Hedging as a tool of risk management in corporate finance: testing of traditional and non-traditional hedging techniques in the example of selected markets

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Define the objectives and the application methods used in the Master thesis.

I. **Theoretical part**

- **Compile theoretical information and literature review on capital market and risk management.**

II. **Practical part**

- **Complete the analysis of current selected markets' dynamics in the selected country.**
- **Prepare the analysis of hedging techniques and their implementation in the selected markets.**
- **Prepare the project of investment hedging with non-traditional methods in the selected markets.**
- **Submit the project to risk and cost analysis.**

Conclusion

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ABSTRAKT

Téma diplomové práce pojednává o tradičních a netradičních hedgingových technikách. Teoretická část je zaměřena na historii finančních trhů. Detailně popisuje systém řízení rizik, hedging a diverzifikaci a vysvětluje běžné metody pro analýzu trhu, které slouží i jako úvod pro moderní analýzy trhu, jakými jsou například Black Swan a Dragon King. Pro praktickou část byl vybrán trh s ropou. Trh s ropu je rozebrán pomocí několika analýz: politické, makroekonomické a mikroekonomické. Na tyto obecné analýzy navazuje tradiční přístup technické analýzy. Cílem práce bylo zjistit, zda může moderní metoda Dragon King pomoci při predikci pohybu ceny ropy. Projektu je zakončen srovnávací analýzou. Závěry zjištěné v rámci praktické části byly porovnány s výsledky vynálezce techniky Dragon King.

Klíčová slova: Řízení rizik, zajištění, technická analýza, diverzifikace, Dragon king

ABSTRACT

The master's thesis deals with the analysis of traditional and non-traditional hedging techniques. The theoretical part includes the history of markets and financial markets. It gives detailed description of risk management, hedging, diversification. It explains the common ways of market analysis. Especially, it stresses out the technical and fundamental analysis. It gives an introduction to modern methodologies of market analysis, such as Black Swan and Dragon King. In the practical part of the thesis, oil market was selected as an example. It gives an explanation of oil and its characteristics. There is a political, macroeconomic and microeconomic analysis of oil market. Then it analyzes the market using traditional technical analysis approach. The subject of the thesis was to understand if it is possible to use Dragon King Method to predict the movement of oil prices. Based on the conducted model, at the end of the thesis there is a project of comparative analysis. The results obtained in this thesis were compared to the results of inventor of the Dragon King technique. Comparison showed a similarity in the approaches, hence can be used in the decision making processes during hedging.

Keywords: Risk management, hedging, technical analysis, diversification, Dragon King

Contents

INTRODUCTION

During the last couple of decades, the world experienced several drastic recessions, preceded by sudden crashes of financial market. Almost all of them somehow were related to oil and energy sector. The oil crisis of 70s in the last century, crashing oil prices in 2006 and 2014 can be good examples of such events. Besides them, the financial market saw such dramatic changes as dotcom crisis, flash crash in 2010, which severely damaged not only the financial sector but the whole economy of the world as well. In this regards, one starts to ask if there are necessary tools and techniques that would help investors and traders to avoid such collision, or go through them with minimum losses. Due to this phenomenon, the role of risk management has been increasing significantly over the past few years. Managing your investment and minimizing the exposure to risk is fundamental to survive in the modern realms of financial world.

In the theoretical part we will explore the market, its history in relation to finance. We will do literature review on hedging and risk management. We will briefly describe the Black Swan methodology. We will cover the main characteristics of hedging.

Risk management offers you two tools in this financial matter: diversification and hedging. In this paper, we are going to explore the latter in the world oil market. As this commodity is a crucial goods that is used in almost every sphere of life. Abundance of data makes the choice of oil logical. As an example of this market, we will try to explore the traditional market analysis approaches, with stressing more on the classical hedging techniques. We will try to analyze the movement of oil prices in historical perspective, apply the rules of hedging to them and see if they can give us an insight to the market behavior.

On the second part of our analysis, we will introduce a modern approach to risk management, called Dragon Kings. This concept is very broad and can be applied to many fields including geology, medicine economy and of course finance. We will attempt to use this model to predict the movement of oil prices, hence giving us another tool to use in our decision making process regarding to hedging.

We will test our model using statistical methods such as regression and ANOVA to test our model to significance.

OBJECTIVES AND METHODS OF MASTER THESIS PROCESSING

The main goal of the thesis to test and get insight to the main traditional and modern techniques related to risk management and hedging.

The goal of the analysis is to determine whether it is possible to use modern mathematical model to predict the movement of prices in the market, hence giving us another useful tool to make better investment and trading decisions.

Methodology of the analysis is mathematical and statistical modeling, as well as technical analysis.

Data used in the analysis is primary, it is a raw data taken from authoritative sources and markets. Data collection method is analysis of primary sources, markets and countries statistical findings.

The result of the analysis will be testes using statistical tests and conclusions are considered to be useful in the further scientific development of the field.

I. THEORY

1 MARKET AND RISK MANAGEMENT: HISTORY AND MAIN CHARACTERISTICS

For thousands of years, people have been involved in some sort of trading and exchange process that helped them from survival to self-realization. The place in which those exchanges are undergone is usually called the market. A market is one of the many types of systems, institutions, procedures, social relations and infrastructures in which two or more parties encounter in exchange.

From historical perspective players used to exchange goods and services by barter, however nowadays, most markets rely on sellers offering their goods or services (including labor) in exchange for money from buying side. So in other words a market is the process by which the prices of goods and services are formed up. Markets facilitate trade, they help to distribute and allocate the resources through society. A market is usually created by nature, but sometimes it is constructed deliberately by humans in order to enable the exchange of services and goods.

The first leads of the marked can be tracked down to 3000 BC. In the territory of current Cyprus, huge amount of metals have been found, which indicates the gathering of people of that time to exchange with the commodity. Water was far the easiest method of transporting goods is especially in an era when towns and villages were connected by footpaths and did not have the necessary infrastructure. The first extensive trade routes are up and down the great rivers which became the beginnings of early economic development - the Nile, the Tigris and Euphrates, the Indus and the Yellow River.

On the other part of the world an important trade route became established along a string of oases north of the Himalayas. China and its several dynasties were depended on the trading processes they have with the east and west civilizations. The Silk Road played an important role in this development, connecting the two major empires of the time with each other.

Markets differ in form, scale, location, and types of participants, as well as the types of goods and services traded. There are different types of markets in the world and rough categorization is as follows:

1. Physical consumer markets
    - Retail markets, shop centers, public markets, Main streets and many more
    - Stores, auction markets

2. Physical business markets
    - Wholesale markets, markets of intermediate goods
    - Labor markets and trade fairs.
3. Nonphysical markets
    - Internet and electronic markets and many more.
4. Financial markets
    - Stock and bonds market
    - Currency exchange markets
    - Futures and predictions market

Our work covers the last type of market and process that go in it. A financial market is a place, physical or nonphysical, in which people trade financial securities, commodities, and other fungible items of value at low transaction costs and at prices that reflect supply and demand. Securities are formed up by stocks and bonds, and commodities including precious metals or agricultural products. Inside of the financial terms the words capital market and money exchange markets are used interchangeably, as long and short term referrals to raise finance respectively. As the market is a place where the buyers meet the sellers, without financial markets, borrowers would have difficulty finding lenders themselves.

1.1 Definition of risk and risk management

The objective of both sides is raising finance and growth. However, the market is a dynamic structure and it is connected to overall development of economy. Hence, in the market both buyers and sellers face different challenges and risks. This raises the importance of achieving the expected results with minimum losses. Realization of this goal is a task of interdisciplinary field of Risk management.

Risk in itself is not bad; risk is essential to progress, and failure is often an important part of learning. But we must learn to balance the possible negative consequences of risk against the potential benefits of its associated opportunity. (Van Scoy, 1992) A risk is a potential future harm that may come from some present action such as, bad decision making, crisis situations, price changes and many more. The loss is often considered in terms of direct financial loss, but also can be a loss in terms of credibility, future business, and loss of property or life.

Risk management is a rapidly developing discipline and there are many and varied views and descriptions of what risk management involves, how it should be conducted and what it is for. Risk management is not just something for corporations or public organizations, but for any activity whether short or long term.

The goal of good risk management is the identification and treatment of these risks. Its objective is to add sustainable value to all the activities of the organization or individual. It develops the understanding of the potential upside and downside of all those factors which can affect the organization or an individual. It increases the probability of success, and reduces both the probability of failure and the uncertainty of achieving the objectives (IRM, 2002).

A listing of all risks that a firm or an individual investor faces can be difficult. One step towards making them understandable and manageable is to sort risk into broad categories. In addition to organizing risks into groups, it is a key step towards determining what to do about these risks. In general, risk can be categorized based on the following criteria (Rhoads, R. 2011):

- Market versus Firm-specific risk when risk affects either a specific company or a whole market
- Operating versus Financial Risk, which can include changing interest rates, risk premiums and so on
- Continuous Risks versus Event Risk, where the former constitutes for long term economic risk, while the latter is sudden unexpected events
- Catastrophic risk versus Smaller risks which ultimately depends on the size and the value of a particular company

In financial markets, the risk management becomes essential, as both in long and short terms of investment and trading, financial markets represent higher risks of loss. In this matter it is important to understand the difference between investment and trading.

The term ‘investing” could be associated with the different activities, but the common target in these activities is to “employ” the money (funds) during the time period seeking to enhance the investor’s wealth (Levišauskait, 2010).

Alongside with the investment, the term trading or speculation is frequently used. Trading can be described as investment too, but it is connected with the short-term investment horizons and usually includes purchasing the securities with the hope that its price will increase

rapidly, providing a quick profit. Speculators try to buy low and to sell high, their primary concern is with anticipating and profiting from market fluctuations (Levišauskait, 2010). But as the volatility in the financial markets is and become more and more unpredictable, trading is treated as the investments of highest risk. In contrast, an investment is based upon the analysis and its main goal is to promise safety of principle sum invested and to earn the satisfactory risk (Levišauskait, 2010).

1.1.1 Main techniques and tools of risk management

High volatility or unpredictability of financial market movements does not make the trading stop employing the tools of risk management. There are two main tools that can be useful in investment as well as in trading, to reduce the possible risk: diversification and hedging (WITZANY, 2010).

Diversification refers to the technique when an investment portfolio of a particular company or individual investor consist of several amounts of different, mutually exclusive or inclusive assets, stocks, commodities or currency. Effective diversification requires management of the correlation between the asset returns and the liability returns, issues internal to the portfolio, and cross-correlations between the returns from different stocks and commodities.

In corporate portfolio models, diversification is thought of as being vertical or horizontal. Horizontal diversification is when a company or investor expands the existing product line or purchases related commodities, company's shares and so on. Vertical diversification is synonymous with integrating the supply chain or amalgamating distributions channels.

Non-incremental diversification is a strategy followed by conglomerates, where the individual business lines have little to do with one another, yet the company is attaining diversification from exogenous risk factors to stabilize and provide opportunity for active management of diverse resources (Ansoff, 1999).

Hedging on the other hand is analogous to taking out an insurance policy. If you own a home in a forest area, you will want to protect that asset from the risk of forest fires – to hedge it, in other words – by taking out insurance. There is a risk-reward tradeoff in hedging; while it reduces potential risk, it also decreases the potential gains. In other words, hedging isn't free. In the case of the fire insurance policy, the monthly payments add up, and if the fire never comes, the policy holder receives no payout. Still, most people would choose to take that predictable, circumscribed loss rather than suddenly lose the roof over

their head. Let's take a closer look on the cost composition of hedging. There are two types of them:

- Explicit costs: most businesses insure against at least some risk and the costs of risk protection are easy to compute. They take the form of the insurance premiums that you have to pay to get the protection. In general, the tradeoff is simple. The more complete the protection against risk, the greater the cost of the insurance. In addition, the cost of insurance will increase with the likelihood and the expected impact of a specified risk. A business located in coastal countries will have to pay more to insure against floods and hurricanes than one in the mid-west or desert.
- Implicit costs: the hedging costs become less explicit as companies look at other ways of hedging against risk. Firms that try to hedge against risk through their financing choices – using euro debt to fund euro assets, for instance – may be able to reduce their default risk (and consequently their cost of borrowing) but the savings are miniscule.

A perfect hedge is one that eliminates all risk in a position or portfolio. In other words, the hedge is 100% negatively correlated to the vulnerable asset. This is more an ideal than a reality on financial markets and even the hypothetical perfect hedge is not without cost. Basis risk refers to the risk that an asset and a hedge will not move in opposite directions as expected; "basis" refers to the discrepancy.

1.1.2 Instruments of hedging: futures

The main instrument that can be used in the hedging is derivatives, which consist of:

- Futures
- Put options
- Call options
- Swaps
- Forward contract

Because the connection of derivatives and their underlying asset (bonds, stocks, commodities) is well studied, derivatives can be effective hedges against their underlying assets. Let's go deeper into the derivative instruments.

Forward Contracts - When a firm has an agreement to pay (receive) a fixed amount of foreign currency at some date in the future, in most currencies it can obtain a contract today

that specifies a price at which it can buy (sell) the foreign currency at the specified date in the future. This essentially converts the uncertain future home currency value of this liability (asset) into a certain home currency value to be received on the specified date, independent of the change in the exchange rate over the remaining life of the contract (Bodnar, 2010).

A future contract is an agreement between two parties than they agree tom transact with the respect to some financial asset at a predetermined price at a specified future date (Levišauskait, 2010). One party agree to buy the financial asset, the other agrees to sell the financial asset. It is very important, that in futures contract case both parties are obligated to perform and neither party charges the fee.

Contracts are negotiated at futures exchanges, which act as a marketplace between buyers and sellers. The buyer of a contract is said to be long position holder, and the selling party is said to be short position holder (Chicago Fed, 2015).

The first futures contracts were introduced for agricultural commodities, and later for natural resources such as oil. Financial futures were introduced in 1972, and in recent decades, currency futures, interest rate futures and stock market index futures have played an increasingly shaped the overall futures markets. The original use of futures contracts was to minimize the risk of price or exchange rate movements by allowing two sides of the transaction to fix prices or rates in advance for future transactions. This could be advantageous when an investor expects to receive payment in foreign currency in the future, and wishes to protect against an unfavorable movement of the currency in the interval before payment is done. On the other hand, futures contracts offer a great opportunity for speculators, as if they can predict the price movement correctly, they can buy futures contracts hereby saving or profiting from the price movement.

The first futures exchange market was the Dōjima Rice Exchange in Japan in the 1730s, to meet the needs of samurai who—being paid in rice and after a series of bad harvests—needed a stable conversion to coin (Schaede, 1989).

The Chicago Board of Trade (CBOT) listed the first-ever standardized 'exchange traded' forward contracts in 1864, which were called futures contracts. They based this contract on grain trading, and started a trend that saw contracts created on a number of different commodities as well as a number of futures exchanges set up in countries around the world (CME group, 2010). The 1972 creation of the International Monetary Market (IMM), the

world's first financial futures exchange, launched currency futures. In 1976, the IMM added interest rate futures on US treasury bills, and in 1982 they added stock market index futures.

1.1.3 Instruments of hedging: options

Another instrument of hedging is option. There are two types of option:

Call option: in financial terms, it is a contract which gives the buyer the right, but not the obligation, to buy an underlying asset or instrument at a specified strike price on a specified date, depending on the form of the option.

