# CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

*Department of Economics*

# ANALYSIS OF NATURAL GAS COMMODITY PRICE DEVELOPMENT

Diploma Thesis

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**Declaration**

I declare that I have worked on my diploma thesis “Analysis of Natural Gas Commodity Price Development” by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague ……………………………

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Jiří Hrabák

**Acknowledgement**

I would like to thank Ing. Petr Procházka, Msc. Ph.D. for his support, supervision and assistance during assessment of my Diploma Thesis.

Author: Jiří Hrabák

**Summary**

The literature review of the thesis provides basic insight to the history of natural gas, nominal and real prices development for the U.S and Europe between years 1960 and 2013 and other important knowledge regarding the objectives of this study including methods used.

Three main objectives of the thesis were stated as following. To analyze natural gas cost efficiency as a source of energy between years 1960 and 2013. Second objective is to provide technical analysis of natural gas price development for the most actual period possible between 1st January 2013 and 15th March 2014 with use of NYMEX market price with use of patterns and indicators such as two simple moving averages and moving average convergence-divergence which are related to such analysis. Last and third objective is to create econometric model that explains changes in price of natural gas in the U.S. by chosen factors affecting its price followed by analysis for results obtained.

**Key words**

Natural gas price, price development, analysis of natural gas price, quantitative analysis of natural gas pricing, natural gas commodity, natural gas consumers, distributors of natural gas

## Souhrn

Literární rešerše této diplomové práce uvádí základy historie zemního plynu, dále také cenový vývoj zemního plynu mezi léty 1960 až 2013 jak pro Spojené státy americké, tak pro Evropu s ohledem na reálnou a nominální tržní hodnotu a dále podává důležité znalosti vztahující se na cíle této práce včetně použitých metod.

Tři hlavni cíle této diplomové práce jsou následující. Analyzovat hospodárnost zemního plynu jako zdroje energie mezi roky 1960 až 2013. Druhým cílem je provézt technickou analýzu vývoje ceny zemního plynu pro nejaktuálnější možné časové období, tedy mezi 1. lednem roku 2013 a 15. březnem roku 2014 a vycházející z tžní ceny udávané obchodní burzou NYMEX za použití vzorců a indikátorů jakými jsou dva jednoduché klouzavé průměry ale také indikátor MACD, které se vztahují k tomuto druhu analýzy. Třetím a posledním cílem je vytvoření ekonometrického modelu vysvětlujícího změny v ceně amerického zemního plynu pomocí faktorů ovlivňujících jeho cenu. Analýza obdržených výsledků z tohoto modelu bude následovat.



## Klíčová slova

Cena zemního plynu, vývoj ceny, analýza ceny zemního plynu, kvantitativní analýza oceňování zemního plynu, zemní plyn jako zboží, spotřebitelé zemního plynu, distributoři zemního plynu

**CONTENT**

## 1. Introduction to Natural Gas

Global consumption of natural gas stands for about half of the total world crude oil consumption. Utilized mainly for electricity generation represents the "cleanest" fossil fuel and plays key role in modern competitive economy.

Natural gas prices vary across the world and so they can be generally distinguished into 3 price regions such as U.S., Europe and Japan.

The biggest producer of natural gas since 2012 are U.S. due to the discovery of new extracting methods of unconventional natural gas also called shale gas. U.S. increased total natural gas production to total of 681.4 billion cubic meters for 2012. This fact significantly influenced natural gas prices in the world and allowed globally better economic growth.

*Natural gas is a major global commodity. Natural gas supplies the fuel for 21.3% of global electricity generation, making it the second largest source behind coal at 41%, according to the International Energy Agency's "Key World Energy Statistics" booklet. Aside from electricity generation, natural gas is also supplied directly to businesses and consumers for heating, cooling, and cooking. Natural gas accounts for 21.1% of overall global energy usage, placing it third behind oil at 33% and coal at 27%. The United States is the world's largest producer of natural gas followed closely by Russia. Japan, Germany and the United States are the largest importers of natural gas.* (BARCHARTS.COM, Natural Gas ETPs – Exposure to Natural Gas Prices Is Not an Easy Fix, 2010)

For many years, U.S. natural gas prices were subject to government price controls, it has only been recently that the chains have been broken. The contract that started trading in 1990, is now the second most actively traded energy contract. Of all natural gas that is produced, industry uses about one-third, homeowners use one-fourth, and utilities consume the balance. A fifty year supply of natural gas is under ground, and it is virtually "free" to tap, except for transportation and storage costs with middleman profits in between. The contract size is 10,000 mmBtu (Million British Thermal Units), with price quoted in dollars and cents per mmBtu. Prices were about $1 in 1992 and above $10 during the winter of 2000 when it was freezing cold in both North America and Europe, then under $2 a year later, and again $10 during the winter of 2003. (KLEINMAN, 2010)

## 2. Objectives and Methodology

### 2.1 Objectives

Energy quality topic not so hotly discussed few years ago but today it is playing key role in the economic growth and it will continue to gain on importance. Objective of the thesis is to analyze the potential influence of natural gas for the economic growth, mainly its contribution. This study research the question what factors are strong determinants of natural gas price. Important is to prove how important natural gas is for the society wealth, because this commodity is sometimes marginalized even today. Another objective is to point out that natural gas can be very successfully traded in order to earn some profit by trading commodities. To illustrate and demonstrate possible scenarios how to make profit by appropriate trading or speculating on this commodity by use of technical analysis together with fundamental analysis.

### 2.2 Methodology

General information about natural gas including natural gas history, supply, demand, trade with natural gas and price development of natural gas is reviewed in the theoretical part of the thesis. For purpose of the research methods of qualitative and quantitative analysis were employed. The thesis is based on studied literature, more precisely, books, academic articles and internet sources relating to the price of natural gas.

Practical part of the study is focused on fundamental and technical analysis of natural gas price in years 1960-2013 and little beyond that period to provide the most actual information about the topic.

First part of the practical study is application of technical analysis on the natural gas market (NYMEX). For this purpose free tool MetaTrader version 5.0 was used. There were implemented patterns and indicators which are in general essential to predict or to explain the price development of natural gas on the current market.

Another contribution to the study related to practical part of the thesis was analysis of cost-efficiency of natural gas, also in comparison with most widely used alternative fuel. Energy returned on energy invested and energy indicator ratio was studied in the thesis. Because of the huge variety of information related to the world natural gas market, its diversity together with many immature natural gas markets, the study focused mainly on natural gas price development in the United States.

Econometric model for natural gas price was formulated using software GRETL, where assumptions and expected behaviour of exogenous variables were explained. The econometric model contains one endogenous variable y1t which relates to the natural gas price in the U.S. and five exogenous variables regarding to natural gas reserves, natural gas consumption, natural gas production, Dow Jones average industrial index and finally to price of crude oil. All prices were listed in USD. In this part of the thesis there were also discussed and solved problem with high multicollinearity between exogenous variables.

## 3. Natural Gas Properties

*Natural gas is a combustible gas that is a mixture of simple hydrocarbon compounds. It is a fossil fuel that contains primarily methane, along with small amounts of ethane, butane, pentane, and propane. Natural gas does not contain carbon monoxide. The by-products of burning natural gas are primarily carbon dioxide and water vapour.* (STLAWRENCEGAS, Properties of Natural Gas, 2014)

Earth gas has no colour, no taste, no smell and belongs among non-toxic gasses. It weights circa forty percent less than air. This property causes its dissipitation within the Earth's environment. There are positive attributes such as high temperature of ignition while having narrow range of flammability so it burns in temperature over 1100 degrees Celsius using four to fifteen percent air mix.

*Natural gas is found in rocks beneath the earth's surface, in sedimentary rock that is porous. Production companies explore, drill, and bring the natural gas to the surface. Transmission companies operate large pipelines that bring the gas from the production sites ("wellheads") to "gate stations" where distribution companies.* (STLAWRENCEGAS, Properties of Natural Gas, 2014)

Energy equivalent to one kilowatt hour of electricity is 3,412 British thermal units (Btu). For illustration one barrel of crude oil equals to 4,846,800 Btu

## 4. History

Following lines give general insight into the history and development of gas use by a human beings. This fossil fuel became commercially useful substance not so long ago, but as a natural existing gas it has been known for centuries.

Chinese around 500 B.C. used natural gas to boil sea water in order to get drinkable water. Their pipeline system was created by crude bamboo tucked into places where the gas was seeping to the surface.

In Britain around 1785 the first commercialized use of natural gas took place. They obtain gas by heating the coal for purposes of lighting the houses and streets. Also in the United States natural gas was used to light streets and houses, it happened in 1816 in Baltimore and the same method of extraction has been used.

Natural gas naturally occurring was identified by French explorers in America in 1626. It was in place of Lake Erie, igniting gases were seeping above surface. The man who dug the first successful natural gas well was William Hart in the U.S. in New York, Fredonia. After that first gas light company was established in Fredonia which also became the first American company distributing natural gas.

The first municipal earth gas distributor was a firm grounded in Philadelphia in the year 1836. There is even today the biggest working public gas transportation system in the whole United States holding the name Philadelphia Gas Works. At that time gas was used only as a medium for lighting but then so called Bunsen burner device was developed.

Such discovery gave way for too many other possible uses of gas. Later in the 20th century a pipeline was constructed allowing the use of natural gas to increase dramatically.

## Natural Gas Today

Natural gas is today very important component of world's supply of energy. Natural gas is today supplying more than 50% of the residential and commercial customers in U.S. More than 40% of U.S. industry is currently using natural gas, because it is clean, safe and cost efficient compared to other alternative sources of energy. Supply of natural gas for U.S. comes from 99% from North America. According to latest environmental friendly trend, natural gas as the cleanest burning fossil fuel plays the key role in modern competitive economy. With regard to how huge the underground natural gas pipeline system is, it is astonishingly safe.

Liquefied natural gas uses abbreviation LNG and it offers new method of supplying by energy. LNG is today hotly discussed topic by world top leaders, because demand for energy must be met, if it is economically possible. There are currently about 4 running LNG facilities running and about ten more is under construction.

## Regulation

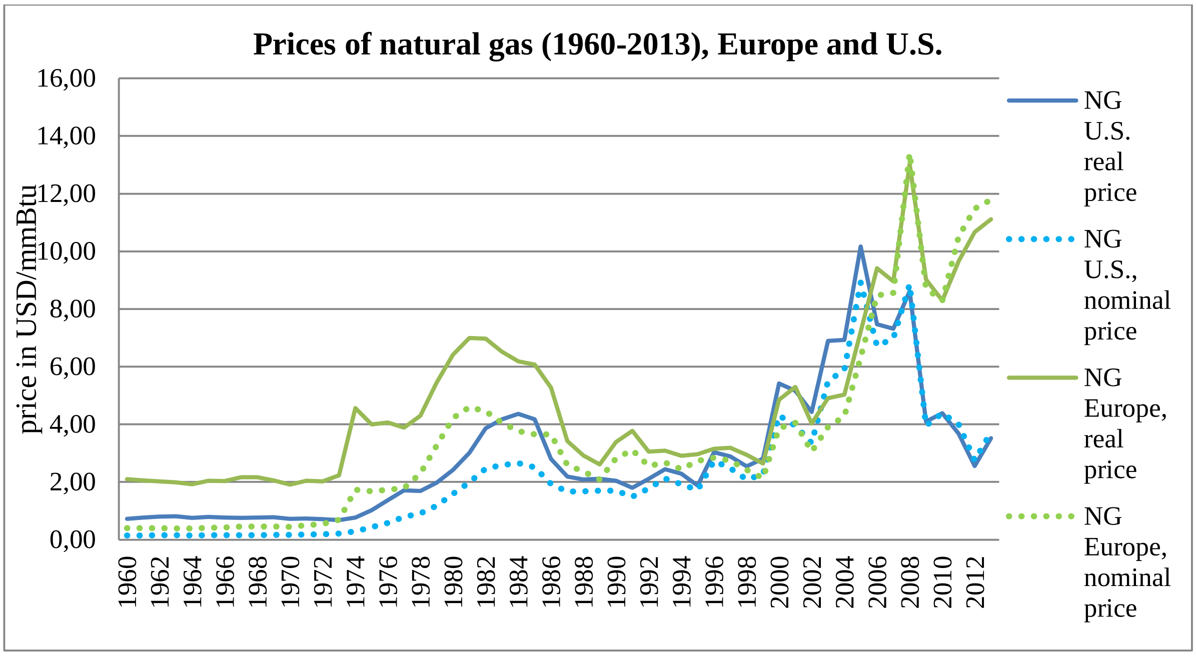
In 1938, U.S. government started to regulate prices of natural gas, because natural gas industry was heavily concentrated together with monopolistic behaviour, which causes due to its power tendencies to charge higher than competitive prices. Regulation was done based on Natural Gas Act that began to regulate the interstate gas industry to prevent consumers from often unreasonable high prices of natural gas. Federal Power Commission (FPC) was given the jurisdiction to regulate the sale and also transportation in interstate commerce.

The Department of Energy Organization Act (1977) shifted to the Federal Energy Regulatory Commission most of the Federal Power commission's function of regulation over the electric power and NG industries. (AMERICAN PUBLIC GAS ASSOCCIATION, A Brief History of Natural Gas, 2012)

## 5. Natural Gas Prices (1960-2013), Europe and U.S.

According to chart below illustration of real and nominal natural gas prices development in Europe and U.S. is given.

**Chart 1:**




(Source: data available at BP, Statistical Review of World Energy 2013, 2014, own processing)

## 6. Demand and Supply

### 6.1 Supply

Estimated reserves of natural gas are rapidly increasing during last years. Latest information about proved reserves comes from statistical review of world energy 2013 workbook in which there are described proved reserves of natural gas for year 2012. South and Central America has actually reserves of 7.6 trillion cubic meters. Whole Europe and Eurasia currently holds about 58 trillion cubic meters where 54.5 are located in Former Soviet Union. OECD countries have reserves of 18.6 trillion cubic meters of natural gas. Non-OECD countries stand for 168 trillion cubic meters of natural gas. The largest proved reserve for continent has Middle East counting reserves of natural gas for 80.5 trillion cubic meters. North America's reserves are 10.8 trillion cubic meters. Asia pacific region holds 15.5 trillion cubic meters and finally Africa has reserves in volume 14.5 trillion cubic meters.

