity he buys or sells in order to be protected from an event that cannot be foreseen in the future. Let us take the case of a company that intends to buy oil in three months. The spot price is 40 $ a barrel while the futures price is 48 $. The buyer expects a great volatility in the oils price so in order to lock in the price he buys futures contacts the number of which depend on his total exposure. No matter what happens in the future the buyer knows in advance that he will pay 48 $ per barrel.

While hedgers want to eliminate an exposure to movements in the price of a commodity a speculator takes position in the market and never uses commodities in any manufacturing capacity. Speculators try to guess the trend of the market in order to make profits. A speculator buys a futures contract if he expects that spot prices will rise and sells a futures contract if he anticipates a price decline. Many people argue that speculators can cause market distortions but while this can be true they add liquidity to the market which is of course something positive. The price movements of futures contracts are very unpredictable so anyone who wants to capitalize on these movements runs a very high risk (Haugen, 1992).

Investing in futures is not exactly like gambling. When gambling is concerned one party will lose and one party will win and total risk will increase. Hedging involves a transfer risk mechanism that barely results in a total risk increase

Arbitrageurs are a third important group of participants in derivatives markets. Arbitrage involves lock in a riskless profit by entering simultaneously into transactions in two or more markets. In a following section we shall demonstrate how arbitrage is sometimes possible when the futures price of an asset or commodity is out of line with the cash price.

Let us now mention the advantages and disadvantages of futures. An advantage of a future contract is that it is a highly leveraged investment. An investor who wishes to trade a future invests a small fraction of the value of the contract which it is called a margin. His profits will be a multiple compared to the initial amount he invested and his percentage return will be much higher than the return he would realize if he bought the commodity (Meigs & Meigs, 1970).

Another advantage is that if a speculator takes position in the market he is not obliged to deliver or buy the underlying commodity. He can close his position at any time in a market that is characterized by high liquidity. A potential advantage is also that the commission charges for initiating a position in the market are very small.

The disadvantages can be the following. Leverage can work against the investor if he does not guess correctly the market movement. An investor might put 1.000 $ as a margin but lose a multiple amount i.e. 5.000 $ which makes the investment extremely risky. In few words a speculator can lose more than he invested.

A future contract unlike stocks is a short term investment. When the future expires the investor should switch to another contract. Finally trading future requires constant monitoring. The prices of derivatives constantly change exhibiting high volatility and the investor / speculator should be on the alert.

Prices and returns of commodities futures are affected by three major factor such as the spot price the roll yield and the collateral interest. Futures as mentioned earlier are closely related to spot prices. If such a thing does not occur than arbitrage opportunities arise. Moreover when spot prices change than expectations about future spot prices might change and as a result of this the price of the future which reflects the expected future spot price will change as well (Gorton, Hayashi, & Rouwenhorst, 2007).

As we know future contracts have different expirations. Let us assume than an investor has a long position in a contact which expires in a few days and wishes to maintain his long position by rolling to another contract of different expiration. The contract which expires in a few days will converge to the final spot price. In a backwardation market where the price of the futures contract converges upwardly to the expected spot price the investor will close his position selling the expensive contract by expiration and will switch to a cheaper contract realizing a positive roll yield. In a contago market where the price of the short term future is higher than the expected short term spot price the investor will realize a negative roll yield by selling the contract at expiration and buying a more expensive contract. Exactly the opposite will occur if the investor wants to maintain a short position. In other words in a backwarded market the futures contract is traded at a discount relatively to its fair value while the opposite occurs in a contango market.

Finally, another factor that affects futures prices is the interest rate. This occurs because spot and future prices are related through a specific formula that takes into consideration the interest rate.

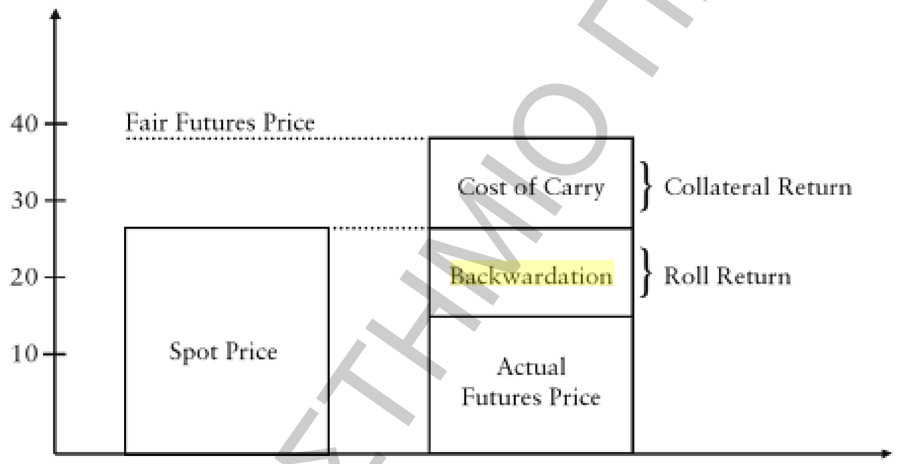


Figure 1: Comparison of Spot Price and Fair Futures Price (*Source: www.liffeinvestor.com/learning-center/futures/why-investors-use-futures)*

Return components of futures

In the present assignment we are going to examine how hedging pressure and the level of inventories affect commodity futures prices /returns. We are going to examine the theory of storage which assumes that holders of inventories enjoy implicit benefits and the backwardation theory which states that commodity producers and inventory holders hedge future spot price risk by taking short positions in the futures market. The hedging pressure and the level of inventories held mainly affects the roll yield described above which in turns affects commodities future returns.

2. THE EXPANSION OF COMMODITY FUTURES AND COMMODITY PRICES

During the last decade we have experienced a radical change in the structure of commodity markets which has not been experienced during all the previous decades. Commodity futures markets transitioned from a primarily telephone/open outcry trading platform to a computer/electronic order matching platform. Every investor now could have access to this market incurring at the same time declining transaction costs (Scott H. Irwin & Dwight R. Sanders, 2012).

Investments in commodities therefore have exhibited a surge during the last years through commodity futures and commodity index funds which have adopted a passive strategy by investing in this market and forming a portfolio that tracks the corresponding index. In 2009 the total commodity index investment in the US amounted to 174 bil $.

An important factor that has contributed to the expansion of commodity futures was the financialisation of the corresponding market. Financialisation is defined as the increasing importance of financial markets in the operation of the economy.

In the following diagram we show how investments in futures increased during the last decades.

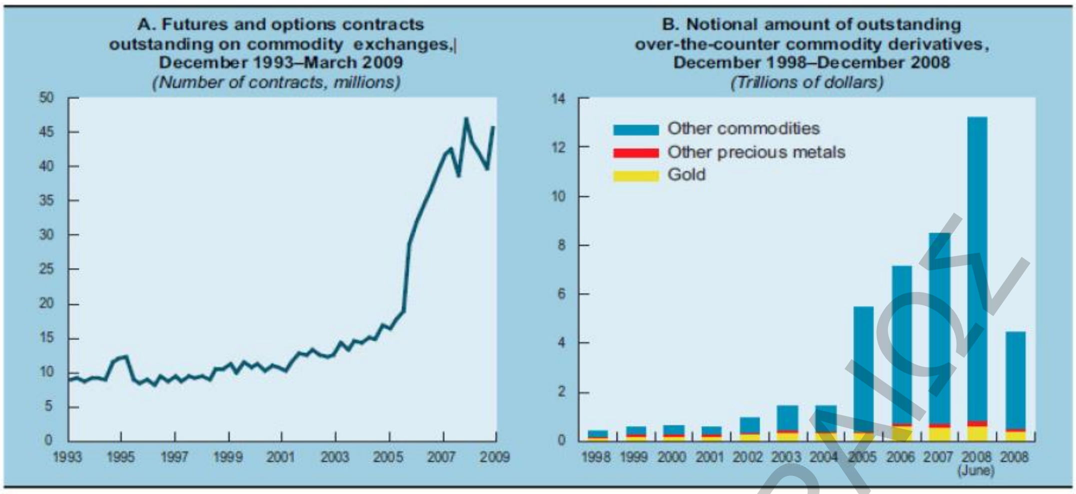
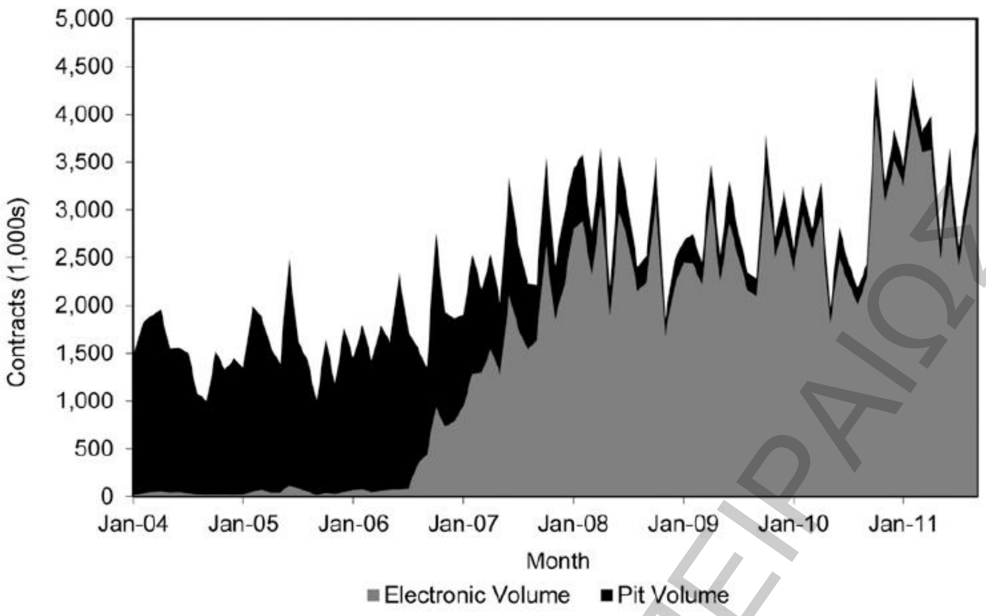


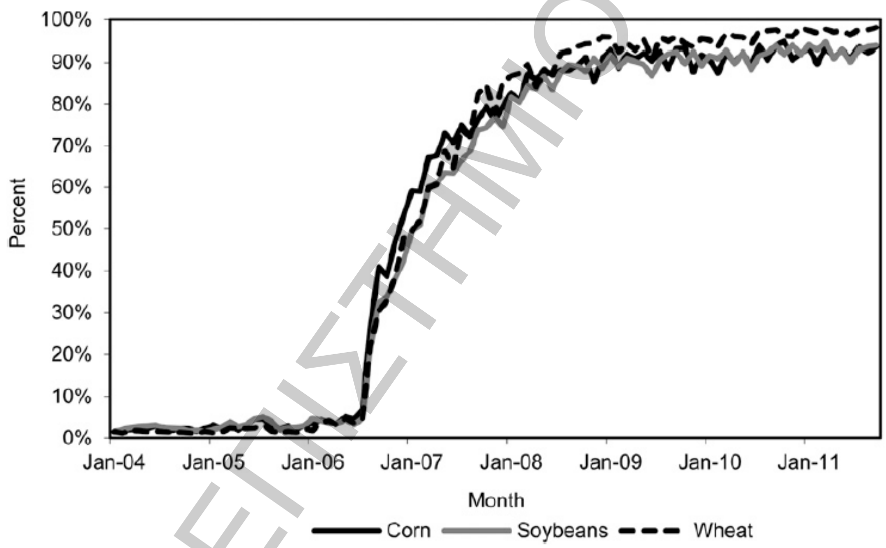
Figure 2: a) Evolution of contracts during 1993-2009, b) commodity derivatives (*Source: Scott H. Irwin & Dwight R. Sanders, 2012*).

In the last decades the rapid growth of emerging markets has also resulted in the increase of demand for commodity products. Economies such as India and China appeared as strong players in the global market and therefore an increased demand for commodities such as copper, oil, and soybeans was bound to occur. Let us now examine some facts regarding the enormous growth of the commodity future market

Trading volumes in this period increased dramatically. For the period between 2000 – 2003 the soybean futures had an average trading volume of 1.2 mil contracts. Over the next six years the trading volume for the specific market more than tripled. The increase in the livestock futures was even more significant. Despite the increase in the trading volume the proportions of trading activity to market volume remained rather constant.

Electronic trading after a modest increase for the period 2000 – 2005 expanded rapidly after 2006. In July 2006, electronic trading volume was less than 5 % of total monthly volume in soybean futures contracts. A few months later over 80 % of the monthly trade had migrated from the trading pit to the electronic platform. The general trend of electronic volume can be seen in the following diagram.





Percent of Futures Volume Transacted on Electronic Platform, Grains, 2004–2011

Figure 3: a)Electronic volume contracts vs P/t Volume contracts b)Electronic platform transactions *(Source: Scott H. Irwin & Dwight R. Sanders, 2012).*

In 2003 open interest started to increase dramatically and reached a peak of 878.000 contracts at the beginning of 2008. Open interest declined during the financial crises of late 2008 and 2009, but then moved higher again in 2011. In the following diagram we can see the interposal increase of future contracts for specific commodities (Liang, Miller, Harri, & Coble, 2012).

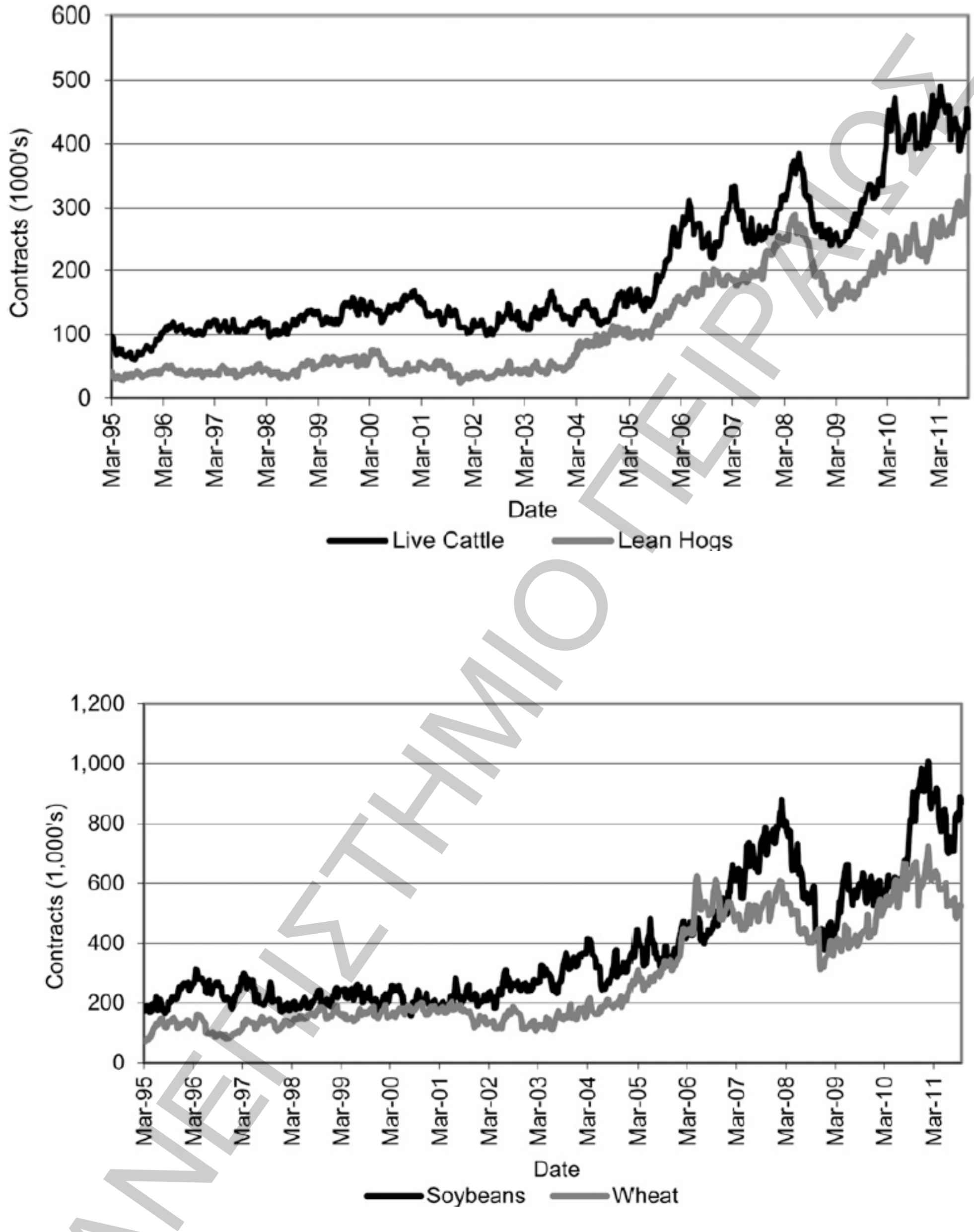


Figure 4. Evolution of contracts concerning a)Live Cattle b)Lean Hogs, c)Soybeans d)Wheat over the period 1995-2011. *(Source: Journal of Agricultural and Applied Economics, 2012).*

Another issue we can examine is the mix of market participants. No reported traders have been playing a declining role in the futures market. One of the reasons for this trend was the rapid development of index funds which invested huge amounts of resources in the market. In the grain market for instance non reporting traders comprised as much as 35 % of open interest while during the last years this percentage was about 10 %. It is obvious that the relative importance of no commercial traders has declined.