Put option: it is contract which gives the owner the right, but not the obligation, to sell an underlying asset or instrument at a specified strike price on a specified date, depending on the form of the option.

As we can see the main difference between options and futures is in the degree of freedom that investors can take during the trading. While if a company has a futures contract, they are obliged to buy or sell the asset, but if they have an option, they have only right to sell or buy the asset.

The power of options lies in their versatility. They enable companies and investors to adapt or adjust their positions according to any situation that comes up. Options can be as speculative or as conservative as traders want. This means it is possible to do everything from protecting a position from a decline to outright betting on the movement of a market or index.

However, this advantage in versatility has its own costs. Options are complex securities and can be extremely risky. This is why, when trading options in exchange markets, we can see a disclaimer like the following (Nasdaq):

Options involve risks and are not suitable for everyone. Option trading can be speculative in nature and carry substantial risk of loss. Only invest with risk capital.

Options contracts have been known and traded for decades. The Chicago Board Options Exchange was formed up in 1973, which set up a regime using standardized forms and terms and trade through a guaranteed clearing house. This has led to incensement in trading activity and academic interest since then.

Today, many options are created in a standardized form and traded through clearing houses on regulated options exchanges, while other over-the-counter options are written as bilat-

eral, customized contracts between a single buyer and seller, one or both of which may be a dealer or market-maker. Minimum required specification of any options contract is as follows:

- whether the option holder has the right to buy (a call option) or the right to sell (a put option)
- the quantity and class of the underlying asset(s) (e.g., 100 shares of XYZ Co. B stock)
- the strike price, also known as the exercise price, which is the price at which the underlying transaction will occur upon exercise
- the expiration date, or expiry, which is the last date the option can be exercised
- the settlement terms, for instance whether the seller must deliver the actual asset on exercise, or may simply tender the equivalent cash amount
- the terms by which the option is quoted in the market to convert the quoted price into the actual premium – the total amount paid by the holder to the buyer

There are mainly two common classifications of options in terms of styles that are:

- American option – an option that may be exercised on any trading day on or before expiration.
- European option – an option that may only be exercised on expiry.

As we told before, because of its nature, options have been am interesting topic for academic field from financial mathematics point of view. There are lots of financial models dedicated to options, their characteristics and their values. The value of an option can be estimated using a variety of quantitative techniques based on the concept of risk neutral pricing and using stochastic calculus. The most basic model is the Black–Scholes model. More sophisticated models are used to model the volatility smile. These models are implemented using a variety of numerical techniques (Reilly, Frank K.; Brown, Keith C, 2003). In general, standard option valuation models depend on the following factors:

- The current market price of the underlying security,
- the strike price of the option, particularly in relation to the current market price of the underlying security
- the cost of holding a position in the underlying security, including interest and dividends,

- the time to expiration together with any restrictions on when exercise may occur, and
- approximate estimate of the future volatility of the underlying security's price over the life of the option.

More advanced models can require additional factors, such as an estimate of how volatility changes over time and for various underlying price levels, or the dynamics of stochastic interest rates. Once the model is choses there are additional different type of techniques to implement the chosen models into real life situations, the most used ones being analytical techniques, binominal tree pricing method, Monte Carlo simulation techniques and many more (Graham, Benjamin a David L Dodd. 2009).

In general, despite their complexity and requirements of mathematical modeling, options are essential part of hedging, helping investors and traders to avoid or minimize the wide variety of financial risks.

1.1.4 Instruments of hedging: Swaps

Swaps are another tool that is used in the hedging of a position or investment. Swaps are agreement between two parties to exchange sequences of cash flows for a set period of time. Usually, at the time the contract begins, at least one of these series of cash flows is determined by a random or uncertain variable, such as an interest rate, foreign exchange rate, equity price or commodity price. Conceptually, a swap as either a portfolio of forward contracts or as a long position in one bond coupled with a short position in another bond.

Unlike most standardized options and futures contracts, swaps are not exchange-traded instruments. Instead, swaps are customized contracts that are traded in the over-the-counter market between private parties. Firms and financial institutions dominate the swaps market, with few individuals ever participating. Because swaps occur on the over-the-counter market, there is always the risk of a counterparty defaulting on the swap.

From historical perspective, the first swap occurred in 1987 between World Bank and IBM. Since then there has been a development of International Swaps and Derivatives Association and a huge increase in the volumes of swaps.

The five most common types of swaps, in order of their quantitative importance, are: interest rate swaps, currency swaps, credit swaps, commodity swaps and equity swaps. To evaluate swaps, financial analytics use so called Net present value of all estimated future

cash flows. That means that when the swap is newly formed, it has value of equal to zero. As time passes, it can gain either a positive value or a negative value.

As we can see from the discussion in this part, most of the techniques that are used during hedging process require a clear understanding of market movement and confidence. Because hedging is related to minimize the risk that should occur in the future, predicting the movement of price of stocks, bonds, commodities and other assets is very important.

While there are always classical and much analyzed approaches to predict the market movements, such as technical analysis, the recent developments in the field of financial mathematics can give us some fresh ideas about the market and prices.

1.2 Main methods of market analysis

When it comes to the analysis of the market, there are two approaches that dominate the school of thoughts: technical and fundamental analysis. Technical analysis looks at the price movement of a security and uses this data to predict its future price movements.

The principles of technical analysis are derived from hundreds of years of financial market data (de la Vega, 1688). During the 1920s and 1930s Richard W. Schabacker published several books which were dedicated and continued the work of Charles Dow and William Peter Hamilton in their books Stock Market Theory and Practice and Technical Market Analysis. In 1948 Robert D. Edwards and John Magee published Technical Analysis of Stock Trends which is widely known to be one of the most fundamental works of the technical analysis. It is exclusively concerned with trend analysis and chart patterns and remains very useful even today's time. Early technical analysis was almost exclusively the analysis of charts, because the processing power of computers was not available for the modern degree of statistical analysis. However, nowadays powerful computers are employed by the big corporations and hedge funds to analyze the market faster and more precisely, making the prediction of the price efficient.

Fundamental analysis, on the other hand, looks at economic factors, known as fundamentals. By looking at the balance sheet, and all the statements, a fundamental analyst tries to determine a company's value. In financial terms, an analyst attempts to measure a company's intrinsic value. In this approach, investment decisions are fairly simple to make - if the price of a stock trades below its intrinsic value, it's a good investment. This is somewhat an oversimplification of course, but it shows the core process that is embraced by the fundamental analysis.

There are differences in time framework as well. Fundamental analysis takes a considerably long-term approach to analyzing the market compared to technical analysis. While technical analysis can be used on a timeframe of weeks, days or even minutes, fundamental analysis often looks at data over a number of years.

Another notable difference between two approaches lies in the conceptual behavior of them regarding the market. Not only is technical analysis more short term in nature than fundamental analysis, but the goals of a purchase (or sale) of a stock, commodities are usually different for each method. In general, technical analysis is used for trading, whereas fundamental analysis is used to investing. Investors buy assets they believe can increase in value, while traders buy assets they believe they can sell to somebody else at a greater price.

While technical analysis is a security analysis methodology for forecasting the direction of prices through the study of past market data, primarily price and volume (Kirkpatrick & Dahlquist, 2006), it is based on the assumption that price which is indicated at any point of a time includes all the necessary information regarding the asset, hence making the analysis of economic indicators, balance sheet, income statement and other data useless.

1.2.1 Basis of technical analysis

The field of technical analysis is based on three assumptions:

- The market discounts everything.
- Price moves in trends.
- History tends to repeat itself.

Let’s consider the each assumption in more detail:

1. Technical analysis assumes that, at any given time, a stock's price reflects everything that has or could affect the company or any commodity - including fundamental factors. Technical analysts believe that the company's fundamentals, along with broader economic factors and market psychology, are all priced into the stock, removing the need to actually consider these factors separately. This only leaves the analysis of price movement, which technical theory views as a product of the supply and demand for a particular stock in the market (Fama, Fisher, Jensen, and Roll, 1969). This approach is based on so called Efficient Market Hypothesis developed by Eugene Fama in 1969.

2. In technical analysis, price movements are considered to follow trends. This means that after a trend has been established, the future price movement is more likely to be in the same direction as the trend than to be against it. This assumption underlies the most technical analysis strategies used to predict the price movement in the market.
3. Another important idea in technical analysis is that history repeats itself, mainly in terms of price movement, meaning that the patterns that happened once at one point of time could and would happened again. The repetitive nature of price movements is attributed to market psychology; market participants tend to provide a consistent reaction to similar market stimuli over time. During the crisis sell options are favored, and market participants demonstrate it in each volatile situation.

Technicians employ many methods, tools and techniques as well, among which the important role is played by use of charts. Using charts, technical analysts seek to identify price patterns and market trends in financial markets and attempt to exploit those patterns

Technicians using charts search for archetypal price chart patterns, such as the well-known head and shoulders or double top/bottom reversal patterns, study technical indicators, moving averages, and look for forms such as lines of support, resistance, channels, and more obscure formations such as flags, pennants, balance days and cup and handle patterns (Elder, 1993). Technical analytics pay a huge attention to such mathematical simulations of price such as the moving average, relative strength index, and MACD. They include correlations between changes in Options (implied volatility) and put/call ratios with price.

From technical perspective, there are many analytical tools that can be implemented by technicians. Some of them like Dow Theory or Elliot wave theory may ignore the conventional techniques of the analysis, yet many traders who base their routines under technical analysis combine multiple methods to predict the market behavior.

1.3 Modern models of market analysis: Black Swan methodology

In recent years, there have been a lot of financial crises who shattered the belief of market in the efficiency of technical analysis. In the early 2000s, there was a dotcom crisis, followed by the bubble formed due to the extreme rise of internet businesses. There were 2008s Financial Crisis, who turned into massive recession for the most of the countries in the world, and recently the world's market struggling again because of political tension in the Middle East, confrontation between USA and Russia, as well as many other factors.

These drastic changes in the market are of course mostly affected by the political, global factors. However, the recent years of academic development in the field of finance and risk management has been focusing on modern approaches to the prediction of market movement. Handful of fruitful theories have been developed and tested. While we will consider one of the most popular one among them – Dragon King – in our next analysis chapter, in this part of our work we decided to review antagonist of the Dragon King, the Black Swan approach to risk, prediction and market movement.

The concept of black swan events was popularized by the writer Nassim Nicholas Taleb in his book, "The Black Swan: The Impact Of The Highly Improbable" (Taleb, 2008). The essence of his work is that the world is severely affected by events that are rare and difficult to predict. The implications for markets and investment are compelling and need to be taken seriously.

What we call here a Black Swan is an event with the following three attributes (Taleb 2008):

- It is an outlier, it lies beyond our beliefs and expectations
- The even has a significant impact on the market in our case
- Human behavior tends to seek explanations to the event, after it happened.

Classic black swan events include the rise of the internet and personal computer, the Sept. 11 attacks and World War I. However, many other events such as floods like Catherine hurricane, droughts, epidemics like Ebola, bird flu and so on are either improbable, unpredictable or both. This "non-computability" of rare events is not compatible with scientific methods; no scientific methodology can actually grasp the possibility of such events with significant accuracy. The result is that people develop a psychological bias and "collective blindness" to them (Taleb, 2008). The very fact that such rare but major events are by definition outliers makes them dangerous.

Stock and other investment markets are affected by all manner of events starting in supply-demand and finishing in the relationship of USA with Russia. Downturns or crashes such as the dreadful Black Monday or the stock market crash of 1987 or the internet bubble of 2000, or recent flash crashes were relatively "model-able," but the Sept. 11 attacks, Ukrainian Crisis 2014, rise of terrorism, conflicts in Middle East, where the most amount of oil is produced, were far less forecasted and predicted.

The point is, while all traders and investors want to predict the future, most of them fail to grasp the whole picture. We can model and predict some things (to an extent), but not others - not the black swan events. And this creates psychological and practical problems (Taleb, 2008).

For example, even if we correctly predict some things that impact on the oil price and other financial markets, such as election results and meeting in OPEC countries, some other event like a natural disaster or war can override these other factors and throw our plans to totally different ways of developing. Furthermore, events of this kind can happen any time and last for any length of time.

Taleb was not the first one to argue with the conventional market analysis techniques such as candlesticks and others. The work of Gerd Gigerenzer also provides some useful inputs. Gigerenzer argues that 50% or more of decisions are made intuitively, but people often shy away from using them as they are hard to justify. Instead, people make "safer," more conservative decisions. Thus, fund managers may not be contrarian, simply because it is easier at the time to go with the flow (Gigerenzer, 2008).

Gigerenzer points out the importance of intuition and claims that no model, be it a complex or simple can outweigh our intuition in terms of predicting the future. Gigerenzer considers the Nobel Prize-winning work of Harry Markowitz on diversification. He argues that one would really need data extending over 500 years for it to work. Even a huge collection of data could not predict the events in 2008 and 2009. The standard asset allocation models did not work well at all at that time. Investors and traders still need to diversify, but intuitive approaches are arguably just as good as complicated models, which simply cannot integrate black swan events in any meaningful manner (Gigerenzer, 2008).

The main idea of Black Swan is not to attempt to predict these events, but to build robustness against negative ones that happen, while being able to exploit positive ones. The model contends that banks and trading firms are very vulnerable to hazardous black swan events and are exposed to unpredictable losses (Taleb, 2008). On the subject of business, market and price movements in particular, aforementioned authors are highly critical of the widespread use of the normal distribution model as the basis for calculating risk.

Companies which have been struck by Black Swan events often struggle because they have a difficult time making good decisions as the event unfolds. Even the most prepared and well-run organizations can find themselves in this situation. To understand why, we need

to first understand what it feels like to operate in a Black Swan and how decision-making becomes much more complex in that environment. The following are common characteristics of many of the Black Swan events that have occurred (Nancy Green, 2011):

- Response to a crisis and a solution to the scenario are typically two distinctly different components of an effective Black Swan response. It's not just about responding to the drastic price change of oil for instance, and getting the situation under immediate control; it's also about figuring out how to fix the problem itself and trying to avoid it to happen again.
- Oftentimes, no solution to the problem exists; rather, it must be created. Unfortunately, the underlying problem is not always obvious, which means that leadership may have to search to find the true cause. Furthermore, the size/scope of the problem is not always easy to quantify immediately, which makes it difficult to fully assess impact. To make matters worse, the organization may need to go through several solutions before finding one that works and/or may need more than one solution to address different aspects of the problem; all of which take precious time. On 17th of July, the member states of OPEC gathered in Doha and tried to have some agreement on the controlling the price of an oil. The meeting has failed and the next day the major markets in world opened with a drastically low oil prices. OPEC decided to meet again but in June. As we can see, the organization is failing to find a solution to Black Swan event and now the process will continue until some agreement is achieved.
- Do not underestimate the fear factor associated with having a problem with not - known solution. Again with recent example, Saudi Arabia refused to sing any agreement on the freezing the oil production, due to the fact that its competition Iran decided to avoid the meeting. Saudi Arabia's response is typical fear factor against black swan event.
- Public relations issues can be massive. Middle East problems, Crisis in Ukraina are literally shaping the world market and being aware of them will be crucial in detecting the further black swan events.
- Governmental and regulatory agencies may require a response before the size/scope of the issue has been fully estimated and understood, any viable solutions are available. A poorly crafted response or one that appears inadequate or lacks transparency can damage credibility and/or lead to even further scrutiny. This is exactly what

happened in the OPEC meeting on 17th of April. The world oil markets reacted with crashed in response of failure in the agreement between OPEC countries.