Fast development in new drilling technologies brings more light into the industry producing and extracting natural gas from underground. (BP, Statistical Review of World Energy 2013, 2014)

### 6.2 Demand

Demand for natural gas increases during colder months due to the use as heating fuel by consumers. Natural gas is used to heat more than 50% of U.S. homes. Production of natural gas is in general constant during the whole year. About 12% of natural gas produced is stored in storages usually near to the final consumers when temperatures are above average. Demand for natural gas is fast growing in last few decades.

Consumption of natural gas is affected by variety of price fluctuations and trends within overall economic growth. Current trend of consumption of natural gas is increasing due to the strong economic growth. Many prediction scenarios give different outcomes how the consumption of natural gas will develop. Of course slower economic growth will result in lowering of natural gas consumption. Natural gas is very often used for electricity generation and it will be the main driver in consumption trend in longer term. Cost efficiency is the main driver when choosing the right fuel. Continual economic growth is demanding for new energy generating capacities. Many power plants are nowadays switching to natural gas as an alternative fuel. (AMERICAN PETROLEUM INSTITUTE, Natural Gas Supply and Demand, 2014)

### 6.2.1 Price Elasticity of Demand

The Price Elasticity of Demand (commonly known as just price elasticity) measures the rate of response of quantity demanded due to a price change. The formula for the Price Elasticity of Demand (PEoD) is:

**PEoD = (% Change in Quantity Demanded)/(% Change in Price)**

(ABOUT.COM ECONOMICS, MOFFATT, Price Elasticity of demand, 2014)

## 7. EROEI and EIR

Formula for EROI and EIR computation can be following:

EIR p, NG = (Btu/$ of natural gas) / (Btu/GDP of economy) or,
= (total NG consumption in Btu/total expenditures on NG)/(Btu/GDP of economy
EROI = total energy input / total energy output (KING, Energy intensity ratios as net energy measures of United States energy production and expenditures, 2010)

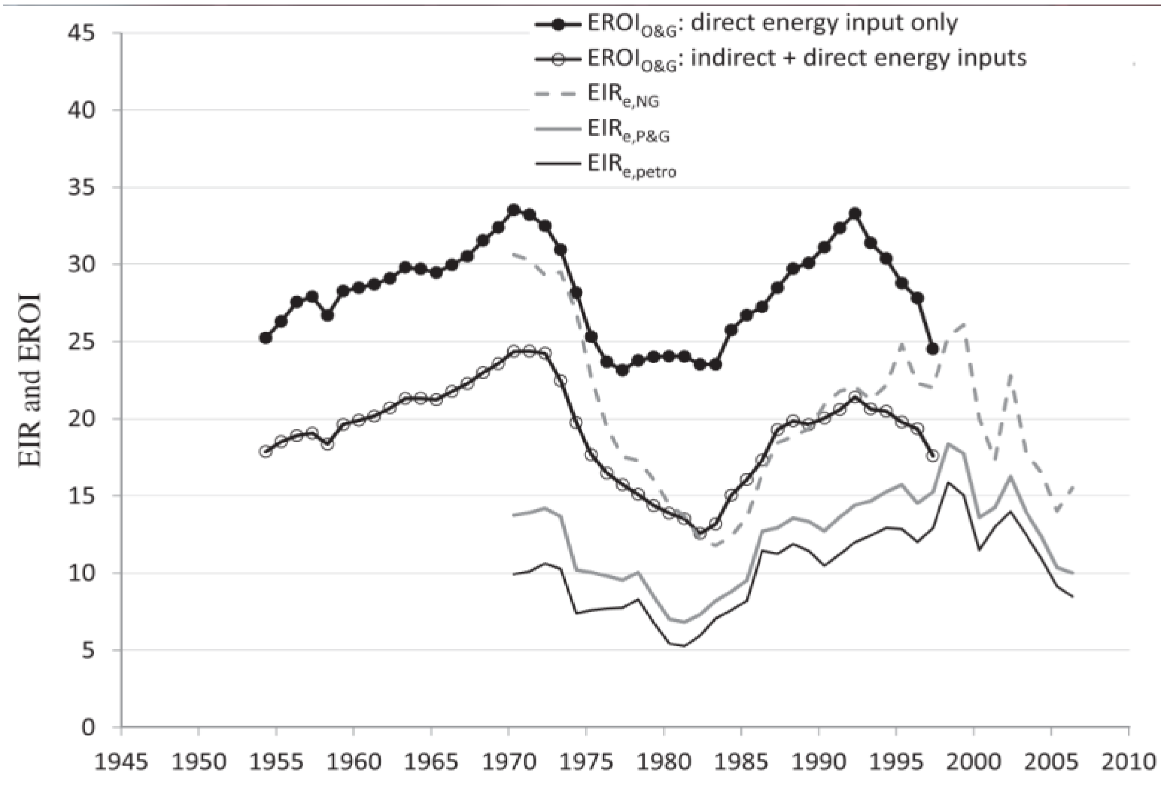
Energy returned on energy invested (ERoI) and energy intensity ration (ERI) are generally measurement of quality of energy produced. Characteristics for both EROI and EIR are equal. Energy or fuel systems with higher EIR or EROI are of better quality and therefore bring more energy to society.

Basically, the EROI is the net energy remaining after exploration, development and extraction has been factored in. When we just consider the energy coming out of the ground, this is called the EROI from wellhead. We also must factor in the refining, distribution and energy cost to maintain the infrastructure system to get a more complete EROI ratio. This will be discussed in a later article. But, if we just go by the basic EROI from the wellhead, Cutler Cleveland of Boston University reported that the EROI of oil and gas extraction in the United States has declined from 100:1 in 1930, to 30:1 in 1970, down to 11:1 in year 2000. (THE MARKET ORACLE, ANGELO, Peak Silver and Mining by Falling EROI, 2009)

According to the work of C.W. King from the University of Texas at Austin in which the author tried to measure the level of EROI and EIR following can be stated. The energy intensity ration (ERI) for natural gas production is about three or four times higher than energy intensity ration of crude oil production from year 1949 until year 1971. The ERI for natural gas in year 1949 was 140, than it significantly dropped. In year 1962 the same ration was just 79. The energy intensity ration (ERI) shows a fast decline from ration 94 in year 1971 to just 19 in year 1982. It was all driven by greater than 500% increase in the real price of natural gas together with economic stagnation in 1970’s after big crude oil peak. After the regulation of natural gas price in the U.S. was gone after Natural Gas policy Act in 1978 after which the opportunity to make interstate trade arise and caused also increase in natural gas price.

After the mid-1990s trend of ERI for natural gas was following ERI trend for crude oil production and was about at the same ratio. Beginning in year 2005 the ERI of natural gas was separated once again from ERI of crude oil production which might be cause by exploration of unconventional natural gas reserves such as shale gas. (KING, Energy intensity ratios as net energy measures of United States energy production and expenditures, 2010)

**Chart 2: Energy Returned on Energy Invested (EROI), Energy Intensity Ration (EIR)**



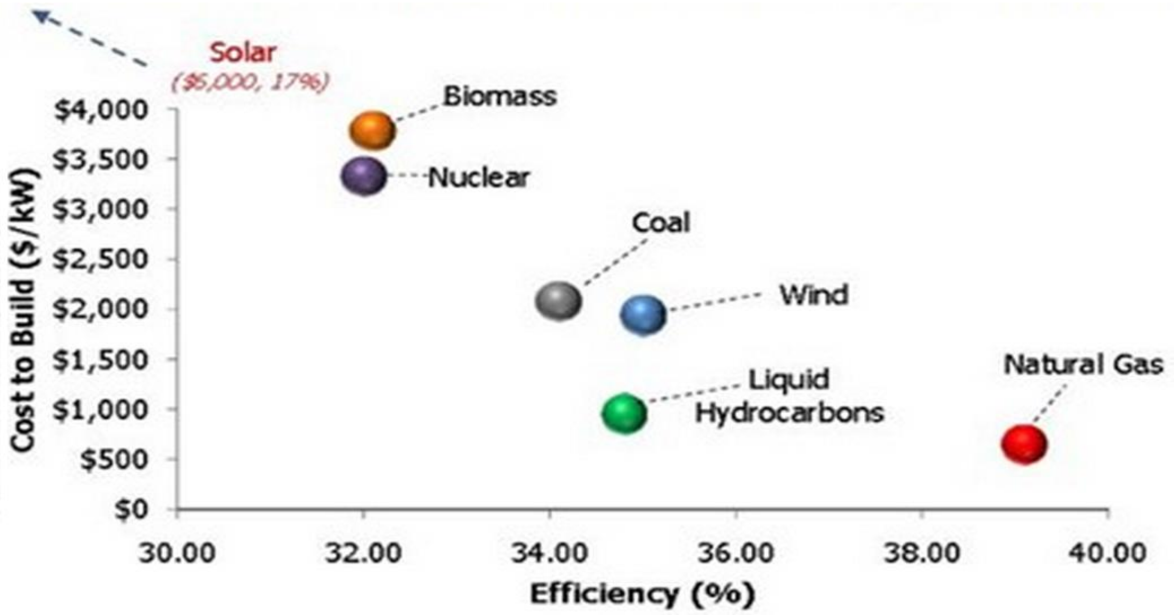

(Source: KING, Energy intensity ratios as net energy measures of United States energy production and expenditures, 2010)

## 8. Cost Efficiency of the Natural Gas

Cost efficiency can be basically calculated as Btu input divided by Btu output. Producers and also users of electricity are always concerned about cost efficiency of used fuel. Electric market is highly competitive environment. Total cost of unit of electricity produced is main concern of operators. Natural gas power plants are faster and cheaper for construction, together with high efficiency of natural gas compared to alternative fuels. All this mentioned can result in lower rates charged to electric power consumers.

In general, conventional natural gas plant costs about $1000 per KW of capacity constructed. Coal-fired power plants construction cost is about $2,500 or more per kilowatt of capacity. A nuclear power plant costs are higher than $4000 per KW of capacity. Wind generating electricity plants costs are about two times higher than cost of natural gas plant. And finally, cost of modern solar power plants are estimated for about $6000 per kilowatt of capacity. (AMERICAN PUBLIC GAS ASSOCCIATION, Clean and Efficient, 2014)

**Chart 3: Cost efficiency of natural gas compared with other fuels**




(Source: AMERICAN PUBLIC GAS ASSOCCIATION, Clean and Efficient, 2014)

## 9. Trade

### 9.1 **Exchange Traded Funds**

The investment into commodities has always been unstable probably all over the world. Because of the political instruments application many exchange traded funds or ETFs were pushed down as they are risky.

*Meanwhile, in the natural gas market, prices have been severely under pressure, not just for this month, but for the longer term as well. This is largely due to a burst of supply, thanks to fresh technologies that bring out more of this precious commodity.*

*The success of 'shale gas' – natural gas trapped within dense sedimentary rock formations or shale formations – has transformed the domestic energy supply, with a potentially inexpensive and abundant new source of fuel for one of the world's largest energy consumers.* (ZACKS, Is This a Better ETF for Natural Gas Investors, 2013)
According to the Energy Information Administration bureau the US is forecasting the gas production volume of more than fifty quadrillion British thermal units of oil and earth gas for the upcoming year thus making the US the greatest earth gas producer in the world. The second largest gas producer would then be Russia with ten percent less volume when compared to the U.S., but still making two hundred percent more than the world's third largest earth gas producer in the Saudi Arabia.

**Fund Objective and Index Exposure**

Released in 2007 the FCG – ETF report keeps record of the ISE reserve Natural Gas Index. This is a same weighted index consisting of exchange providing firms which make an important piece of their profits by the production and exploration of earth gas.

The Henry Hub Natural Gas Price Index being also a same weighted index is trying to perform similarly just without expenses of natural gas. Here the investment is done in futures contracts on earth gas via NYMEX. When compared ETF to FCG it is rich on AUM while having the asset base at 894 million dollars. (ZACKS, Is This a Better ETF for Natural Gas Investors, 2013)

**Playing the Sector Through ETFs**

With regards to the choppy ways of the energy markets one is probably better off when using the volatile but still rewarding sector thru ETF's. Specifically it is advised to tap the energy bull trend by aiming at the exploration and production set.

*This sub-sector serves as a pretty good proxy for oil/gas price fluctuations and can act as an excellent investment medium for those who wish to take a long-term exposure within the energy sector. While all oil/gas-related stocks stand to benefit from rising commodity prices, companies in the E&P sector are the best placed, as they will be able to extract more value for their products. (*ZACKS*, A Comprehensive Guide to Oil & Gas ETFs,* 2014*)*

## 9.2 Forwards, Futures, Swaps and Options

### 9.2.1 Forward and Futures

The big distinguishment between forward contracts and futures is to be found in the way the deals with future contracts are required to be done by trading on futures exchanges whereas forward contracts are normally made by businesses located in non-centralized OTC markets.

*Because a futures contract is transacted on an exchange, the traders originating the contract use the exchange clearinghouse as the counter-party to their trade. While both a short trader (seller) and long trader (buyer) are required to create a futures contract, both traders execute the trade with the clearinghouse as the direct counter-party. This allows a* *futures contract to be created without the problems associated with forward contracting which typically depends on the creditworthiness of the counter-party. By design, futures contracts are readily transferable via the trading mechanisms provided by the exchange. Because forward contracts depend on the performance of the two original parties to the contract, these contracts are often difficult to transfer.* (POITRAS, Futures Markets and Forwards Markets, 2006)

One example of such difference could be that the trader of future contracts needs to close out in a situation where an equal number of offsetting contract for that commodity is transacted while the original position is aborted. Forwards are mostly offsetting the establishment of another forward while keeping the conditions as close to the previous one as possible.

*Unless the forward contract provides a method for cash settlement at delivery, this will potentially involve two deliveries having to be matched in the cash market on the delivery date. In modern markets, considerable variation is observed in the relative use of forward or futures contracting across commodity markets. For example, in currency markets, the large value and volume of many individual trades has the bulk of transactions for future delivery conducted in the currency forward market.* (POITRAS, Futures Markets and Forwards Markets, 2006)

Currency that is being traded via futures are just a small part in the total amount of trade of the world's currency market. Since forward trading has a lot in common with the cash market deals the ability to trade forwards directly is forbidden to the strong players because currency forwards poses the regular marking to market.