In the following diagram we demonstrate the trend of no reported traders.

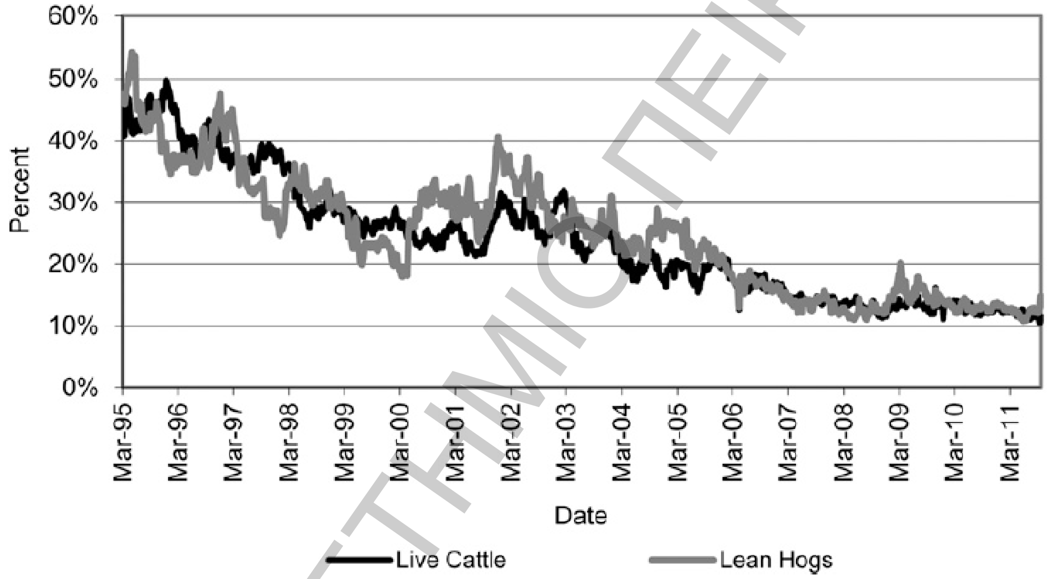


Figure 5: No reported traders *(Source: Journal of Agricultural and Applied Economics, 2012).*

After examining the trend of no reported traders we shall view some statistics regarding the composition of market participants. These statistics is presented in the following data.

Time Period	Index Traders (%)	Processors and Merchants (%)	Swap Dealers (%)	Managed Money (%)	Other Reportables (%)	Non-reporting Traders (%)
Panel A: Corn						
Jan 2004–May 2005	11.1					18.9
June 2006–Dec 2008	11.6	33.4	12.5	15.3	25.5	13.4
Jan 2009–Oct 2011	15.0	29.0	15.1	18.2	24.3	13.4
Panel B: Soybeans						
Jan 2004–May 2005	9.5					21.8
June 2006–Dec 2008	13.1	31.6	13.1	18.3	23.0	14.0
Jan 2009–Oct 2011	15.3	30.4	14.9	19.3	24.1	11.4
Panel C: Wheat						
Jan 2004–May 2005	20.5					13.0
June 2006–Dec 2008	21.9	24.0	21.9	22.3	21.7	10.1
Jan 2009–Oct 2011	24.7	22.9	24.3	21.1	22.3	9.5
Panel D: Live cattle						
Jan 2004–May 2005						19.4
June 2006–Dec 2008	21.0	26.4	18.8	24.4	16.0	14.5
Jan 2009–Oct 2011	17.7	27.3	15.3	25.7	19.0	12.7
Panel E: Lean hogs						
Jan 2004–May 2005						22.6
June 2006–Dec 2008	22.0	26.4	19.3	22.1	18.3	14.0
Jan 2009–Oct 2011	20.2	25.2	17.1	23.8	20.2	13.7

Table 1: Percent of Total Open Interest by Trader Category 2004-2011. *(Source: Supplemental COT Reports).*

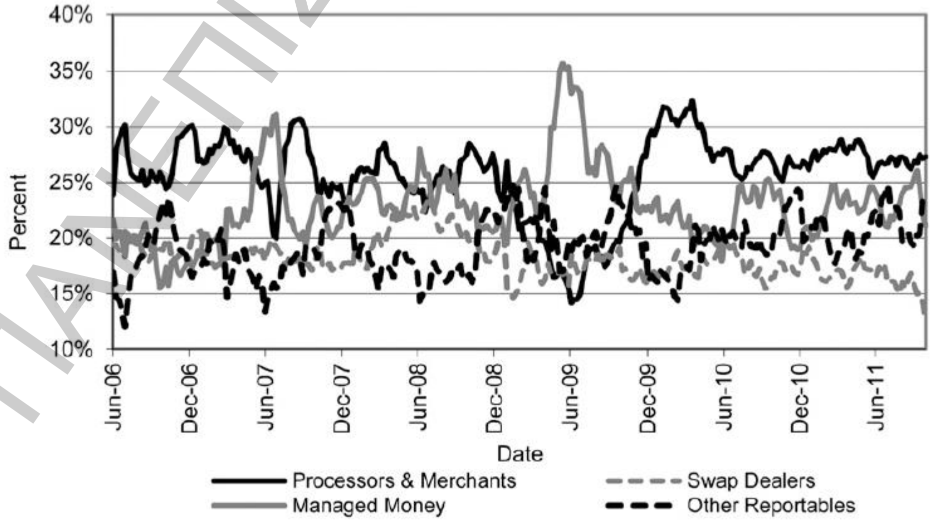


Figure 6: Composition of market participants *(Source: Supplemental COT Reports).*

The expansion of the commodity market can be viewed from a rational and an irrational perspective as well. The broader market participation and the declining risk premium represent the positive impact of the outburst of this market. There were however as we already mentioned irrational impacts such as the creation of a bubble both in the spot and futures market. This bubble resulted in erroneous investment decisions and in a natural subsequent price collapse.

Commodities prices were driven up mainly by speculators actions. This type of investors viewed commodities futures a very profitable investment due to its low risk. Speculators according to many investors played a very important role in the oil spike before the crisis of 2008.

The price increase of commodity futures during the last ten years amounted to about 250 %. The increase was not attributed only to speculators but to commodity index funds which wanted to exploit the diversification benefits of a commodity. The collapse of commodity prices according to many researchers was not the result of high prices. It was the result of price sensitiveness of index funds which had to liquidate their position (Gorton, Hayashi, & Rouwenhorst, 2007).

Gilbert (2009) states that there is a significant relation between index fund trading and price changes in the futures market. The particular author states that the impact of the presence of index funds on the last price increase was about 15 %. In a subsequent research he finds that there was a significant relation between index fund trading and food prices increases.

Singleton (2011) by running a regression of crude oil futures prices as a dependent variable and several independent variables he finds that index trading has a statistically significant relation with future commodity contracts prices.

Other researchers however argue that there was not a significant linkage between the level of commodity futures prices and the positions initiated by index funds. Even if the relation was significant it is hardly likely than index funds resulted in the bubble.

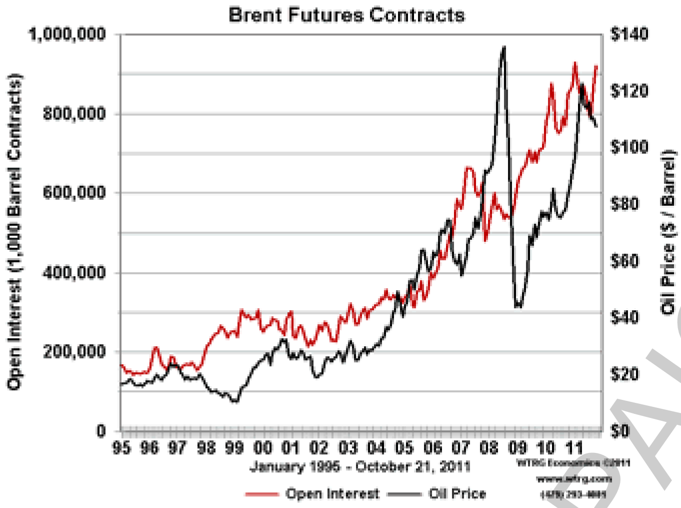


Figure 7. Brent Futures Contracts *(Source: Singleton 2011)*

Let us now examine more extensively the benefits stemming from the expansion of the commodity market. A rational impact of the surge in the trading of commodities was the market integration. Prior to the development of index funds commodity markets not fully integrated with other financial markets. After the increased presence of index funds however the market integration intensified and there were now stronger linkages between commodities and other financial markets. The increased correlation between commodities and other classes of assets implies that commodity futures reflect in a more efficient way shocks that occur within the economy. Finally, the integration between the commodity market and other financial markets was attributed according to a few researchers not to index funds but to hedge funds. The latter enter usually the market for speculative reasons aiming at realizing short term capital gains.

As we shall see later the backwardation theory predicts that short hedgers will compensate long speculators with a risk premium. As the commodity market expanded this risk premium was reduced since more information was now available regarding future spot prices reducing therefore uncertainly regarding this aspect. Moreover the development of index funds resulted in the decreased volatility of future prices which obviously constituted an additional reason for the declining risk premium. Hamilton and Yu (2011) present evidence that risk premiums in crude oil futures declined sharply after 2005.

Let us now see why commodities represented during the last years such an attractive investment especially for index funds. Commodities generally speaking, form an alternative asset class and their prices either in the spot market or in the futures market show a small or negative correlation with assets such as stocks or bonds. Recent studies however show that commodities have become more correlated to other assets due to the increased presence of index traders in the commodities market. The underlying factors that affect commodity prices appear to be different than the factors affecting other financial assets. Moreover, commodities serve as an inflation hedge (Whaley, 2010).

Investing in commodities offers diversification benefits. Investors by investing in commodities can reduce their risk by not sacrificing return. Including commodities in an investor's portfolio shift upwards the efficient frontier set. All the studies made during the last decades have demonstrated that investors are better off by including commodities in their optimal portfolio. This can be shown in the following diagram.

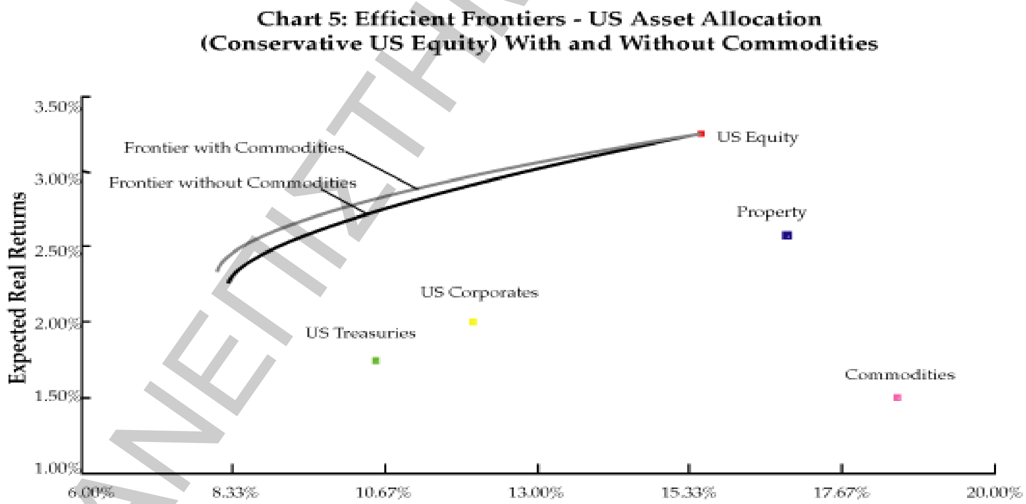


Figure 8: Efficient frontiers-US AssetAllocation (Conservative US Equity) With and Without Commodities *(Source: Whaley 2010).*

However we should take into account two major points. First the Marcovitz approach regarding the efficient set is based on the normality of asset returns. Commodity futures prices might not be normally distributed. Secondly, previous studies have tried to detect the benefits of investing in commodities within an in sample setting while the portfolio choice should be examined in an out of sample setting since investors constantly rebalance their portfolio (Whaley, 2010).

The following diagram depicts price appreciations of four individual commodity features, crude oil, wheat, copper, gold, and one commodity index, the S&P GSCI, over the period January 1990 to May 2012. In each case, the prices are normalized to be 100 in January 1990.

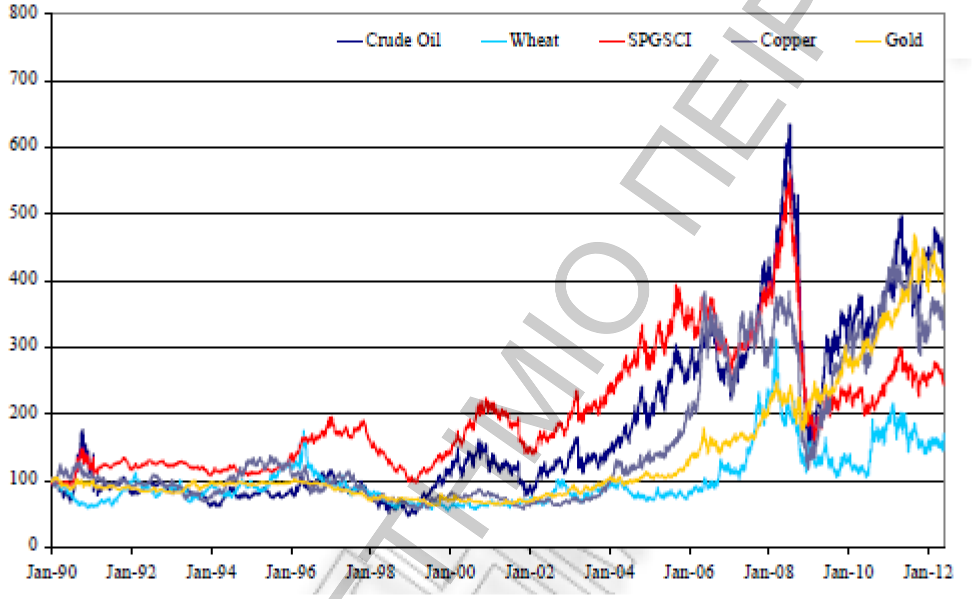


Figure 9: Commodity prices over the period January 1990-May 2012 (*Source: Journal of Agricultural and Applied Economics 2012)*

3. THE BASIC CHARACTERISTICS OF FUTURE CONTRACTS

Let us now define what a commodity future is stressing out its main attributes. A commodity future is an agreement either to buy or to sell a specific quantity of a commodity at a specific future date and at a specific price. A very important question that arises is how the price is determined. As we already saw and we shall explain later there are many factors affecting the price of a future contract.

When somebody buys or sells a future contract he locks in the price he will pay in the future. So the current price of the future contract embeds expectations about the future spot price that will prevail at expiration. These contracts are forward looking and if future spot prices are expected to be much higher than current spot prices the futures price will be high as well. Lower expected spot prices in the future will be reflected in a low current futures price (Black, 1976).

Futures investors who buy contracts will benefit if the futures spot price at expiration is higher than the expected price. The opposite will occur for investors who have to deliver a product that is for sellers of the contract. If future spot prices are lower than expected prices than a hedger who locked in the price of the commodity to be purchased will lose because if he did not buy the contact he would have paid a lower price.

The return an investor will realize if he does not succeed in outsmarting the market is the risk premium. The latter is defined as the difference between the current futures price and the expected future spot price. If the price of the futures is set below the expected spot price at time of expiration then the buyer of the future earns a risk premium. If the price of the futures contract is set above the expected spot price then it is the seller of the future who is compensated for taking the corresponding position. (Kat & Oomen, 2007).

From the introductory section we can infer that the risk premium of futures depends on the volatility of the spot price, the risk associated with interest rates and the volatility of the roll yield. The roll yield in turn is affected by factors such as storage costs, convenience yield e.t.c. The most prominent factor that explains variations in future returns is the roll yield. The latter determines if the current market is at a contango or backwarded. In the following diagram we present empirical values for the roll yield.

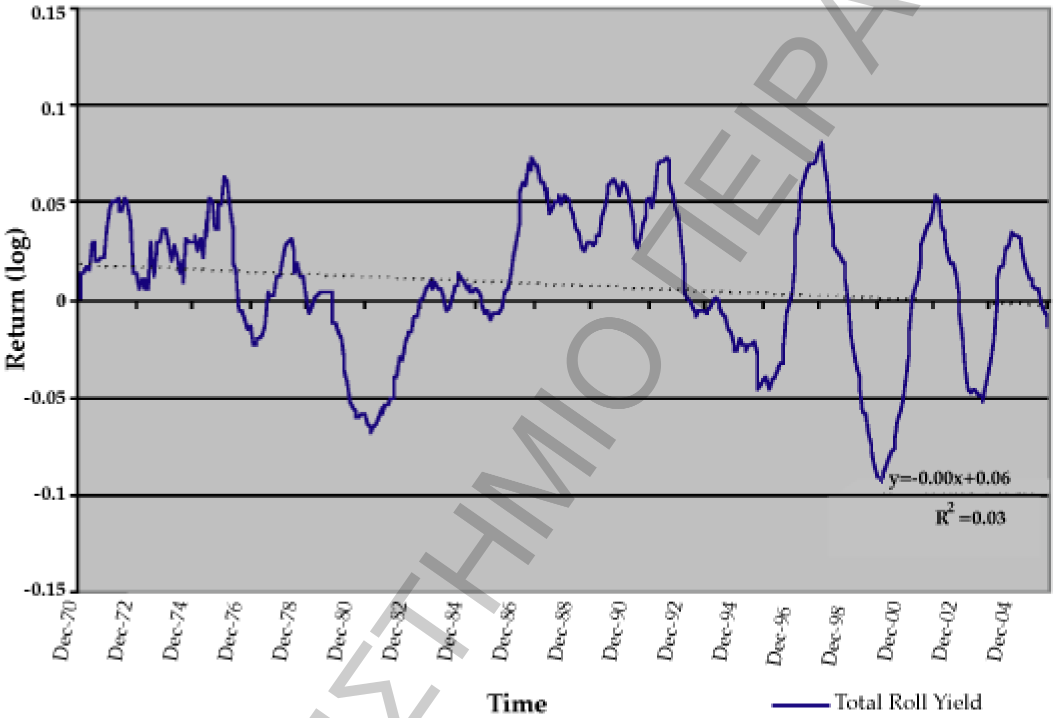


Figure 10: Twelve Month Moving Average Roll Yield (1970-2004) *(Source: Kat, Oomen, 2007)*

Someone might ask to which of the market participants the risk premium accrues. To buyers or to sellers. According to the theory of backwardation the risk premium will accrue to the buyers of the contract. In his case there are a lot of producers who want to lock in the price of their output. To accomplish such a think they will resort to the hedging technique and sell a futures contract. In order to motivate speculators to buy a contract they will have to compensate them for the risk they initiate with a risk premium which means that the futures price will be below the expected spot price (Keynes, 1930).