- Productivity may be negatively impacted as employees may be concerned, uncertain and distracted.
- Cash flow, liquidity and additional financial and economic factors may be adversely affected. Organizations that have always transacted business on a strong financial footing may find themselves unable to cope or to operate in an environment where cash flow, credit and/or liquidity quickly become uncertain, constrained or perhaps even unavailable.
- If publicly traded, an organization's stock price may plummet. The falling stock price drives additional issues which require attention and may create a further cascading effect on cash flow, credit, liquidity, brand reputation, consumer confidence, etc.
- Lastly, the organization must mount an effective Black Swan response while still running its day-to-day business. Companies cannot stop their works to response to crisis, they have to move on and simultaneously find a solution to the issue.

Despite the fact that Black Swan methodology resists the possibility to predict the future movement, it also suggests way to be prepared to such events, if they occur:

However, it is not preparing for a singular type of event, but rather for the impact and strengthening the ability of the organization, investor, and individual trader to anticipate and detect trends before they have a probability to evolve into a full-blown Black Swan event (LeRoy, S. F., & Werner, J. 2014).

1. Combine Enterprise Risk Management with the organization's crisis management plans, business continuity plans and supply chain risk management, to provide the infrastructure to support effective Black Swan preparedness and response. If you are individual investor or trader, form up your own risk management plan.
2. Proactively form an internal Black Swan diary with multidisciplinary information, so investor can become familiar with theory, the success factors for Black Swan response, and the tools and analytics available to support investment. Possible ways and tools to develop:
    - ERM o Risk management
    - Data and data management

- Analytics
- Claims
- Crisis communications/crisis management, consulting with other investor regarding the matter

In summary, in coping with a Black Swan event, we should not attempt to predict it, but to build robustness against negative ones that occur and exploit positive ones (Taleb,). It is possible to prepare, if one focuses on preparing for the impact. And investors should recognize the critical role of survivor psychology in shaping an environment where good decision-making can be conducted even in the midst of drastic chaos. Black Swan response doesn't have to be a question of survival. Armed with the right tools and the approaches, the possibilities are endless, and the opportunity for success is exponentially greater.

From hedging perspective, learning the impact of Black Swan can be very beneficial. Not in a direct way, because it will not help to predict the movement, but in an indirect way, as when you prepare for the events, crashes and crisis situations, it is much easier to be calm when they happen and try to figure out such way of exiting the problem, so the losses are minimal.

2 INDUSTRIAL EXAMPLE OF HEDGING

As we talked in this chapter hedging is much more than just buying an option or futures. It is way of risk management so whatever you are doing, be it a long term of investment or short term of trading, the risk of losing money is as minimal as possible. In the world hedging is one of the most used techniques of risk management, and when it comes to oil and fuel commodities, the role of hedging becomes even more essential.

2.1 Hedging in an industry: airlines and fuel prices

Hedging is a common practice of almost all airline companies that is used for protection against losses and gains caused by increase and decrease in fuel price. Thus, hedging smooth out fuel costs. As fuel constitutes around one sixth of the airlines' costs, hedging procedure contributes to stabilization of the total costs. Airline companies usually hedge from 30 to 60 percent of their fuel costs that are supposed to be in the future. As whole financial performance improves due to reducing volatility in figures, price for the airline's stock increases. This can be inferred from the fact that risk is considered as an extra cost. This theoretical foundation coincides with a practical application that determines to what extent fuel should be hedged while fuel price itself is unsteady.

Although hedging became very common phenomenon only less than a quarter of a century ago, today almost all airlines use this method to decrease potential risk.

According to the market fundamental, the expected value of a hedge equals zero due to the fact that market price comprise balanced price of the fuel of sellers and buyers and airline companies cannot influence market price. The expected value of such a compromise is zero. If reverse situation is expected by airlines, they speculate other than hedge. As a result, the aim of hedging is not to increase profits but to reduce volatility of this profit.

However, when an airline can become a bankrupt in the near future, fuel hedging can be helpful. As any airline in such a situation tends to escape future losses, they intend to hedge the price from sudden increase. But it is almost impossible to sign contract for future prices because there is no guarantee that these companies will be able to pay in case of losses. Alternative solution is a "call" option that covers fixed upper margin in fuel prices.

Practical instruments for decrease in price risk of fuel can be divided into three different types:

- Forward contracts
- Futures contracts
- Options, collars, swaps

Forward contract is an agreement to buy or sell fuel at a fixed price at a future date. There are 3 distinguished features that characterize forward contracts:

- forward contracts are not sold
- it is a specially formulated agreement between the parties
- you do not need to pay a premium (as in case of options) and a deposit (as futures) when contract is signed

As we stated before futures contracts or futures are an agreement that obliges both parties to implement the sale of fuel in the future at a specified price. These techniques are frequently adopted by the airlines to hedge their investment into fuel.

Another commonly used instrument for risk protection is a collar that combines a call and a put option. It is a procedure that gives opportunity to set upper and lower bounds for buying a put option and selling a call option.

Finally, swap is a financial transaction in which two counterparties agree to exchange one financial instrument to another after a certain time, in a strictly specified time.

According to the statistics of airline companies, the most common used fuels for hedging are jet fuel, gas oil and crude derivatives. They insure about one year of expected consumption, and most of them are hedged for three months ahead. Investigations in this field show that crude oil is supposed to be more liquid and flexible for hedging technique. However, only some of the airlines companies report in their balance sheets information about results of hedging activity. As a result, it becomes quite problematic to conduct an efficient analysis and to make truthful conclusions about usefulness of fuel hedging.

Most studies in the field of fuel hedging have only focused on foreign currency risk rather than fuel price. According to their theory, shareholders manage the risk better than it can be done on a firm management level. Such approaches, however, have failed to address such factors as taxation, access to information and economies of scale in hedging operations.

Allayanis and Weston (2001) analyzed non-financial US firms from 1990 to 1995 using statistics on foreign currency derivative. They demonstrated that firm value was higher in

those firms which applied currency hedging. This indicator was around 4.87% for hedging companies.

Carter et al. (2003) employed the previous approach to fuel price hedging. They made the same inference from their investigation.

By contrast, Rao (1999) estimated influence of purchasing different oil futures for different timeframe. According to their findings, volatility of revenue dropped by almost a quarter when hedging was applied. A considerable amount of literature has been published on correlation between oil price changes and overall financial performance of airlines. While Jones and Kaul (1996) concluded that oil prices influence stock returns, Huang et al. (1996) found no evidence to prove relationship of these indicators.

The impact of shocks in oil price on stock returns has been widely investigated by Sadorsky (1999) and J P Morgan (2001). Sadorsky showed that positive shocks in prices lower real stock returns and as a result economic growth. By contrast, Morgan found little correlation.

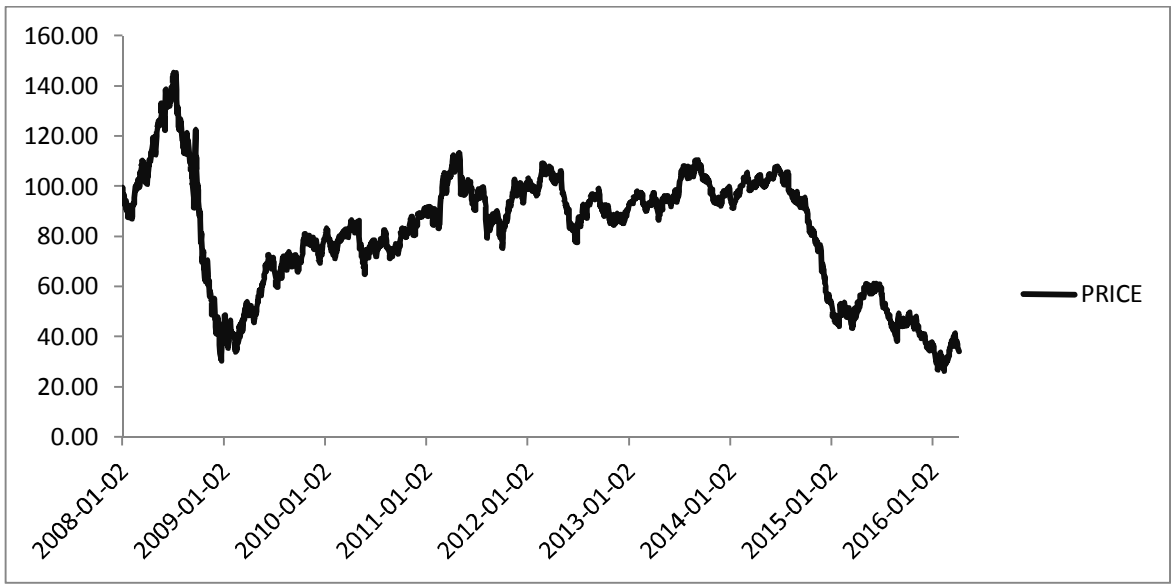
II. ANALYSIS

3 HEDGING IN A CORPORATE FINANCE

When it comes to the analysis, especially in the corporate finance, hedging becomes just more than a simple insurance of investments. It opens a wide variety of interesting and complex options to maneuver.

In the second part of this work, we are going to base our analysis on the Crude Oil data. Type of oil is West Texas intermediate (WTI), which is produced in Oklahoma. This oil has got the ID series of DCOILWTICO in the New York Exchange market, and is the second most widely traded type of oil after Brent. However, wide availability of the historical, as well as the hedging related data, made WTI the basis of our analysis.

Picture 1. Price of a WTI crude oil, between 2008 and 2016.



Source: US Energy Information Administration. www.eia.gov

We are going to analyze the movement of the price in a historical perspective, starting from 2009. As the huge collapse between 2008 and 2009, is obviously related to the world financial crisis.

We will investigate the major changes in the price after 2009 and try to find an explanation from macroeconomic, political, social perspectives.

The assumption is that there is a new investment Company XXX. They have a portfolio of 100.000 US dollars. We will assume that now is 2nd of January in 2014 and company wants to invest its portfolio to Crude Oil, with the possibility of additional investments.

We will try to analyze this decision from classical technical analysis, and will try to hedge it using conventional methods, such pair trading with Oil futures, derivatives. We will try to find out the ways of diversifying the portfolio with other different investments opportunities at that specific time. Furthermore, using correlation analysis we will explore the opportunity of investments into non-traditional pairs, meaning what other commodities, or currency had had a negative relationship with crude oil.

In the next part, we are going to use more complex and modern techniques of risk management to analyze if it was possible for a company to predict the huge changes in the behavior of the oil price. We are going to focus on two distinct, yet powerful conceptions of modern era, Black Swan and Dragon King. We will see what those methods would say regarding the changes and would we able to apply them in our hedging process.

3.1 Oil: technical characteristics, history and impact.

During millions of years of evolution, remaining of plants and animals, dwelled on earth formed, layer by layer into hydrocarbons. With pressure rising gradually, they turned into liquid form and accumulated in underground pools and reservoirs. This liquid is now known as crude oil. There are mainly two types of crude oil: heavy and light crude oil. They are differentiated using specific measures called Specific Gravity and API gravity.

Specific gravity is how dense the oil is related to water (Hough, J.S., Briggs, D.E., Stevens, R and Young, 1991). It is calculated using the formula:

$$SG_{true} = \frac{p_{sample}}{p_{H2O}}$$

API gravity is conducted by American Petroleum Institute. This is an inverse measure related to SG. It indicated how heavy of light the oil is related to water. The formula of calculating it from SG is as follows:

$$API_{gravity} = \frac{141.5}{SG} - 131.5$$

141.5 and 131.5 are universally considered measurements, derived from Baume Scale, which indicates the density of different liquids (Perry, 2008). In general, if the API gravity of oil is less than 10, it is heavier than water and it sinks in it. If it is higher than 10 it is lighter than water and it floats on it.

Heavy crude oil is defined as any liquid petroleum which has API gravity less than 20 (Dusseault 2001). New York Mercantile Exchange (NYMEX) defines the light crude oil as

one with API gravity between 37 and 42 (NYMEX, 2008). In our example we are focusing our analysis on WTI which has API 39.6 and SG around 0.827, which is lighter than another popular type Brent. It has about 0.24% sulfur, hence is rated as a sweet crude oil (having less than 0.5% sulfur). Despite the fact that it is produced within USA (Oklahoma, Cushing), WTI is benchmark crude oil, which means it is directly quoted in the market and can be considered one of the three giant types of oil, alongside with Brent and Dubai Crude, which define the oil market in the world.

Cushing, Oklahoma is the main hub for WTI crude oil, as well as the main price settlement point for over 30 years in NYMEX. Town is very small with more than 7500 people, yet it is a crucial transportation point with many interesting opportunities (CME group, 2010). As it was said before WTI is a benchmark in oil pricing and it has been traded closely to Brent and OPEC basket, albeit being discounted against Brent due to the fact that WTI is in higher quality compared to Brent and has got two premium points against OPEC basket.

3.1.1 Microeconomic analysis

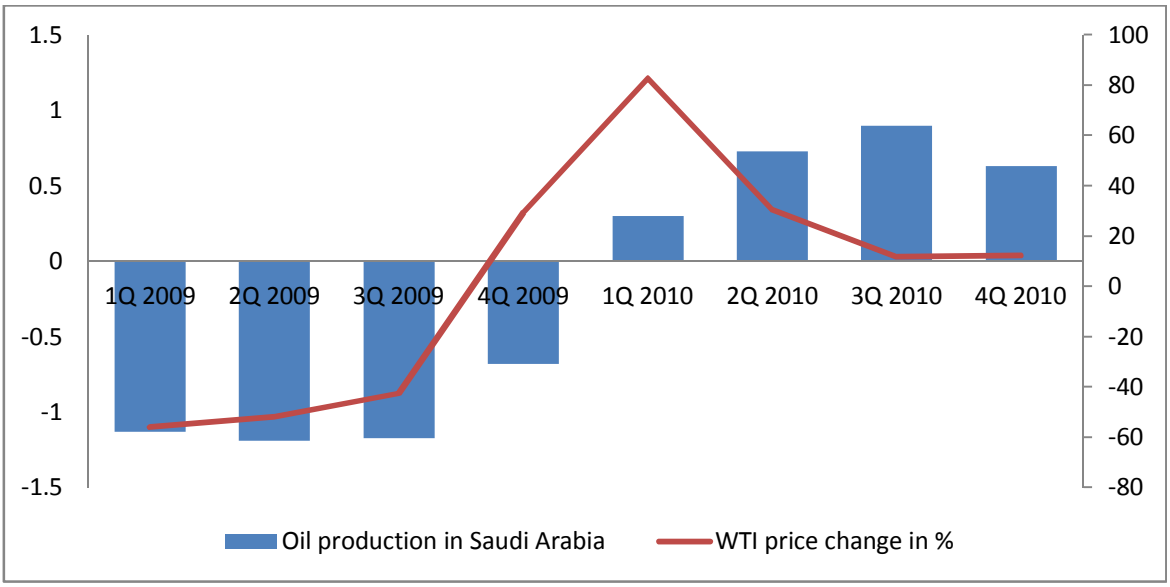
Oil, as any other commodity is subjected to a demand-supply relation. Excessive amount of production decreases the price, when the shortage raises it. However, oil is a very specific product, which is not hand-made. Earth has got its limits in terms of existence of oil in it. Furthermore, oil is one of the basic commodities used in almost every sphere of life. It is not a seemingly fresh element in human's life. In one or another form, oil is said to be used 4000 years ago to build walls and castles (Chisholm, Hugh, 1911). The first oil wells are found in China, to be used 347 AD (George E. Totten, 2007). The first oil refinery was founded by I. Lucasiewicz in 1856 (Frank, Alison Fleig, 2005).