*Restricted participation is needed to control default risk. As such, differences in the functioning of futures and forward markets impacts the specific method of contracting selected for conducting commodity transactions. For example, in contrast to forward trading, futures markets are designed to encourage participation by large and small speculative traders. The increased participation of speculators not directly involved in the market for the physical commodity provides an important source of additional liquidity to* *futures markets not available in forward markets. In order to achieve this liquidity certain restrictions are imposed on trading, such as limits on position sizes and the imposition of filing requirements. By restricting participation to 5 large players in the commodity market, many of the restrictions required for the functioning of futures markets are not present in forward markets.* (POITRAS, Futures Markets and Forwards Markets, 2006)

### 9.2.2 Commodity Swaps

*A Commodity Swap is an agreement involving the exchange of a series of commodity price payments (fixed amount) against variable commodity price payments (market price) resulting exclusively in a cash settlement (settlement amount).*

*The buyer of a Commodity Swap acquires the right to be paid a settlement amount (compensation) if the market price rises above the fixed amount. In contract, the buyer of a Commodity Swap is obliged to pay the settlement amount if the market price falls below the fixed amount.*

The purchasing party of a commodity swap recieves also the right of being paid a settlement amount in such a situation when the market price rises beyond a set fixed amount. In a contract the selling party is required to cover the settlement amount in case that the market price plummets below a certain fixed amount.

*Both streams of payment (fixed/variable) are in the same currency and based on the same nominal amount. While the fixed side of the swap is of the benchmark nature (it is constant), the variable side is related to the trading price of the relevant commodities quoted on a stock exchange or otherwise published on the commodities futures market on the relevant fixing date or to a commodity price index.* (CASTAGNINO, 2009), (UNICREDITBANK, Commodity swaps and commodity options with cash settlement, 2014)

### 9.2.3 Options

*An option is the right either to buy or to sell a specific amount or value of a particular underlying interest, for fixed price, by exercising the options before their specified expiration dates. The options markets provide a mechanism where many different types of market players can achieve their specific investment goals. An options investor may be looking for long term or short term profits, or they may be looking to hedge an existing stock or commodity position.* (TIGERTRADINGCLUB, Introduction to Options Trading, 2002)

Does not matter the goal but it is certain that a businessman has to understand the nature of the market he or she is about to trade at. Option is financial tool which can be traded on its own. The option contracts derive their price from an underlying assets whose price options are based upon. When the price of underlying asset plummets, the price of option follows and this pays vice versa. The value of option is also reflected in other market conditions such as volatility, stock splits, dividends, etc. (CASTAGNINO, 2009), (TIGERTRADINGCLUB, Introduction to Options Trading, 2002)

## 9.3 Stocks and Bonds

*Stocks and bonds are financial instruments for investors to obtain a return and for companies to raise capital. Put very simply, stocks offer an ownership stake in the company and bonds are akin to loans made to the company. Stocks of a company are offered at the time of an IPO (Initial Public Offering) or later equity sales. The company offers investors an ownership stake by selling stocks. Stocks can be either common stock or preferred stock. Preferred stock is further divided into participating and non-participating preferred stock.* (DIFFEN, Bond vs Stock, 2014)

The value of stocks reflects the value of a company it represents, that is why the price development of stocks goes up and down according to the way certain company is seen by the market. On the opposite or inverted side of stocks are bonds which are in their essence loans which are offered at a certain fixed interest rate.

*When a company believes that it can raise capital cheaper by borrowing money from banks, institutional investors or individuals, they may choose to offer interest-paying corporate bonds. With bonds, an investor is promised a fixed return. While bonds are "safer" than stocks because of lower volatility, it should be noted that there is always a chance that company will be unable to repay bond-holders. In that sense, bonds are not "risk-free".* (DIFFEN, Bond vs Stock, 2014)

But it is important to keep in mind that when a scenario of a company declaring bankruptcy comes to place, those who loose as first are stockholders followed by creditiors with bond holders.

## 10. Factors Affecting Natural Gas Prices

*Natural gas prices are a function of market supply and demand. Because of limited alternatives for natural gas consumption or production in the short run, even small changes in supply or demand over a short period can result in large price movements to bring supply and demand back into balance. (*EIA*, Factors Affecting Natural Gas Prices,* 2013*)*

The following is distinguishmnent of factors which influence the price development of natural gas. The influences can be divided into sub-groups according to the cause of their impact:

***Factors on the supply side that may affect prices include:***

-*Variations in the amount of natural gas being produced*

-*The volume of gas being imported and/or exported*

-*The amount of gas in storage facilities (referred to as storage levels)*

-*Increases in supply result in lower prices, and decreases in supply tend to increase prices.*

***Factors on the demand side that may affect prices include:***

-*The level of economic growth*

-*Variations in winter and summer weather*

-*Oil prices*

**Domestic Natural Gas Prices Driven Primarily by Supply**

*Most of the natural gas consumed in the United States comes from domestic production. U.S. dry production increased from 2006 through 2012, when it reached its highest recorded annual total. The increases in production were the result of more efficient, cost-effective drilling techniques, notably in the production of natural gas from shale formations. (*EIA*, Factors Affecting Natural Gas Prices,* 2013*)*

Higher supply of earth gas is reflected in the lower prices of gas which on the other side can cause decrease in the volume of harvesting thus decreasing production and as a result further increase in the price of gas.

**Severe Weather Can Disrupt Production**

*Hurricanes and other severe weather can affect the supply of natural gas. For example, in the summer of 2005, hurricanes along the U.S. Gulf Coast caused the equivalent of about 4% of U.S. total production to be shut in between August 2005 and June 2006. (*EIA*, Factors Affecting Natural Gas Prices,* 2013*)*

**Imports Contribute to our Supply of Natural Gas**

In the year 2012 the US pipeline and liquid earth gas net import created six percent part of the sum of the US earth gas consumption. Nearly one hundred percent of the pipeline imported fuel came from Canada.

*Natural gas pipeline gross imports, which have declined over the past five years, are projected by EIA to remain near their 2012 level through 2014. LNG imports are forecast to remain at minimal levels of less than 0.5 Bcf/d in both 2013 and 2014. In 2012 the U.S. imported 3,135,346 Mcf of natural gas and exported 1,618,946 Mcf, resulting in net imports of 1,516,400 Mcf, or 6% of U.S. 2012 natural gas consumption. (*EIA*, Factors Affecting Natural Gas Prices,* 2013*)*

**Economic Growth Can Affect Natural Gas Demand and Prices**

*The strength of the economy is a major factor influencing natural gas markets. During periods of economic growth, the increased demand for goods and services from the commercial and industrial sectors generates an increase in natural gas demand. This is particularly true in the industrial sector, which is the leading consumer of natural gas, as both a plant fuel and as a feedstock for many products such as fertilizer and pharmaceuticals. (*EIA, *Factors Affecting Natural Gas Prices*, 2013*)*

The higher the demand is the higher the production thus higher the price. On the other hand cooling economic growth rate causes inverse effects.

**Winter Weather Strongly Influences Residential and Commercial Demand**

*During cold months, residential and commercial end users consume natural gas for heating, which places upward pressure on prices as demand increases. If unexpected or severe weather occurs, the effect on prices intensifies because supply is often unable to react quickly to short-term increases in demand. These effects of weather on natural gas prices may be exacerbated if the natural gas transportation system is already operating at full capacity. (*EIA, *Factors Affecting Natural Gas Prices*, 2013*)*

In such scenario the increase of price is most probable then resulting lowering of total demand for earth's gas shall bring the market back in balance. Reserves of gas placed into storages during the time of demand recession can be utilised to dampen the sudden increase in demand in such a situation as a cold weather.

**Hot Summer Weather Can Increase Power Plant Demand for Gas**

*Temperatures also can have an effect on prices in the cooling season. About 30% of U.S. electricity is generated by natural gas. Hotter than normal temperatures can increase the* *demand for air conditioning, in turn, increasing the power sector's demand for natural gas, which can increase prices. (*EIA*, Factors Affecting Natural Gas Prices*, 2013*)*

**Natural Gas Supplies Held in Storage Play a Key Role in Meeting Peak Demand**

The general image of supply of gas can also be affected through a volume of gas stashed under the ground in storage fields. There it makes an essential supply component for the cold seasons thus providing dampers in sudden teeth in demand. This way the steady volumes of gas production are maintained.

*Levels of natural gas in storage typically increase during the refill season (April through October), when demand for natural gas is low, and decrease during the heating season (November through March), when space heating demand for natural gas is high. Natural gas in storage represents an incremental source of supply immediately available to the market. This can counteract the effects of sudden increases in demand for natural gas, or supply disruptions such as pipeline outages that cause demand to exceed supply and thus lead to higher prices. (*EIA*, Factors Affecting Natural Gas Prices*, 2013*)*

**Competition with Other Fuels Can Influence Natural Gas Prices**

A great amount of gas is digested primarily by industrial companies together with electricity generating fleets. These consumers are able to switch to other fuels such as coal or oil according to the price development of these substitutes.

*Because of the interrelationship among these fuel markets, when prices of the other fuels fall, any resultant shift in demand from natural gas to coal or oil reduces natural gas demand and pulls natural gas prices downward. When prices of the competing fuels rise, relative to natural gas prices, there may be a cutover from the competing fuels to natural* *gas, increasing its use and pushing natural gas prices upward. (*EIA, *Factors* Affecting Natural Gas Prices, 2013*)*

Since circa one third of electricity was createt from coal in 2012 the earth gas production was rising thus generating thirty percent of electricity in 2012. Electric energy produced by the use of earth gas can be more interesting when compared to other sources of electric energy such as coal.

## 11. Commodity Exchange and Stock Market

*A commodity exchange is a market organized to allow for the selling and buying of commodity. Commodity, which are hard goods, as opposite to services, may be bought and sold on a commodity exchange in three types of markets: cash, futures and options. (*INVESTOR GLOSSARY, Commodity Exchange, 2013*)*

The exchange of commodities is generally known to be mainly public thing since almost everyone is able to do business via market's member companies. The commodity exchange influences the trade of its participants while the prices are regulated by supply and demand.

*A commodity exchange provides the rules, procedures, and physical for commodity speculating, oversees trading practices, and gathers and disseminates market place information. Commodity exchange transactions are held on the 47 commodity exchange floor, in what is called a pit, and must be effected within certain time limits. Floor traders, floor brokers and futures commissions traders working on the floor of a commodity exchange must be registered by the SEC (Securities and exchange commission). (*INVESTOR GLOSSARY, Commodity Exchange, 2013*)*

## 11.1 Markets

CBOT (Chicago board of trade) – Well known commodity exchange. Founded in 1848, mainly agricultural commodities were traded here at the beginning, nowadays commodities, stock indexes and other tradable options can be found there.

NYMEX (New York mercantile exchange) – This market place was established in 1882. Nowadays it is the largest commodity exchange market place in the world. Possibility for commodity trading provides division called COMEX.

The Czech Republic has 5 commodity exchange markets but their significance is very low compared to the other stock markets outside the Czech Republic, because of the low amount traded.

## 11.2 Participants

People trading on commodity market, can be classified in three groups:

**Large speculators** – also called professional traders. They often represent some big institution such banks. The number of contracts they trade exceeds hundreds.
**Commercials** – Subjects that need to buy or sell commodities in order to consume or trade with them – (producers, consumers)
**Small speculators** – Speculators of this category, trade only very limited amount of contracts. (NESNÍDAL, PODHAJSKÝ, 2005)

Function of commodity market in general is that it allows traders or speculators to trade with the commodities even they don't own any of these physically. When trader sell commodity contract, he is basically speculating that price of commodity he bought will be lower in future but 1 day before the contract expiration date. Before expiration of contract sellers have to buy the same amount of commodity that he sold. (NESNÍDAL, PODHAJSKÝ, 2005)

## 12. Market Analysis

### 12.1 Fundamental Analysis

*Fundamental analysis is basically the study of supply and demand. The fundamentalist says that the cause and effect of price movement is explained by supply and demand. Fundamental analysis appeals to our logic. After all, if Brazil is suffering throught during the flowering phase of soybean plant, you can rationally explain why bean prices are rising. A good fundamentalist is able to forecast a major price move well in advance of the technician,. Some fundamentalists have what amounts to "inside information" (and this is perfectly legal in the futures markets).*

*Fundamentalists are able to trade courage of their convictions and are not shaken out easily during false market movements. They are better able emotionally to maximize positions, because fundamentals can take long time to change.* (KLEINMAN, 2010)

Fundamental analysis can be divided into:

**Economic fundamental analysis** - macroeconomic factors determining prices being researched to show possibilities of an investment

**Industrial fundamental analysis** is searching for and ideal industry for investment by analysis of growing potential of different groups of firms in different branches of industry.

**Company fundamental analysis** – Focuses on analysis of some company in order to be able to provide essential information to trader/investor in which company to invest.

This type of analysis is a task of longer-term analysis, usually not short time period. In contrast to technical analysis which is aimed on short-term periods. Fundamental analysis is based on historical data which might be somehow related to the market. (BRADA, 2000)

## 12.2 Psychological Analysis

This type of analysis assumes that behaviour when trading is affected by emotions. Presumption, that trader behaviour is different when they feel that they belong to some bigger group of speculators. This type of analysis assumes that market is not influenced by macroeconomic factors. (BRADA, 2000)

## 12.3 Technical Analysis

Technician is concerned with market action only. The basic issue here is not that fundamentals are what ultimately moves price—the technician concedes this point. The technician believes it us virtually impossible for most of us to know all the fundamentals that affect price at any given time. By the time the news reaches most of us, it has been disseminated so widely that it has been discounted in price. Because a trader makes or loses money via price movements, the technician believes this is what should be studied. In other words, the technician believes price is the ultimate fundamental. (KLEINMAN, 2010)

Three Principles for Technical Analysis:

In trade values/rates are covering all phenomena, which may have so impact on it (unlike the case of fundamental analysis mentioned above).

Trade values are changing according to the trends, which have every time specific level of inertia. Cycles and formations repeat. People in similar situations act similar like previously in history.

Most of technical analysis is a task of short time frame such as hours or shorter time intervals. (BRADA, 2000)

### 12.3.1 Terminology

Basic terminology when trading:

**Open** – price on the beginning of given time frame

**Close** – price on the end of given time frame

**High** – maximal price in given time frame

**Low** – minimal price in given time frame

**Bull market** – market with upward sloping trend

**Bear market** – market with downward sloping trend

**First notice day (FDN)** – Day, when trader is pointed out, that he owe a contract and that in near future he will have to get rid of it or take over discussed commodity. The second possibility, which is take-over usually not profitable case for an investor.