In a world where there are mainly producers who use the commodity as an input there will be many future contract buyers who want to lock in the price as an insurance for a future price increase. In this case the futures price will be set above the expected spot price and sellers of commodity futures will gain a risk premium.

When investing in a futures contract we should stress out the following points:

- The realized payoff of a future contract is the risk premium plus any deviation of the future spot price from the expected future price.
- A long position in futures is expected to earn positive excess returns if the future price is set below the expected spot price. If such a thing occurs then a long investor will earn a positive return since the futures price will converge to the expected spot price as we approach expiration. We should mention however that most of the time expectations fail which renders our analysis very theoretical.
- Expected trends in spot prices are not a source of return to an investor in futures

To illustrate how the risk premium works we present a numerical example. Let us assume that we live in a market, which mainly consist of sellers who want to sell the output of oil in the future. To minimize the risk of future price fluctuations they are going to sell future contracts.

Let us assume that the spot price is 30 $ a barrel and market participants expect price to be 27 $ in 3 months. Someone would expect that the current price of the future should be 27 $ (ignoring other parameters which will be analyzed in other sections). This is not the case however. In order to motivate investors to take a long position the contract should be traded lets sat at 25 $ offering to buyers a risk premium of 2 $. If the spot price in 3 months is 26 then the buyers will realize a return of 1 $ which is the risk premium of 2 $ minus the 1 $ deviation of the final spot price from the expected spot price. If the spot price is finally at 32 $ investors will earn 5 $ which can be broken down as the risk premium (2 $) plus the deviation from the spot market (3 $).

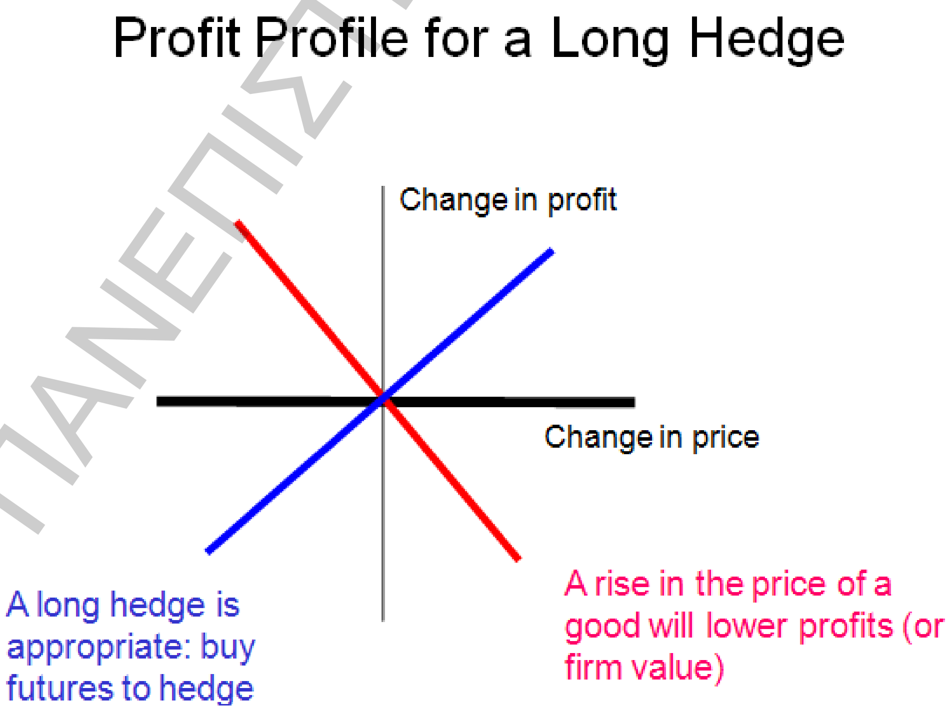
Before proceeding in the next chapter we shall make a reference to the hedging pressure theory which determines to a great extent not only the risk premium but also the type of investors who will capture this return. Risk premiums are present in both backwarded and contangoed markets. In the former market hedgers are net short and speculators are net long while in the latter hedgers are net long and speculators are net short. Backwardation is associated with an appreciation in commodity futures prices while contango is associated with depreciation in commodity futures prices (Hirshleifer, 1989).

4. HEDGING USING COMMODITY FUTURE CONTRACTS

4.1 The concept of hedging

A company that knows that it is due to sell an asset at a particular time in the future can hedge by taking a short futures position. This is called a short hedge. If the price of the commodity goes down the investor will lose on the sale of the asset but will realize a gain in the short futures position. If the price of the asset goes up the company gains from the sale of the commodity but takes a loss on the futures position. If a company knows that it will buy an asset in the future it can hedge by taking a long futures position.

In the following diagrams we present the payoff profile for a long and short hedge.



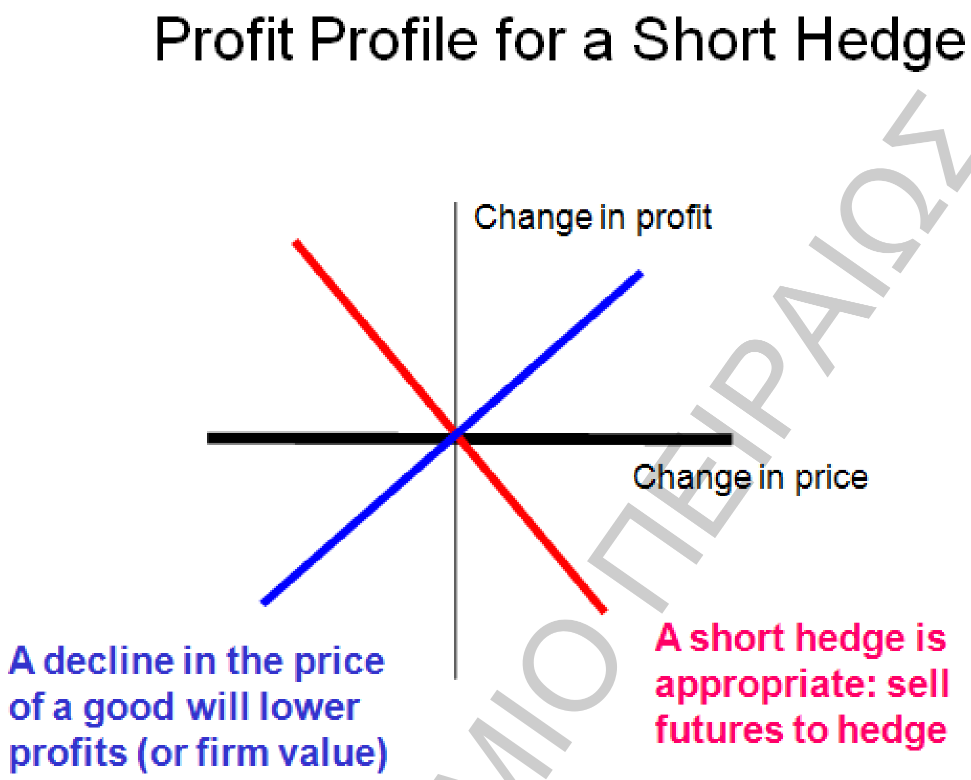


Figure 11: Profit Profile a)for a Long Hedge, b)for a Short Hedge *(Source: Hull 1998)*

Hedging does not necessarily improve the financial outcome. Hedging can make the outcome worse roughly 50 % of the time. What it definitely does is to reduce risk by making the outcome more certain. There are many reasons for which hedging using futures works less then perfectly in practice (Hull, 1998).

- The asset whose price is to be hedged may not be exactly the same as the asset underlying the futures contract
- The hedger may be uncertain as to the exact date when the commodity will be sold or bought.
- The hedge may require the futures contract to be closed out well below the expiration date. These problems give rise to what is termed basis risk.

4.2 The basis risk

The basis is defined as the spot price of an asset to be hedged minus futures price of contracts used. When the spot price increases by more than the futures price the basis is strengthening while when the futures prices increases by more than the spot price the basis is weakening (Hull, 1998).

We define b1 = S1- F1 and b2 = S2 – F2 where S1 spot price at time t1 S2 spot price at time t2 , F1 futures price at time t1 , F2 futures price at time t2 , b1 basis at time t1 and b2 basis at time t2.

Let us assume that a hedger who plans to sell an asset at time t2 takes a short position at t1. The effective price to be obtained for the asset with hedging is S2+F1 – F2 = F1 + b2. The hedging risk is associated with b2 and this is called the basis risk. With commodities such as gold and silver the basis risk is rather small since the relationship between the futures price and the spot price of these commodities is well defined. In the case of a commodity such as oil corn or copper imbalances between supply and demand and the difficulties sometimes associated with storing the commodity can lead to large variations in the basis and therefore to a much higher basis risk.

We know present an example relating to the above. It is June 8 and a company will need to purchase 20.000 barrels of crude oil at some time in October or November. The contract size is 1.000 barrels. The company decides to use the December contract for hedging and takes a long position in 20 December contracts. The future price of June 8 is 18 $ per barrel. The company knowing now that it will need to purchase the oil on November decides to close out its future contract position. The spot prices and future prices on November are 20 $ and 19,1 $ per barrel so that the basis is 0.9 $. The effective price paid is 18.9 $ per barrel and is calculated as the final spot price of 20 $ less the gain on the futures of 1,1 $ or as the initial futures price of 18 $ plus the final basis of 0,9 $.

4.3 The optimal hedge ratio

The basic functions of future markets are price discovery, hedging, speculation, risk sharing. As we already know hedgers use these markets as a means to avoid risk associated with adverse movements in the cash market. A hedge is performed when an investor takes positions both in the cash and future market. The investor expects that any losses in the cash market will be offset by gains in the futures market. However an investor might be better off in case he does not use hedging if for instance the price of commodity a producer delivers rises in the spot market.

The optimal hedge ratio is the ratio of the size of the position taken in futures contracts to the size of the exposure and aims at minimizing the investor's risk. The formula is the following such as $\mathbf{H = \rho * \sigma_S / \sigma_F}$, where σ_S is the standard deviation of the change in spot price during a period of time equal to the life of the hedge, σ_F is the standard deviation of the change in futures prices during a period of time equal to the life of the hedge and ρ is the correlation between the change in spot price and the change in futures price.

Let us present now an example relating to the computation of the optimal hedge ratio. A company is planning to buy one million gallons of jet fuel in three months. The standard deviation of the change in the price per gallon of jet fuel over a three month period is calculated as 0,032. The company chooses to hedge by buying futures contracts on heating oil. The standard deviation of the change in the future price over a three month period is 0,04 and the coefficient of correlation between the three month change in the price of jet fuel and the three month change in the futures price is 0,8. The optimal hedge ratio is 0,8 * 0,032 / 0,04 = 0,64. One heating oil futures is on 42.000 gallons. The company should therefore buy 0,64 * 1.000.000/ 42.000 = 15 contracts.

5. THE RELATION BETWEEN COMMODITY FUTURE AND SPOT PRICES

All derivatives valuation models make use of a fundamental idea. It is always possible to develop a portfolio consisting of the underlying asset and a risk free rate that perfectly the future cash flows of the derivative and in our case the future contract. A perfect tracking portfolio is a combination of securities that perfectly replicates the future cash flows of another investment (Titman, 1992).

The ability to perfectly track a derivatives payoff with a dynamic strategy usually depends on a few assumptions which are the following:

- The price of the underlying security must change smoothly
- It must be possible to trade both the derivative and the underlying security constantly
- Markets must be frictionless

5.1 Future contract that provides no income

There is a specific formula that connects the current price of the future with the stock price. The formula is as following: $\mathbf{F = S * (1+R)^{T-t}}$

Where F is the current price of the future R is the annual interest rate and T-t is the time left until expiration. If this equation does not hold then arbitrage opportunities arise.

Let us assume that $\mathbf{F < S * (1+R)^{T-t}}$.

In this case the investor can short the asset get the proceeds and invest it getting the risk free rate for a given period. At the same time the investor will buy a future. When the future contract expires the investor will buy the asset under the terms of the contract for F and will deliver the asset closing his short position in the cash market. The profit he will get will be equal to $\mathbf{S * (1+R)^{T-t} – F}$.

If F > $S * (1+R)^{T-t}$ the investor can borrow S dollars for a period T-t at the risk free rate buy the asset and make a short position in the future contract. At time T the asset is sold under the terms of the futures contract and $S * (1+R)^{T-t}$ is used to repay the loan. A profit of $F - S * (1+R)^{T-t}$ is realized at time T**.**

We now present a simple example. Suppose that the price of the stock is 40 $ the future contract trades at 41 $ the risk free rate is r = 0,05 and the contract expires in three months. In this case $S * (1+R)^{T-t}$ = 40,5 $ and F = 41 $. The investor can sell short a future and buy the good by borrowing 40 $. When the contract expires the investor will have to pay 40,5 and will get 41. Therefore he will realize a risk free profit of 0,5. All investors will detect this arbitrage opportunity and arbitrage will take place until the equation holds.

5.2 Future contract that provides income

Let us assume that we are dealing with a stock that provides income I. This income can come in the form of a dividend. The price of the future referring to the stock will be equal to $\mathbf{F = (S - I) * (1+R)^{T-t}}$

If $F > (S - I) * (1+R)^{T-t}$ then the investor can borrow an amount of money equal S and buy the stock. At the same time he will open a short future position. Assuming that the income is used to pay part of the loan, when the future expires the investor will pay an amount of $(S - I) * (1+R)^{T-t}$. At the same time he will get an amount F from the future contract and the profit he will realize will be equal to $F - (S - I) * (1+R)^{T-t}$.

We now present a numerical example. Suppose we have a 10 month future contract with a price if 50 $. The risk free rate is equal to 8 % and dividends per share are expected after three months, six months and nine months. The price of the future will be the following:

We first compute the present value of the dividends which are equal to 2,16. The variable T-t is equal to 0,83 so the future price is given by the formula

$F = (50 - 2{,}160)*(1+0{,}08)^{0{,}83} = 51{,}14$. If the price of F is different then arbitrage opportunities arise.

5.3 Futures on commodities

We now move to consider commodity futures contracts. Lets consider the commodity of silver and gold. The latter are being used usually for investment purposes and bear a storage cost. Let us denote as U the present value of storage costs. In this case the formula is **$F = (S + U) * (1+R)^{T-t}$**

If $F > (S + U) * (1+R)^{T-t}$ then the investor will borrow an amount of $(S + U) * (1+R)$ to buy the good which costs S and pay also the storage costs. The investor will at the same time short the future contract. When the commodity future contract expires the arbitrageur will realize a profit of $F - (S + U) * (1+R)^{T-t}$

If $F < (S + U) * (1+R)^{T-t}$ the investor will sell the commodity save the storage costs and invest the proceeds at the risk free rate. At the same time he will buy the futures contract. The profit at T will be equal to $(S + U) * (1+R)^{T-t} - F$.

5.4 Convenience yield

Before analyzing the concept of convenience yield for commodities lets present a simple example. Suppose that in August there is a sun eclipse. In this case demand for sun glasses will rise from individuals who desire to watch this phenomenon. After the sun eclipse the demand for sun glasses will come down to normal levels. Therefore the price of this item will be let us say very high in July and very low after august. So why someone should buy sunglasses before august since the latter will be sold at a much lower price later. The answer is that individuals will have a high utility from experiencing this phenomenon regardless of the price movements. This utility can be described as a convenience yield.

The price of commodities exhibits significant fluctuations. The increased volatility is related to business cycles. Companies in order to tackle with adverse price movements might hold high inventories even if they are obliged to tie up significant amount of capital. The benefit of holding a commodity rather than the futures relating to this commodity is defined as the convenience yield.

If a company holds low inventories of a commodity input it might not be able to respond to a positive demand shock. The firm for instance might have to increase its output due to high demand but will have a low amount of input ας an inventory for the production of the output. Therefore it will not be able to respond to this market change. A company so while holding a physical asset captures a sort of liquidity premium which will be foregone if he buys a future for the same commodity.

The convenience yield explains to a great extent the difference between a commodity’s spot price and its future price. Convenience yield is regarded as a premium for holding a commodity physically in stock. Futures prices of financial assets usually have a forward curve with a positive slope due to the interest rate effect we described before. This means that the futures price is greater than the spot price and the difference is reflecting the cost of carry. If futures price are equal to the spot price arbitrage opportunities arise (Copeland, Weston & Shastri, 2004).