The importance of oil however, was boosted by the invention of internal combustion engine and the rise of aviation. Moreover, the production of such materials as plastic, fertilizers, organic chemistry products which are the sub-commodities of oil made the latter hugely important to the economic development in the beginning of XX century.

Nowadays, oil can be found in almost everything, from plastic bags to the computer which we are using at the moment. Because of such involvement in life, oil prices are very sensitive to any changes in the balance of supply and demand. In the next few pictures it is clear that, from microeconomic perspective oil price can be manipulated by production and consumption (Picture 2).

In the graph below there is a comparison of the WTI type oil price change in percentage with the production of oil and its projections in Saudi Arabia. As we can see, in 2009 Saudi Arabia decreased the production almost 1 million barrels per day. This made the price of the WTI skyrocket by 80 % until the first quarter of the 2010.

Picture 2. Effects of oil supply on the price of WTI



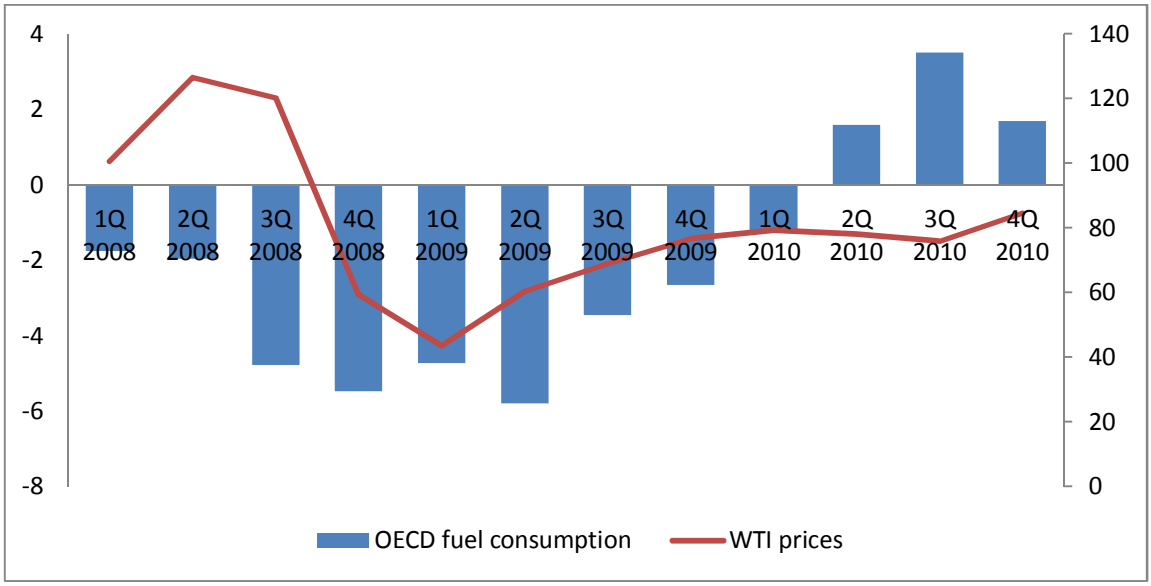
Source: US Energy Information Administration, Thomson Reuters www.eia.gov

Then, Saudi Arabia increased the production by 0.5 million barrels per day and it immediately reflected in the price of WTI. It plummeted from 80 % to 13 % by the end of 2010.

In the graph above (Picture 3), there is a demand side of the oil market and its influence on the price. Between the third quarter of the 2008 and the second quarter of 2009, the fuel consumption in OECD countries remained in its bottom line mainly due to the financial crisis. As a result of lack in demand, the market was oversupplied. This in turn decreased the prices of WTI to almost 40 US dollars in the beginning of 2009.

The price started to correct and increase, simultaneously with the raise of the consumption of fuel in 2010 and by the end of the fourth quarter it was doubled, at 84.61 US dollar per barrel.

Picture 3. Effect of demand for fuel on WTI prices



Source: Source: US Energy Information Administration, Thomson Reuters www.eia.gov

Aforementioned two examples show us one very interesting and crucial phenomenon. As we said it before WTI is produced in Oklahoma and consumed primarily in the States. Until 2016 it was not ratified to export because of the 40 years old veto on oil exportation by the US government. Saudi Arabia is a main member of OPEC, which produces OPEC basket; OECD consumes mainly Brent type of crude oil. None of those countries directly consume WTI oil. Yet the changes in their behavior and production immediately influence the price of WTI. This is a clear indicator from microeconomic perspective that oil is a global commodity, sensitive to changes and complex to analyze.

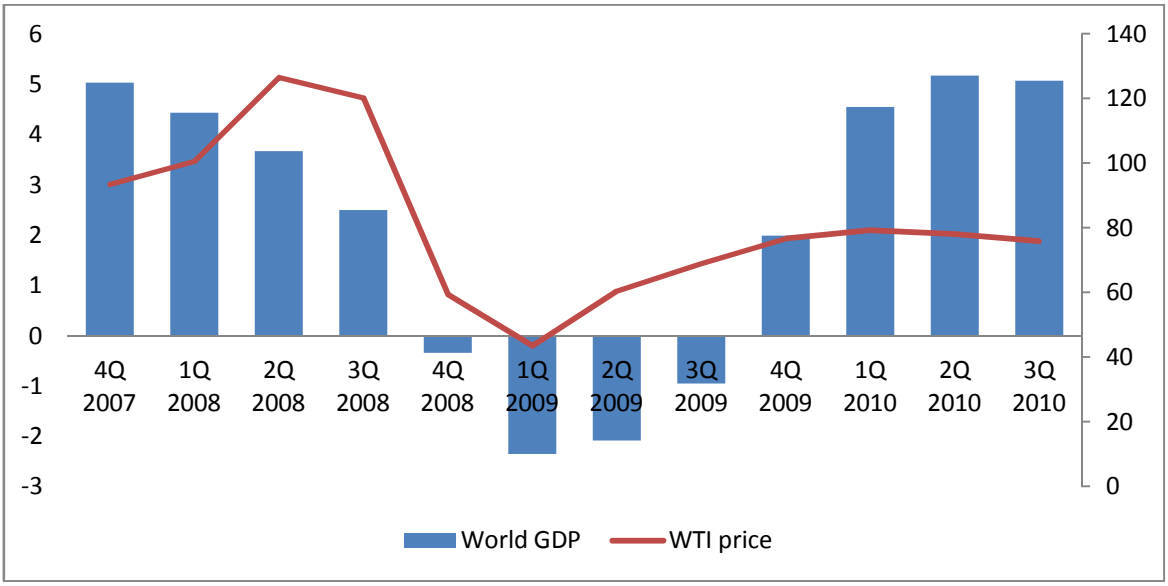
3.1.2 Macroeconomic analysis

Albeit the demand-supply ratio determines the oil market, there are other important factors that have to be counted. Oil being a main source of production, manufacturing, technology, shapes the economic development of countries, as well as the world. Impact of oil doubles when it comes to the countries that are heavily depend on its production and export.

First, let have a look on the relationship between world GDP and WTI prices. In the graph below there is a two year movement of WTI prices and world GDP.

Here (Picture 4) we can see that the relationship between the price and GDP is inverse, meaning that demand affects the WTI prices, but WTI price shifts the world GDP. In the third quarter of the 2008 the oil price started plummeting, despite the fact that GDP remained relatively favorable.

Picture 4. Effect of oil price on World GDP



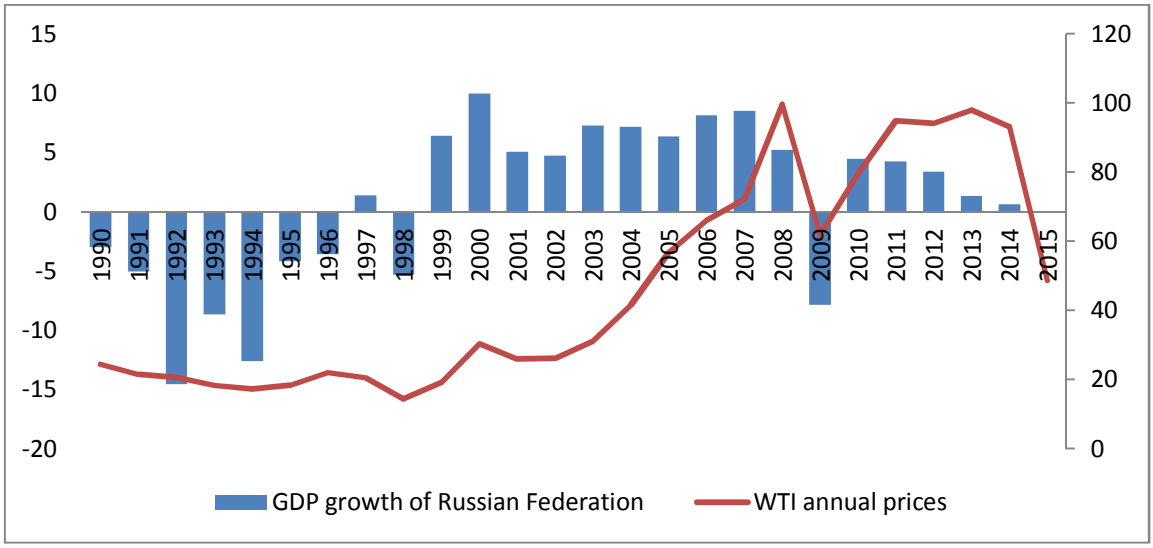
Source: US Energy Information Administration, Thomson Reuters www.eia.gov

Yet in the next quarter, GDP reacted immediately and reached below zero level for the first time in recent years, and continued to decrease until it hit the bottom in the beginning of 2009. Exact opposite reaction can be seen after. WTI prices increased due mainly because of raising fuel consumptions and world GDP followed and by the end of the 2010 it almost recovered to the level it had in the beginning of 2007, with 5.08 % annual growth.

On an individual country level, Russia is a great example to consider. It is the most resource-rich county in the world, having estimated 76 trillion US dollars' worth natural resources, with an abundant amount of oil and natural gas (Michael B. Sauter, Charles B. Stockdale, Paul Ausick, 2012). As of 2013 Russia's oil and gas sector is accounted for 70% of total exports, 52 % of budget revenues and 16 % of GDP (World Bank, 2014).

As we can see on the graph below (Picture 5), when oil prices were high and increasing between 1999 and 2007, Russia saw its most prolific years in terms of GDP growth reaching 8.53 % in 2007. Yet, the financial crisis crashed the WTI prices, with it Russian GDP growth depleted as well. This behavior can be seen repeating in between 2010 and 2015, when Russian economy gradually entered in recession with WTI prices plummeting in the meantime.

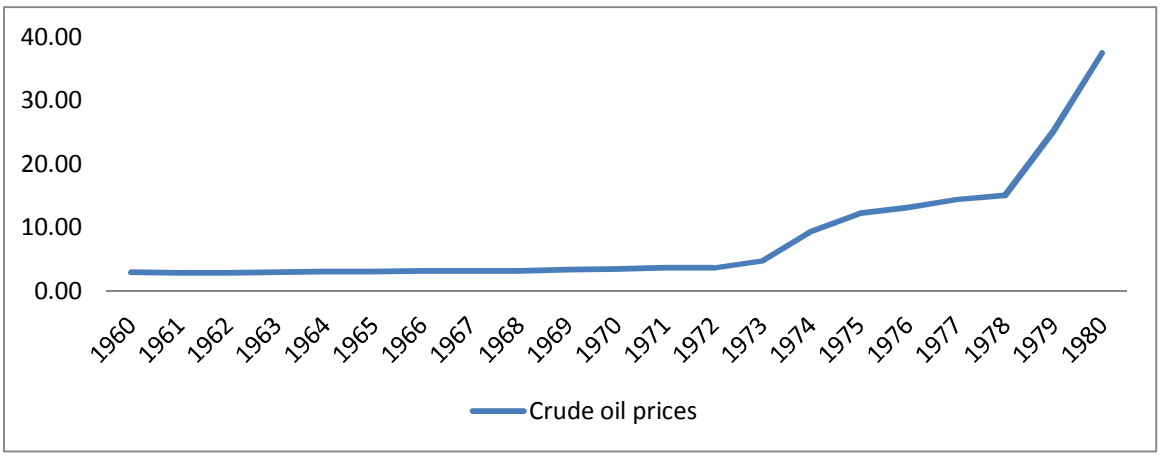
Picture 5. Annual GDP growth of Russian Federation and WTI prices



Source: World Bank. World Development Indicators. www.worldbank.org, US Energy Information Administration, Thomson Reuters www.eia.gov

When we analyze the behavior of oil market from macroeconomic perspective there is another aspect for it: Cartels. In economics, cartel is an oligopolistic structure which has an agreement between competing firms on the regulation of market (Sullivan, Arthur; Steven M. Sheffrin, 2003). On a global level, the most notable example of cartel is Organization of the Petroleum Exporting Countries, OPEC. OPEC was founded in 1960 by Venezuela, Saudi Arabia, Iraq, Iran and Kuwait. Nowadays, it has got 13 members and is accounted for 40% world oil production and 73% of world's proven oil reserves. These sheer numbers can easily indicate what regulative and speculative power the cartel has over the price of crude oil. However, one example is able to demonstrate the effect even precisely.

Picture 6. Crude oil prices during 1970s



Source: US Energy Information Administration, Thomson Reuters www.eia.gov

In 1973 OPEC countries, with Egypt and Syria announced an embargo against Canada, UK, USA, Netherlands and Japan. In only one year time framework, the price of crude oil skyrocketed from 3 USD in the beginning of 1973 to 12 USD by the end of 1974, when the embargo was lifted. This quadruple rise later called "oil crisis" shifted the world economy and caused many long term effect on global politics. It was succeed by the 1973-1974 stock market crash, during which Dow Jones Industrial Average in New York Stock Exchange lost 45% of its value, making the crash the seventh-worst bear market in the history of the index (Woodard, Dustin, 2007). The reason of the embargo lies beyond the framework of macroeconomics or demand-supply relations.

3.1.3 Political analysis

As we talked in the previous chapter, oil is an essential commodity of many countries. Its sensitivity makes it one of the most useful political tools in the hands of who possesses the abundant amount of it.

In 1973, the Yom Kippur War, also known as Arab-Israeli war started by the attack of Arab coalition led by Egypt and Syria to Israeli occupied territories in October 6th. From the historical perspective, Israel was backed by USA, while former Soviet Union was an ally of Egypt. So the Arab-Israeli war became an indirect competition between two superpowers of that time. On 25th of October the same year war was ended with an arguable win from Israeli side.

Due to the fact that USA supported Israel during the war, OPEC countries led by Saudi Arabia announced a 5% monthly cut in oil production in October 17^{th,} 1973. Two days later, president of the US Nixon authorized 2.2 billion appropriations to Israel. As a response, Saudi Arabia declared an embargo against USA and Netherlands, Canada afterwards. This was the beginning of energy crisis indicated in the graph above.

