Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Diploma Thesis

Foreign trade of Russia – Case study of natural gas

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

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Economics and Management
Economics and Management

Thesis title

Russian foreign trade – Case study of natural gas export

Objectives of thesis

The fundamental objective of thesis is to estimate the significance of natural gas export in the Russian economy, main changes and the dynamics of output over the last decade. The purpose of theoretical part is to discover of Russian foreign trade directions, identify main partners, highlight barriers for the economy of Russia, evaluate memberships in international organizations and trade agreements. Analytical part devoted to practical application of selected methods in studying the dependence of natural gas exports on various indicators influencing natural resources transportation. Last but not least, aim of this thesis is to suggest ways of enhancing the efficiency of foreign trade policies in export of Russian natural gas.

Methodology

Diploma thesis is divided into two parts: theoretical and practical. In the first part, which is practical, I use literature review as a method of collecting information from scientific books, publications, articles, selected databases and websites. Practical part contains application of econometric tools in one-equation model with quantitative analysis of statistical data gathered from government databases such as Russian Federal State Statistics Service.

The proposed extent of the thesis

40 – 60 pages

Keywords

foreign trade, Russian economy, trade barriers, export, natural gas

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Recommended information sources

DEVOLD H. Oil and gas production handbook: An introduction to oil and gas production, transport, refining and petrochemical industry, 3rd edition, ABB, Oslo, ISBN 978-82-997886-3-2

HILYARD J.F. The oil & gas industry: A nontechnical guide, 2012, ISBN 978-1-59370-254-0

JENÍČEK, V. – KREPL, V. – ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE. INSTITUT TROPŮ A SUBTROPŮ. *Foreign trade and development economics.* Prague: Czech University of Life Sciences, 2007. ISBN 978-80-213-1651-5.

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Declaration

I declare that I have worked on my diploma thesis titled " Foreign trade of Russia – Case study of natural gas" 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 their person.

In Prague on 30th November 2020 ________________________

Acknowledgement

I would like to thank my supervisor, prof Ing. Mansoor Maitah, Ph.D. et. Ph.D. for the continues support, motivation and patience. I would also like to express the deepest appreciation to my family who always supported me not only morally but economicallly as well, I thank you for your guidence, without your wise counsel I would not reach this success. Finally, I could not completed this dissertation without my friends who provided stimulating discussions as well as happy distractions to rest myself outside of my research.

Foreign trade of Russia – Case study of natural gas

Summary

The diploma thesis is devoted to study foreign trade of the Russian Federation, focusing on natural gas exports. This work is divided into two part: theoretical and practical. Theoretical part is aimed to discover the essence of natural gas, global gas market, overview of gas industry in Russia and membership of energy organizations. Practical part deals with trade balance, main trade partners, role of natural gas exports in the Russian economy and statistical analysis of relationship among exports of Russian natural gas and selected economic indicators is performed with construction of one-equation econometric model, i.e. the purpose of this part of thesis is to find out factors that affect a volume of chosen commodity transported to other countries and their degree of influence. It is also supported by model estimation, economic and statistical verification, model application. The time interval for analysis is taken for a 20-year period from 2000 to 2019. The data for econometric model is taken from the Federal State Statistics Service of Russia, the Central Bank of Russia and International Energy Agency.

Keywords: Russia, natural gas, exports, foreign trade, trade balance, commodity, natural resources

Zahraniční obchod Ruska - případová studie zemního plynu

Souhrn

Tato diplomová práce je věnována studiu zahraničního obchodu Ruské federace se zaměřením na export zemního plynu. Tato práce je rozdělena na dvě části: teoretickou a praktickou. Teoretická část je zaměřena na objevení podstaty zemního plynu, globálního trhu s plynem, přehledu plynárenského průmyslu v Rusku a členství v energetických organizacích. Praktická část se zabývá obchodní bilancí, hlavními obchodními partnery, rolí exportu zemního plynu v ruské ekonomice a statistickou analýzou vztahu mezi exportem ruského zemního plynu a vybranými ekonomickými ukazateli je provedena konstrukce rovnicového ekonometrického modelu, tj. Účelu tato část práce je zjistit faktory, které ovlivňují objem vybrané komodity přepravované do jiných zemí a jejich míru vlivu. Podporuje to také odhad modelu, ekonomické a statistické ověření, aplikace modelu. Časový interval pro analýzu je stanoven na 20leté období od roku 2000 do roku 2019. Údaje pro ekonometrický model jsou převzaty z Federální státní statistické služby Ruska, Ruské centrální banky a Mezinárodní energetické agentury.

Klíčová slova: Rusko, zemní plyn, vývoz, zahraniční obchod, obchodní bilance, komodita, přírodní zdroje

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List of abbreviations

APG	Associated Petroleum Gas
Bcm	Billion cubic meters
CBR	The Central Bank of Russia
CIS	The Commonwealth of Independent States
DW	Durbin-Watson statistic
ECT	The Energy Charter Treaty
EU	The European Union
FASR	The Federal Antimonopoly Service of Russia
FDI	Foreign Direct Investments
FSSSR (Rosstat)	The Federal State Statistics Service of Russia
FCSR	The Federal Customs Service of Russia
USSR	The Union of Soviet Socialist Republics
FDI	Foreign Direct Investments
GECF	The Gas Exporting Countries Forum
IMF	The International Monetary Fund
LNG	Liquified Natural Gas
NGL	Natural Gas Liquid
OPEC	The Organization of the Petroleum Exporting Countries
Tcm	Trillion cubic meters
UK	The United Kingdom
US	The United States
USD	US dollar
USSR	The Union of Soviet Socialist Republics
WTO	The World Trade Organization
WWII	World War II