Futures prices referring to commodities can be smaller than spot prices which is described as a back warded market situation. This result in a negative cost of carry value despite the existence of storage costs. The benefits so accruing to the holder of a commodity come in the form of dealing effectively with unexpected market developments. As we mentioned before this is regarded as the convenience yield and should be subtracted from the futures price. If the convenience yield is much higher then storage costs then the market is backwarded. When convenience yield is depressed this means that there is an abundance of inventories which makes holding them less worthwhile.

The price of the future will be the following:

$$F_{tT} = S_t e^{(r_{tT} + c_{tT} - CY_{tT})(T-t)}$$

In the following diagram we present a typical example of futures prices being smaller than spot prices resulting in a negative forward yield for a given period of time.

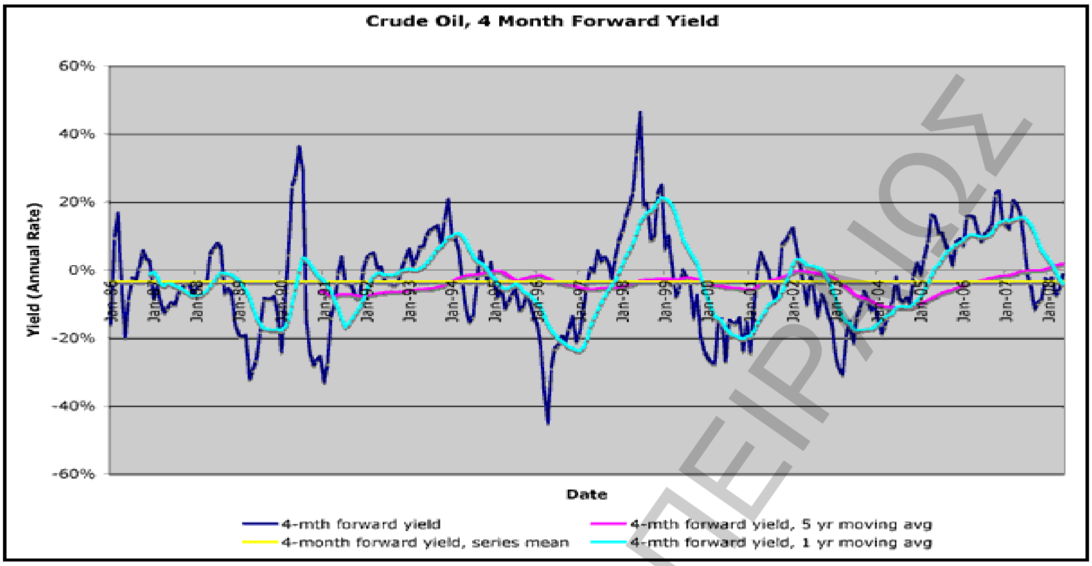


Figure 12: Comparison of future prices and spot prices

The convenience yield is analogous to the dividend that is paid to the holder of a stock and if the investor buys a futures contract he will miss the opportunity of getting the dividend. Therefore the income / dividend that is missed should be subtracted by the futures price.

A very important question that arises is which are the driving forces that determine the convenience yield? Many researches have suggested that there is a relation between the convenience yield and the current stock level of a commodity. This relation appears to be negative (Brennan, 1991).

Heaney (2002) found that the convenience yield is statistically and economically important for explaining the variation of spot and futures prices. The convenience yield increases with a declining level of inventories and therefore with the commodities criticality. The convenience yield should also depend on expectations about the future level of inventory (Fama & French, 1988).

In a following section we are going to develop the theory of storage which makes constant references to the convenience yield issue.

5.5 Difficulties in arbitrage opportunities

In the previous sections we saw that arbitrage opportunities ensure that a specific relation between the price of the commodity in the spot market and the price of the future will be established. This relation primarily depends on the interest rate, on the storage costs and on the convenience yield. However many times there are many obstacles to the realization of arbitrage some of which are the following (Lautier, 2009).

- Many times there are very few places where a commodity can be delivered when the contract expires. Wheat for example can e delivered in only two places.
- The storage costs relating to a commodity are not always the same for all companies. This cost varies according to the firms storing capacity. The storage cost for a good such as the petroleum changes depending on if capacities are located in warm or cold areas.
- The problem of transport represents also another difficulty for arbitrage. There might be for instance a strike that will disrupt all transportations or a shortage of means of transport. In these cases we shall observe very low future prices compared to spot prices resulting in a backwarded market.
- Arbitrage can be very difficult when the commodity cannot be stored. A classical example of this is electricity.
- Finally, carrying out short sales in a commodity can be very risky. If someone decides to dispose a commodity that is used as an input he might experience significant disruptions in the production process.

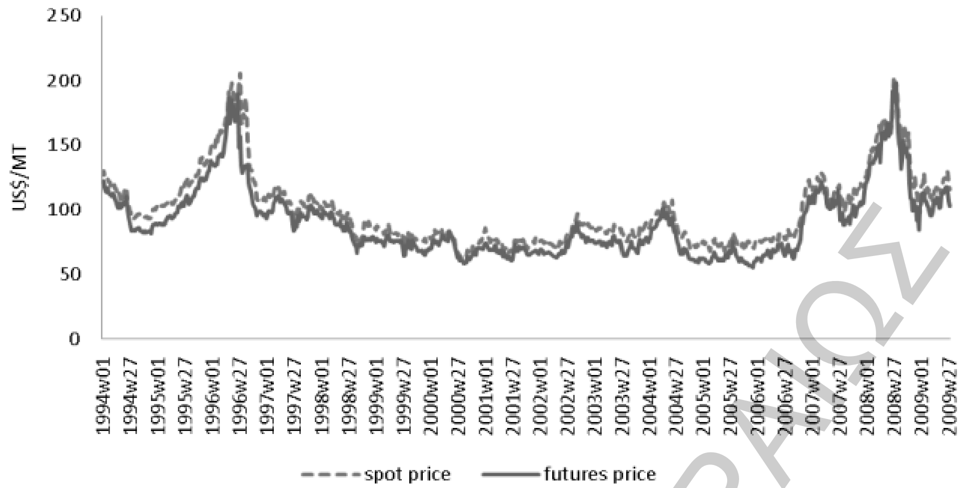
5.6 The relation between spot and futures prices - empirical evidence

In the previous chapters we saw that there is a certain relation between spot commodity prices and future commodity prices which depends on the interest rate, storage costs and convenience yield. Future and spot prices change according to expectations regarding the future spot price and according to the supply and demand condition respectively. No matter what happens the relation between these prices will prevail which means that future prices and spot prices will move at the same direction If spot prices rises than the futures price will rise as well and vice versa. A very important question which arises is that spot prices changes result in future price changes or vice versa. Do future prices dominate spot prices or the other way round?

The answer to the previous question is not so clear. The truth is that futures have a price discovery role. The futures market is a market where risk is reallocated amongst producers who want to hedge their production and speculators. This is the risk transfer role.

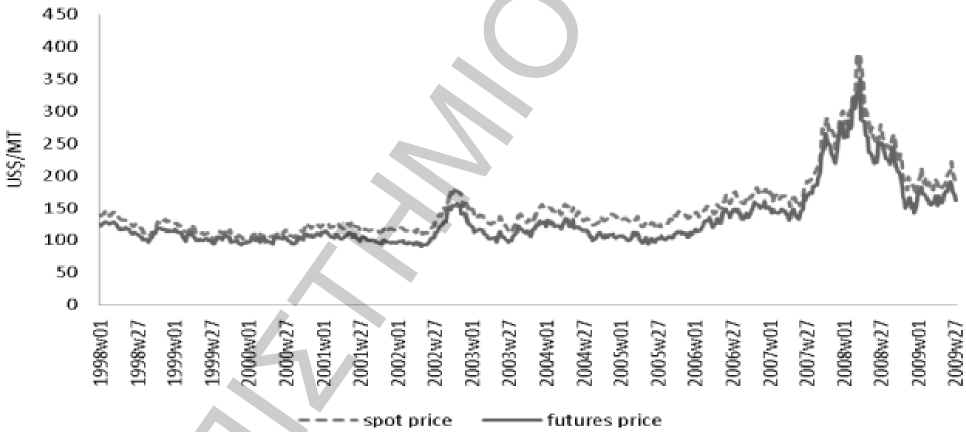
Futures however play another role. They convey information about the expected spot price. Producers of a commodity and buyers of a commodity who use it as an input adjust their supply and demand decisions according to their future expectations. Companies also use futures markets to price their commodities since these markets are more transparent and liquid than the commodities in the spot market. This means that future prices which reflect expected spot prices are more likely to affect spot prices than the other way round.

The fact that future price convey information does not necessarily mean that future definitely affect spot price. It is as we mentioned earlier quite possible but not sure. To find the direction of information flows between spot and future prices appears to be an empirical issue. Hernandez and Torrero (2010) in their study tried to examine causal relationships between spot and future prices. The commodities concerned are wheat, corn and soybean. The sample period is from 1994 to 2009. The figures below show how the evolution of spot and future prices for commodities such as corn, wheat and soybean. The volatility also for spot and future prices is also demonstrated.



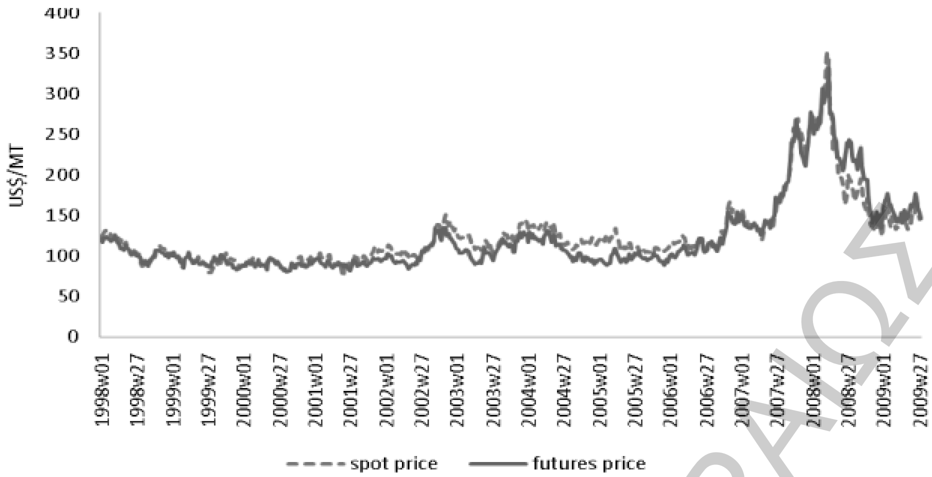
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Notes: CPI = Consumer Price Index; US$/MT = U.S. dollars per metric ton; w = week.
Prices deflated by U.S. CPI, January 1994 = 1.

Figure 13: Corn: Weekly spot and future prices, 1994-2009



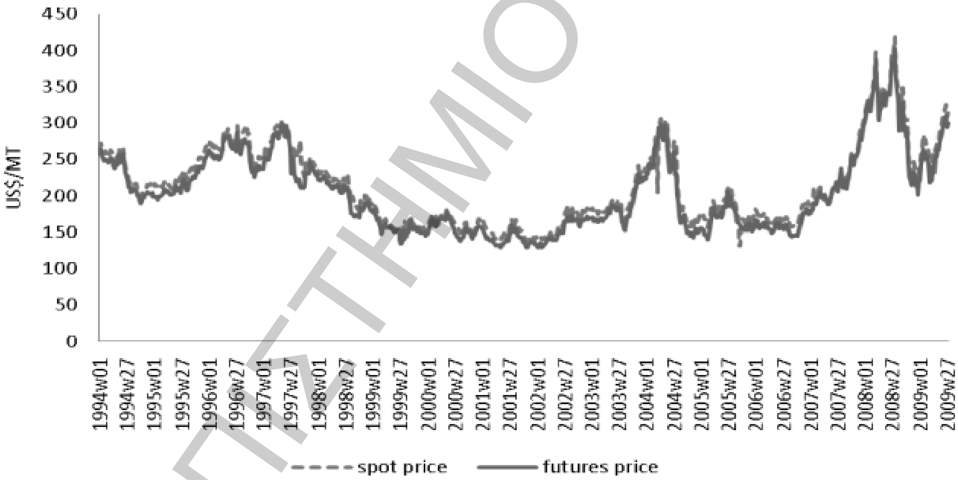
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Notes: CPI = Consumer Price Index; US$/MT = U.S. dollars per metric ton; w = week.
Prices deflated by U.S. CPI, January 1998 = 1

Figure 14: Hard Wheat: Weekly spot and future prices, 1998-2009



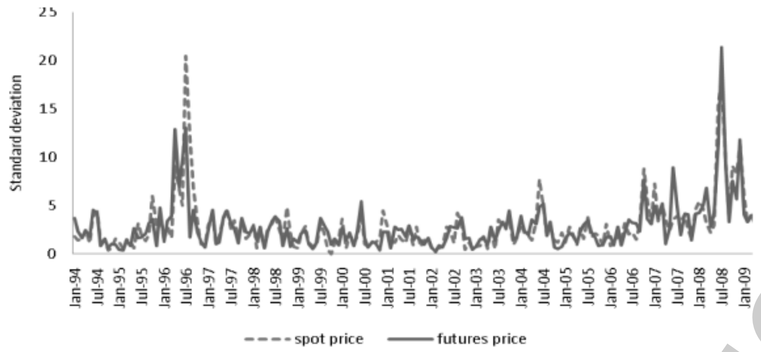
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Notes: CPI = Consumer Price Index; US$/MT = U.S. dollars per metric ton; w = week.
Prices deflated by U.S. CPI, January 1998 = 1

Figure 15: Soft wheat: Weekly spot and future prices, 1998-2009



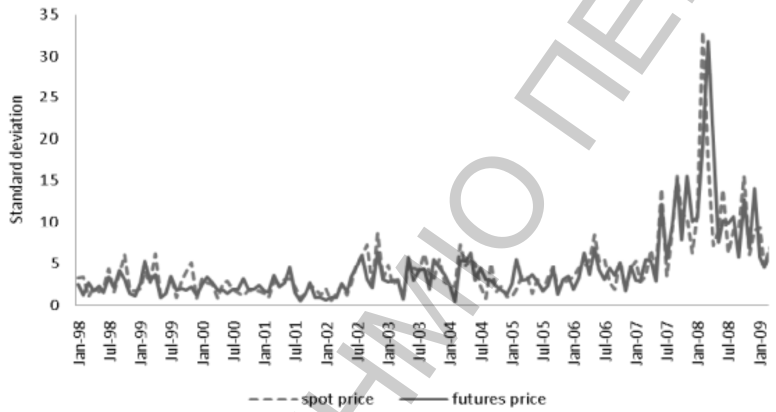
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine) and Commodity Research Bureau futures database (CRB Infotech CD).
Notes: CPI = Consumer Price Index; US$/MT = U.S. dollars per metric ton; w = week.
Prices deflated by U.S. CPI, January 1994 = 1

Figure 16: Soybeans: Weekly spot and future prices, 1998-2009



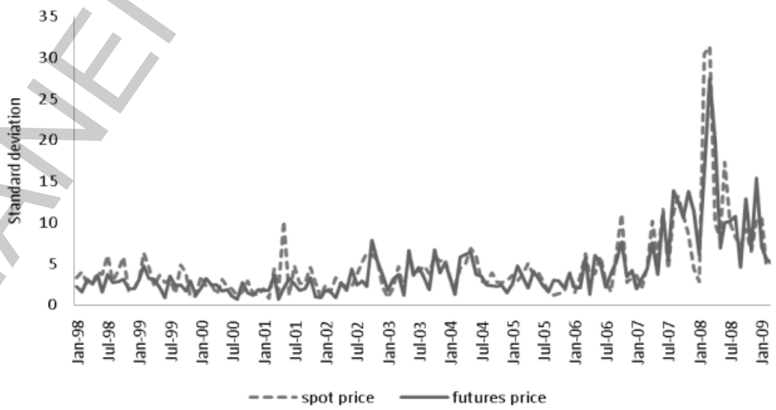
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Note: Monthly volatility based on weekly spot and futures prices.

Figure 17: Corn: Monthly volatility in spot and future prices, 1994-2009



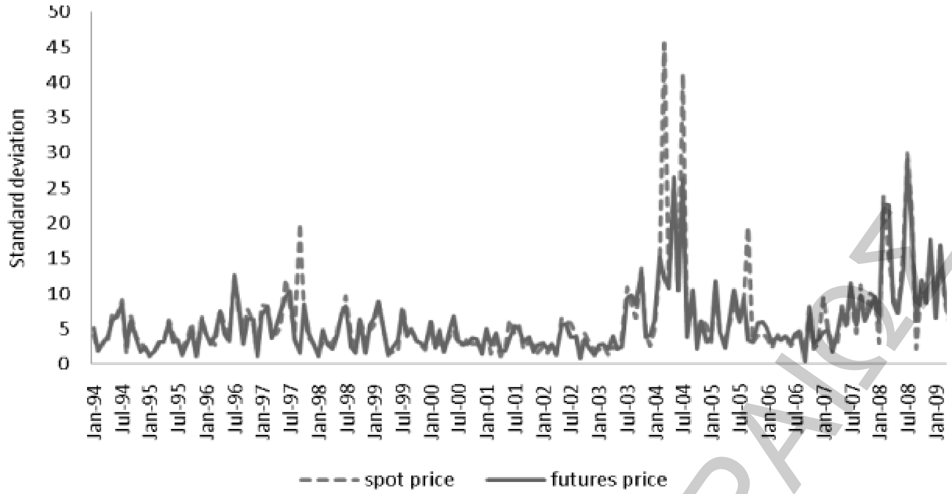
Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Note: Monthly volatility based on weekly spot and futures prices.