**Last trading day (FND)** – It is the last possible day when trader can get "cancel" the contract.

**Long and short positions** – Trader can act in market in two directions. In one case trader buys commodity contracts and he is "long", while he expects, that the price of chosen instrument will grow in the future. The second possibility how to behave in the market is when trader is "short" and sells commodity contracts, while he is expecting price decrease in traded instrument. Aim of long position investment is to buy at low price and then sell the same amount for higher price. On the other hand, when trader is short his objective is to sell at high price and after that buy when the initial price of his "sell" is exceeded in order to make profit. The possibilities are that trader can profit in both cases – while the price is going up or down. (NESNÍDAL, 2005)

**Correction** - *A reverse movement, often negative, when price in stocks, bonds, commodity or index changes. When the market is showing a trend of closing lower, a correction may be at hand. A correction in the market as a whole does not necessarily tell us how any one stock is performing, however. A stock may remain strong despite a correction - for example, consumer staples tend to perform steadily in any market. A stock could also perform about the same as the overall market during a correction, or it could plummet even further than the overall market. A correction can be opportunity for value investors to pick up good companies at bargain prices.* (INVESTOPEDIA, Definition of Correction, 2014)

**Arbitrage** – *Arbitrage is an opportunity to profit without taking risk, as there is no uncertainty involvement.*

**Margin** – *A percentage of the total value of transaction that a trader is required to deposit as collateral to open position.*

**Overbought** – *It is said that when a currency pair has risen at untypical acceleration, the currency pair is overbought*

**Oversold** - *It is said that when a currency pair has fallen at untypical acceleration, the currency pair is oversold* (STRAIGHTFOREX, Forex Glossary, 2014)

**STOP-LOSS** - *An order placed with a broker to sell a security when it reaches a certain price. A stop-loss order is designed to limit an investor's loss on a position in a security. Although most investors associate a stop-loss order only with a long position, it can also be used for a short position, in which case the security would be bought if it trades above a defined price. A stop-loss order takes the emotion out of trading decisions and can be especially handy when one is on vacation or cannot watch his/her position. However, execution is not guaranteed, particularly in situations where trading in the stock is halted or gaps down (or up) in price. Also known as a "stop order" or "stop-market order."* (INVESTOPEDIA, Stop-Loss Order, 2014)

### 12.3.2 Graphs

#### 12.3.2.1 Bar Chart

A bar chart is method of summarizing a set of categorical data. It displays the data using a number of bars of the same width, each of which representing a particular category. The height of each bar is proportional to a specific aggregation (e.g., to the sum of the values in the category it represents). The categories could be something like an age group or a geographical location, etc. (CUSTOM-ANALYTICS.THOMSONREUTERSLIFESCIENCES, What is Bar Chart?, 2014)

Bar chart is very often used graph and is made of bars. Each bar provides different information. Basically there are 4 types of information included in a single bar, open, close, high and low. “Open” provides information of an opening market price that occurs in the market in given time frame. In the end of given time frame that covers 1 bar, there is “Close” information which refers to the price of closing the market in that time frame. Highest price that was reached for each bar during given time frame is called “High”. Lowest price that occurred during given time period for single bar is called “Low”.

#### 12.3.2.1 Line Chart

This kind of graph does not contain information about price range traded in every single time frame. Therefore they are not used for forecast purposes. Line chart connects usually closing prices, but it is also possible to find line charts connecting opening prices, low prices, or high prices.

#### 12.3.2.2 Point and Figure Chart

These types of charts do not take into consideration a timeline. These charts consist of number of columns, either consist of X (description of rising price) and O (description of decreasing price). (BRADA, 2000)

#### 12.3.2.3 Candlestick Chart

*In order to create a candlestick chart, you must have a data set that contains* ***open, high, low and close*** *values for every single time period you want to be displayed. The hollow or filled portion of the candlestick is called "the body" (also referred to as "the real body"). The long thin lines above and below the body represent the high/low range and are called "shadows" (also referred to as "wicks" and "tails"). The high is marked by the top of the upper shadow and the low by the bottom of the lower shadow. If the stock closes higher than its opening price, a hollow candlestick is drawn with the bottom of the body repressenting the opening price and the top of the body representing the closing price. If the stock closes lower than its opening price, a filled candlestick is drawn with the top of the body representing the opening price and the bottom of the body representing the closing price.* (STOCKCHARTS, Introduction to Candlesticks, 2014)

When comparing candlestick charts to other traditional forms many users find the candlestick bars more optically attractive and better for interpretation. Every candle provides user-friendly image of the price development. The relation between open and close is very easy to read as well as the high and low.

If close value is bigger than open a hollow candlestick is applied thus showing pressure to buy. The pressure to sell is shown by the use of filled sticks when the close is less than open.

*Candlesticks do not reflect the sequence of events between the open and close, only the relationship between the open and the close. The high and the low are obvious and indisputable, but candlesticks (and bar charts) cannot tell us which came first.* (STOCKCHARTS, Introduction to Candlesticks, 2014)

### 12.3.3 Patterns

#### 12.3.3.1 Trend Lines

Related to the Charles Dow research market prices have a tendency to go in trends. Trend of market price development can be upward, downward or horizontal. According to such trend appears we can distinguish the trend lines into next three categories: short-term, middle-term and long-term. Trends can be generally sorted according to their time frame. Short-term trend lasts up to three months. Middle-term trend lasts up to 6 months and trend that lasts more than 6 months is called long-term trend. Downward slopping trend line is generated by linking series of maximal values. On the other hand, linking series of minimal values generate upward slopping trend line.

When the trend penetrates through the trend line, new trend should be established. For signal to sell is considered the moment when market trend breaks the trend line of the bull market. As a buy opportunity can be understood a signal when the trend of the bear market is broken.
Trend significance relies on a length of time frame for which trend occurs, as well as on number of connected values by the line in current time frame. (BRADA, 2000), (NESNÍDAL, PODHAJSKÝ, 2005)

#### 12.3.3.2 Support and Resistance

Support and resistance represent essential crossings in places of the supply and demand forces meet. In the financial markets supply increase forces price downwards while increasing demand pushes the price upwards. The bearish trend can have the same meaning as supply whereas demand could be used as a alternative for bullish trend.
With increasing demand price shifts up and with increasing supply the price goes down. In a situation where supply and demand are in balance, prices shift sideways.

*Support is the price level at which demand is thought to be strong enough to prevent the price from declining further.*

*Resistance is the price level at which selling is thought to be strong enough to prevent the price from rising further. If a support or resistance level is broken, it signals that the relationship between supply and demand has been changed. A resistance breakout signals that demand (bulls) has gained the upper hand and a support break signals that supply (bears) has won the battle.* (STOCKCHARTS, Support and Resistance, 2014)

**Figure 1: Resistance Level**


(Source: STOCKCHARTS, Support and Resistance, 2014)

### 12.3.3.3 Double Top or Double Bottom

There is hardly any more frequently used pattern than the double bottom or double top. This pattern by itself seems to be worthy proving that the technical analysis really works and that it is not completely uncontrollable development of price values as many academics claim it to be.

*Price charts simply express trader sentiment and double tops and double bottoms represent a retesting of temporary extremes. If prices were truly random, why do they pause so frequently at just those points? To traders, the answer is that many participants* *are making their stand at those clearly demarcated levels.* (SCHLOSSBERG, INVESTOPEDIA, Trading Double Tops and Double Bottoms, 2013)

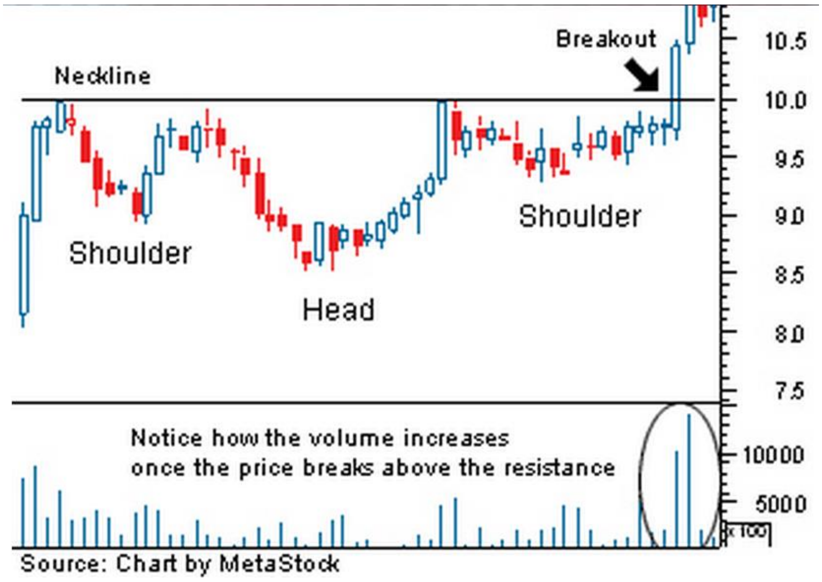
#### 12.3.3.4 Inverse Head and Shoulders (Head-and-Shoulders Bottom)

This pattern works exactly the opposite way the head and shoulders top pattern does. It shows when the situation is set to go up. That is why this pattern appears at the end of a decreasing trend. The inverse head and shoulders is known as a reversal pattern thus giving sign as the security heads higher after the pattern appears.

*Again, there are four steps to this pattern, starting with the formation of the left shoulder, which occurs when the price falls to a new low and rallies to a high. The formation of the head, which is the second step, occurs when the price moves to a low that is below the previous low, followed by a return to the previous high. This move back to the previous high creates the neckline for this chart pattern. The third step is the formation of the right shoulder, which sees a sell-off, but to a low that is higher than the previous one, followed by a return to the neckline. The pattern is complete when the price breaks above the neckline.*

(LANGAGER, MURPHY, INVESTOPEDIA, Analysing Chart Patterns: Head and Shoulders, 2014)

**Figure 2: Head and Shoulders Bottom**




(Source: LANGAGER, MURPHY, INVESTOPEDIA, Analysing Chart Patterns: Head and Shoulders, 2014)

**The Breaking of the Neckline and the Potential Return Move**

As it is visible on the chart above, the head and shoulders pattern appears as the neckline breaks following change in the trend so that the price develops in other direction afterwards. The divergence point from the original path is when the majority of traders would enter.

*However, the security will not always just continue in the direction suggested by the pattern after the breakout. For this reason it's important to be aware of what is known as a "throwback" move. This situation occurs when the price breaks through the neckline, setting a new high or low (depending on the pattern), followed by a retreat back to the neckline.* (LANGAGER, MURPHY, INVESTOPEDIA, Analysing Chart Patterns: Head and Shoulders, 2014)

#### 12.3.3.5 Symmetrical Triangle

*The symmetrical triangle, which can also be referred to as a coil, usually forms during a trend as a continuation pattern.* (STOCKCHARTS, Symmetrical Triangle (Continuation), 2014)

This patter is created due to at least two lower highs and two higher lows. After connecting the points by narrow line leading through lower highs and then connecting the points between higher lows by another narrow line, the direction of the lines converge in particular shape what is so called symmetrical triangle as the time continue to shift towards right. Generated particular shape may look like it is a contracting wedge, which is also much wider at the beginning and after that considerably narrowing as the time line is extended.

Symmetrical triangles can point out the continuation of current trend or even the trend reversal but they usually point on the first mentioned trend progress which is continuing in current trend.

*Regardless of the nature of the pattern, continuation or reversal, the direction of the next major move can only be determined after a valid breakout.* (STOCKCHARTS, Symmetrical Triangle (Continuation), 2014)

Example below will illustrate how symmetrical triangle can look like.

**Figure 3: Symmetric Triangle**


(Source: STOCKCHARTS, Symmetrical Triangle (Continuation), 2014)

1. **Trend**: To be able to estimate such pattern as continuation pattern, there must exist already on going trend in length of at least few months where the symmetrical triangle describes consolidation period next continuing after breakout.

2. **Four (4) Points**: Amount of two points in minimum is necessary to form a trend line. In order to be able for symmetrical triangle to form at least two trend lines are necessary. That means minimal number of four points is required to be able to evaluate the pattern as the symmetrical triangle. The first high should have higher value than the second high so that the upper line has a downward slope. On the other hand, the first lower than the second low so that the lower line is in upward sloping direction. Ideal situation under which this pattern forms is 3 points for upper line and 3 points for lower line which is in total six points for ideal forming of such pattern, before breakout.

3. **Volume***: As the symmetrical triangle extends and the trading range contracts, volume should start to diminish. This refers to the quiet before the storm, or the tightening consolidation before the breakout.*

4. **Duration***: The symmetrical triangle can extend for a few weeks or many months. If the pattern is less than 3 weeks, it is usually considered a pennant. Typically, the time duration is about 3 months.* (STOCKCHARTS, Symmetrical Triangle (Continuation), 2014)

#### 12.3.3.6 Rising Wedge (Reversal)

*The Rising Wedge is a bearish pattern that begins wide at the bottom and contracts as prices move higher and the trading range narrows. In contrast to symmetrical triangles, which have no definitive slope and no bullish or bearish bias, rising wedges definitely slope up and have a bearish bias.* (STOCKCHARTS, Rising Wedge (Reversal), 2014)

This pattern belongs certainly among the most difficult ones to be effectively recognized and use. Since being a formation of consolidation the lowering of upper momentum after every following high provides this pattern its bearish appearance. But the waves of higher highs and lower lows makes this pattern bullish. The breaking point of support appears as the forces of supply win and the price decrease becomes probable. There is not a single method of measuring the amount of drop.

Figure 4 illustrates example of Rising Wedge.

**Figure 4: Rising Wedge (Reversal)**


(Source: STOCKCHART, Rising Wedge (Reversal), 2014)

### 12.3.4 Technical Indicators

***Technical Indicators*** *are the often squiggly lines found above, below and on-top-of the price information on a technical chart. Indicators that use the same scale as prices are typically plotted on top of the price bars and are therefore referred to as "****Overlays.****"* (STOCKCHARTS, Technical Indicators and Overlays, 2014)

#### 12.3.4.1 Moving Average

Moving averages smooth the price data to form a trend following indicator. They do not predict price direction, but rather define the current direction with a lag. Moving averages lag because they are based on past prices. Despite this lag, moving averages help smooth price action and filter out the noise. They also form the building blocks for many other technical indicators and overlays, such as Bollinger Bands, MACD and the McClellan Oscillator. The two most popular types of moving averages are the Simple Moving Average (SMA) and the Exponential Moving Average (EMA). These moving averages can be used to identify the direction of the trend or define potential support and resistance levels.