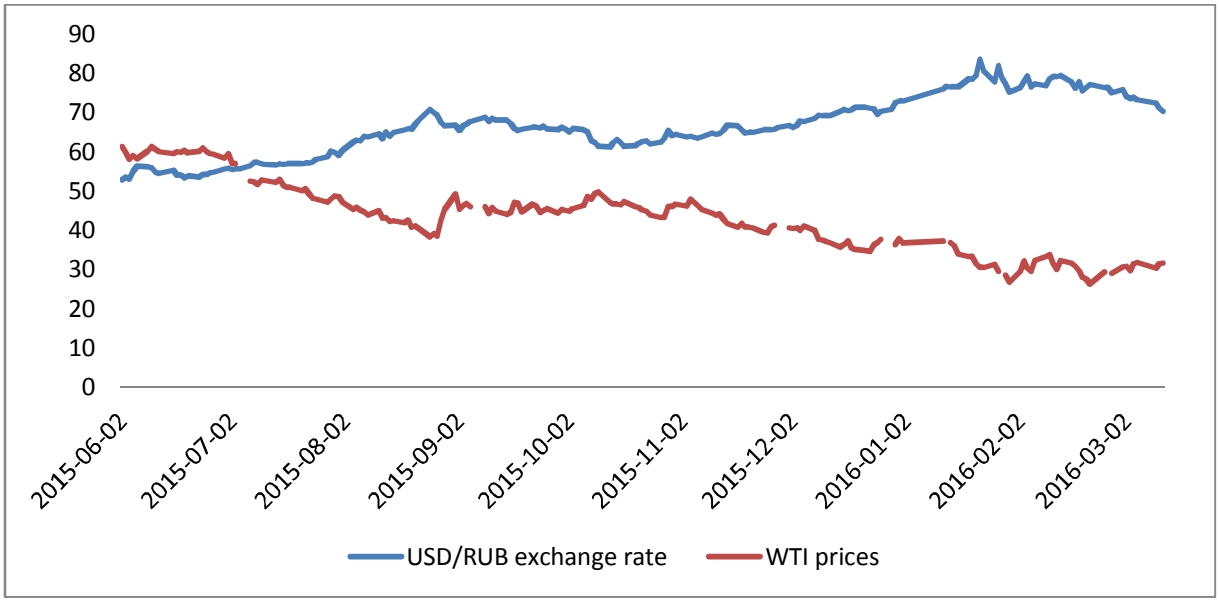
Another fresh and interesting example can be seen, again in Russia. In 2014 there was a massive revolutionary movement in Ukraine. As a result of 5 month internal war, the government was overthrown and a new one formed with a clear intention of joining the country to European Union. In between of this revolution, also called Ukrainian Crisis, Russia took control of Crimea, small land mass entirely surrounded by water. In February 2014, the island held a referendum, result of which was to join Russia. Although the result of the referendum is disputed between Ukraine and Russia, in July 2015 Russian Minister Dmitry Medvedev announced a whole integration of the island to Russia.

This seemingly non-oil related actions, shaped the whole economic development of Russian Federation in the first half of this decade. Considering that Russia is one of the major oil producers, its economy directly affected the oil market.

On July 31st 2014, EU announced an embargo on the export of equipment for the oil industry Russia, as the third part of sanction, which had begun on March 2014 (EU council regulations, 2014). Few months later, on September 2014, the US government declared its sanctions against the biggest oil companies like Gazprom Neft, Lukoil, Surgutneftgas and others. Also USA banned any cooperation between USA and Russian oil related companies.

All these actions severely damaged Russian ruble, which is closely tied to export and has a correlation with oil prices. The demonstration can be seen in the next picture.

Picture 7. Dynamics of oil price and USD/RUB exchange rates.



Source: US Energy Information Administration, Thomson Reuters www.eia.gov, Central Bank of Russian Federation www.cbr.ru

We decided to run a correlation test, to prove the graph from mathematical perspective. The table below shows the result of the test.

Table 1. Correlation between WTI prices and USD/RUB exchange rates.

	WTI	USD/RUB
WTI	1	
USD/RUB	-0.94078	1

Source: Own calculations.

As, we can see there is statistically significant and strong negative correlation between WTI prices and exchange rates of Russian ruble.

4 TECHNICAL ANALYSIS

Let's get back to our example. As we assumed our company XXX is a new in the market and has got an initial portfolio of 100,000 USD. It is 2nd of January, 2014 Thursday.

Because Company XXX will not actually use the oil, we have to differentiate between spot price the oil and its futures price. Spot price is a price of a stock (especially commodities) on a specific date and time, between seller and buyer. Futures is a price of a commodity in a specified delivery time, related to its spot price, added with interest rate, to minimize the risk of loss.

We will assume that our company is able to both buy and sell the crude oil, depending on the contracts type. The company plays and intermediate role between producers of the oil and its users, refiners and other related insutry players and is capable of storing the oil.

The company is able to increse its initial portfolio, depending on the behaviour of the market, by adding an extra investments, or diversfying the budget into hedging and trading part.

The underlying price of the WTI is daily, starting from the beginning of September, until the December 31st, 2013. The market will open in 2nd of January, 2014, so our company can start trading.

If we analyze the graph below (Picture 8) from a longer perspective, we can see that until the November 2013, the downward trend was obvious. Between, November and December, the market entered in so called straight phase, where there was not a significant movement to either direction.

However, the last three days of November represent an interesting moment. In the graph below, we can look at it in a closer distance. The first three bars on the chart have got a name Three Black Crows. It consists of three long candlesticks, and represents an indication of negativity in the market sentiment. Each candle opened below the previous day's open, and candlesticks also closed progressively downward to establish a new near-term low.

Picture 8. Dynamics of WTI prices by the end of 2013

Source: New York Mercantile Exchange. www.investing.com

Three Black Crows pattern indicates a strong price reversal from a bull market to a bear market. Steve Nison considered the pattern to be useful in long term (Nison, 2001).

On 6th of November, another interesting pattern occurred (indicated with an upward arrow). It is consisted of red candle (Picture 9), which is within a following green one. This pattern is called Engulfing Bullish Line (Nison, 2001).

When it appears in the bottom of the market, it usually indicated a major reversal. However, as we can see the bottom of the both candles match. This is related to another pattern called Tweezers Bottom and it is following our previous pattern, indicating the entrance to a volatile path.

So what practical suggestion can be withdrawn from this analysis? Our company would have been advised to choose the sell option, but with very moderate amount.

Picture 9. Volatility in WTI prices during November 2013

Source: New York Mercantile Exchange. www.investing.com

By the end of November however, market showed an indication that it had started to go upward. Between 28th and 30th of November, during three days of trading, there was formation of reversal pattern called Morning Star.

This pattern includes three candles: bearish candle, long red candle in our example, very small upward or downward doji (second black arrow in the graph), which demonstrates indecision in the market and the following long bullish candle, which shows that buying traders are active. The following graph (Picture 10) demonstrates, what happened next.

The market actually took a turn to rise, as it was expected from Morning Start pattern. During the last month the prices reached to 25.20 USD. The last red bar on the graph is the closing price on 31st of December, 2013.

Analyzing the last two bars (Picture 10), there could be an assumption that, this was a formation of new Three Black Crows pattern which would indicate that price is reversing

again. So this is an important moment for our company, as there are two possible scenarios: buy or sell.

Picture 10. WTI price movement in December 2013

Source: New York Mercantile Exchange. www.investing.com

Buy option has an argument of the reversal pattern in the beginning of December. Furthermore, during the month price never crossed the resistance line (straight diagonal line in the graph), indicating that growth would continue. On the other hand, the last two days of trades closed with lower lows and that could have been a sign of another reversal.

Assuming that the next day of the trades, our company will invest into oil, we are going to explore different scenarios of decision made by the company. To make the analysis easier and clearer from hedging perspective, we are going to assume that all the money in hands of the company will be spent.

4.1 Scenarios of hedging and its consequences

The table 2 below shows the possible options of investment into oil.

Table 2. Scenarios of investment.

№	Amount of investment	Type of trading	Expected move	Basis assumption
Scenario 1	100,000	Daily	Downward	Possible three black crow
Scenario 2	100,000	Weekly	Downward	Possible three black crow
Scenario 3	100,000	Monthly	Upward/Downward	Morning Star
Scenario 4	100,000	1 Year	Upward	Long term dynamics

Source: Own calculations

In the scenario one, the decision is to sell option, as Company expects a downturn movement. The graph below shows what actually happened on daily basis between 2nd and 27th of January (Picture 11).

Picture 11. WTI price dynamics in January 2014 on daily basis.

Source: New York Mercantile Exchange. www.investing.com

In 2nd of January oil market opened in a price of 98.50 USD per barrel. Scenario 1 assumes that the movement will be downward; hence sell option in the beginning of the trades is favorable.
As market progressed, we can see that price went down to 95.34 USD. So simple calculations suggest that one day trade with oil could have brought our company approximately 3208 USD profit, as the price went down for 3.16 USD:

$$100{,}000 : 98.50 = 1015.2 * 95.34 = 96{,}792 - 100{,}000 = -3208$$

But, as we analyzed before the formation of Three Black Crows pattern suggested the further decrease in the price. Hence company is advised to hold the sell position. The market reached the bottom during that respective time framework on 14th of January, with price being 91.51 USD. Ending the trade at this moment would give the company 7099 USD profit, which is shown in the following calculation:

$$100{,}000 : 98.50 = 1015.2 * 91.51 = 92{,}900 - 100{,}000 = -7099$$

After, the bottom was hit; market slowly corrected itself and started to move upward. By the end of 27th of January, it almost recovered to the initial price at the beginning of the month. The market closed that day with the price being 95.72 USD, which means that if the Company XXX would have held the position opened in the first days of the trading until the end of the month; it would have still made 2825 USD profit:

$$100{,}000 : 98.50 = 1015.2 * 95.72 = 97{,}175 - 100{,}000 = -2825$$

Let's elongate the holding position to weekly basis, as it is stated in the Scenario 2. The graph below (Picture 12) demonstrates the weekly movement of the oil price between 2nd of January and 24th of March, 2014. Scenario assumes that the price will decrease during the next few weeks, based on conclusion with regards to reversal patterns.

From the beginning of the week, price continued to decrease during the next 2 weeks of trading, which is shown by the two first candles of the graph above.

Picture 12. Crude oil price dynamics on weekly basis.

Source: New York Mercantile Exchange. www.investing.com

The second week, which ended in 20th of January, had the closing price of 93.39 USD.

$$100{,}000 : 98.50 = 1015.2 * 93.39 = 94{,}812.18 - 100{,}000 = -5187.81$$

Ending the trades on 20th of January would have brought 5187.81 USD as a profit, as it is demonstrated in the calculation. However, the following several weeks, market started gaining positions back and possessed an upward trend until the beginning of March. In the beginning of 10th of February 2014, price overlapped the opening position of the Company. The peak was reached in the first week of March, with the closing price being 102.73 USD. This made a loss of 4294.41 USD:

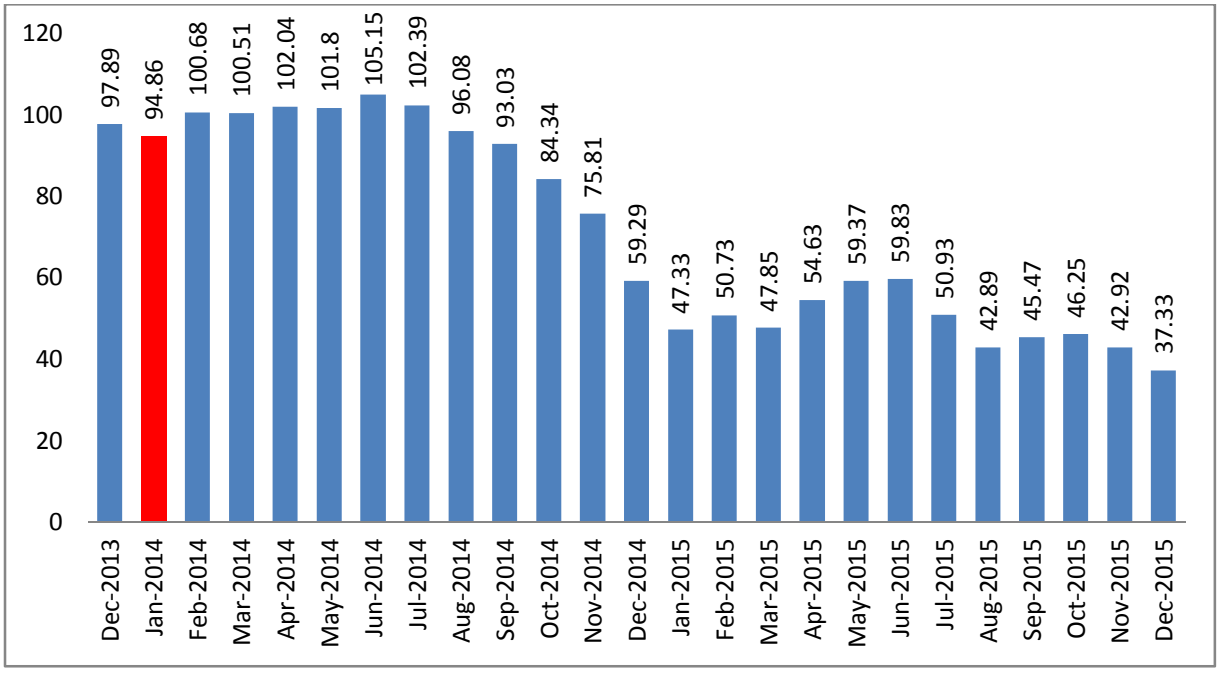
$$100{,}000 : 98.50 = 1015.2 * 102.73 = 104294.41 - 100{,}000 = 4294.41$$

The reason of such change in the upward direction was the beginning of the Ukrainian Crisis. Traders and investors saw that Russia, one of the greatest exporters of the oil was in contradictory with USA, and there were fears that Russia will reduce the supply as a defensive move to the sanctions from EU and USA. This led the price of oil to jump and overlap 100 USD per barrel.

So what could have company done to avoid this type of loss? One option is to take long hedge with oil futures.

4.2 Crude Oil Futures Long Hedge Example

Picture 13. The dynamics of WTI crude oil futures in two years.



Source: US Energy Information Administration, Thomson Reuters www.eia.gov

In January 2014, Contract number 1 for WTI crude oil futures – indicated with a red bar – which had 1000 barrels per contract, was 94.86 USD per barrel.

To hedge against a rise in crude oil price, our company should decide to freeze in a future purchase price of USD 94.86/barrel by taking a long position in a related number of NYMEX WTI Crude Oil futures contracts. With each NYMEX WTI Crude Oil futures contract covering 1000 barrels of crude oil, the company will need to go long 1 futures

contract to implement the hedge, considering the fact that initial budget of the investment is 100,000 USD.

The effect of putting in place the hedge should guarantee that the oil refinery will be able to purchase the 1000 barrels of crude oil at USD 94.86/barrel for a total amount of USD 94,860. Let's see how this is achieved by looking at scenarios in which the price of crude oil makes a significant move in upwards direction until the beginning of March, as it is shown on the Picture 12.