Figure 18: Hard wheat: Monthly volatility in spot and future prices, 1998-2009



Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Note: Monthly volatility based on weekly spot and futures prices.

Figure 19: Soft wheat : Monthly volatility in spot and future prices, 1998-2009



Sources: FAO International Commodity Prices Database, Chicago Mercantile Exchange Group end-of-day dataset (CME DataMine), and Commodity Research Bureau futures database (CRB Infotech CD).
Note: Monthly volatility based on weekly spot and futures prices.

Figure 20: Soybeans: Monthly volatility in spot and future prices, 1994-2009

The particular study attempted to analyze the dynamic relation between spot and future prices by using Granger causality tests. These tests examines whether past values of one variable contain additional information on the current value of the second variable. Therefore the first variable contains additional information on the value of the second variable. Through this statistical method we can see whether futures returns Granger cause spot returns. We can see also if volatility of future returns causes volatility in spot returns.

We shall not analyze how the Granger causality test is performed and how the statistic values of the test can be interpreted. Such an analysis is beyond the scope of our dissertation. What we are mainly interested in is to see the empirical evidence of the study regarding the relationship of futures and spot prices and to be more specific to identify the cause and the result. Do changes in future prices result in changes of prices in the spot market?

The result of the study suggests that future markets dominate spot markets. Changes of prices in the spot market are mostly a result of a change of prices in the futures market. Despite the results however we should not forget to mention that we are talking about the result of one specific paper. The chances are that there is a dynamic interaction between spot and future prices.

6. NORMAL BACKWARDATION THEORY

6.1 The fundamentals of the theory

In the previous section we mentioned what a backwarded market is. In this case future prices are very low relatively to spot prices. In fact they are so low that we have a downward sloping future curve.

We already know that futures are used by investors who want to lock in the price they are going to pay in the future. A company that wants to sell a product that has not under its possession at the present moment will have two choices. The first one is to sell the product on the spot market at the date it will have produced the product. The problem is the specific company runs the risk of selling the product at a much lower price than the current one. In this case the selling price might not even cover the cost of producing it resulting in significant losses. On the contrary the price might go up and the company will benefit. However, if the latter is risk averse it will be concerned with the possible price decline. Price fluctuations are a very important source of risk which can incur significant losses for the company.

This gives rise to the second option of the company. It can resort to the futures market by locking in the price of the product. In this case the selling process is known in advance and therefore the risk of not knowing the future spot price stops being a concern. The disadvantage of this strategy is that the future spot price might go much higher than the agreed price therefore the company misses the opportunity of realizing outstanding profits. It reduces or eliminates, however, the existing risk.

The investor will sell future contracts and will wait for the future contracts to expire and deliver the product having of course already locked in the price. If the expiration of the future contract is longer and does not coincide with the time of delivery the investor will close his position by buying future contracts and sell the product in the spot market. The profit /losses in the spot market will offset profits / losses in the future market. The exposure of the investor in the futures market depends on the hedge ratio. The investor's objective is that the outcome in the futures market to exactly offset the outcome in the spot market. If the investor aims at locking in the price of an input purchased he will buy a future contract.

When an investor buys or sells such a contract he agrees to pay or get a price that will prevail in the future. The futures contract price tries to guess which the future spot price will be or to mention it in a different way the current futures price discounts the future spot price therefore it embeds expectations about the latter. We should not forget to mention that in the futures market an investor agrees upon a price that will be paid in the future. It is natural so to conclude that the current future price is totally representative of the expected future spot price.

A perfect futures market is that one which the current market price is the best estimate of the futures price given the available information. In an efficient market a future market price embeds all the available best information regarding the future spot price and if any gains are being realized they will be attributed to lack.

Realized futures prices are anticipatory as they represent approximations to the best possible current prospects of the future. The realized spot price in the future might be different than the current future price. But on average any positive deviations will be offset by negative deviations.

Let us make a reference to the rational expectations theory. The specific theory implies that people try to forecast economic variable in such a way so that to minimize forecast errors. Economic agents rely on the information available on past prices. In an efficient market however past prices are not indicative of future prices.

In the rational expectation model the prevailing price at T+1 will be equal to the expected price at period t given the information at period t

$$\pi^{e}_{t+1} = E\,[\pi_{t+1} | \text{information at time } t] = E_t\,[\pi_{t+1}]$$

The rational expectation theory is therefore used to assess how individuals predict future events. The particular theory does not take predict the element of human behavior. When a prediction is taking place it is assumed that economic agents do not commit systematic errors and any deviations observed are entirely random in nature.

If the expectation theory is applied in the futures market the future price is the expected spot price of the underlying security. Therefore the futures price is an unbiased estimator of the future spot price. The expectation hypothesis is based on risk neutrality. As we mentioned earlier the expected profit for any future position is zero. In the real world however investors are not risk neutral and the above hypothesis is not valid. A risk adverse investor will demand a risk premium for the position he takes in the futures market.

John Keynes in the thirties attempted to develop a theory that would explain the fact that the hypothesis failed to predict future prices. The fair value of a futures contract is dependent on expectation about the future spot prices. The problem is that many times the fair value significantly deviates from the traded value of a contract and it is lower.

The normal backawardation theory assumes that hedgers want to take a short position in the futures market and in order to induce speculators to take long positions in the future market they should compensate them with a risk premium. The return investors will realize will be bigger than the risk free rate.

Keynes asserted that the futures price for a commodity should be less than the expected spot price prevailing in the future. The difference from the expected spot price and the current futures price is the return captured by a long investor being compensated for the risk he takes. The risk is of course associated with futures price fluctuations. A long investor by buying a futures contract runs the risk of selling it at a lower price. This theory bears a strong resemblance with the capital asset pricing model. The latter states that the return of a stock will be equal to the risk free rate plus the product of the beta and the risk premium prevail in the market.

The normal backwardation theory implies that future prices will rise as we approach at the maturity of the contract. This means that an investor who buys a futures contract shortly before expiration and sells it at expiration will realize a positive yield which as we mentioned earlier is called the roll yield. The theory also implies that contacts which are near maturity will be more expensive than contacts which expire later.

The profit of the speculator who initiates a long position in the futures market will be equal to the hedgers expected loss. The latter are willing to take this loss (expected spot price – price of the futures) since they transfer part of their risk to speculators.

The normal backwardation theory suggests that the excess return of a commodity futures return should be regarded as an insurance risk premium. Hedgers reap significant benefits by selling futures contacts. In fact they manage to hedge their production against future price fluctuations in the spot market. Consequently they should pay a cost for the benefits they get. This cost is the risk premium or excess return captured by long investors.

Since it is very difficult to know the expected spot price the theory already analyzed cannot be observed. Although normal backwardation is unobservable evidence of excessive past returns represents a good indicator of this situation. Kolb in 1990 tested for the normal backwardation theory and he found that in some futures contacts there were positive excess returns but in other contracts there were negative returns. Therefore the normal backwardation theory cannot be valid since excess returns have to be positive for all contracts.

Gorton and Rouwenhorst (2008) show that there has been a significant risk premium over the years 1957 to 2004 which is consistent with the theory of Keynes.

Dusak (1973) shows by using an intertemporal capital asset pricing model that whenever a risk premium exists chances will be low that this premium will be positive and constant. The net position of hedgers in the commodity market is not always a short one and the risk premium changes over time.

Fama and French (1987) investigated the theory of normal backwardation for 21 agricultural, metal, and livestock commodities. They found evidence of time varying risk premiums for 7 of the 21 commodities. By conducting t – tests they did not find strong evidence for a positive risk premium.

6.2 The forecasting ability of speculators

The normal backwardation theory amongst other assumes that speculators do not possess any forecasting ability. The profit speculators realize comes in the form of the risk premium they capture as a result of bearing the corresponding risk. Therefore prices of futures will rise as expiration approaches.

However, there is a lot of evidence that the backwardation theory does not exist. This means that the profits they get stem from their forecasting ability. The profits speculators get are not related to any risk premium. It is forecasting ability and not the bearing of risk that determines the profits of speculators. While the theory of normal backwardation might exist for particular markets under special conditions, it does not explain the flow of profits observed in the futures markets. In this case the futures price will be an unbiased estimator of the expected spot price.

The fact that many times prices fall in a predictable manner and speculators are net long means that investors relied on their forecasting ability, which in this case it failed. Moreover, the rewards speculators get can be a combination of forecasting ability and risk bearing. The weight of each of the two components is determined by empirical investigation. The returns of speculators according to Keynes will come in the form of an insurance premium only if forecasting ability is trivial

7. THE THEORY OF STORAGE

In the previous section we saw that the theory of backwardation focus on the analysis of hedging positions and on the process of transferring risk from hedgers to speculators who open a long position. The theory relies on the assumption that short hedging represents a lower volume than long hedging, therefore speculators should restore this market imbalance and on the assumption that there must be a difference between the futures price and the spot price expected at the contract's delivery date. There must be a positive risk premium which compensates speculators for the risks they take in their activity.

The theory of storage is another theory which explains the relation between spot prices and futures prices. The factors that determine the price of futures contracts is the spot price, the convenience yield and storage costs. The theory of storage enables us to justify the influence of the level of inventories in futures prices.

Inventories give the opportunity to producers to avoid stock outs and production disruptions. The more inventories a company holds, the fewer the chances that a production disruption will affect prices. There is a benefit from having a big amount of inventories associated with the low impact of a possible production disruption or a sudden increase of demand by consumers.

7.1 Determinants of level of inventories

The level of inventories a company holds represents a large fraction of its total working capital. Inventories represent about 44 % of current assets and 18 % of the total assets. An effective inventory management system should manage the tradeoffs amongst costs, customer service and other constraints (Liang, Miller, Harri, & Coble, 2012).

Firms hold inventories for three basic reasons such as smoothing production, stock out avoidance and the third reason refers to the existence of specific inventory models which determine an optimal inventory level. A huge level of inventories implies for the firm opportunity costs since it ties up capital that could have been used for other more productive sources.

If capital markets were perfect the critical issue of the level of inventories would be irrelevant. The real world however is entirely different. Firms are exposed to uncertainties concerning the level of inventories to be held at any given period. This explains why buffer stocks are maintained to cater for stock outs. The size of optimal inventory therefore depends on the marginal benefits of holding inventories and the corresponding marginal costs.

Marginal benefits refer to the benefits realized by avoiding stock outs customer satisfaction, while the costs include the costs of finance, storage costs, ordering costs e.t.c. The equation of the marginal benefit and marginal cost will determine the optimal level of inventories. If a firm experiences a shortage in inventories it will deal with this shortage through utilizing its internal resources, aggressive collection policies, negotiations with suppliers or even raising external finance. The bigger the shortage the greater the associated costs incurred. Holding a low amount of inventories decreases storage costs and also the probability that inventories will become obsolete. More over capital will be used in different more profitable ways.

Holding a high amount of inventories increases storage costs, and ties up significant amount of capital. By holding also inventories for a long time increases agency problems might arise since the firm in this case does not maximize the value of the company. Having however a high amount of inventories will reduce ordering costs and most importantly will make a company more responsive to an increase in demand. Lazaridis (2006) however found no significant relation between the profitability of a firm and the inventory period.

The micro factors affecting the level of investment in inventories are the following:

- The firm's size. The bigger the firm the bigger the amount of inventories held.
- The length of the cash conversion cycle. Firms should strive to minimize the cash conversion cycle if they aim at maximizing their profits. A company that attaches a significant weight to the cash conversion cycle should hold a low level of inventories.
- The liquidity of current assets. When items such as receivables and cash equivalents can be easily converted into cash the firm will hold a smaller amount of inventories.
- The volatility of sales. The more volatile sales are the bigger the necessity of holding a big amount of inventories.
- The value of the opportunity cost. When the return of alternative investments is high then the company will not tie up capital by investing in inventories.
- The firm's ability to generate internal resources. If a firm has insufficient internal resources it should finance its investments through external resources. According to the pecking order theory the cost of financing through external resources is quite high. This means that if a company has a problem in generating sufficient internal resources it will be quite difficult to carry out any investments and in our case inventory investments.
- The macro factor affecting investments in inventories is the general economic conditions. It has been found that during recession's inventories decline significantly. Maccini (2006) found that the rate of growth in gross domestic product affects the investment in working capital and in turn investments in inventories.

7.2 Analyzing the storage costs

In the previous section we mentioned several of the costs incurred when a company holds inventories. We shall now make a more extensive analysis of the inventory costs (Working, 1949).

The ordering cost consists of the cost of procurement and the inbound logistics. This kind of stock includes costs related to the clerical work of preparing, releasing, monitoring, and receiving orders.

The storage costs include the cost of building, the cost of material handling equipments, IT hardware and applications, operational costs, communication costs and utilities and the cost of human resources.

The cost of capital relates to the cost of investments carried out, interest on working capital, insurance costs e.t.c.

When a company orders more inventories than necessary carrying / storage costs will be high but ordering costs will be low. When the company has a shortage of inventories ordering costs are high but carrying costs are low. The company should try to minimize ordering and carrying costs. The amount of inventories that satisfies the condition of total cost minimization is the economic order quantity. The economic order-quantity model considers the tradeoff between ordering cost and storage cost.

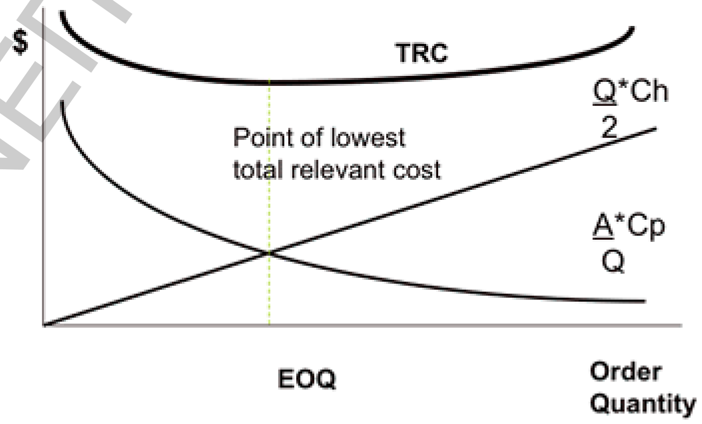


Figure 21: Inventory costs *(Source: www.managementstudyguide.com/inventory-costs.htm).*

7.3 Developing the theory of storage

An upward futures curve means that futures prices are above spot prices. The difference is attributed to the cost of holding inventories, to marginal warehouse costs and to the interest that is lost when investing in inventories. When an investor buys futures he saves these costs. Therefore the future price will be higher than the spot price roughly by the amount of the carry costs associated with holding inventories.

This link between these two prices is known as the cost of carry arbitrage. However many times producers hold inventories even when they know that the spot price will drop in the future or when the futures price which reflects the expected spot price is lower than the current spot price. Many times for instance investors prefer to buy in the spot market agricultural products at harvest period although they know that the price of these commodities will predictably fall. Investors could have bought instead futures the price of which reflects the declining future spot prices. However they do not and resort to the spot market.

To reconcile spot prices above futures prices Kaldor (1940) introduced the concept of convenience yield which does not accrue to holders of futures. This is known as the theory of storage.

Under normal conditions stocks of commodities possess a yield measured in terms of themselves. This yield is not accrued to investors who hold futures since as we know the holder of such a contract agrees to buy a good in the future and does not possess this good right now. The convenience yield should be deducted from carrying costs and therefore the formula between futures prices and spot prices will be the following:

$$F_{t,T} - S_t = S_t r_t + w_t - c_t \, .$$

The convenience yield corresponds to the coupon linked with the bonds or the dividends given by a stock portfolio. When inventories are abundant the convenience yield will be low since the benefits foregone by a future holder will be low. When inventories are low there are a lot of chances of a low responsiveness to a demand shock so the convenience yield is high.

Working (1927) has found evidence that the level of inventories of wheat were affecting the price of wheat futures. The problem in that period however was that he did not have sufficient data regarding the level of inventories.

In 1933 Working having now more inventory data found that when there was a shortage of wheat the July, futures were much higher than the September futures. When there was abundance of wheat September futures were slightly more expensive.

Kaldor (1940) noted that holding an asset during backwardation does not make sense since it is clear from the futures market that prices will drop. For this reason as we mentioned earlier he introduced the concept of convenience yield which explains the tendency of investors to use the spot market even though at first sight this is action is not to their interest.

Breman (1958) asserts that the convenience yield is the advantage of being able to satisfy customers without being any delays in the delivery of the good or the advantage of benefiting from a rise in the price of the good. A futures holder is denied these advantages so the biggest the conveniences yield the lower the price of the future contract.

Convenience yield should not exist for the commodity of electricity since the latter is not storable. In the case of the Scandinavian market however electricity is generated from water stored in the dams so the theory of storage can apply even for this good.

7.4 Relating level of inventories to commodity futures prices

In the previous section we saw that when the convenience yield is high futures prices can be lower than spot prices since in this case investors will avoid buying futures knowing that if they do so they miss the convenience yield. According to the theory of storage the convenience yield explains to a great extent the relationship between spot and futures prices.