A simple moving average is formed by computing the average price of a security over a specific number of periods**.** Most moving averages are based on closing prices. A 5-day simple moving average is the five day sum of closing prices divided by five. As its name implies, a moving average is an average that moves. Old data is dropped as new data comes available. This causes the average to move along the time scale. Below is an example of a 5-day moving average evolving over three days. (STOCKSCHARTS, Moving Averages - Simple and Exponential, 2014)

**Exponential Moving Average Calculation**

Exponential moving averages reduce the lag by applying more weight to recent prices. The weighting applied to the most recent price depends on the number of periods in the moving average. There are three steps to calculating an exponential moving average. First, calculate the simple moving average. An exponential moving average (EMA) has to start somewhere so a simple moving average is used as the previous period's EMA in the first calculation. Second, calculate the weighting multiplier. Third, calculate the exponential moving average. The formula below is for a 10-day EMA.

**Moving Average Convergence-Divergence (MACD)**

*Developed by Gerald Appeal in the late seventies, the Moving Average Convergence-Divergence (MACD) indicator is one of the simplest and most effective momentum indicators available. The MACD turns two trend-following indicators, moving averages, into a momentum oscillator by subtracting the longer moving average from the shorter moving average. As a result, the MACD offers the best of both worlds: trend following and momentum. The MACD fluctuates above and below the zero line as the moving averages converge, cross and diverge. Traders can look for signal line crossovers, centreline crossovers and divergences to generate signals. Because the MACD is unbounded, it is not* *particularly useful for identifying overbought and oversold levels.* (STOCKCHARTS, Moving Average Convergence-Divergence, 2014)

*Below there is a figure with a large bearish divergence from August to October. The stock forged a higher high above 28, but the MACD Line fell short of its prior high and formed a lower high. The subsequent signal line crossover and support break in the MACD were bearish. On the price chart, notice how broken support turned into resistance on the throwback bounce in November (red dotted line). This throwback provided a second chance to sell or sell short.* (STOCKCHARTS, Moving Average Convergence-Divergence, 2014)

**Figure 5: Moving Average Convergence-Divergence**


**(Source:** STOCKCHARTS, Moving Average Convergence-Divergence, 2014)

### 12.3.4.2 Relative Strength Index (RSI)

*Developed J. Welles Wilder, the Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements. RSI oscillates between zero and 100. Traditionally, and according to Wilder, RSI is considered overbought when above 70 and oversold when below 30.* (STOCKCHARTS.COM, Relative strength index (RSI), 2014)

Signs to buy or sell are also provided by divergences, failure swings and centreline crossovers. Relative Strength Index may be useful in identification of general trend as well. Relative Strength Index belongs among the most popular momentum indicators. It is described in many publications over the past decade.

#### *12.3.4.3 William %R*

*Developed by Larry Williams, Williams %R is a momentum indicator that is the inverse of the Fast Stochastic Oscillator. Also referred to as %R, Williams %R reflects the level of the close relative to the highest high for the look-back period. In contrast, the Stochastic Oscillator reflects the level of the close relative to the lowest low. %R corrects for the inversion by multiplying the raw value by -100. As a result, the Fast Stochastic Oscillator and Williams %R produce the exact same lines, only the scaling is different. Williams %R oscillates from 0 to -100. Readings from 0 to -20 are considered overbought. Readings from -80 to -100 are considered oversold. Unsurprisingly, signals derived from the Stochastic Oscillator are also applicable to Williams %R.* (STOCKSCHARTS.COM, William %R, 2014)

There are many indicators for technical analysis and new types of indicators are still being developed. Most popular indicators were already mentioned above.

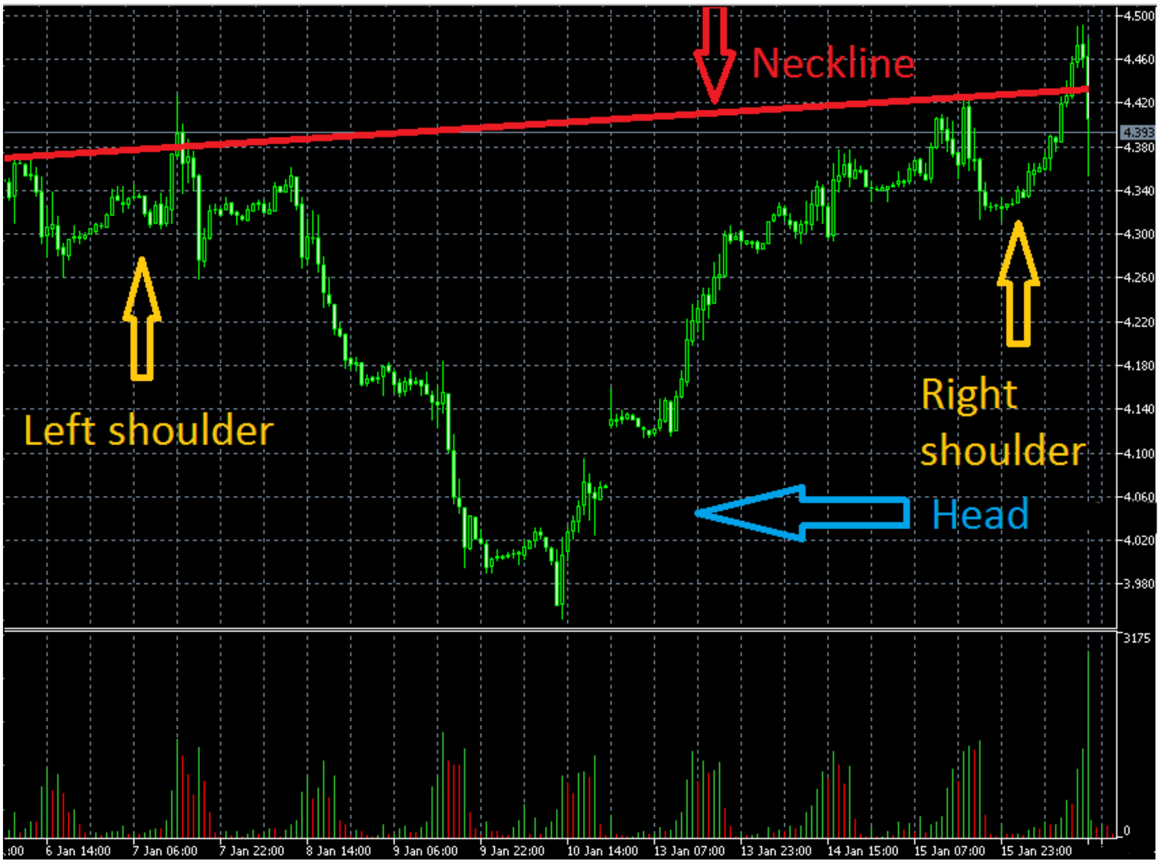
## 13. Practical Part

### 13.1 Technical Analysis Application

Patterns and indicators for technical analysis were introduced in chapter above. In this chapter practical application of technical analysis will be illustratively explained on natural gas market (NYMEX). Periodicity of chart is 1 day or 1 hour, which means every single candlestick relates to 1 day or 1 hour time frame. Price is always expressed in U.S. dollars per million Btu. Time frame in covered by charts is from January 2013 till 15th March 2014. Price of natural gas (NYMEX) is obtained based on Henry Hub natural gas price. Tool used to market analysis is MetaTrader ver.5.0.

#### 13.1.1 Head and Shoulders Bottom

**Chart 4: Head and Shoulders Bottom**



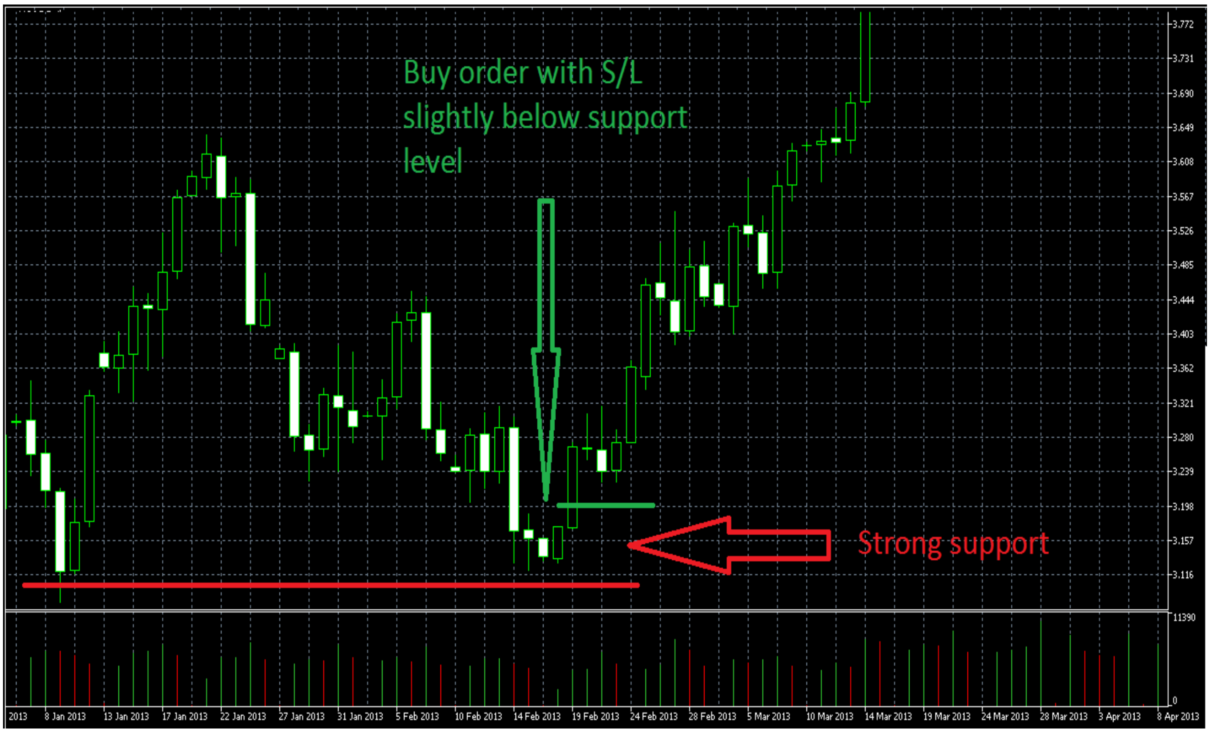

(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

Period on the chart above covers time between 6th January 2014 and end of 15th January 2014. Natural gas price vary between $3.963 per and $ 4.400 per Million Btu. It seems that uptrend is ruling the market in this time frame. Apparently good signals to sell comes from beginning of the chart on 6th January 2014 to 12:00 A.m. of 9th January 2014, there is a resistance barrier. On 8th January 2014 the formation of candlesticks in the chart signalize fall to the support barrier all followed possibly by attempt to break the resistance on $4.420 level. Resistance territory can be seen above the red line in range between $4.420 and $4.500. Everything since now was just mentioning good opportunities to go for sell. Opportunities to buy are indicated between 10th January 2014 and 14th January 2014 thanks to patterns generated by candlesticks from the first half-period of the chart. It is visible that prices low for each day is higher since 9th January which shows uptrend and move the price towards resistance level. Since January 14th January there is an opportunity of buy around $ 4.310 since the price shifts its lows higher as the time frame moves.

We can see that on 7th January there is an attempt to break through resistance level at $4.420 after that price is trying its support at 3.980. The support at this price level is very strong so there is very fast upward shift in price towards latest resistance level which hasn't been broken yet. Since 15th January you can see the development of price under certain market conditions which are in this case strong demand for natural gas. Therefor we assume that after 15th July there is a strong opportunity to buy because price may rise. Future development of price confirms this prediction but it was also due to strong fundamental reasons regarding this time frame.

### 13.1.2 Support and STOP-LOSS

**Chart 5: Support and STOP-LOSS**




(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

Chart covers a time frame from 6th January 2013 to 14th March 2013, when natural gas prices moves between $3.110 and $3.770. From 6th January to 9th January price is declining and is trying to break support at $3.100 for the first time but without success. Since 9th January 2013 the price had some light correction which resulted in price increase to $3.640 since that moment price level of natural gas had no further need to increase and decrease towards support level has begun. Second attempt on 15th February 2013 to break support level at $3.110 failed and the price jumped higher pretty quickly without any big pullbacks. Support level at $3.110 in period between January and February 2013 is a good example of strong support. Second attempt to break generated support level failed even harder than in previous one resulting low $. After considering that price hadn't break support level for the second time we assume that is great opportunity to place a buy order with STOP-LOSS slightly below proven support line. As a STOP-LOSS slightly below support level we considered $3.050. Applying STOP-LOSS should prevent trader from huge losses which may occur in case the support level is broken. If the price shifts below estimated support level the STOP-LOSS will be triggered. If the price broke through the support level it is really hard to tell where is the next support or the next low before the price will rise again. There was no other attempt to test this support level in that time frame and price of natural gas plumed significantly higher.

### 13.1.3 Rising Wedge and Falling Wedge

**Chart 6: Rising Wedge, Falling Wedge**


(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

This analysis lasts from 1st January 2013 to 10th July 2013 and natural gas prices moved between \$3.080 and \$4.450 per Million Btu. It takes several months for rising wedge or falling wedge to be able to form. Rising wedge in this case was created from 11th January to 25th of April, where the price was fluctuating between $3.120 and $4.400. As you can see reaction highs and reaction lows are converging which make an upward sloping cone in case of rising wedge. Next hint was given by volume of sales which was overall higher in period between 16th and 25th of April 2013. Therefore there is a signal given by rising wedge that trend is turning to be bearish which has proven to be true according to further development of price. After employment of such analysis, there is clear solution which is go for sell. There is no doubt on 5th May that trend turns downward. Falling wedge as a bullish pattern can be understood by given chart between 5th May and 9th of July. Price in this period for this kind of bullish pattern fluctuated between $3.530 and $4.300 per million Btu. Considering last discussed pattern recommendation should be to put buy position around $3.500 level, because we expect the trend will be now upward. Both of these patterns were shaping more than 1 month.

### 13.1.4 RSI and Williams%R

**Chart 7: Relative Strenght Index and Williams %R**


(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

Williams %R and Relative Strength Index (RSI) belong to group of oscillators, which helps to determine, whether is market overbought or oversold. On the picture there are 4 different graphs, on the top price of natural gas is shown in candlestick chart, the most slim graph which is under the price graph is volume of sales, light blue line graph is for

Williams %R and finally on the bottom is located RSI line chart. Williams %R range uses values from

0 to (-100), range 0 to -20 provide signal that the market is overbought which means you should sell. When the market line generated by Williams %R is located in range -80 to -100, it means that market is oversold and suggest you to buy. Father of this technique made over $1,000,000 from $10,000 of initial investment by use of this technique. On the other hand, Relative Strength Index uses a scale from 0 to 100. As a signal to sell are considered values in range from 70 to 100. Signal to buy are in range from 0 to 30.