With the increase in crude oil price to USD 102.73/barrel, the company will now have to pay USD 102,730 for the 1000 barrels of crude oil. However, this increased purchase price and going out of the limit of the original investment budget will be covered by the gains in the futures market. As the company went with long futures position at a lower price of USD 94.86/barrel, it will have gained 7.87 USD per barrel. Company hedged with one futures contract, which has a total of 1000 barrels of crude oil, hereby the total gain from the long futures position is 7870 USD.

$$102.73 - 94.86 = 7.87 * 1000 = 7870$$

If we assume that, the company will hold the position till the 17th of March, the framework we have for our analysis, the gain from futures contract will not be that high. Because, the closing price of crude oil on 17th of March 2014 was 99.26 USD. The gain against futures contract price is 4.4 USD/barrel, which gives the company a profit of 4400 USD, considering they had 1 futures contract:

$$99.26 - 94.86 = 4.4 * 1000 = 4400$$

Hence, the company is advised to close the position as soon as the price overlapped 100 USD per barrel to gain the maximum amount of profit.

4.3 Crude Oil Futures Long Hedge Example

Our initial Scenario 3 considers the monthly trade and expects both movements in the price, which will be clearer as the date approaches. The graph below shows the dynamics of Crude Oil prices in one year, between January 2014 and 2015.

We assume that our company has got an offer from refinery company that wants to buy 1000 barrels of crude oil. Our company is able to sell this amount from its storage units. Contract dictates to consider the spot price at the time of delivery as the basis.

Picture 14. Crude oil price dynamics in 2014, monthly basis

Source: New York Mercantile Exchange. www.investing.com

From the beginning of the March we expect the price to move up, hence we decide to hedge it against falling. The opening price in that month is 100 USD per barrel (Picture 13) and the futures price for March is 100.51 USD per barrel (Picture 12). Let's analyze the different times of delivery and how the hedge put by our company work out.

If we assume that the delivery time is 4 month, the spot price should be considered for July. The Crude oil had closing price of 101.82 USD per barrel in July. This means that by selling 1000 barrel crude oil the company could gain 101,820 USD; however, the futures price we entered was 100.51 USD. This leads to a loss of 1.31 USD per barrel and considering that we have 1 futures contract, the loss is 1310 USD.

$$101.82 - 100.51 = 1.31 * 1000 = 1310$$

At the end, even if the company is able to get net sales of 101,820 USD, because they entered a hedge position with lower futures price, the gain is loss because of it:

$$101{,}820 - 1310 = 100{,}510$$

100,510 USD is the same net sales that the company would have got if they sold the oil for 100.51 USD as a spot price in the beginning of March.

Let's now consider that the delivery month is October. The closing price of crude oil in October was 86.08 USD per barrel (Picture 13). This would have made the company sell the oil with the net sales of 86,080 USD. However, because they entered in futures contract with 100.51 USD the gain is 14.43 USD per barrel. There was 1 futures in the contract, which includes 1000 barrels of crude oil. Making the gain from hedge 14,430 USD:

$$101.51 - 86.08 = 14.43 * 1000 = 14{,}430$$

So at the end, the company is advised to hedge the sell with futures, in anticipation that prices will fall.

To better understand other hedging options that can be useful in trading, we will give 2 examples from recent market situation, with theoretical option chain prices.

The graph (Picture 15) below shows the dynamics of the WTI prices in monthly basis, traded in NYMEX, New York.

Picture 15. Dynamics of WTI option prices in 2015-2016

Source: New York Mercantile Exchange. www.investing.com

Let's look at the April 2015, in that time the near-month NYMEX WTI Crude Oil futures contract is trading at the price of USD 50.41 per barrel. According to NYMEX, WTI Crude Oil call option with the same expiration month and a nearby strike price of USD 50.00 is being priced at USD 5/barrel. Since each underlying WTI Oil futures contract represents 1000 barrels of crude oil, the premium you need to pay to own the call option is USD 5,000.

We can see that in the next month, April 2015, the price went up to 59.80 USD per barrel. At this price, company can assume that their call option is in the money.

If they exercised the call option in April, company was able to have a long position in the underlying crude oil futures at the strike price of USD 50.00. This means that they could buy the underlying crude oil at only USD 50.00/barrel on delivery day.

To take the profit, they would trade a short futures position in the underlying crude oil futures with one contract, at the market price of USD 59.80 per barrel. In this case they earn 9.8 USD per barrel of oil. Since each WTI Sweet Crude Oil call option covers 1000 barrels of crude oil, gain from the long call position is 9,800 USD:

$$59.80 - 50.00 = 9.80 * 1000 = 9{,}800$$

However, to calculate the net profit, we have to deduct the premium the company paid for the call option, 5,000 USD hence reaching the total of 4,800 USD profit. The table below summarizes the process.

Table 3. Long WTI crude oil call option

Gain from Option Exercise	=	**(Market Price of Underlying Futures - Option Strike Price) x Contract Size**
	=	(USD 59.80/barrel - USD 50.00/barrel) x 1000 barrel
	=	USD 9,800
Investment	=	**Premium Paid**
	=	USD 5,000
Net Profit	=	**Gain from Option Exercise - Investment**
	=	9,800 USD - 5,000 USD
	=	USD 4,800
Return on Investment	=	96%

Source: Own calculations.

In trading environment, often times, there is no need to exercise the options as, because of the expiration day time framework.

Let's look at the July 2015, WTI price that day opened with 58.56 USD per barrel of oil. NYMEX WTI put option with strike price of 58.00 USD per barrel and with same month of expiration was priced for 3,2 USD per barrel. WTI futures contracts include 1000 barrels, thus the company had to pay 3,200 USD premiums to have the put option. At the end of July and the beginning of August, the price fell to 52.84 USD per barrel (Picture 15).
The company could exercise the put option then, and open a short position in the underlying WTI crude oil futures at the strike price of USD 58.00. In different expression, it means that the company could sell 1,000 barrels of crude oil at 58.00 USD per barrel on delivery day.
In order to take the profit, they should open an offsetting long position with one futures contract at the August market price of USD 52.84 per barrel, resulting in a gain of 5.16 USD per barrel. Since each NYMEX WTI Crude Oil put option includes 1,000 barrels of crude oil, gain from the long put position is USD 5,160.
However, again similar to the call option, we have to deduct the premium the company paid for securing the put option. Final profit, after that would be 1960 USD. The table below summarizes the process.

Table 4. Long WTI crude oil put option

Gain from Option Exercise	=	**(Option Strike Price - Market Price of Underlying Futures) x Contract Size**
	=	(USD 58.00/barrel - USD 52.84/barrel) x 1000 barrel
	=	USD 5,160
Investment	=	**Premium Paid**
	=	USD 3,200
Net Profit	=	**Gain from Option Exercise - Investment**
	=	5,160 USD – 3,200 USD
	=	USD 1,960
Return on Investment	=	61.25%

Source: Own calculations.

This abovementioned two examples show how traders and investors can secure their investments using most common and traditional ways of hedging, hence makes their losses as small as possible, while reaching a profit from the transaction.

Another way of dealing with risk of loss is diversification of investment portfolio. Diversification itself is much broader tool of risk management, which helps to avoid or reduce the non-systematic risk in the investment. Hedging on the other hand works with singular market stocks, commodities and so on. Although there are some differences between them, knowing the concept of diversification can help to understand and implement the hedging more efficiently.

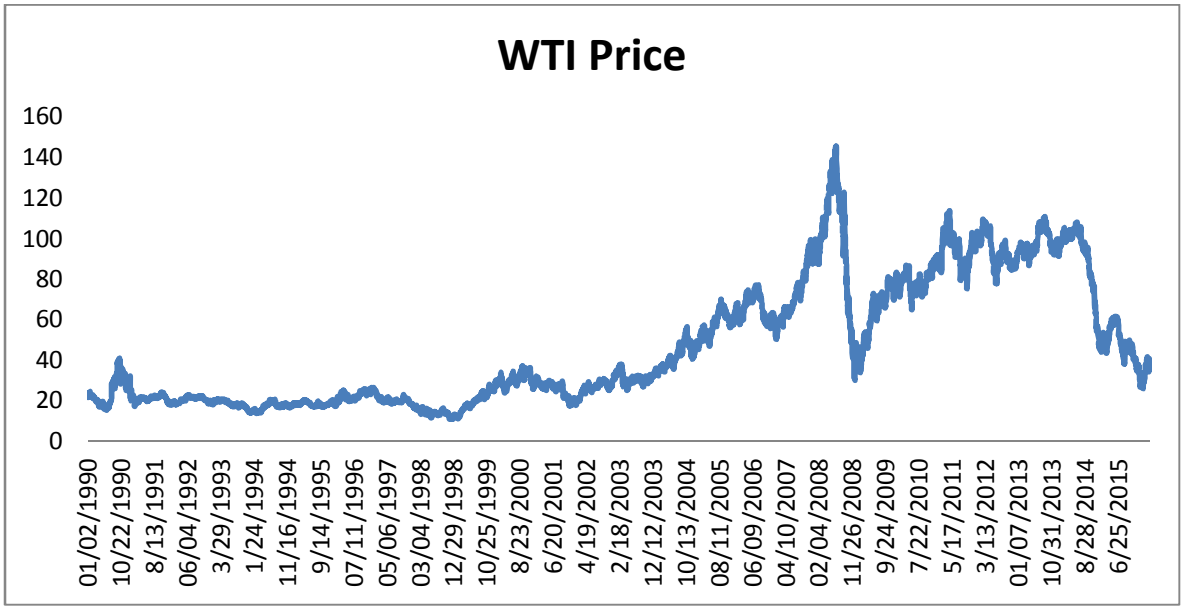
The core concept of diversification is to have a portfolio that contains lots of different assets, commodities, currency and other stocks. This helps the investor to minimize the overall risk of losing money, as if one of the components of the portfolio is having risk of money loss, the gain from other assets would cover it. In a simplified form, the pair trading is a way of hedging. This is done in an attempt to cover the loss of one stock by the gain in the other. In our analysis, the example of currency-commodity pair trading could be very useful.

Predicting the next move in the markets is the fundamental to making profit in trading, as well as in investment, however the implementation of this tactics is much harder than we think. Professional currency traders have long been aware of the fact that trading currencies requires looking broader than just the world of Forex. The fact is that currencies are influenced by many factors – politics, supply and demand, economic growth, interest rates, and many more. Especially, considering that growth and exports are closely linked with a country's domestic industry, it is obvious for some currencies to be significantly correlated with commodity prices. Knowing which currency is paired with what commodity can help traders and investors understand, as well as forecast certain market behavior. In our analysis we will try to look at some currencies that are influenced by the oil price and explore what our company can do in order to protect the investment into oil.

We have already showed that Russian ruble is one of the key examples of oil-currency pair. Another country that is heavily depends on the export of oil is Canada. As a net oil exporter, Canada is strongly damaged by declines in oil price, while increase in it significantly boosts the economy of Canada.

Over the past few decades, the price of oil has fluctuated significantly (Picture 16). For instance, it went up from $60 per barrel in 2006 to a high of $147.27 a barrel in 2008, before decreasing back below $40 a barrel in 2009 and increasing again to above $80 during 2011. Considering that many countries around the world were and are in recession, the trend of oil prices can make the difference between a deeper crisis and an economic recovery.

Picture 16. Dynamics of oil prices in recent history.

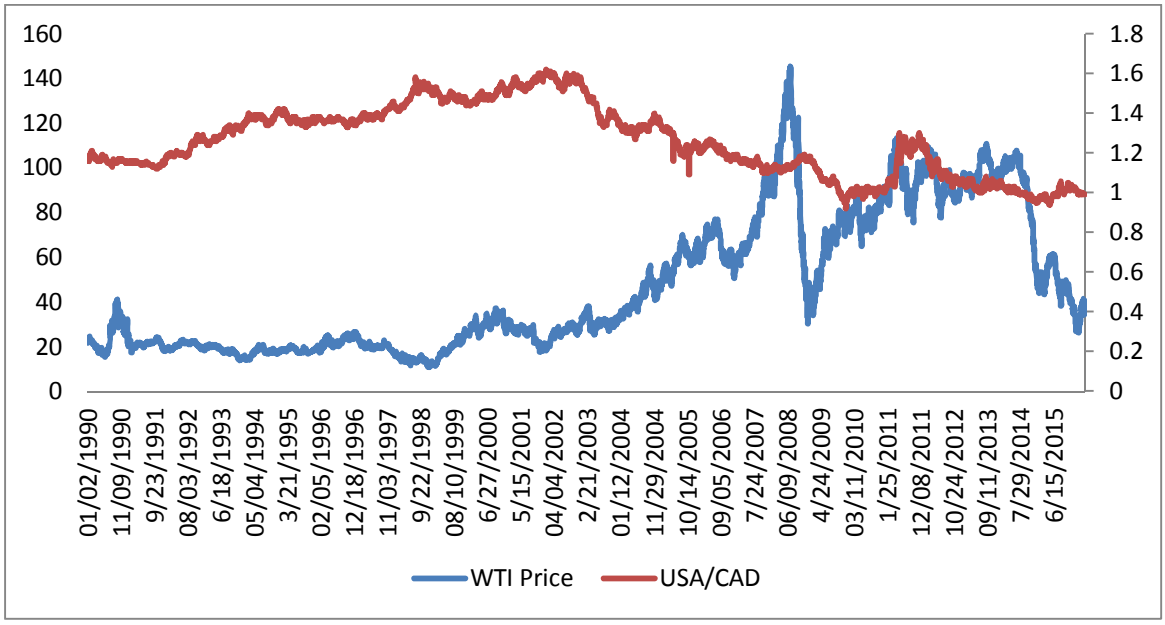


Source: US Energy Information Administration, Thomson Reuters www.eia.gov

During the years 2006-2009, for instance, the correlation between the Canadian dollar and oil prices was approximately 80%. On a day-to-day basis, the correlation can change and vary, but over the long term it has been significant due to the fact that the value of the Canadian dollar has good reason to be sensitive to the price of oil. Canada is the seventh-largest producer of crude oil in the world and continues to move forward on the list, with production increasing rapidly. In 2000, Canada overlapped Saudi Arabia as the United States' most significant oil supplier. The fact is that the size of Canada's oil reserves is second only to Saudi Arabia. Considering that Canada is the neighbor of USA, thus minimizing the logistic cost, as well as the heavy involvement of the USA in the middle east, often times seen as intervention by the Arab countries makes Canada one of the more comfortable and efficient places from which the U.S. can import oil. But Canada does not service only U.S. demand. The country's vast oil resources are starting to gain a lot of attention from China.

Picture 17 shows the relationship between oil and the Canadian loony. Without of any mathematical test, one can see that if the price of oil increases Canadian currency weakens regarding the US dollar and vice versa.

Picture 17. Comparative dynamics between USA/CAD and WTI crude oil prices



Source: US Energy Information Administration, Thomson Reuters www.eia.gov

However, to make the graph mathematically provable, there was ran a correlation test between two indicators. Karl Pearson suggested a mathematical method for measuring the magnitude of linear relationship between the two variables. It is most widely used method in practice and it is known as Pearsonian coefficient of correlation (Anderson, 1974). It is denoted by 'r'. The formula for calculating 'r' is

$$r = \frac{COV(x, y)}{\sigma x \times \sigma y}$$

The table below shows the result of such test. As we can see from the table 4, the correlation coefficient between WTI crude oil prices and USD/CAD currency exchange rate is –66.05, which is a moderately significant result. It also shows the reverse relationship between indicators, meaning that if oil prices go up, USA/CAD exchange rate will go down.