As we noted earlier the one who holds a big amount inventories has the advantage on speculating from any inventory price appreciation and at the same time insurance is provided against any possible stock outs. When inventories are low this advantage is more appreciated. Lets see now how the level of inventories is related to the convenience yield

Routledge (2000) stated that trading profit is the only motive for holding inventories. In such a case stocks can be seen as a way to allocate resources through time. However, as long as the speculative motive is retained, nothing is said about inventories being held in backwardation.

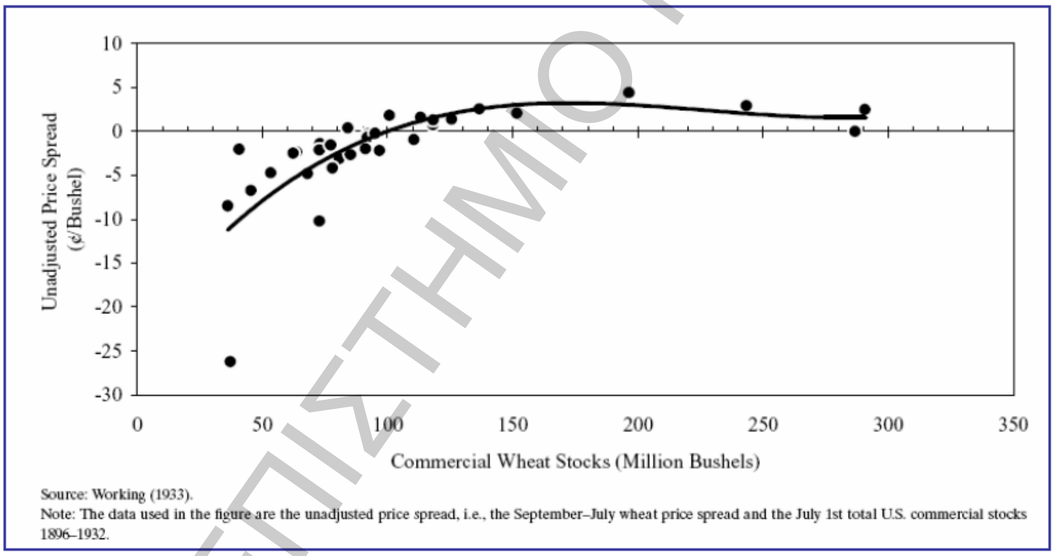
Holding also a lot of stocks has another advantage. When a company holds a low level of inventories the ordering cost we mentioned will be high. Therefore the company misses the opportunity of having a lower ordering cost. This is a reason why in this case the convenience yield will be high. In 1986 Williams provided another explanation. The latter indeed give the possibility to undertake transactions immediately; they insure the access to the merchandise.

Finally, holding inventories reduces the risk of a production disruption. Moreover when there is an abundance of inventories customers will be more easily satisfied. From the above it is clear that in periods of abundance of inventories companies will get the corresponding benefits and will be more willing to hold future contracts. However in periods of goods scarcity inventories will be low and the companies will be reluctant to buy future contracts since holding the physical asset is more precious. In this case the convenience yield will be very high even offsetting the carrying costs. If the convenience yield is higher than the storage costs the futures price will be lower than the spot price and consequently the market will be backwarded.

We can infer that the convenience yield should be negatively correlated to the level of stocks. Moreover, as stocks and spot prices are also negatively correlated, the convenience yield is a positive function of the spot price. When there is a scarcity of inventories the spot price will be high, the convenience yield will be high and the futures price will be low relative to the spot price. In this case future prices will rise in a rather predictable way as we head towards expiration.

When there is an abundance of inventories the spot price will be low the convenience yield will be low and the price of the futures contracts will be high relative to the spot price. In this case the futures price will decline in order to converge to the final future spot price.

If the convenience yield is high in period of inventory scarcity, then holding inventories in a backwarded market is rational. In this case stocks level and futures price will be negatively correlated. The following diagram shows the spreads between September and July contracts in relation to the level of inventories. There is strong evidence of a negative relation between inventories and futures prices



Source : Carter & Giha (2007)

Figure 22: Practical example of relation between inventories and future prices (Wheat stocks/Unadjusted Price Spread)

In the above analysis we mentioned that when the level of inventories is low the futures price will be low therefore someone buying futures might realize significant returns if he buys the future commodity contract based on the fact that this contract is undervalued due to the presence of the convenience yield. However things get very complicated when we allow for the fact that expectations regarding the future spot price constantly change.

7.5 Review of literature

Let us now view a sort of review of literature for the concepts mentioned above.

Thompson (1986) shows that the price-stock relationship can be stronger when local stocks are taken into account, instead of worldwide stocks.

Famma and French (1988) that the marginal convenience yield on inventory declines at a decreasing rate. They also mention that convenience yield arises from supply inelasticity. The latter will be lower at business cycle peaks. Routledge, Seppi assert that the correlation between spot prices and convenience yield is not constant due to the existence of the convenience yield.

Dincerler and Khokher (June 2005) state that as abundance of inventories reach critical levels inventories will be withdrawn since storage costs in this case will be very high. They also asserted that when demand exceeds a certain level in inventories will decline to alleviate the relative scarcity. In their analysis adjustment costs are being taken into consideration. If adjustments costs are high a positive demand shock will not affect the present supply, therefore the spot price will significantly rise and the futures price will not change. If adjustment costs are low there will be a parallel shift in the futures curve.

Cassasus states that a higher convenience yield spot price correlation results in higher mean reversion. He also shows show how a substantial increase in mean reversion can result from “negative co variation between spot prices and risk premium. Hodges and Ribeiro mention that withdrawals from storage influence the commodities present and future scarcity.

Gibson and Schwartz suggest that the convenience yield may not be perfectly correlated to the spot price and could instead be regarded as a stochastic variable having a mean reverting behavior.

Deaton and Laroque (1992) develop an extension of the theory of storage. They do not make direct predictions about future prices but they make predictions about the future volatility of a stock. When inventories are low the ability of inventories to absorb shocks stemming from changes in demand drops, therefore the conditional volatility of future prices increases. In the GHR theory the risk premium of a futures contract is related to the level of inventories. When inventories are low the expected spot price will exhibit an increased volatility and long buyers of futures will demand a high premium for entering the market

According to the extension of the storage theory when the basis is positive the convenience yield will be high and therefore the level of inventories will be low. As we saw before when inventories are low any market shocks will not be easily absorbed and spot prices will be very volatile. Therefore, future holders will demand a risk premium. Assuming that the basis is indicative of the level of inventories in the following diagram we present the relationship between the basis and the risk premium based on the work of Gorton, Hayashi and Rouwenhorst.

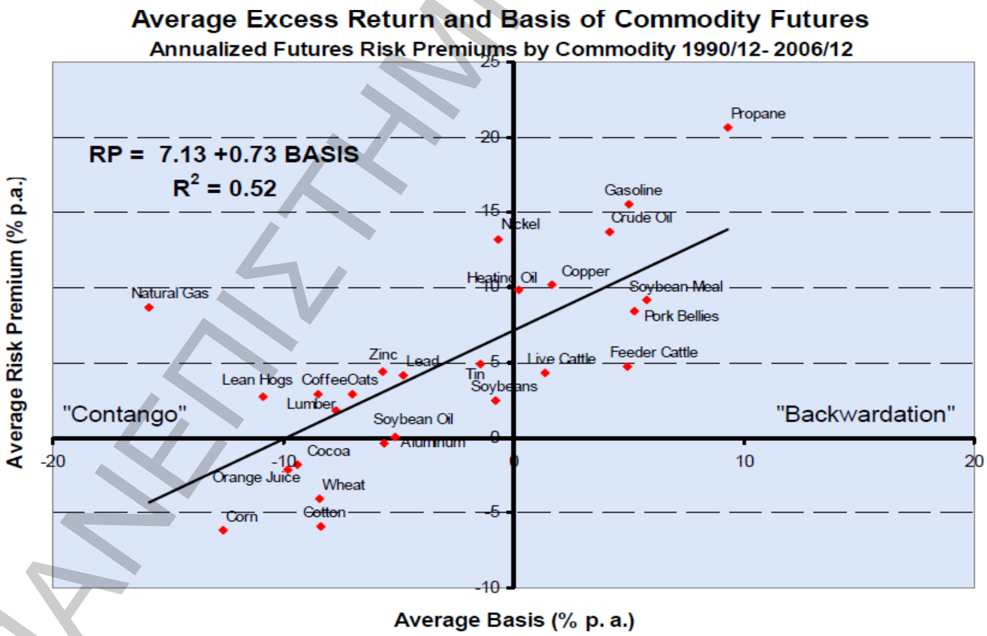


Figure 23: Average Excess Return and Basis of Commodity futures *(Source: Gorton, Hayashi and Rouwenhorst (2004)).*

The link between level of stocks and future prices lies on the existence of the convenience yield. There are however many objections to this theory. The first objection is associated with the fact that the convenience yield cannot be observed.

There is not any traded asset corresponding to this variable. In the field of finance however all assets are priced according to expectations. For example the futures price is related to the expected spot price. Therefore the above argument might not stand, Lautier, D. (2009).

The second objection was presented by Williams and Wright. They assert that storage under backwardation can occur not because there is an implicit remuneration for holding inventories but because aggregated stock data give a false image of the relationship between prices and inventories.

8. HEDGING PRESSURE AND FUTURE PRICES / RETURNS

The theory of storage predicts that the level of inventories determines to a big extent future prices. Inventories play the role of smoothing cash flows through time. If there is a negative demand shock spot prices will drop and expected spot prices are anticipated to rise. In this case companies / producers will want to hold inventories to benefit from a possible price increase. If inventories are low the convenience yield will be high. Demand shocks drive the level of inventories and spot prices. The theory of storage therefore is concerned with optimal inventory management.

The relation between future and spot prices is shown in the equation below. The key variable is that of the convenience yield which is named c. The bigger the convenience yield the more backwarded the future market will be

$$F_{t,T} = S_t e^{(r+u-c)T},$$

Holding inventories to benefit from price fluctuations and to absorb shocks is one choice. Producers use hedging in order to decrease risk or even eliminate it. Hedging also is better suited to deal with default risk. The increase of the latter one increases the propensity of investors to hedge (www.finance.sauder.ubc.ca).

The theory of storage predicts that investors will use the hedging technique according to the value of the convenience yield. Investors will prefer to buy inputs at a very high spot price knowing that a certain level of inventories yields many benefits. The theory of storage however does not make a reference to the risk premium of future contracts.

As we mentioned in the first sections the theory of normal backwardation relates the futures prices to the value of the risk premium. Risk adverse speculators demand a risk premium for taking on the price risk producers wish to hedge against. The formula the theory is based on is the following:

$$F_{t,T} = E_t\left[S_T\right] - \pi_{t,T},$$

Where πt,T is the risk premium demanded by long investors. The theory of storage and normal backwardation theory are not mutually exclusive. A time varying risk premium is consistent with optimal inventory management as long as investors are risk averse. Gorton, Hayashi, and Rouwenhorst (2007) assert that time varying future risk premiums are affected by inventory levels. Therefore in the real world we observe hedging demand, time varying risk premiums, speculation and optimal inventory levels. All these variables interact with each other which means that the two theories developed are not irrelevant with each other.

In this section we shall show how futures prices are related to hedging demand. It is quite natural to assume that hedging pressure and risk premium are closely related. The relation of these two variables is quite complex and depends on many factors.

8.1 Developing the hedging pressure theory

The variable of hedging pressure is defined in the following way:

HP = (number of short hedge positions – number of long hedge positions) / total number of hedge positions

When hedgers are net short the hedging pressure takes a positive value. In this case there are many producers who want to hedge their output produced by locking in the selling price. If hedgers are net long the HP value is negative and in this case there are many producers who are mainly concerned with hedging the inputs used for the production of an output. Evidence suggests that hedgers are on average net short.

The normal backwardation theory developed by Keynes assumes that hedgers are net short and speculators net long. Hedgers by selling future contracts transfer part of their risk to speculators who take long positions. Therefore the latter will demand a risk premium for the risk they initiate. The implication of the theory is the following.

Being in a backwarded or contango market depends on the net position of hedgers and speculators. We mentioned what happens in a backwarded market. In a contango market however hedgers are net long and speculators are net short.

The hedging pressure theory of Hirshleifer (1990) suggests that risk premiums are present in both backwarded and contango markets. In the first case a long position will be profitable while in the second case short positions will be the ones that will generate profits

A weak point of the theories developed is that they document a contemporaneous correlation between future prices and traders positions. This correlation does not make a reference about a causal relationship. Another weak point is that they treat hedging pressure as exogenous but trader's position many times responds accordingly to a supply or demand shock. If for instance a negative supply shock drives down inventories and current spot prices increase hedgers might find it advantageous to hedge more in equilibrium, despite the fact that the compensation they have to offer to speculators has increased due to increased uncertainty about future spot prices. If therefore hedging pressure predicts risk premiums to what extent does this reflect an optimal response to fundamental shocks. It might be due to these shocks and not due to hedging pressures that futures returns moved to a specific direction (Gorton, Hayashi, and Rouwenhorst, 2007).

8.2 Two papers developed with respect to hedging theory – examination and comparison

According to the theory of normal backwardation the world is comprised of net short hedgers that are obliged to compensate net long speculators to take the corresponding positions in the futures market. In this section by analyzing two papers we shall assess the relationship between hedging pressure and futures returns. The papers examined will be those of Gorton, Hayashi, and Rouwenhorst (2007) and Roon, Ninjman and Veld (2000).

Roon et al (2000) examine how futures risk premium is affected by factors such as the systematic risk and hedging pressure which is defined by the difference between the number of short contracts and the number of long contracts. In the specific section we shall not make reference to the systematic risk component of the risk premium but to the component of hedging pressure. This paper has the distinct feature that it presents a model which takes into account the fact that the futures risk premium is determined not only by its own hedging pressure but by the hedging pressure of other markets which is known as cross hedging pressure.

The paper attempts to determine the relation between cross hedging pressure and futures risk premium. The data refers to 20 contracts which are divided into four categories each containing five future contracts. The observation period is from 1986 to 1994. All data are obtained from the futures institute industry. The returns are computed from the first and second nearest maturity future. The strategy from switching from one contract to another is employed. The independent variable as already mentioned is the hedging pressure or hedging demand by producers and is defined as:

$$\hat{Q}^{m}_{s,t} = \frac{\text{number of short hedge positions} - \text{number of long hedge positions}}{\text{total number of hedge positions}}$$

This variable is used as a proxy for the non marketable risk. The following table provides descriptive statistics for hedging demand and the results from the regression performed with the futures risk premium as the dependent variable and hedging demand as the independent variable.

	Avg.	Std. Dev.	$\hat{\theta}$	$t(\hat{\theta})$
Financial				
S&P 500	−6.7	6.1	−0.019	(−0.53)
Value Line	0.3	52.9	−0.001	(−0.13)
T-bond	−1.0	8.3	0.056	(2.87)
T-bill	23.5	16.7	0.005	(3.97)
Eurodollar	−2.2	5.0	0.011	(2.60)
Agricultural				
Wheat	17.8	24.2	0.048	(4.58)
Corn	1.5	15.1	0.119	(5.27)
Soybeans	19.7	18.3	0.066	(4.18)
Live cattle	25.4	15.0	0.013	(1.07)
World sugar	23.6	18.1	0.137	(4.34)
Mineral				
Gold	−0.2	20.5	0.049	(5.47)
Silver	39.4	11.7	0.086	(2.81)
Platinum	33.8	22.4	0.054	(3.80)
Crude oil	−2.1	6.8	0.160	(2.07)
Heating oil	6.7	9.9	0.226	(4.36)
Currency				
Deutsche mark	3.6	26.9	0.050	(10.10)
British pound	1.2	42.7	0.031	(9.45)
Japanese yen	7.8	34.8	0.037	(8.62)
Canadian dollar	15.8	45.8	0.009	(6.93)
Swiss franc	2.7	39.9	0.035	(8.47)

Table 2: Semimonthly data for calculation of hedging pressures. *(Source: Roon et al (2000))*

As it is shown by Table 2, hedging pressures are calculated by semimonthly data for the period of January 1986 to December 1994, excluding observations for October 1987. Mean returns and standard deviations are in percentage. Θ is the slope coefficient from a regression of the futures returns on their own hedging pressure. The t-values for θ are based on heteroskedasticity consistent standard errors.

The above results shows that for more products both financial and commodity hedging demand is positive which means that there are more short investors than long investors. The coefficient of the independent variable is statistically significant for almost all the commodity products. The statistical significance is derived by the value of the t statistic which in almost all the cases is quite large and lies beyond the critical values.

The paper also examines the cross hedging pressure effect by studying each group of future contracts and analyzing the hedging pressure variables within each group of future returns. The regression that was run was the following:

$$r_{i,t+1}^{(j)} = \alpha_i^{(j)} + \beta_i^{(j)} r_{t+1}^{S\&P500} + \sum_{s=1}^{5} \theta_{s,i}^{(j)} \hat{q}_{s,t}^{(j)} + \varepsilon_{i,t+1}^{(j)},$$

Where i refers to futures contract i in market j (financial, agricultural, mineral, currency). The variables $\dot{q}^{(j)}_{s,t}$ are the five hedging pressure variables within the own group $\dot{\theta}^{(j)}_{s,i}$ therefore measures the sensitivity of the futures return to the hedging pressure variables in its own.