On the beginning of the chart, values from RSI and Williams %R were in the over bough are which alarm us that signal to sell may come in near future. After the oscillator of RSI or Williams R crosses to the neutral area it is than considered as a signal to sell. However the oscillator crosses from over bough area to lower area between 10th of December 2013 and 17th of December 2014 of RSI and Williams R the price of natural gas remain almost the same about $4.300. Then the oscillators returned immediately back to over bough area signalizing there were no big changes in price.

Williams %R and RSI indicators left overbought area again on 23th of December 2014 which finally gave a good signal to sell which also mean to go for short. The price drift until the indicators indicated oversold area on 6th of January was $0.500, which is considered as a huge jump in price as it generates more than 10% of price. According to the market price of natural gas and signals from RSI and Williams %R oscillators between 16th of January and 7th of February we assume there are no relevant signals which can persuade us to go for short or long position.

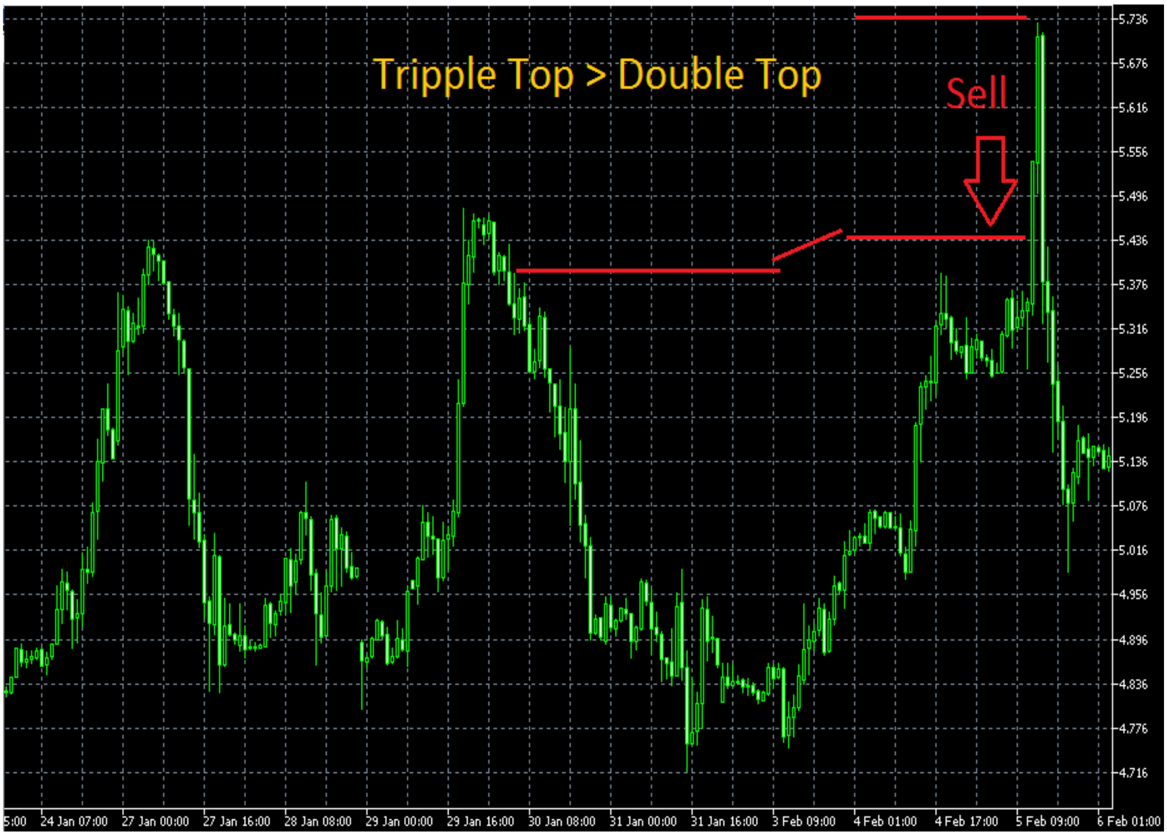
With regard to the data there is a noticeable difference in oscillator indications mainly on 10th of February, where Williams %R oscillator provides signal to buy by leaving oversold area while RSI oscillator indicator stayed somewhere in the middle of neutral area with slow motion towards overbought are. The real jump in price from 10th of February 2014 to 23th of February 2014 was from $4.570 to $6.495 that means almost $2 move. Williams %R oscillator proved here how simply and accurately can predict the price trend and if someone was listening to this one particular indicator in that certain time he would make a fortune.

Right after beginning of 23th of February RSI and Williams %R oscillators left again overbought are to provide signal that price are now declining. In this particular case both indicators gave us sufficient level of correct signal but Williams %R oscillator worked better because it provide more clear and accurate signal to go for short.

Comparing Williams %R and RSI, the RSI is less aggressive than Williams %R  and is less often located in boundary zones. RSI never reached its minimum or maximum as Williams %R indicator did it. By reaching boundary zones later can be lowered number of false signals but in case of chart above Williams %R indicator has proven better with being more aggressive.

### 13.1.5 Double Top and Triple Top

**Chart: Triple Top and Double Top**




(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

This scenario takes place between 24th January 2014 and 6th February 2014, natural gas price moves in the range between $4.800 and $5.736 per million Btu. Three peaks were created around 27th January, 29th January and 5th February. Related to the theories, every other peak should be lower than the previous one, because the peak is a sign that traders don't want to buy for the top or higher price of the first peak. First two tops are almost on the same price level and they formed in two days. Regarding the chart where for every hour there is a one candlestick informing about opening and closing price. Third top in price was formed whole one week after second top which can be considered as long period. Third top reached price $5.730 and after that price was falling very fast towards $5.150 area. However two tops already provides good information where resistance barrier stands, third top actually makes trader much more confident than he can be with "just" two tops. Usually trader can assume that after third top there won't be next attempt to break resistance which means price will go first back to area where support barrier is located. All above mentioned is a signal to go for short, in other words it is time to sell. Time interval between 2nd and 3rd top is time for placement of short positions, especially when price after 2nd top is declining is the right opportunity to go for sell, because trader knows when the resistance is and is just awaiting some correction in price (price fall). Actually chart above is missing amount of sale volumes so it is really hard to tell if the trend started to be downward, which should be supported by higher volume of trade as the price declines. I won't recommend going for long in this case as we can see the price for which natural gas is traded is overall pretty high compared to average. Therefore we expect some price correction with downward direction. As it has been already told, chart for this particular time frame gave us huge opportunities to go for short. As further development of price of natural gas shown there wasn't any more attempt to penetrate resistance level in next few days. Two tops are good pattern for technical analysis but having 3 tops pattern is even much better.

### 13.1.6 Moving Average and MACD

**Chart 9: Moving Average and Moving Average Convergence-Divergence**


(Source: own processing of data from itrade capital market Ltd, Meta trader – demo)

Chart above is related to time frame between 17th January 2014 and 28th February 2014, price of natural gas fluctuated in the range of approximately $4.200 and $6.500 per million Btu. There are basically applied 3 moving averages. Two moving averages which are distinguished by colour are applied in the chart where price is described by candlesticks.

The violet line is for moving average with value of 15 periods. Blue line is for moving average with the value set on 50 periods. Length of one period is set to one hour. Usually two or more moving averages are applied in such cases to obtain some relevant information about market trend. Red circles indicate intersects with violet and blue moving averages lines, in total there are 7 intersects. The more moving averages you include the longer you have to wait for the reasonable signal to get, because you have to wait until all included line of moving averages intersect and just after that you can read signal in which direction the market trend is developing.

First intersect brings actually very clear and good signal that the trend is upward sloping as you can confirm by the price development. Second and third intersect marked with red circle provide signal that market trend is sloping downwards but we do not think it is a good time to go for short. As a good time to go for short we consider the fourth intersect circled by red, because the resistance level was already tested for third time and there is very little chance that market is going to test this resistance level again in near future. As you can see the price decline after reaching the third top was much bigger than in cases after first or second top price decline.

Finally we got to the circled intersection no. 5 which by use of moving averages shows clear signal that the trend started to upward sloping. Lines of moving averages crossed and moved along with no overlays. After the intersection mentioned we assume to go for long until the lines will cross again, which should lead in change trend direction again. Really interesting is the sixth intersection marked with red circle, which indicates that the trend turned downward. It is really fascinating how fast and reliably these moving averages worked in this particular case, price of natural gas moved from $6.150 to $4.450 all the time along with signal that trend is decreasing. On the chart above it is obvious how accurately these moving averages worked in praxis when also reading the market price development.

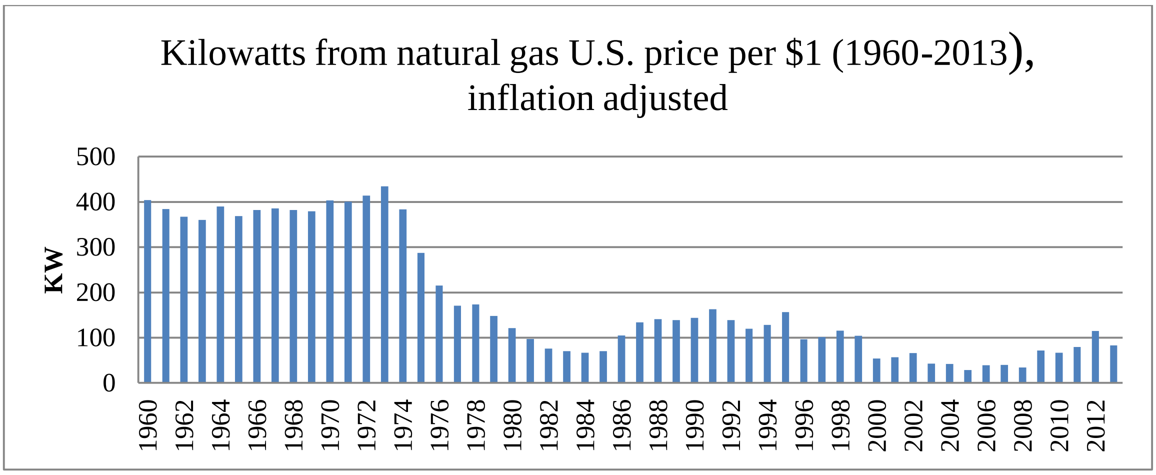
Last moving average that was employed in the chart above was moving average convergence-divergence (MACD). It is the 12 day exponential moving average minus the 26 day exponential moving average. Number of periods was set to 9. Length of each period in chart was again 1hour. Therefore MACD values are 26,12,9. Red line in MACD chart indicates the signal which moving average convergence-divergence provide. Author missed third intercept of moving averages but despite this mistake intercepts were described correctly.

To conclude chapter above, it is important to say, that there is lot of methods, which can accurately predict market behaviour. In general, anybody can create its own method, which can fit him better for particular cases. Indicators can bring good signals but also false signals and the amount of false signals can be reduced by using more techniques simultaneously, which also results in the fact that to get signal with use of more indicators is much more time demanding (to get signal). Usually less aggressive method may bring more false signals. On the other hand, less aggressive indicators can lead to getting the signal late which can be also crucial when considering a trade.

### 13.2 Cost Efficiency of Natural Gas

Author of this thesis created bar chart to illustrate natural gas cost efficiency. It is calculated with regard to the U.S. natural gas price in years 1960-2013, adjusted by inflation rate.

**Chart 10:**




(Source: available data at World Bank Commodity Price Data (The Pink Sheet), 2014, own processing)

Using formula with ratio 293Kw of energy per mmBtu. It is obvious from the chart that prices of natural gas with regard to the cost efficiency expressed in kilowatts per 1 USD, has its peak in year 1973 where the 1 USD for the U.S. natural gas price generated almost 450 kilowatts of electricity. After 1973 price cost efficiency of natural gas is sharply declining. Remember that this chart is related to U.S. natural gas market, because situation on the natural gas markets in the rest of the world was even worse. After decline since 1973 the bottom for next 15 years of KW/$ ratio was met in 1984. As already mentioned next bottom came in year 2000. In period from 2000 – 2008 world economy was in recession which according to the graph ended in 2009. Since 2009 KW/$ ratio started to increase till 2012. In year 2013 there is a decline of this efficiency ratio again by about one fourth compared to the previous year 2012.

## 13.3 Econometric Model

### 13.3.1 Declaring Variables

This chapter is focused on monitoring of the development of natural gas price in the U.S., where the price is indicated in USD per million British thermal units. This research examines the natural gas price in relation to natural gas reserves in the U.S. (in trillion cubic meters), natural gas consumption in North America (in trillion cubic meters), natural gas production in North America in trillion cubic meters, DOW Jones industrial average index and finally the price of crude oil (in USD/bbl) as an alternative fuel to natural gas. The econometric model is simple containing one endogenous variable and 5 exogenous variables over a period of 33 years (1980-2012). The latest observation is related for the year 2012 because of the data availability. Unfortunately, data provided by “statistical review of world energy” released by BP for year 2013 contains mainly natural gas data till 2012.

### 13.3.2 Assumptions and Expected Variable Behaviour

- Decrease of natural gas reserves listed in trillion cubic meters in North America will cause increase in natural gas price (USD/Million British Thermal units).
- Decrease in natural gas consumption in North America listed in trillion cubic meters causes decrease in price of natural gas in the U.S.
- Increase in natural gas production (trillion cubic meters) in North America will cause decrease in natural gas price.
- Increase in DOW Jones industrial average index causes increase in natural gas price in North America
- Decrease in Crude oil price listed in USD/bbl (barrels) causes decrease in natural gas price in North America.

**Table with variables and used units:**

| **Variable** | **Description** | **Unit** |
|---|---|---|
| Endogenous (β) | | |
| $Y_{1t}$ | the price of natural gas in U.S. at the end of the year in time t | USD/mmBtu |
| Exogenous (γ) | | |
| $X_{1t}$ | Unit vector | USD/mmBtu |
| $X_{2t}$ | natural gas reserves North America | trillion cubic meters |
| $X_{3t}$ | natural gas consumption of North America | trillion cubic meters |
| $X_{4t}$ | natural gas production of North America | trillion cubic meters |
| $X_{5t}$ | DOW Jones Industrial Index | Unit-less |
| X6t | price of crude oil | USD/bbl |

Source: author's creation

Formulation of economic model is following:

Price of natural gas in U.S. $Y1t = f(X1t, X2t, X3t, X4t, X5t, X6t)$

Econometric model formulation:

$$\beta_{1t} Y_{1t} = \gamma_1 X_{1t} + \gamma_2 X_{2t} + \gamma_3 X_{3t} + \gamma_4 X_{4t} + \gamma_5 X_{5t} + \gamma_6 X_6 t + U_{1t}$$

### 13.3.3 Data Set

Total number of observation is 33. Data for observations were gathered annually as an average of monthly data for 1980-2012.