Table 5. Correlation table between WTI price and USD/CAD exchange rate

	WTI Price	USD/CAD
WTI Price	1	
USD/CAD	-0.6605	1

Source: Own calculations

So what practical use our company can have from this calculation? One thing they can do is trading in both markets with similar moves. As oil and the exchange rate are negatively correlated, if the company invest into oil in the long term, additional investment into exchange rate in a short term span can reduce the risk of loss.

For instance, as of the Picture 15, if the company buys 1,000 barrels of oil for 39.28 USD per barrel expecting a rise in the price after 3 month, it can also buy a short position is USD/CAD exchange for 1.282. The recent dynamics of the currency exchange is indicated on the graph below.

Picture 18. USD/CAD exchange rate dynamics for April 2016

Source: New York Mercantile Exchange. www.investing.com

If the price of crude oil will go up, the company will gain a profit, yet loses in the exchange rate. However, if the oil prices go down, because of the negative correlation, USA/CAD will increase, hence bringing a short term profit for the company, albeit there will be loss from oil price movement. Key factor is the ratio of investment into both markets and time framework, as it is very important to choose the right short and long term positions.

It is also very important to stress that just because a relationships exists "on average" over time, does not mean that strong correlations exists at all times. While these currency-

commodity pairs can be very useful to watching for their high correlation trends towards a commodity, there will be moments when the strong link between the indicators does not exist and may even go in the opposite direction for some time.

As we could see from this chapter, traditional approaches to hedging still play an important role in investment and trading decisions. Be it a futures trading and hedging the oil with its underlying futures, or calculation the put and call options in order to make profit from increase, as well at the decrease in the price dynamics, they all are still important and can help the investors and trader to make better decisions.

Despite these aforementioned facts, the recent years of market and investment practices have been experiencing newer and more complex phenomena occurring and participating in the market. Hedge funds can be a very good example. Albeit they have been existed for decades and turn into popularity rapidly, growing to be one of the world's largest asset management classes has happened by 2014 (Lemke, Lins, Hoenig, 2014). As of June 2013, the estimated size of the global hedge fund industry was US$2.4 trillion (CPIC, 2019).

One very notable characteristics of most modern hedge funds is so called HFT, high frequency trading. High-frequency trading (HFT) is a kind of algorithmic trading which considered to have high turnover rates, high speeds, and high order-to-trade ratios that leverages high-frequency financial data (Aldridge, Irene, 2013) and electronic trading tools. High frequency trading has equaled to 50% of all US equity trades in 2012 (Lati, 2009).

While it opens up huge advantages in terms of ease and technology, recent critics have argued that high frequency trading makes the market vulnerable and unpredictable. So called Flash Crash in 2010, which caused a panic in the market can be considered as an example (Vuorenmaa, Tommi; Wang, Liang, 2013).

So, when we talk about hedging and risk management, investment and trading, or prices and different techniques, one thing remains very important. Time and future are fundamental elements of any type of action that is related to trading or investment, including hedging. No matter how careful the company is, and how much diverse portfolio it has, or what type of hedging techniques it is using, element of prediction is always in the center of the market. Whole idea of trading and investment revolves around predicting and forecasting the movement of the price, hence being able to make earlier decision to make profit from that movement.

Traditional methods associated with financial mathematics and hedging is Black-Scholes model. This is a mathematical model of a financial market containing derivative instru-

ments. From the model, one can deduce the specific formula, which gives a theoretical estimate of the price of European-style options (MacKenzie, Donald, 2006).

The formula behind this model is as follows:

$$C = SN(d_1) - N(d_2)Ke^{-rt}$$

$$d_1 = \frac{\ln(S/K) + \left(r + s^2/2\right)t}{s*\sqrt{t}} \text{ and } d_2 = d_1 - s * \sqrt{t}$$

Where:

C = Call premium

S = Current stock price

t = Time until the option exercises

K = Option striking price

r = Risk free interest rate

N = Cumulative standard normal distribution

e = Exponential term

s = Standard deviation

ln = Natural logarithm

The Black-Scholes model for calculating the premium of an option was conducted in 1973 in a paper called "The Pricing of Options and Corporate Liabilities" published in the Journal of Political Economy. The formula is developed by three economists Fischer Black, Myron Scholes and Robert Merton.

The Black-Scholes model calculates the theoretical price of European put and call options. It does not count any dividends paid during the option's lifetime. The latter defect was corrected in the modern models such as Cox-Rubenstein Binomial Option Pricing Model to account for dividends by determining the ex-dividend date value of the underlying stock. We can examine the model in our data. We will take into consideration the recent WTI crude oil prices on daily basis, which are represented in the next picture.

Picture 19. WTI crude oil recent daily price dynamics.

Source: New York Mercantile Exchange. www.investing.com

The last opening price for the WTI crude oil was 41.27 USD per barrel. We will enter the details into Black Scholes Calculator. The results can be seen in the following table 6.

As we can see, in the presence of current price the theoretical value of call option per barrel should be 1.0387 USD and the value of put option should be 0.3986 USD per barrel. The main indicators from the model are Delta which is the rate change in the option price with respect to a given change in the price of underlying asset; Theta, which is the rate of change in the option prices as the time passes, while nothing else is changed.

Black-Scholes model can be a great way of approximation of the market movement. The Black–Scholes model disagrees with real market numbers in a couple of ways, some of them which are very significant. It is widely employed as a useful approximation, but proper application requires understanding its limitations.

Table 6. Results of Black Scholes calculations of the WTI options prices.

			Call	Put
Options calculation model	**Black Scholes**	**Theoretical Value**	1.0387	0.3986
		Delta	0.6558	-0.3442
Stock Price	41.63	**Delta 100's**	65.5827	-34.417
Exercise Price	41.00	**Lambda (%)**	26.284	-34.943
Value Date	15/01/2016	**Gamma**	0.2173	0.2173
Early-Exercise Date	18/01/2016	**Gamma (1%)**	0.0905	0.0905
Expiration Date	18/01/2016	**Theta**	-0.1061	-0.1027
Volatility (%)	44.89	**Theta (7 days)**	-0.4087	-0.3986
Interest Rate (%)	3.00	**Vega**	0.0139	0.0139
Dividend Method	Continuous	**Rho**	0.0022	-0.0012
Yield Rate (%)	0	**Psi**	0.0022	0.0012
		Strike Sensitivity	-0.6406	0.3592
		Intrinsic Value	0.63	0
		Time Value	0.4087	0.3986
		Zero Volatility	0.6401	0
		Market Option Price	20.04	8.51
		Implied Volatility (%)	25.01	25.00

Source: Own calculations, SPSS software package

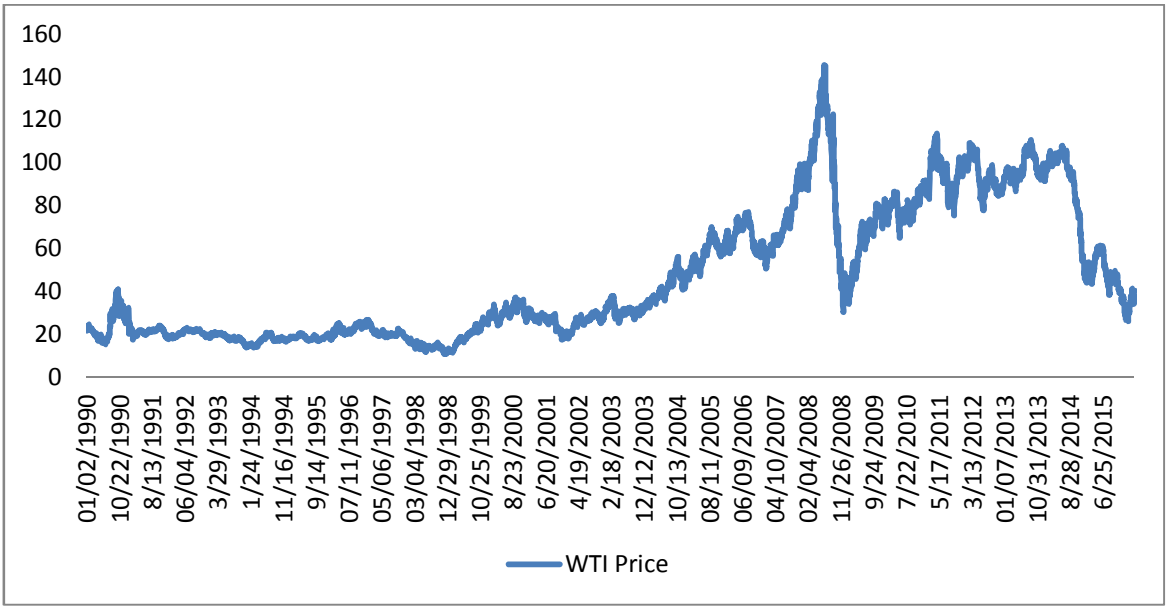
Blindly following the model exposes the user to unexpected risk (Yalincak, Hakan 2012). Mainly:

- it assumes that there is instant, cost-less trading which is difficult to hedge
- it underestimates the extreme moves, counts the market as stationary
- originally it is only related to European type of options

As we talked before, in the modern era of high frequency trading and algorithmic hedge funds, the actual prediction of the price movement becomes central element in the risk management. Let's have a look at the price of WTI crude oil in long term (Picture 20).

As it is clear from the graph, in the last decade the price of crude oil has been very volatile, experiencing multiple crashes, especially in 2008 and 2015. Was it possible to predict these crashes beforehand? Was it possible to forecast these sudden changes or explosions of bubble, using some sort of techniques? There are two approaches to this question that prevail in the modern financial risk management: Black Swan and Dragon King.

Picture 20. WTI crude oil prices, historical data



Source: New York Mercantile Exchange. www.investing.com

Black Swan approach generally discards the notion of predictability of such sudden changes, and is described as an event that comes as a surprise, has a major effect, and is often inappropriately rationalized after the fact with the benefit of hindsight (Taleb, 2008). The theory was developed by Nassim Nicholas Taleb to explain (Taleb, 2008):

- The disproportionate role of high-profile, hard-to-predict, and rare events that are beyond the realm of normal expectations in history, science, finance, and technology.
- The non-computability of the probability of the consequential rare events using scientific methods.

In out example, the sudden crashes in 2008, and dramatic decrease in the price of oil in 2015; the recessions are all Black Swan events, which are hard to predict because they lie beyond our expectation. They are so called "outliers" because nothing in the past can convincingly point to their possibility of happening.

Black Swan methodology does not completely deny the possibility of financial predictions. Predicting financial markets can be done, but their accuracy is as much a matter of luck and intuition as of skill and sophisticated modeling. Black Swan events can happen regularly, Flash Crash, Russian national debt, Catherine Hurricane, all are the examples of events that are out of our vision and control, but which have an enormous impact on the market.

This does not necessarily mean that modeling and forecasting cannot or should not be done. But it also emphasizes the importance of intuition, common sense and simplicity. Furthermore, the methodology suggests that investment portfolios need to be adapted to crisis and black swan events as much as possible. Diversification, constant monitoring, rebalancing - are less likely to let us down than models and techniques that are fundamentally incapable of taking everything into account.

The second modern approach to this problem is Dragon Kings, which possesses opposing view on the predictability of outliers.

Dragon king is double metaphor which consist of events that have two characteristics, one they are extremely large in size or impact (a "king") and second they were born of unique origins (a "dragon") relative to their peers (other events from the same system). Dragon King events are closely related to mechanisms such as positive feedback in which the small change in the system produces more and more resonance in a loop type; tipping points which describes moment when the system suddenly and dramatically changes its behavior; bifurcations which are mathematical expression of small changes in the system that completely alters its topology; and phase transitions, that tend to occur in nonlinear and complex systems, and serve to push dragon king events to extreme levels. By understanding and monitoring these dynamics, some predictability of such events may be obtained (Sornette, Ouillon, 2012).

The theory has been developed by Prof. Didier Sornette, who assumes that many of the crises that we have faced in the recent decades are in fact dragon king events, rather than black swans and they might be predictable to some degree. Dragon King theory pays special attention to extreme situation in any given system. From a scientific standpoint, such extremes are interesting because they may reveal fundamental, often hidden, but important, organizing principles.

The dragon king concept raises many questions about how one can deal with risk. Of course, if possible, it is always advised to avoid exposure to large risks However, in many fields especially in finance, exposure to risk is a necessary and inevitable situation, thus a trade-off between risk and return should to be monitored.

In an adaptive system, where prediction of dragon kings is successful, companies can act to defend the system or even profit. In our case, if the company will be able to foresee coming crashes or sudden changes in the behavior of oil price, they can change their investment decision and keep the risk at minimum or even gain a profit. How to design such de-

fensive systems, as well as how to monitor and navigate the upcoming risk, is an important and interdisciplinary field where dragon kings must be considered.

Another important part of the problem is how to quantify the risk. No matter in what system is risk being taken care of, be it an insurance company, hedge fund or government, risk has to be related to time or a period. Usually this period is one year.

To provide different parameters to risk characterizations, the dynamic dragon kings must be agreed upon its terms of annual frequency and severity statistics. Provided that the statistical properties of the system are consistent over time (stationary), frequency and severity statistics may be constructed using past observations, Monte Carlo simulations, or assumptions. If one does not have such indicators or enough data, there is only possibility of developing a scenario. However, in any case, given the nature of present being uncertain, a range of scenarios should be considered.

Despite being complex and derived mostly from physics, given a model and data, dragon king can be obtained as a statistical model estimate. This model estimate can then be used to explore other important quantities such as probability of the occurrence of a dragon king event in a future time interval, and the most probable occurrence time. When doing statistical modeling of outliers and extreme events, and using complex or nonlinear models, there is always a substantial uncertainty. Hence overall significance of the model, as well as its parameters are very important to be examined thoroughly.

For the last pass of our analysis, we will try to use original and simplified Log-Periodic Power Law, to examine our WTI oil price movement with dragon king methodology and see whether it was possible to predict the sudden changes that had occurred over time.

Some complex system experts consider an ideal market with no dividends, and where interest rates, risk aversion and market liquidity are equaled to zero or ignored (Johansen, 2000). Therefore, the fundamental value for an asset is $p(t) = 0$, so any positive value of $p(t)$ represents a bubble. (Geraskin, Fantazzini, 2009). In general, $p(t)$ can be viewed as the price with an excess in the underlying value of an asset. If we consider this framework to be true, there are two types of agents: first, a group of rational agents who are identical in their preferences and characteristics, so they can be substituted with a single representative agent. Second is a group of irrational agents whose non centralized and different behavior leads to the development of a financial bubble. As the bubble progress the first group of agents start ot take the development as critical and suddenly change their positions to short, thus causing a huge crash. A financial crash is not a certain event in this model, but it is

characterized by a probability distribution: hence, it is expected that financial agents will continue investing, because the risk of the crash to happen is compensated by the positive return generated by the financial bubble and there exists a small probability for the bubble to disappear smoothly, without the occurrence of a crash. (Geraskin, Fantazzini, 2009). If we look at the price of crude oil until the 2008 (Picture 20), we can see very similar behavior in the market. Investors and traders believed that the growth would continue further, making them to forget about the risk of crash, because the gain was huge.