The following tables present the results for the commodity products:

	$\hat{\theta}_{wheat}$	$\hat{\theta}_{corn}$	$\hat{\theta}_{soyb.}$	$\hat{\theta}_{l.cttle}$	$\hat{\theta}_{sugar}$	W_{all}	W_{other}
Wheat	4.76	2.13	−0.02	0.32	2.54	43.54	9.46
	(4.61)	(1.01)	(−0.02)	(0.17)	(1.47)	(0.000)	(0.305)
Corn	2.35	10.89	−1.13	−0.59	3.22	39.71	8.34
	(1.83)	(5.39)	(−0.59)	(−0.28)	(1.56)	(0.000)	(0.401)
Soybeans	0.81	3.11	5.38	3.00	0.85	35.10	19.74
	(0.84)	(5.39)	(3.12)	(1.37)	(0.54)	(0.000)	(0.011)
Live cattle	1.19	−0.07	−1.35	1.40	−1.02	6.00	4.40
	(1.37)	(−0.06)	(−1.20)	(1.26)	(−1.13)	(0.815)	(0.820)
World sugar	−0.04	−10.27	5.71	−9.35	17.07	41.46	15.56
	(−0.01)	(−2.36)	(1.68)	(−2.26)	(5.11)	(0.000)	(0.049)
All						(0.000)	(0.000)

Table 3: Agricultural products' sensitivity of the futures return *(Source: Roon et al (2000))*

	$\hat{\theta}_{gold}$	$\hat{\theta}_{silver}$	$\hat{\theta}_{plat.}$	$\hat{\theta}_{crude}$	$\hat{\theta}_{heating}$	W_{all}	W_{other}
Gold	2.88	3.03	2.03	2.74	2.56	58.05	19.36
	(2.81)	(1.92)	(2.16)	(0.87)	(1.28)	(0.000)	(0.013)
Silver	2.10	8.07	5.22	−2.91	1.22	29.95	15.99
	(0.99)	(2.75)	(3.15)	(−0.51)	(0.35)	(0.001)	(0.043)
Platinum	−1.63	6.20	6.51	−0.70	1.99	38.74	16.38
	(−1.09)	(2.44)	(4.37)	(−0.11)	(0.52)	(0.000)	(0.037)
Crude oil	2.95	−0.07	−4.94	15.56	24.41	34.77	28.15
	(0.97)	(−0.02)	(−1.52)	(1.59)	(4.03)	(0.000)	(0.000)
Heating oil	1.46	3.05	−4.29	12.99	19.93	35.51	6.98
	(0.42)	(0.74)	(−1.20)	(1.46)	(3.92)	(0.000)	(0.539)
All						(0.000)	(0.000)

Table 4: Mineral products' sensitivity of the futures return *(Source: Roon et al (2000))*

The Wald statistic tests the hypothesis that all coefficients are equal to zero while the w-other statistics tests the hypothesis that all the reported coefficients are equal to zero apart from the own hedging variable. The values in brackets of the last two columns are the corresponding p-values. The results present strong evidence of a cross hedging pressure effect.

We shall now examine the price pressure hypothesis. If the demand for future contracts increases suddenly there will be a temporary upward bias in the price of the future contract which will normally be reversed. This means that a demand shock might cause after a while a negative futures return

When hedging pressure increases the number of short contracts increases causing a sudden drop in the price of future contracts. This drop however might be temporary and the price of the futures will in turn go up. Therefore the price pressure effect should be taken into account. The model which was used by Roon et al (2004) implied that risk premia for all futures contracts are determined by a systematic risk component , as well as hedging pressure variables for all nonmarketable risks, reflecting all nonmarketable positions that agents may face. This leads to the following:

$$r_{i,t+1} = \alpha_i + \theta_i \frac{\hat{q}_{i,t}}{\sigma(\hat{q}_{i,t})} + \varphi_i \frac{\Delta\hat{q}_{i,t}}{\sigma(\Delta\hat{q}_{i,t})} + \varepsilon_{i,t+1}.$$

The table below shows the corresponding results:

	$\hat{\theta}$	$t(\hat{\theta})$	$\hat{\varphi}$	$t(\hat{\varphi})$	W_{all}	W_{other}
Panel A: Financial						
S&P 500	−0.26	(−1.14)	0.70	(2.39)	(0.000)	(0.000)
Value Line	0.11	(0.47)	0.31	(1.37)	(0.000)	(0.002)
T-bond	0.32	(2.41)	0.78	(5.28)	(0.000)	(0.000)
T-bill	0.05	(2.57)	0.11	(4.99)	(0.000)	(0.111)
Eurodollar	0.03	(2.08)	0.09	(5.04)	(0.000)	(0.000)
Panel B: Agricultural						
Wheat	0.37	(1.59)	2.52	(9.51)	(0.025)	(0.295)
Corn	0.99	(3.39)	2.94	(12.22)	(0.063)	(0.327)
Soybeans	0.69	(2.32)	1.56	(2.18)	(0.009)	(0.017)
Live cattle	0.12	(0.76)	0.27	(1.19)	(0.764)	(0.851)
World sugar	1.30	(2.32)	4.16	(7.70)	(0.065)	(0.205)
Panel C: Mineral						
Gold	0.47	(2.89)	1.72	(7.80)	(0.000)	(0.150)
Silver	0.26	(0.80)	2.50	(8.08)	(0.039)	(0.042)
Platinum	0.62	(1.81)	2.30	(8.64)	(0.063)	(0.143)
Crude oil	0.85	(1.48)	0.64	(1.55)	(0.000)	(0.001)
Heating oil	1.40	(3.00)	2.20	(3.80)	(0.054)	(0.855)
Panel D: Currency						
Deutsche mark	0.91	(5.93)	1.00	(5.67)	(0.000)	(0.001)
British pound	0.92	(5.83)	1.06	(7.61)	(0.000)	(0.009)
Japanese yen	0.92	(5.41)	0.87	(5.02)	(0.000)	(0.161)
Canadian dollar	0.24	(4.16)	0.51	(9.27)	(0.001)	(0.285)
Swiss franc	0.99	(6.47)	0.99	(6.52)	(0.000)	(0.000)

Table 5: Price pressure effect results for a) Financial products b)Agricultural products c)Mineral products, D) currency products *(Source: Roon et al (2000))*

The results show that there are strong hedging pressure effects even when accounting for the pressure effect.

After analyzing the paper of Roon, Ninjman and Veld (2000) let us mention the results obtained from the other paper of Gorton, Hayashi, and Rouwenhorst with respect always to the concept of hedging theory. The particular paper examines the empirical evidence of the classical theory of storage which links inventories to futures returns and explains the situation of a backwarded as a result of a high convenience yield. Apart from this it makes one step further and examines the link between inventories and risk premium and the link between risk premium and price volatility. Our objective is to examine the analysis of the paper with respect to hedging pressure and future risk premium. We shall then compare this paper to the previous one already developed.

In the previous section we saw that hedging pressure is an explanation for the varying risk premiums of futures. The current paper tests the hedging pressure idea from a different standpoint. It reports for each commodity the average net position by trader category, the standard deviation of the position and the percentage of the months the position is long.

The table below shows that commercials are on average net short while non commercials are net long something which is consistent with the Kenyan theory regarding the risk premium developed earlier. The average net short position of commercials across commodities is about 10 % which indicates that commercials are both long and short. The table also shows that there are cross sectional differences in net positions over time. The variable row shows the persistence of the position as measured by the first order autocorrelation coefficient.

		Net Long Positions of Traders as Percent of Open Interest											
		Commercials				Non-Commercials				Non Reportable			
	Commodity	Average	Stdev	%Long	rho	Average	Stdev	%Long	rho	Average	Stdev	%Long	rho
Metals	Copper	-16.67	22.70	26.19	0.76	8.28	17.01	67.86	0.74	8.39	8.42	85.32	0.81
	Platinum	-38.93	24.02	7.14	0.71	23.99	22.00	83.73	0.74	14.94	7.83	97.62	0.79
	Palladium	-30.48	30.15	22.62	0.92	17.33	18.70	76.59	0.88	13.15	14.72	82.14	0.92
Softs	Cotton	-4.02	23.11	42.06	0.71	-1.41	19.93	49.60	0.73	5.42	6.32	83.73	0.76
	Cocoa	-8.77	16.14	28.97	0.78	2.40	12.61	56.35	0.74	6.38	5.74	89.29	0.88
	Sugar	-20.72	21.66	22.62	0.73	9.43	14.85	72.22	0.72	11.30	9.04	90.08	0.77
	Orange Juice	-15.06	25.57	26.19	0.77	6.38	17.41	64.29	0.70	8.68	13.65	83.73	0.86
	Lumber	-10.50	18.62	32.14	0.74	4.57	15.21	66.67	0.62	5.93	12.00	69.84	0.74
	Coffee	-17.41	15.38	16.67	0.59	6.49	13.65	69.84	0.56	10.92	4.76	100.00	0.76
Grains	Wheat	-9.35	15.77	30.95	0.73	4.60	12.74	59.52	0.73	4.75	8.54	68.25	0.80
	Corn	1.01	13.81	51.59	0.76	5.69	10.97	66.27	0.74	-6.70	5.97	11.11	0.83
	Soybeans	-10.73	17.61	27.38	0.87	6.67	12.68	70.24	0.80	4.06	7.68	68.65	0.89
	Soybean Oil	-13.11	18.28	28.97	0.74	5.17	12.94	63.49	0.75	7.94	7.23	87.70	0.72
	Soybean Meal	-13.72	14.89	21.43	0.70	4.67	10.25	67.06	0.70	9.04	5.85	94.05	0.69
	Oats	-37.15	15.92	1.19	0.71	11.95	11.51	90.87	0.77	25.20	13.49	98.02	0.82
	Rough Rice	-7.43	21.14	37.07	0.85	2.72	13.35	53.88	0.83	4.71	13.99	56.90	0.82
Meats	Pork Bellies	-0.84	14.41	43.65	0.76	-1.91	18.82	44.84	0.68	2.75	18.76	53.17	0.80
	Live Cattle	-8.31	11.34	26.98	0.85	8.05	10.25	75.40	0.73	0.26	10.21	48.02	0.88
	Lean Hogs	0.59	12.02	46.83	0.68	5.81	14.47	66.67	0.64	-6.40	7.99	17.46	0.56
	Feeder Cattle	8.79	11.90	75.00	0.75	8.86	12.96	76.19	0.70	-17.65	13.99	14.29	0.87
	Milk	10.94	16.42	76.58	0.85	1.12	10.89	45.05	0.75	-12.06	8.83	4.50	0.75
Energies	Heating Oil	-9.00	9.75	18.65	0.61	1.80	6.26	59.92	0.55	7.20	5.41	90.87	0.72
	Crude Oil	-0.10	8.43	47.62	0.66	0.39	6.28	50.79	0.68	-0.29	3.39	46.83	0.58
	Unleaded Gas	-8.76	11.43	23.81	0.60	6.54	8.58	76.19	0.65	2.22	4.50	73.02	0.38
	Propane	-9.82	11.83	19.74	0.71	-0.61	6.08	28.29	0.71	10.43	10.35	82.24	0.65
	Natural Gas	-7.01	8.22	22.00	0.63	0.76	7.21	56.00	0.65	6.25	3.47	98.00	0.79

Table 6: Summary statistics of distributions of individual commodity futures returns. Annualized monthly returns 1959/7-2004/12 (*Source: Gorton and Rouwenhorst (2004)*)

Regressions are performed with futures returns as the dependent variable and the net long position as the independent variable. The linear regression which was performed is summarized below.

In linear regression, the model specification is that the dependent variable, y_i is a linear combination of the parameters (but need not be linear in the independent variables). For example, in simple linear regression for modeling n data points there is one independent variable: x_i, and two parameters, β_0 and β_1:

straight line: $y_i = \beta_0 + \beta_1 x_i + \varepsilon_i, \quad i = 1, \ldots, n.$

In multiple linear regression, there are several independent variables or functions of independent variables.

Adding a term in x_i^2 to the preceding regression gives:

parabola: $y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \varepsilon_i, \ i = 1, \ldots, n.$

This is still linear regression; although the expression on the right hand side is quadratic in the independent variable x_i, it is linear in the parameters β_0, β_1 and β_2.

In both cases, ε_i is an error term and the subscript i indexes a particular observation.

Given a random sample from the population, we estimate the population parameters and obtain the sample linear regression model:

$$\widehat{y}_i = \widehat{\beta}_0 + \widehat{\beta}_1 x_i.$$

The residual, $e_i = y_i - \widehat{y}_i$, is the difference between the value of the dependent variable predicted by the model, $\widehat{y}_i$, and the true value of the dependent variable, y_i. One method of estimation is ordinary least squares. This method obtains parameter estimates that minimize the sum of squared residuals, SSE, also sometimes denoted RSS:

$$SSE = \sum_{i=1}^{n} e_i^2.$$

Minimization of this function results in a set of normal equations, a set of simultaneous linear equations in the parameters, which are solved to yield the parameter estimators, $\widehat{\beta}_0, \widehat{\beta}_1$.

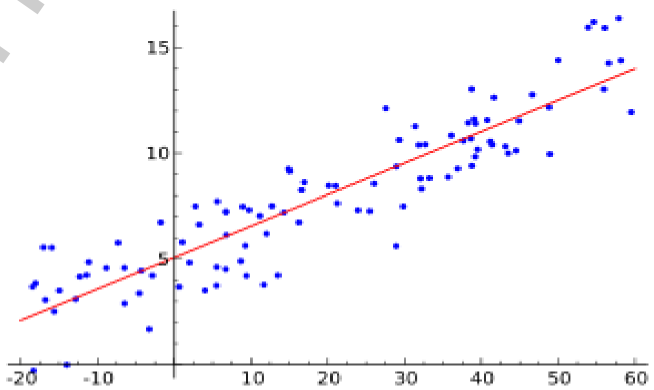


Figure 24: Illustration of linear regression on a data set.

In the case of simple regression, the formulas for the least squares estimates are:

$$\widehat{\beta_1} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} \text{ and } \hat{\beta_0} = \bar{y} - \widehat{\beta_1}\bar{x}$$

where $\bar{x}$ is the mean (average) of the x values and $\bar{y}$ is the mean of the y values.

Under the assumption that the population error term has a constant variance, the estimate of that variance is given by:

$$\hat{\sigma}_\varepsilon^2 = \frac{SSE}{n-2}.$$

This is called the mean square error (MSE) of the regression. The denominator is the sample size reduced by the number of model parameters estimated from the same data, (*n*-*p*) for *p* regressors or (*n*-*p*-1) if an intercept is used. In this case, *p*=1 so the denominator is *n*-2.

The standard errors of the parameter estimates are given by:

$$\hat{\sigma}_{\beta_0} = \hat{\sigma}_\varepsilon \sqrt{\frac{1}{n} + \frac{\bar{x}^2}{\sum(x_i - \bar{x})^2}}$$
$$\hat{\sigma}_{\beta_1} = \hat{\sigma}_\varepsilon \sqrt{\frac{1}{\sum(x_i - \bar{x})^2}}.$$

Under the further assumption that the population error term is normally distributed, the researcher can use these estimated standard errors to create confidence intervals and conduct hypothesis tests about the population parameters.

Hedging pressure enters the regression both contemporaneously or predictively. In the left side of the table the futures return is measured from t-1 until t while the hedging pressure at t. The slopes of the regression are negative and in most cases statistically significant which means than an increase in futures short position or a decrease in a long position is associated with a positive futures return. This in turn means that hedging pressure might affect futures return but at the same time hedging pressure might be adjusted according to the trend of the futures price trend.

In the right column of the table hedging pressure is measured at the beginning of the futures return interval. The regression therefore tries to assess if there is a predictive value and tries to predict futures returns with a given hedging pressure. The slopes of this regression are not statistically significant which means that hedging pressure cannot predict futures excess returns or futures risk premiums.

		Contemporaneous			Lagged		
	Commodity	slope	*t*-stat	R-sq	slope	*t*-stat	R-sq
Metals	Copper	-0.13	-4.95	0.13	-0.02	-0.91	0.00
	Platinum	-0.10	-7.49	0.16	0.00	-0.03	0.00
	Palladium	-0.06	-2.54	0.04	-0.03	-1.22	0.01
Softs	Cotton	-0.16	-8.82	0.22	-0.02	-1.15	0.01
	Cocoa	-0.15	-4.50	0.09	0.00	0.13	0.00
	Sugar	-0.19	-7.24	0.18	0.00	-0.08	0.00
	Orange Juice	-0.07	-3.35	0.05	-0.02	-0.76	0.00
	Lumber	-0.11	-3.70	0.05	-0.03	-0.97	0.00
	Coffee	-0.31	-6.85	0.17	0.04	0.86	0.00
Grains	Wheat	-0.15	-6.12	0.15	0.01	0.49	0.00
	Corn	-0.23	-8.32	0.21	-0.01	-0.30	0.00
	Soybeans	-0.10	-5.19	0.08	0.01	0.27	0.00
	Soybean Oil	-0.16	-8.31	0.18	0.00	0.13	0.00
	Soybean Meal	-0.20	-7.40	0.17	0.00	-0.04	0.00
	Oats	-0.01	-0.23	0.00	0.09	2.17	0.02
	Rough Rice	-0.09	-3.49	0.05	-0.06	-2.43	0.02
Meats	Pork Bellies	0.02	0.35	0.00	0.04	0.79	0.00
	Live Cattle	-0.09	-4.22	0.06	-0.03	-1.38	0.01
	Lean Hogs	-0.19	-5.63	0.09	0.01	0.22	0.00
	Feeder Cattle	-0.03	-1.23	0.01	0.05	2.39	0.02
	Milk	-0.14	-2.41	0.08	-0.08	-1.23	0.02
Energies	Heating Oil	-0.46	-8.22	0.22	-0.05	-0.75	0.00
	Crude Oil	-0.49	-6.73	0.17	-0.12	-1.60	0.01
	Unleaded Gas	-0.35	-6.70	0.15	-0.05	-0.95	0.00
	Propane	0.10	1.03	0.01	-0.12	-1.22	0.01
	Natural Gas	-0.77	-6.13	0.17	-0.10	-0.71	0.00

Table 7: Regression results for various products *(Source: Gorton & Rouwenhorst 2004).*

Let us now compare the two papers. The first paper tries to assess whether or not hedging pressure affect futures risks premium. It presents evidence of statistical significant relation between hedging pressure and futures returns. The second paper computes hedging pressure with a time lag to see if hedging pressure can predict excess futures returns. If finds no evidence of hedging pressure having any predictive value. It also measures hedging pressure at time t in order to see if increased hedging demand (net long positions) is associated with futures return at the same time. He finds a significant negative relation indicating that it is possible that investors adjust their position according to futures returns which means that there is a momentum in investment decision by long investors. This regression however has no predicting value since hedging pressure enters the regression contemporaneously.