**Table 1,** Data set

| Year | Y1t NG price in U.S. (USD/mmBtu) | X2t NG reserves in N.A. (TCM) | X3t NG consumption in N.A. (BCM) | X4t NG production in N.A. (BCM) | X5t DOW Jones industrial avg. | X6t Price of crude oil (USD/bbl) |
|---|---|---|---|---|---|---|
| 1980 | 2.42 | 10 | 638.11 | 592.11 | 891.12 | 36.87 |
| 1981 | 3.01 | 10.4 | 625.06 | 586.35 | 932.91 | 35.48 |
| 1982 | 3.86 | 10.4 | 590.60 | 556.52 | 884.53 | 32.65 |
| … | … | … | ... | … | … | … |
| 2010 | 4.39 | 11 | 849.61 | 745.24 | 10,668.59 | 79.04 |
| 2011 | 3.67 | 11.2 | 867.98 | 785.99 | 11,957.57 | 104.01 |
| 2012 | 2.56 | 10.8 | 906.51 | 812.68 | 12,965.29 | 105.01 |

(Source: data available at: World Bank Commodity Price Data (The Pink sheet) (for all natural gas and crude oil data), data for Dow Jones industrial average (RESEARCH.STLOUISFED.ORG, Federal Reserve Data), 2014, own processing )

**Table 2, Correlation matrix: (**Correlation coefficients, using the observations 1980 - 2012

5% critical value (two-tailed) = 0.3440 for n = 33)

| y1t | x2t | x3t | x4t | x5t | |
|---|---|---|---|---|---|
| 1.0000 | -0.3478 | 0.4182 | 0.3937 | 0.5866 | y1t |
| | 1.0000 | -0.3591 | -0.3152 | -0.4387 | x2t |
| | | 1.0000 | 0.9897 | 0.9272 | x3t |
| | | | 1.0000 | 0.9202 | x4t |
| | | | | 1.0000 | x5t |

| x6t | |
|---|---|
| 0.4678 | y1t |
| 0.3358 | x2t |
| 0.6459 | x3t |
| 0.6743 | x4t |
| 0.6315 | x5t |
| 1.0000 | x6t |

(Source: data available at: World Bank Commodity Price Data (The Pink sheet) (for all natural gas and crude oil data), data for Dow Jones industrial average (RESEARCH.STLOUISFED.ORG, Federal Reserve Data), 2014, own processing using GRETL program)

Red circles mark unwanted correlation between X4t, X3t and X5t. The table shows high correlation between data for natural gas consumption in North America and natural gas production in North America. Next high correlation is between Natural gas consumption and DOW Jones average industrial index. Finally the third and last unwanted high correlation exists between natural gas produced in North America and DOW Jones average industrial index.

To be able to eliminate high correlations between exogenous variables X4t and X3t, X3t and X5t or between X4t and X5t method of first differences is employed. As an output of it is a new data table pictured below (Table 3).

Table 3, Data set adjusted by difference of X4 (NG production) and X5 (Dow Jones average industrial index)

| Year | Y1t NG price in U.S. (USD/mmBtu) | X2t NG reserves in N.A. (TCM) | X3t NG consumption in N.A. (BCM) | Diff. X4t NG production in N.A. (BCM) | Diff. X5t DOW Jones industrial avg. index | X6t Price of crude oil (USD/bbl) |
|---|---|---|---|---|---|---|
| 1981 | 3.01 | 10.40 | 625.06 | 41.79 | -1.38 | 35.48 |
| 1982 | 3.86 | 10.40 | 590.60 | -48.38 | -2.84 | 32.65 |
| 1983 | 4.17 | 10.50 | 555.79 | 306.25 | -2.99 | 29.66 |
| … | … | … | ... | … | … | … |
| 2010 | 4.39 | 11.00 | 849.61 | 1,782.93 | 17.28 | 79.04 |
| 2011 | 3.67 | 11.20 | 867.98 | 1,288.98 | 24.97 | 104.01 |
| 2012 | 2.56 | 10.80 | 906.51 | 1,007.72 | 1.00 | 105.01 |

(Source: data available at: World Bank Commodity Price Data (The Pink sheet) (for all natural gas and crude oil data), data for Dow Jones industrial average (RESEARCH.STLOUISFED.ORG, Federal Reserve Data), 2014, own processing )

Table 4, Correlation matrix – adjusted (Correlation coefficients, using the observations 1981 – 2012 5% critical value (two-tailed) = 0.3494 for n = 32)

| y1t | x2t | x3t | x4t-1 | x5t-1 | |
|---|---|---|---|---|---|
| 1.0000 | -0.3366 | 0.4073 | -0.1688 | 0.4454 | y1t |
| | 1.0000 | -0.3475 | -0.0429 | -0.0704 | x2t |
| | | 1.0000 | 0.1356 | 0.3649 | x3t |
| | | | 1.0000 | 0.3467 | x4t-1 |
| | | | | 1.0000 | x5t-1 |
| | | | | x6t | |
| | | | | 0.4719 | y1t |
| | | | | 0.3386 | x2t |
| | | | | 0.6523 | x3t |
| | | | | -0.0189 | x4t-1 |
| | | | | 0.4574 | x5t-1 |
| | | | | 1.0000 | x6t |

(Source: data available at: World Bank Commodity Price Data (The Pink sheet) (for all natural gas and crude oil data), data for Dow Jones industrial average (RESEARCH.STLOUISFED.ORG, Federal Reserve Data), 2014, own processing using GRETL program)

According to the table no. 4 above, red circles mark problematic points where the multicollinearity occurred. As you can see unwanted multicollinearity between exogenous variables were eliminated by use of adjusted data table set. The new correlation matrix in the table 4 is now appropriate for other calculations. The econometric model will be now estimated by use of Ordinary Least Square method (OLS) in GRETL program.

Table 5, Estimation of parameters using Ordinary Least Square method (OLS):

Using observations 1981-2012 (T = 32), Dependent variable: y1t (price of NG)

| | *Coefficient* | *Std. Error* | *t-ratio* | *p-value* | |
|---|---|---|---|---|---|
| const | 33.1219 | 5.93918 | 5.5769 | <0.00001 | *** |
| x2t | -2.01933 | 0.348892 | -5.7878 | <0.00001 | *** |
| x3t | -0.0207718 | 0.005264 | -3.9460 | 0.00054 | *** |
| Diff. x4 | -0.000199442 | 0.000271249 | -0.7353 | 0.46876 | |
| Diff x5t | 0.0159679 | 0.0274535 | 0.5816 | 0.56582 | |
| x6t | 0.11524 | 0.0214457 | 5.3736 | 0.00001 | *** |

| | | | |
|---|---|---|---|
| Mean dependent var | 4.053750 | S.D. dependent var | 2.170286 |
| Sum squared resid | 38.50709 | S.E. of regression | 1.216981 |
| R-squared | 0.736279 | Adjusted R-squared | 0.685563 |
| F(5, 26) | 14.51779 | P-value(F) | 7.92e-07 |
| Log-likelihood | -48.36774 | Akaike criterion | 108.7355 |
| Schwarz criterion | 117.5299 | Hannan-Quinn | 111.6506 |
| rho | 0.230798 | Durbin-Watson | 1.490183 |

(Source: data available at: World Bank Commodity Price Data (The Pink sheet) (for all natural gas and crude oil data), data for Dow Jones industrial average (RESEARCH.STLOUISFED.ORG, Federal Reserve Data), 2014, own processing using GRETL program)

Econometric model is formulated as:

$\beta_{1t} Y_{1t} = \gamma_1 X_{1t} + \gamma_2 X_{2t} + \gamma_3 X_{3t} + \gamma_4 X_{4t} + \gamma_5 X_5 + \gamma_6 X_6 t + U_{1t}$

---

$\boldsymbol{\beta_{1t} Y_{1t} = 33.1219 * X_{1t} - 2.01933 * X_{2t} - 0.0207718 * X_{3t} - 0.000199442 * X_{4t} + 0.0159679 * X_{5\,t} + 0.11524 * X_6 t} + U_{1t}$

---

### 13.3.4 Economic Verification

After analysing the results for our econometric model, we can state that:

1) If the natural gas reserves in North America, natural gas consumption in North America, natural gas production in North America, Dow Jones average industrial index and crude oil price are equal to zero, than the price of natural gas in the U.S. will be 33.1219 USD/mmBtu (USD per Million British thermal units).

2) If the natural gas reserves in North America increase by 1 unit (1 trillion cubic meters), it will cause decrease in natural gas price in the U.S. by $2.01933 per mmBtu.

3) If the consumption of natural gas in North America increases by 1 billion cubic meters, than the price of natural gas will decrease by $0.0207718 per mmBtu.

4) Increase in natural gas production in North America by 1 billion cubic meters causes decrease in U.S. natural gas price by $0.000199442 per mmBtu.

5) Increase in the value of Dow Jones average industrial index by 1 unit will cause increase in U.S. price of natural gas by $0.0159679 per mmBtu.

6) Increase in the price of crude oil by 1 unit ($1/bbl) will cause increase in the price of U.S. natural gas by $0.11524 per mmBtu

### 13.3.5 Statistical Verification

Adjusted R-squared, **$R^2$** = 0.736279

Adjusted R-squared with value 0.736279 provide us information that the changes in natural gas price in the U.S. are from 73.6% explained by changes in natural gas reserves in North America, natural gas consumption in North America, natural gas production in North America, Dow Jones industrial index and also by changes in price of crude oil. It can be stated that this econometric model has strong goodness of fit.

## 14. Conclusion

Natural gas is a vital source of energy for current world economy while its importance was often marginalized. After decades of increasing consumption in the world, natural gas as an efficient energy source begun to be in the centre of attention not only for U.S. but also for other countries all over the world.

The world's economy is shifting to use more natural gas instead of other sources of energy, because it offers cleanest energy for its cost ration when compared to other fossil fuels.

After the technical analysis was applied the information output is that patterns for technical market analysis indicate in which direction the price is developing, whether there will be moves in price downwards, upwards or even sideways. It makes trader or speculator more confident in predicting next price development in order to make profit.

Concluding application of technical analysis on current natural gas market. We can consider following: indicators are much less misleading than the patterns. Even if the individual patterns appear it can’t make trader confident enough to be sure that price movement will be in particular direction. On the other hand, indicators that were applied in the thesis were astonishingly accurate regarding the current price of natural gas development. Indicators uses historical data related to market price to substitute the data into formulas to predict the future development of price. To get some reliable output from using indicators at least two of them should be employed but in general more is better.

Author of this thesis does not recommend the use of technical analysis as stand-alone guide but to merge both types of analysis, technical and fundamental together in order to minimize the possibility of making a loss.

Price determinants affecting price of natural gas in the U.S. where chosen as following: natural gas reserves located in North America, NG consumption in North America, NG production in North America, Dow Jones industrial index and finally price of crude oil were chosen as the core determinants of natural gas price in the U.S.. In order to evaluate

the influence of each chosen determinant on natural gas price in the U.S. in the long-run, econometric model was created.
Natural gas is mostly used as a fuel for electricity generation and this is also the industry with highest influence on natural gas price.

With regard to data availability for the model, data series uses data just from years 1980-2012. Econometric model as a result was in detail explained in the practical part, price of natural gas in the U.S. is from 73.6% explained by the model. : It can be stated that this econometric model has strong goodness of fit. However, the econometric model could be probably even more accurate using some different price determinants such as price of coal.

After analysing the results for our econometric model, we can state that

1) If the natural gas reserves in North America, natural gas consumption in North America, natural gas production in North America, Dow Jones average industrial index and crude oil price are equal to zero, than the price of natural gas in the U.S. will be 33.1219 USD per Million British thermal units (mmBtu)

2) If the natural gas reserves in North America increase by 1 unit (1 trillion cubic meters), it will cause decrease in natural gas price in the U.S. by $2.01933 per mmBtu.

3) If the consumption of natural gas in North America increases by 1 billion cubic meters, than the price of natural gas will decrease by $0.0207718 per mmBtu.

4) Increase in natural gas production in North America by 1 billion cubic meters causes decrease in U.S. natural gas price by $0.000199442 per mmBtu.

5) Increase in the value of Dow Jones average industrial index by 1 unit will cause increase in U.S. price of natural gas by $0.0159679 per mmBtu.

6) Increase in the price of crude oil by 1 unit ($1/bbl) will cause increase in the price of U.S. natural gas by $0.11524 per mmBtu

Introduction of shale gas to the market by U.S. affected the price of natural gas positively towards the end users. According to the charts of natural gas price development included in the thesis, the prices of natural gas were pushed downwards.

In my opinion earlier shift to higher natural gas demand across all industries could have prevented expensive issues concerned with pollution regulation such as emissions and the astronomically high regulation costs for emission limits.

By the use of natural gas a significant reduction of carbon dioxide emissions in the air can be expected. Therefore after studying a variety of information material concerning fossil fuels, a question of disadvantaging of substitute fossil fuels in favour of natural gas is in place but this has not been discussed in the world economy yet.

Most important price determinants of natural gas in world economy are substitute fossil fuels for electricity generation such as crude oil, coal, nuclear energy, wind, etc., however natural gas is utilized for other purposes of use as well (heating, fertilizers). In the thesis it is described how electricity generation by use of natural gas can be cost efficient. Expanding of natural gas in the global economy will reveal new geopolitical questions.

There are plentiful reserves of natural gas globally which can be extracted and used to impel the economic growth because of its low costs.

There are significantly different markets and prices for natural gas in the world while many of them are still considered immature.

After year 2005 as new methods of extraction of unconventional natural gas resources such as shale gas came to use, the U.S. became to be the world largest exporter of natural gas.

Before that price of natural gas in the U.S. was significantly higher and therefore U.S. had to import natural gas before 2005 because of its lower price compared to domestic market. After this year the situation has changed. The new methods of extraction contributed positively not only to U.S. economy growth but also to global economy growth.

# 15. Bibliography

## 15.1 Books Sources and Academic Articles:


BRADA, J., Technická analýza, VŠE, c2000, 1st edition, ISBN 80-245-0096-5.