The key variable to model the price behavior before a crash is the crash hazard rate h(t), which indicates the probability of crash happening at any moment of time unit, considering that it has not happened yet. The hazard rate h (t) indicates the probability that a great number of traders, investors will assume selling the oil simultaneously, a position in which the market will not be able to satisfy them, unless the prices decrease dramatically. We have to understand that when it is said that investors make decision to sell simultaneously, it does not mean that they have some sort of global communication or collective answer (Johansen, 2000). Rather it means that crash start with small changes, local interactions between hedge funds, or by one single investing company that decides to sell the position and all the market follows him unconsciously, hereby transferring this small start to the whole market on global level.

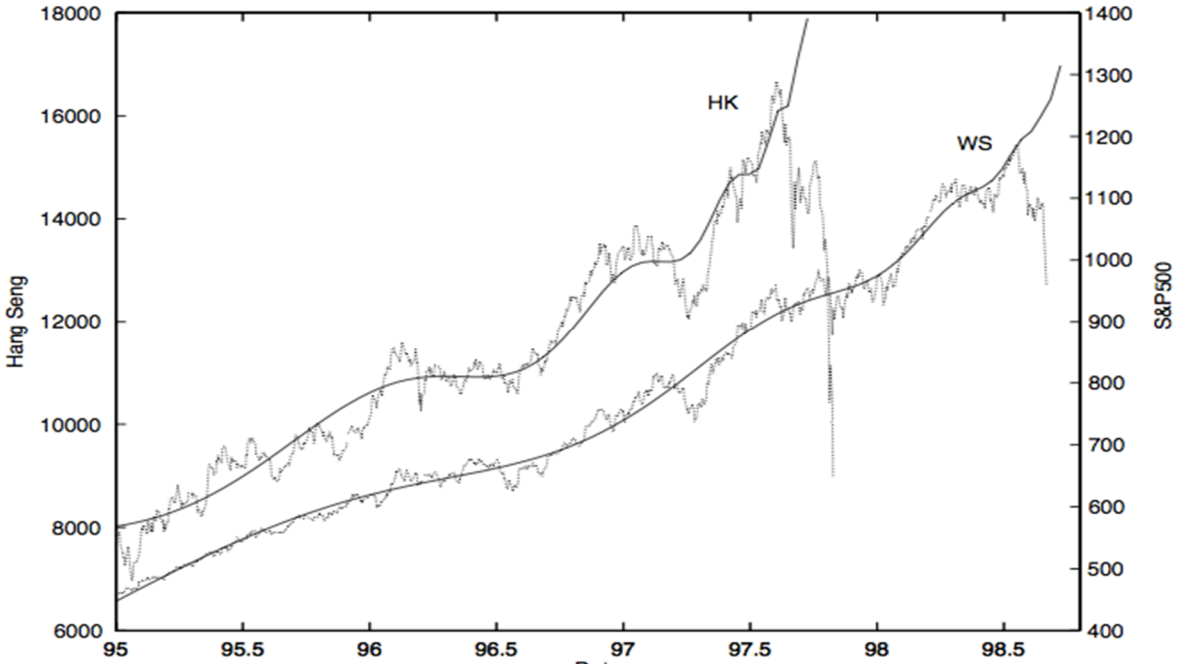
Mathematically our model relies on the following formula, which is the base of Log-Periodic Power Law (LPPL) method:

$$p(t) = A + B(t_c - t)^z + C(t_c - t)^z \cos(\omega log(t_c - t) + \varphi$$

Where, t_c is time of crash with the highest probability, z is exponential growth, *w* is oscillation amplitude. The other parameters, A, B, C and Φ represent no structural interpretations and can be seen as constraints.

The main intuition from the model is that: in any system, especially in financial markets the growth cannot continue exponentially forever. As it is progresses, the oscillation amplitude will be higher and higher until some critical value, where the price suddenly changes its direction. One example of LPPL fitting the Chinese and S&P 500 indices crashes in the end of the last century (Sornette, 2003)

Picture 21. Graphical demonstration of LPPL in the stock markets



Source: Critical market crashes, D.Sornette UCLA, 2003

Despite the fact the idea is intuitive and the formula seems to be simple, it requires critical or crash time estimation, which must be done through statistical methods. If the statistical properties fit certain criteria, then a bubble is forecasted with a most probable time of crash. However, this requires a very heavy computation and enormous amount of data; hence we made certain assumptions. Instead of computing the probable crash time, we assume that it is in one month in the future, at any given time. It allows us to take quicker, alternative approach of computing, by deriving the LPPL formula. Derivation is as follows (Zhou, Sornette, 2002):

$$D_q^H f(x) = \frac{f(x) - f(qx)}{[(1-q)x]^H}$$

Thus the derivative of the LPPL function is:

$$D_q^H y(t) = t^{m-H}[B' + C'g(t)]$$

Where,

$$B' = \frac{-B\tau^m(1-q^m)}{(1-q)^H}, \text{ and } C' = \frac{C\tau^m}{(1-q)^H}$$

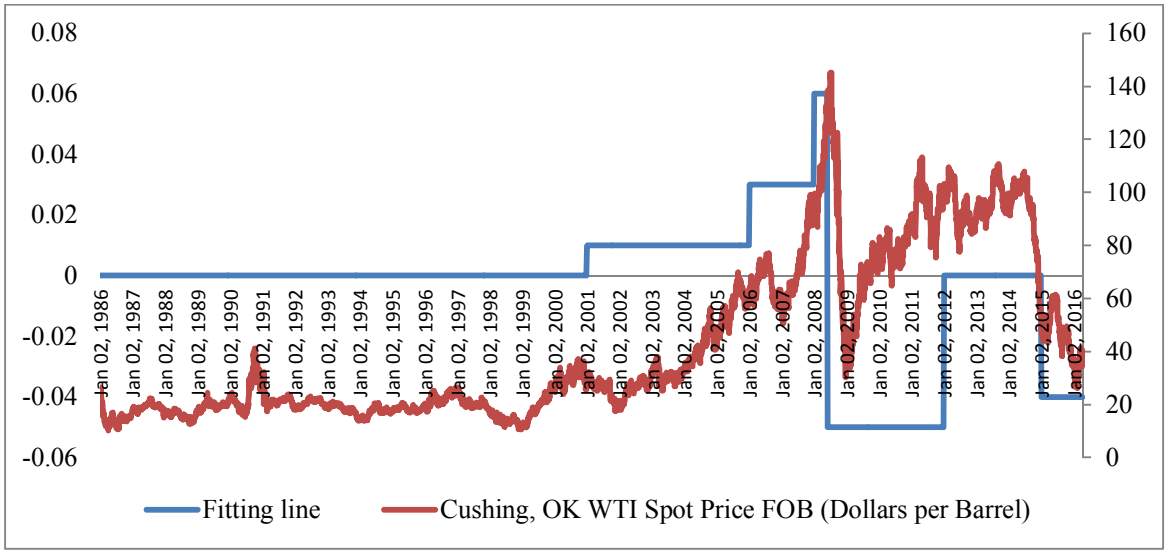
Also,

$g(t) = C_1 \cos(\omega lnt) + C_2 \sin(\omega lnt)$, with $C_1 = 1 - q^m \cos(\omega lnq)$, $C_2 = \sin(\omega lnt)$

The q in the derivative formula is generalized q-analysis to construct signature H,Q discrete scale invariance (Zhou, Sornette, 2002).

For the phenomena of unsustainable growth into which we can put our oil price statistics, we can consider a growth model that features a finite time singularity, which is one month and is a critical point where the growth regime changes. In systems that are discrete scale invariant such as in our analysis model is power law growth, decorated with a log-periodic function (Sornette, 1998). Fitting this model on the growth data (non-linear regression) allows for the prediction of the singularity, in our case the end of unsustainable growth. We are going to use WTI crude oil prices on daily basis, between 1986 and April 2016.

Picture 22. LPPL fitting line with WTI oil historical prices.



Source: Own calculations, SPSS statistics

As we can see from the table LPPL fitting line pretty acurately demonstrates the movement of the WTI crude oil price. Fitting model was taken into consideration as long term bubble warning line, thus between 1986 and 2001 it seems that model could not capture the movement of WTI prices. However, if the model is constructed on short term basis (usually 6 month) volatility in prices will be shown.

The result of the regression analysis is given in the table 7 below. R squared might seem statistically insignificant, however, the specification of the model does not require the parameters to be perfectly correlated. Standard deviation is high enough to consider the model working. P value is very low, so there is very little probability that the null hypothesis, which states that there is no evidence of significance of the paramenters, can not be rejected. F value is extremely high, which in statistical terms can be expressed as the

model having the variation among group to be more than you'd expect to see by random sampling. A large F ratio is an indication both when the null hypothesis is wrong (the data are not picked up from populations that have the same mean) meaning our population has got the same mean and when random sampling happened to give large values in some groups and small values in others, which is again true considering we are anlayzing a highly volatile commodity.

Table 7. Regression and Anova results of the constructed model.

Regression					
R squared	0.0442				
Normalized R	0.0440				
Standard deviation	29.8423				
Observation	7636				
ANOVA	***df***	***SS***	***MS***	***F***	***F signific.***
Regression	1	314127.77	314127.7703	352.728911	5.74793E-77
Tail	7634	6798567.75	890.5642845		
Total	7635	7112695.5			
	Coefficients	***Stand. Er***	***t statistics***	***p value***	***Lower 95%***
Y intercept	41.836	0.345	121.2273	0.00024	41.15981
Parameter	-293.507	15.628	-18.78108	5.75E-77	-324.1422

Source: Own calculations, SPSS statistics software package.

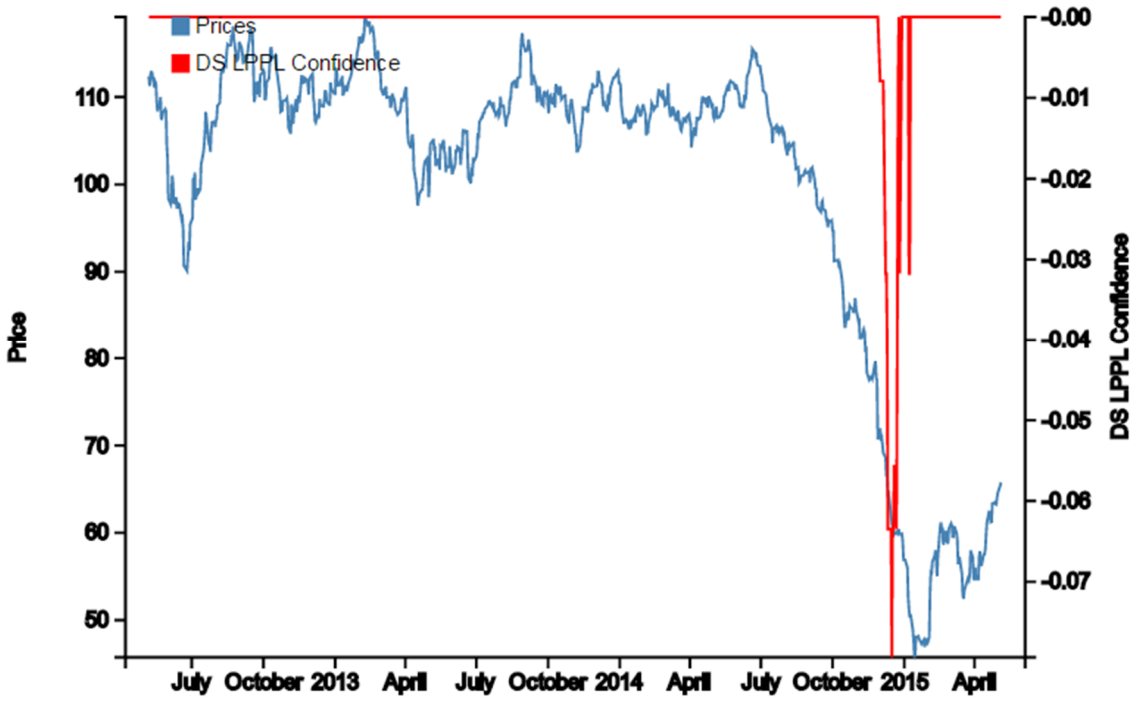
Let's compare our results with the conclusion of professor Sornette, in graphical form.

If we look at the graph on 2015 (Picture 22), we can see that both fitting lines (ours and from Financial Crisis observatory) are demonstrating a similar result. While the analysis of Financial Crisis Observatory is slightly complex and related to Brent type of oil, both types suffered with an identical price change in 2015. This leads to the conclusion, that both models, from longer perspective, fit the actual data quite well.

So what practical use of this analysis our company can adapt. As we said before, these times when whole trading are exposed to different type of risks and are mostly managed by computers, actually predicting the price movement becomes essential to reach success in the market. Long or short term analysis of the price movements using Dragon King Methodology could be helpful in detecting bubbles, drastic price changes, therefore giving our company much needed time to react and reconsider their initial decisions. We are far from

saying that the models we or professor Sornette developed can hundred percent predict the future movement or financial crisis.

Picture 23. Financial Crisis Observatory LPPL model's results.



Source: Financial Crisis Observatory, D.Sornette

Yet, they can be a very useful additional tool in analyzing risk and managing them, hence giving us an important insight to the world's economic and financial development.

CONCLUSION

In this paper, we have analyzed the concept of hedging from different perspectives. We have examined the history of risk management, capital markets, classical and modern approaches to hedging in an example of oil market. Here is the summary of our findings:

1) Market is a place in which two or more sides come to an agreement on the price of a service and goods
2) Markets are as ancient as they can be found in 3000 BC, in Cyprus, where the first gathering on the metal exchange happened.
3) Financial market is a place when securities, stocks, bonds, commodities are traded. Capital market and financial market are interchangeable terms.
4) Risk management is essential tool of any investor who works on long term and trader who speculates the market in a short time framework.
5) There are two major components in risk management: diversification and hedging.
6) Diversification is having a portfolio in which the loss from one item is covered by the gain in the other asset
7) Hedging is a broad subject of risk management which is aimed to minimize the risk of loss from a particular asset or commodity in the portfolio.
8) The traditional way of hedging is done by derivatives. Derivatives consist of futures, options, swaps and forward contracts.
9) Black-Scholes is the most commonly used mathematical model to estimate the value of an option.
10) Traditional ways of market analysis are technical and fundamental analysis. Technical analysis stresses the importance of price signals and works with charts. Fundamental analysis considers the economic and accounting indicators as the most important.
11) Modern approaches in risk management pay important attention to prediction.
12) There are two major conceptions in terms of prediction in modern era: Black Swan and Dragon King.
13) Black Swan approach claims that financial crisis, sudden dramatic price crashes cannot be predicted, as they are not expected in the first place and no model sufficiently can grasp the magnitude of such events.

14) Oil is an essential commodity in the recent decades. Its price is influenced by number of factors, such as supply-demand ratio, macroeconomic development of the world, political stability in the Middle East.
15) Because of the sensitivity of prices to external factors, it is hard to develop a conventional model which would help us to forecast the price movement of oil.
16) For this matter, another modern approach to risk management and prediction, Dragon King Model was applied to the analysis.
17) Results of the model show significant results, F test, p test values showed that model can be constructed and interpreted as statistically significant.
18) Model constructed by us showed similar behavior with the model of professor Sornette, who invented the Dragon King method.
19) Our model can be used for further development of the hedging field.

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