The first paper finds that hedging demand significantly affects futures returns. The relation as predicted by the theory is positive. When investors increase their short position futures price will drop compensating long investors with a risk premium and then will rise as the contract reaches expiration. The paper tries to identify the cross hedging effect something which the second paper does not. The first paper also does not explain if the hedging pressure independent variable enters the equation with a time lag compared to realized futures return. It is possible that hedging pressure is determined by futures returns and not the other way round.

Finally, the first paper tries to identify the price pressure effect. When investors increase their short positions, futures price will drop due to increased supply but then will increase especially if we are talking about a hedging demand shock. It is very important to see if futures returns are explained by hedging pressure or by price pressure or by both. The results show that even after taking into account the price pressure effect hedging pressure explains in a statistical sense expected futures returns.

Now, we will try to make a comparison between the two papers which were examined (Gorton & Rouwenhorst, Roon & Nijman). In both papers an effort is made to specify the impact of hedging pressure to future returns. For this reason some regression models are proposed. In general, hedging pressure is defined as:

$$\hat{q}^{m}_{s,t} = \frac{number\ of\ short\ hedge\ positions - number\ of\ long\ hedge\ positions}{total\ number\ of\ hedge\ positions}$$

The regression models which were proposed are the following:

Gorton & Rouwenhorst

Simple cubic spline regression model:

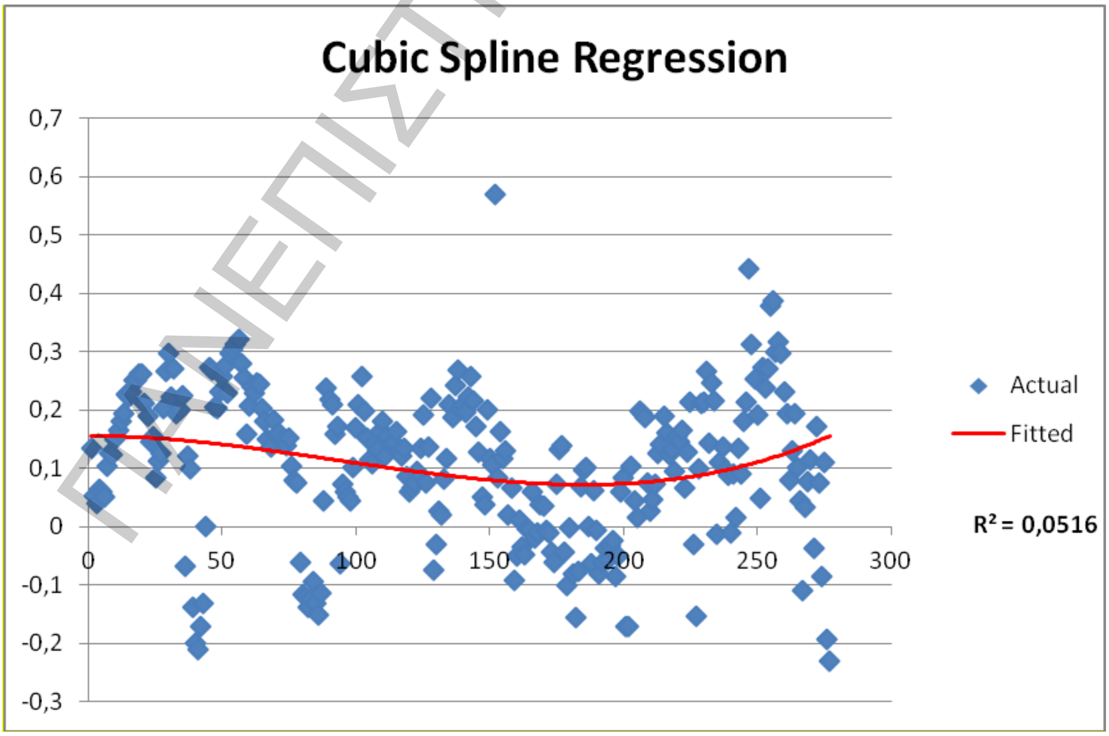
$$r_{i,t+1} = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \beta_3 x_i^2 + \varepsilon_i\,,\; i = 1,....,n$$

Roon& Nijman

$$r_{i,t+1}^{(j)} = a_i^{(j)} + \beta_i^{(j)} r_{t+1}^{S\&P500} + \sum_{s=1}^{5} \theta_{s,i}^{(j)} \hat{q}_{s,t}^{(j)} + \varepsilon_{i,t+1}^{(j)}$$

Where i refers to futures contract i in market j (financial, agricultural, mineral, currency). The variables $\hat{q}_{s,t}^{(j)}$ are the five hedging pressure variables within the own group $\theta_{s,i}^{(j)}$. Therefore measures the sensitivity of the futures return to the hedging pressure variables in its own group. Finally, in our case x_i are the returns of nonzero investments.

We used semi-monthly datasets from CFTC concerning wheat products. The dataset period was January 1986 to December 1994, excluding October 1987. We first used the Gorton & Rouwenhorst cubic spline regression model and then the Roon & Nijman regression model. The software which was used for the regression and the comparison was EVIEWS. The following figures reveal that Roon & Nijman model is more precise.



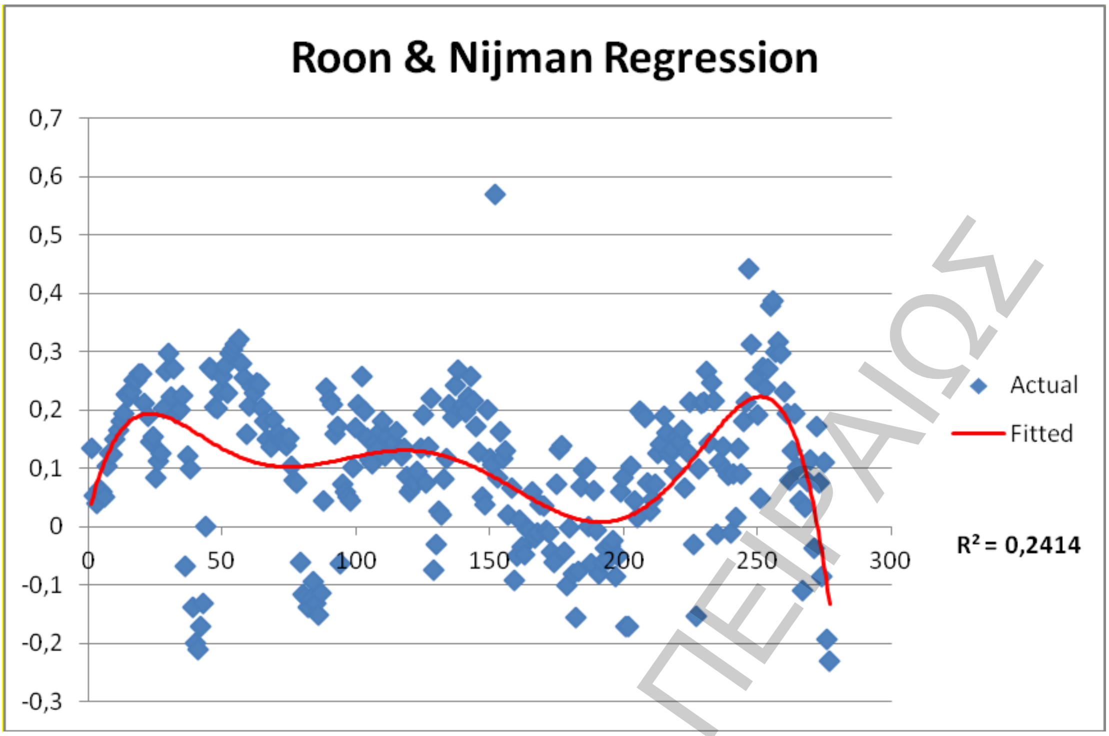


Figure 26 a) Cubic spline regression for wheat hedging pressure, b)Roon & Nijman Regression for wheat hedging pressure

As it is shown the R square value is 5% for the first paper's model and 24% for the second paper's model. This reveals that Roon & Nijman used a more robust regression formula in order to find the relation between future returns and hedging pressure.

9. CONCLUSION

Futures contracts are used by investors who want to hedge their exposure in the spot market and speculators who want to accomplish capital gains by initiating long or short position. The hedgers are concerned with the basis risk while speculators about the price appreciation or depreciation. The futures market plays a crucial role since it embodies a transfer risk mechanism and it has at the same time a price discovery role. The particular market however when is manipulated by speculators can cause many distortions in both the futures and spot markets.

In the present assignment we examined the relation between spot and futures market referring to the backwarded and contango market. In the first case a long investor earns excess returns (positive roll yield) while in the latter he realizes losses (negative roll yield). Examining therefore what determines a backwarded and contango market helps us to explain the determinants of futures return.

According to the Keynes theory when hedgers are net short and speculators are net long one who buys a future contract will earn excess returns since he has to be redeemed for taking risk. According to the theory of storage if the convenience yield is large enough to offset carry costs futures prices are expected to appreciate and a long roll over strategy will yield positive returns. The level of inventories therefore which is related to the convenience yield explains futures returns.

According to the extended version of the theory of storage the level of inventories can determine the risk premium of futures contracts through the linkage of inventories and expected spot price volatility.

The theory of hedging pressure developed by Keynes asserts that the level of hedging demand can explain the futures returns. This theory does not take into account that futures returns can determine the hedging demand parameter raising an issue of causality and that hedging demand is not always exogenous. Moreover futures prices can appreciate not only as a result of increased hedging demand but a result of a temporary supply shock which causes the futures price to decline temporarily and then revert.

In the analysis developed we assume that markets are perfect and efficient. Moreover all information is embedded in the futures prices and agents have no forecasting ability. When a speculator buys a futures contracts at a discount he believes that the futures price reflects the expected spot price minus the risk premium. For every long speculator there will normally be a short speculator. He latter believes that the expected spot price will be low while the former believes that the expected spot price will be high, this means that investors have different expectations.

The one who will earn positive profits systematically means that he has a forecasting ability or better information. Markets are rarely efficient and there are investors who have a positive record of profits in the long term either because they are capable of forecasting the price trend or because they have inside information. This means that future returns are determined not only by the factors we already mentioned but by the actions of speculators.

The fact that many futures returns cannot be explained only by hedging pressure, systematic risk, level of inventories, risk premium means that futures contracts are constantly undervalued or overvalued since expectations about the expected spot price change, these expectations are not homogenous and speculators try to take advantage of these inefficiencies. The assumption that markets are efficient does not hold. Moreover speculators with their actions create price momentums which result in the futures price deviating from its fair value. When for instance the price of a contract keeps rising speculators will be convinced that this trend will continue resulting in a further price increase (violation of the weak form efficient market hypothesis) and many times in a bubble. Therefore an excess future return might not be in line with the fundamentals of the futures price but might be attributed to market distortion. A return of 20 % in one month for instance might not be explained by the theories developed.

Finally, two papers referring to heading pressure were investigated. The first one, Gorton & Rouwenhorst proposed a simple cubic spline regression model in order to examine the relation between hedging pressure and future returns. The second one used a more elaborate regression formula. The regression results after using both methods on the same empirical dataset implied that Roon & Nijman used a more robust regression formula in order to find the relation between future returns and heading pressure. R tests in Roon & Nijman were equal to 24% while the simple cubic spline regression model gave a 5% R test. This reveals the phenomenon's complexity which leads to special mathematical calculations in order to find an approximate formula for hedging pressure and future returns.

BIBLIOGRAPHY

1. Brennan, M. J., (1991). The Price of Convenience and the Valuation of Commodity Contingent Claims, in D. Lund and B. Oksendal, Eds.: *Stochastic Models and Option Values*, North Holland.Gorton and Rouwenhorst (2004) *Facts and fantasies about futures contracts*

2. Black, F. (1976). The Pricing of Commodity Contracts, *Journal of Financial Economics.* 3: 167-179

3. Copeland, T., Weston, J.F., and Shastri, K. (2004*). Financial theory and corporate policy*. 4th Edition

4. Deaton, A. & Laroque, G. *(*1992). "On the Behaviour of Commodity Prices," *Review of Economic Studies*, Wiley Blackwell, vol. 59(1), pages 1-23.

5. Dusak, K. (1973). Futures Trading and Investor Returns: An Investigation of Commodity market Risk Premiums. *Journal of Political Economy* 81:1387-1406

6. Fama, E. & French, K. (1988). Permanent and Temporary Components of Stock Prices. *Journal of Political Economy*. The University of Chicago Press

7. Gilbert, C.L. (2009). *Speculative influences on commodity futures prices 2006-08*. Unctad discussion paper No.197

8. Gorton, G.B., Hayashi, F. and Rouwenhorst, K. G. (2007). 'The fundamentals of commodity futures returns', *NBER Working Paper No. 13249*.

9. Hernandez, M. and Torrero, M. (2010*). The Benefits of Reduced Price Volatility for Agricultural Commodities*

10. Hull, J. (1997). *Options futures and other derivatives*. Pearson Prentice. 4th edition

11. Haugen, R. A. (1992). *Modern investment theory*. Hardcover, Prentice Hall

12. Hirshleifer, D. (1989). Determinants of hedging and risk premium in commodity futures markets, *Journal of Financial and Quantitative Analysis 24:313-331*

13. Kaldor, N. (1940). Speculation and Economic Theory, *Review of Economic Studies,* 50: 78-95.

14. Kat, H. & Oomen, R.C. (2007). What Every Investor Should Know About Commodities Part II: Multivariate Return Analysis. Deutsche Bank AG. *Journal of Investment Management, Vol. 5, No. 3, Third Quarter*

15. Keynes, John M. (1930). *A Treatise on Money*, Vol. 2: 151-163

16. Kolb, Robert W. (1992). "Is Normal Backwardation Normal?" *Journal of Futures Markets*, 12 (2):177-186

17. Lazaridis, I. (2006). Relationship between Working Capital Management and Profitability of Listed Companies in the Athens Stock Exchange. *Journal of Financial Management and Analysis, Vol. 19, No. 1*

18. Lautier, D. (2009). *Convenience Yield and Commodity Markets.* Les Cahiers de la Chaire / www.ifd.dauphine.fr/fileadmin/mediatheque/recherche_et_valo/FDD/CAHIER_22_LAUTIER.pdf.

19. Liang, Y., J.C. Miller, A. Harri, and K.H. Coble. (2011). Crop supply response under risk: Impacts of emerging issues on Southeastern U.S. agriculture. *Journal of Agricultural and Applied Economics* 43(2):181-194.

20. Maccini, L. J., Moore, B. & Schaller, H. (2006). "Inventory Behavior with Permanent Sales Shocks," *Fordham Economics Discussion Paper Series dp 2013-03,* Fordham University, Department of Economics.

21. Meigs Walter B., & Meigs Robert F. (1970). *Financial Accounting, 4th Edition*. New York: McGraw-Hill.

22. Routledge, Br. R. (2000). Equilibrium forward curves for commodities. *Journal of Finance*. 55 (3): 1297–1338

23. Roon, Fr. A. de, Nijman, T. E. & Veld, Ch. (2000). Hedging Pressure Effects in Futures Markets, Journal of Finance, *American Finance Association*, vol. 55(3):1437-1456

24. Sheffrin, St. M. (2003). *Economics: Principles in action*. Upper Saddle River: Pearson Prentice Hall

25. Stoll, H.R., and Whaley, R.E. (2010). Commodity Index Investing *and Commodity* Futures Prices. *Journal of Applied Finance*, Vol. 20, No 1:7-46

26. Titman, S. (1992). *Financial markets and corporate strategy*. Boston: McGraw-Hill.

27. Working, H. (1927). Forecasting the Price of Wheat. *Journal* of *Farm Economics*, vol. *9, 3, 1927*:273-287

28. Working, H. (1949). The theory of the price of storage, *American Economic Review*, n°31, December:1254-1262

29. Scott H. Irwin and Dwight R. Sanders, *"Financialization and Structural Change in Commodity Futures Markets",* Journal of Agricultural and Applied Economics, 44,3(August 2012):371–396, 2012 Southern Agricultural Economics Association

30. Cantecin Dincerler, Zeigham Khokher et al *"An Empirical Analysis of Commodity"*, (June 2005)

31. Diana R. Ribeiro, Stewart D. Hodges, *"A Two-Factor Model for Commodity Prices and Futures Valuation",* (2004)