CASTAGNINO J. P., Derivates: The key principles, Oxford University Press,3rd edition, 2009, ISBN 978-0-19-955636-6

FABOZZI, F, and col. The Handbook of Commodity investing, 1st edition. New Jersey: John Wiley & Sons, Inc., 2008, ISBN 978-0-470-11764-4

GUJARATI D. D., Basic of Econometrics, 4th edition, MGH, 2004, ISBN 0070597936

KAMICH B., Chart patterns, Bloomberg Press, 1st edition, 2009, ISBN 978-1-57660-300-0

KING, Energy intensity ratios as net energy measures of United States energy production and expenditures, [online], 2010, [cited on 19.3.2014], Environ. Res. Lett. **5** 044006 doi:10.1088/1748-9326/5/4/044006, Available at WWW: < http://iopscience.iop.org/1748-9326/5/4/044006/

KIRKPATRICK D., DAHLQUIST J., Technical Analysis: The Complete Resource for Financial Market Technicians, FT Press, 1st edition, ISBN: 978-0131531130

KLEINMAN G., Trading Commodities and Financial Futures: Step-by-Step Guide to Mastering the Markets (4th edition), 2013, Publisher Pearson Eduacation, Inc., ISBN-10: 0133367487

NESNÍDAL T, PODHAJSKÝ P., Obchodování na komoditních trzích, GradaPublishing, 1st edition, 2005, ISBN: 80-247-1499-X

## 15.2 Internet Sources:


ABOUT.COM ECONOMICS, MOFFATT, Price Elasticity of demand, [online], 2014, [cited on 19.3.2014], Available at WWW: <http://economics.about.com/cs/micfrohelp/a/priceelasticity.htm

AMERICAN PETROLEUM INSTITUTE, Natural Gas Supply and Demand, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.api.org/oil-and-natural-gas-overview/exploration-and-production/natural-gas/supply-and-demand

AMERICAN PUBLIC GAS ASSOCCIATION, A Brief History of Natural Gas, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.apga.org/i4a/pages/index.cfm?pageid=3329

AMERICAN PUBLIC GAS ASSOCCIATION, Clean and Efficient, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://anga.us/issues-and-policy/power-generation/clean-and-efficient#.UzcnOPl5Nlo

BARCHART, Natural Gas ETPs – Exposure to Natural Gas Prices Is Not An Easy Fix, [online], 2010, [cited on 19.3.2014], Available at WWW: < http://www.barchart.com/articles/etf/naturalgas

BP, Statistical Review of World Energy 2013, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy-2013.html

DIFFEN, Bond vs Stock, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.diffen.com/difference/Bond_vs_Stock

EIA, Factors Affecting Natural Gas Prices, [online], 2013, [cited on 19.3.2014], Available at WWW: < http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_factors_affecting_prices

HOW TO TRADE STOCKS, Stock market terminology, [online]. 2011, [cited on 19.3.2014], Available at WWW: <http://www.howtotradestocks.org/learn-about-stocks/stock-marketterminology.html>.

INVESTOPEDIA, Correction, [online]. 2014, [cited on 19.3.2014], Available at WWW: <http://www.investopedia.com/terms/c/correction.asp>.

INVESTOPEDIA, LANGAGER, MURPHY, Analysing Chart Patterns: Head and Shoulders, [online], 2014, [cited on 19.3.2014], Available at WWW: <http://www.investopedia.com/university/charts/charts2.asp

INVESTOPEDIA, Stop-Loss Order, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.investopedia.com/terms/s/stop-lossorder.asp

INVESTOR GLOSSARY, Commodity Exchange, [online]. 2014, [cited on 19.3.2014], Available at WWW: < http://www.investorglossary.com/commodityexchange.htm>.

INVESTWORDS.COM, FX, [online]. 2014, [cited on 19.3.2014], Available at WWW: < http://www.investorwords.com/5894/FX.html>.

POITRAS, Futures Markets and Forwards Markets, [online], 2006, [cited on 19.3.2014], Available at WWW: < http://www.sfu.ca/~poitras/futures.pdf

RESEARCH.STLOUISFED.ORG, Federal Reserve Data, [online], 2014, [cited on 9.3.2014], Available at WWW: <http://research.stlouisfed.org/fred2/series/DJIA/downloaddata

SCHLOSSBERG, INVESTOPEDIA, Trading Double Tops and Double Bottoms, [online], 2013, [cited on 19.3.2014], Available at WWW: <http://www.investopedia.com/articles/forex/05/032805.asp

STLAWRENCEGAS, Properties of Natural Gas, [online], 2014, [cited on 19.3.2014], Available at WWW: <https://www.stlawrencegas.com/about_natural_gas/properties_of_natural_gas/

STOCKCHARTS.COM, Moving Average Convergence-Divergence, [online], 2014, [cited on 19.3.2014], Available at WWW: <http://stockcharts.com/help/doku.php?id=chart_school:technical_indicators:moving_average_conve

STOCKSCHARTS, Moving Averages - Simple and Exponential, 2014, [online]. 2014,[cited on 19.3.2014], Available at WWW: http://stockcharts.com/school/doku.php?st=moving+average&id=chart_school:technical_indicators:moving_averages

STOCKCHARTS.COM, Relative strength index (RSI), [online]. 2014,[cited on 19.3.2014], Available at WWW: <http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:relative_strength_index_rsi>.

STOCKCHARTS.COM, Rising Wedge (Reversal), [online], 2014, [cited on 19.3.2014], Available at WWW: <http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:chart_patterns:rising_wedge_reversa

STOCKCHARTS.COM, Symmetrical Triangle (Continuation), [online], 2014, [cited on 19.3.2014], Available at WWW: <http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:chart_patterns:symmetrical_triangle

STOCKCHARTS.COM, Technical Indicators and Overlays, [online], 2014, [cited on 19.3.2014], Available at WWW: <http://stockcharts.com/help/doku.php?id=chart_school:technical_indicators

STOCKSCHARTS.COM, William %R, [online], 2014, [cited on 19.3.2014], Available at WWW: <http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:williams_r

STRAIGHTFOREX.COM, Forex Glossary, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.straightforex.com/forex-glossary/

THE MARKET ORACLE, ANGELO, Peak Silver and Mining by Falling EROI, 2009, [cited on 19.3.2014], Available at WWW: < http://www.marketoracle.co.uk/Article14756.html, (TIGERTRADINGCLUB, Introduction to Options Trading, [online], 2002, [cited on 19.3.2014], Available at WWW: <http://www.tigertradingclub.com/downloads/Introduction_to_Options_Trading.pdf

TRADERS LOG, CFD – Contract For Difference, [online]. 2010, [cited on 19.3.2014], Available at WWW: <http://www.traderslog.com/cfd-contract-fordifference/>.

UNICREDITBANK, Commodity swaps and commodity options with cash settlement, [online], 2014, [cited on 19.3.2014], Available at WWW: < http://www.unicreditbank.cz/files/download/en/PL_Commodity_derivatives_EN.pdf

World Bank Commodity Price Data (The Pink Sheet), [online], 2014, [cited on 19.3.2014], Available at WWW: <http://siteresources.worldbank.org/INTPROSPECTS/Resources/334934-1304428586133/pink_data_a.xlsx

ZACKS, Is This a Better ETF For Natural Gas Investors, [online], 2013, [cited on 19.3.2014], Available at WWW: < http://www.zacks.com/stock/news/111690/Is-This-a-Better-ETF-For-Natural-Gas-Investors

# 16. Supplements

## Initial Data Set used in chapter 13.3.1

| y1t | x2t | x3t | x4t | x5t | x6t | year |
|---|---|---|---|---|---|---|
| 2.42 | 10 | 638.11 | 592.11 | 891.12 | 36.87 | 1980 |
| 3.01 | 10.4 | 625.06 | 586.35 | 932.91 | 35.48 | 1981 |
| 3.86 | 10.4 | 590.60 | 556.52 | 884.53 | 32.65 | 1982 |
| 4.17 | 10.5 | 555.79 | 509.15 | 1,190.78 | 29.66 | 1983 |
| 4.37 | 10.6 | 593.36 | 550.53 | 1,178.55 | 28.56 | 1984 |
| 4.17 | 10.4 | 577.70 | 529.58 | 1,327.99 | 27.18 | 1985 |
| 2.8 | 10.3 | 542.26 | 510.96 | 1,793.10 | 14.35 | 1986 |
| 2.19 | 10.1 | 571.37 | 532.32 | 2,277.53 | 18.15 | 1987 |
| 2.08 | 9.5 | 600.64 | 556.26 | 2,061.48 | 14.72 | 1988 |
| 2.11 | 9.5 | 635.92 | 567.14 | 2,510.34 | 17.84 | 1989 |
| 2.04 | 9.5 | 637.42 | 583.96 | 2,679.45 | 22.88 | 1990 |
| 1.8 | 9.5 | 650.53 | 586.99 | 2,929.04 | 19.37 | 1991 |
| 2.11 | 9.3 | 673.41 | 600.36 | 3,284.08 | 19.02 | 1992 |
| 2.45 | 8.8 | 694.25 | 618.75 | 3,524.92 | 16.84 | 1993 |
| 2.29 | 8.5 | 711.68 | 649.97 | 3,794.58 | 15.89 | 1994 |
| 1.88 | 8.5 | 742.73 | 651.66 | 4,499.39 | 17.18 | 1995 |
| 3.03 | 8.5 | 759.99 | 666.01 | 5,743.89 | 20.42 | 1996 |
| 2.89 | 8.3 | 766.65 | 671.55 | 7,443.15 | 19.17 | 1997 |
| 2.54 | 7.2 | 752.55 | 684.02 | 8,631.94 | 13.06 | 1998 |
| 2.81 | 7.3 | 760.48 | 680.33 | 10,482.61 | 18.07 | 1999 |
| 5.41 | 7.5 | 794.35 | 694.04 | 10,723.75 | 28.23 | 2000 |
| 5.17 | 7.7 | 760.52 | 710.74 | 10,205.77 | 24.35 | 2001 |
| 4.43 | 7.4 | 788.70 | 694.69 | 9,214.85 | 24.93 | 2002 |
| 6.9 | 7.4 | 779.88 | 698.46 | 9,006.64 | 28.90 | 2003 |
| 6.93 | 7.5 | 783.78 | 685.07 | 10,315.51 | 37.73 | 2004 |
| 10.16 | 7.8 | 782.20 | 683.07 | 10,546.66 | 53.39 | 2005 |
| 7.47 | 8 | 778.01 | 700.50 | 11,409.78 | 64.29 | 2006 |
| 7.32 | 8.7 | 813.92 | 711.34 | 13,178.02 | 71.12 | 2007 |
| 8.61 | 9 | 821.46 | 728.64 | 11,244.05 | 96.99 | 2008 |
| 4.1 | 9.8 | 816.12 | 733.73 | 8,885.66 | 61.76 | 2009 |
| 4.39 | 11 | 849.61 | 745.24 | 10,668.59 | 79.04 | 2010 |
| 3.67 | 11.2 | 867.98 | 785.99 | 11,957.57 | 104.01 | 2011 |
| 2.56 | 10.8 | 906.51 | 812.68 | 12,965.29 | 105.01 | 2012 |

**Difference table (chapter 13.3.1) for x5, x4:**

| y1t | x2t | x3t | x4t-1 | x5t-1 | x6t | year |
|---|---|---|---|---|---|---|
| 3.01 | 10.40 | 625.06 | 41.79 | -1.38 | 35.48 | 1981 |
| 3.86 | 10.40 | 590.60 | -48.38 | -2.84 | 32.65 | 1982 |
| 4.17 | 10.50 | 555.79 | 306.25 | -2.99 | 29.66 | 1983 |
| 4.37 | 10.60 | 593.36 | -12.23 | -1.10 | 28.56 | 1984 |
| 4.17 | 10.40 | 577.70 | 149.44 | -1.37 | 27.18 | 1985 |
| 2.80 | 10.30 | 542.26 | 465.11 | -12.83 | 14.35 | 1986 |
| 2.19 | 10.10 | 571.37 | 484.43 | 3.80 | 18.15 | 1987 |
| 2.08 | 9.50 | 600.64 | -216.05 | -3.43 | 14.72 | 1988 |
| 2.11 | 9.50 | 635.92 | 448.86 | 3.12 | 17.84 | 1989 |
| 2.04 | 9.50 | 637.42 | 169.11 | 5.04 | 22.88 | 1990 |
| 1.80 | 9.50 | 650.53 | 249.59 | -3.51 | 19.37 | 1991 |
| 2.11 | 9.30 | 673.41 | 355.04 | -0.35 | 19.02 | 1992 |
| 2.45 | 8.80 | 694.25 | 240.84 | -2.18 | 16.84 | 1993 |
| 2.29 | 8.50 | 711.68 | 269.66 | -0.96 | 15.89 | 1994 |
| 1.88 | 8.50 | 742.73 | 704.81 | 1.30 | 17.18 | 1995 |
| 3.03 | 8.50 | 759.99 | 1,244.50 | 3.24 | 20.42 | 1996 |
| 2.89 | 8.30 | 766.65 | 1,699.26 | -1.25 | 19.17 | 1997 |
| 2.54 | 7.20 | 752.55 | 1,188.79 | -6.11 | 13.06 | 1998 |
| 2.81 | 7.30 | 760.48 | 1,850.67 | 5.01 | 18.07 | 1999 |
| 5.41 | 7.50 | 794.35 | 241.14 | 10.16 | 28.23 | 2000 |
| 5.17 | 7.70 | 760.52 | -517.98 | -3.88 | 24.35 | 2001 |
| 4.43 | 7.40 | 788.70 | -990.92 | 0.58 | 24.93 | 2002 |
| 6.90 | 7.40 | 779.88 | -208.21 | 3.97 | 28.90 | 2003 |
| 6.93 | 7.50 | 783.78 | 1,308.87 | 8.83 | 37.73 | 2004 |
| 10.16 | 7.80 | 782.20 | 231.15 | 15.66 | 53.39 | 2005 |
| 7.47 | 8.00 | 778.01 | 863.12 | 10.90 | 64.29 | 2006 |
| 7.32 | 8.70 | 813.92 | 1,768.24 | 6.83 | 71.12 | 2007 |
| 8.61 | 9.00 | 821.46 | -1,933.97 | 25.87 | 96.99 | 2008 |
| 4.10 | 9.80 | 816.12 | -2,358.39 | -35.23 | 61.76 | 2009 |
| 4.39 | 11.00 | 849.61 | 1,782.93 | 17.28 | 79.04 | 2010 |
| 3.67 | 11.20 | 867.98 | 1,288.98 | 24.97 | 104.01 | 2011 |
| 2.56 | 10.80 | 906.51 | 1,007.72 | 1.00 | 105.01 | 2012 |