1. Introduction

After the end of WWII, the importance of international trade has undoubtedly increased in the economic activity of the world. The long post-war phase was characterized by rapid expansion of merchandise exports soaring by more than 8 percent annually from 1950 to 1973. However, after this period trade growth slowed down due crude oil price shocks and boost of inflation caused by monetary expansion and inadequate macroeconomic adjustment policies. (WTO, 2008)

Foreign trade relations are extremely important for the country's economy. As a supplier of goods and services to the international market, the country demonstrates its capabilities, shows itself as a reliable partner for long-term and trusting relationships. Famous American economist Jeffrey Sachs once pointed out that "The economic success of any country in the world is based on foreign trade. Not a single country has yet succeeded in creating a healthy economy, isolated from the global economic system." (Sachs, 1994)

One of the most traded commodities in the world is natural gas, used for domestic and industrial needs. Being the closest relative to crude oil, it is represented by a gas mixture, mainly consisting of methane – the lightest of carbohydrates. As well as crude oil, natural gas forms underground from remains of microscopic marine organisms and is often produced together with oil. Until quite recently, gas almost has not been used. Moreover, in the beginning of 20th century, when drilling crude oil, gas was burned out since it was considered as a waste of oil production. However, industrialization process pushed humanity to redefine their views on gas from useless natural resource to environmentally friendly fuel, providing a quarter of the world's energy production nowadays. (SPE, 2013)

Gas industry is highly developed in many countries, especially in the Russian Federation, which engaged in the production, transportation, storage and processing of selected commodity. Moreover, Russia is the one of the largest exporters of natural gas in the world and revenues from selling it abroad represent a major source of Russian state budget.

Therefore, in this diploma thesis I attempt to find out the importance Russian gas exports in the foreign trade of this country and reveal the amount of contributions from selling a selected natural resource, which are amounted for the economy of this country.

2. Objectives

The main goal of this work is to study foreign trade of the Russian federation focusing on exports of natural gas. The purpose of theoretical part is to discover a global gas market with world production and consumption of selected resource, highlight barriers for the economy of Russia, evaluate memberships in international organizations and taxation of mineral industry in the Russian Federation. Aim of practical part to find out Russian trade balance, foreign trade directions, identify main partners and find out factors that have a possible influence on volumes of natural gas exports in the Russian Federation. Another subgoals of this thesis include:

- to estimate a significance of natural gas export in the Russian economy
- to find out primary directions of gas export
- to determine main importers of Russia's natural gas
- to study main changes in the gas output over the last decade
- to discover principles of taxation for gas production in Russia

3. Methodology

Theoretical part is consisted of literature review from various sources such as books, scientific journals and articles, reports from petroleum companies and gas organizations, using quantitative, qualitative and comparative methods. In the practical part, to achieve main goals and deeply understand the importance of natural gas exports in the Russian federation, a statistical analysis of relationship between Russian natural gas export and selected indicators is provided. It is represented by an econometric model to study the dependence of natural gas exports on various indicators and their individual significance with the subsequent estimation and application of the model. Moreover, assumptions of the model about autocorrelation, heteroskedasticity and normal distribution of residuals are also checked whether they are correct or not. This work is also devoted to ensuring a forecast of natural gas export volumes for future years. The data for analysis is taken for a 20-year period (2000 -2019) from different available public sources such as International Energy Agency (IEA), the Central Bank of Russia and the Federal State Statistics Service of Russia. (FSSSR).

3.1. Econometric analysis

Econometrics as a science arose in the first half of 20th century as a result of active use of mathematical and statistical methods for solving certain problems of economic theory. The term "econometrics" was firstly introduced by Norwegian statistician Ragnar Frisch in 1930 and defined it as "scientific discipline based on synthesis of economic theory, statistics and mathematics". This approach is widely used in many branches of economics such as finance, macroeconomics, microeconomics etc. (Hansen, 2020)

Economic events are highly interrelated and interdependent to each other thus values of many economic indicators are changing over time due to these relationships. As an example, aggregate demand depends on price of goods, consumption – on level of income or volume of investments – on interest rate etc. Therefore, the aim of researcher is to provide a quantitative analysis of existing economic connections based on modern development theories, their quantitative assessment and study the possibility of using the identified links in economic analysis and forecasting. (Samuelson, Koopmans, Stone, 1954)

Any econometric study is based on construction of econometric model, corresponding to real economic phenomena. This process starts with qualitative study of the problem using methods of economic theory, extraction of factors influencing a selected indicator and making certain assumptions about the nature of alleged dependence. In the following stage, studied connection are expressed in the mathematical form. Moreover, it should be noted that due to inability of taking into account all possible factors affecting a selected indicator, assumed relationships between variables will not be accurately connected thus there is a certain error that exists in the econometric model. (Shanchenko, 2008)

The main tools of mathematical statistics used in construction of econometric models are correlation and regression analysis. The first approach aims to check the presence and significance of linear relationships between variables. The second approach directly deals with investigating functional relationships among variables. (Chatterjee, Hadi, 2006)

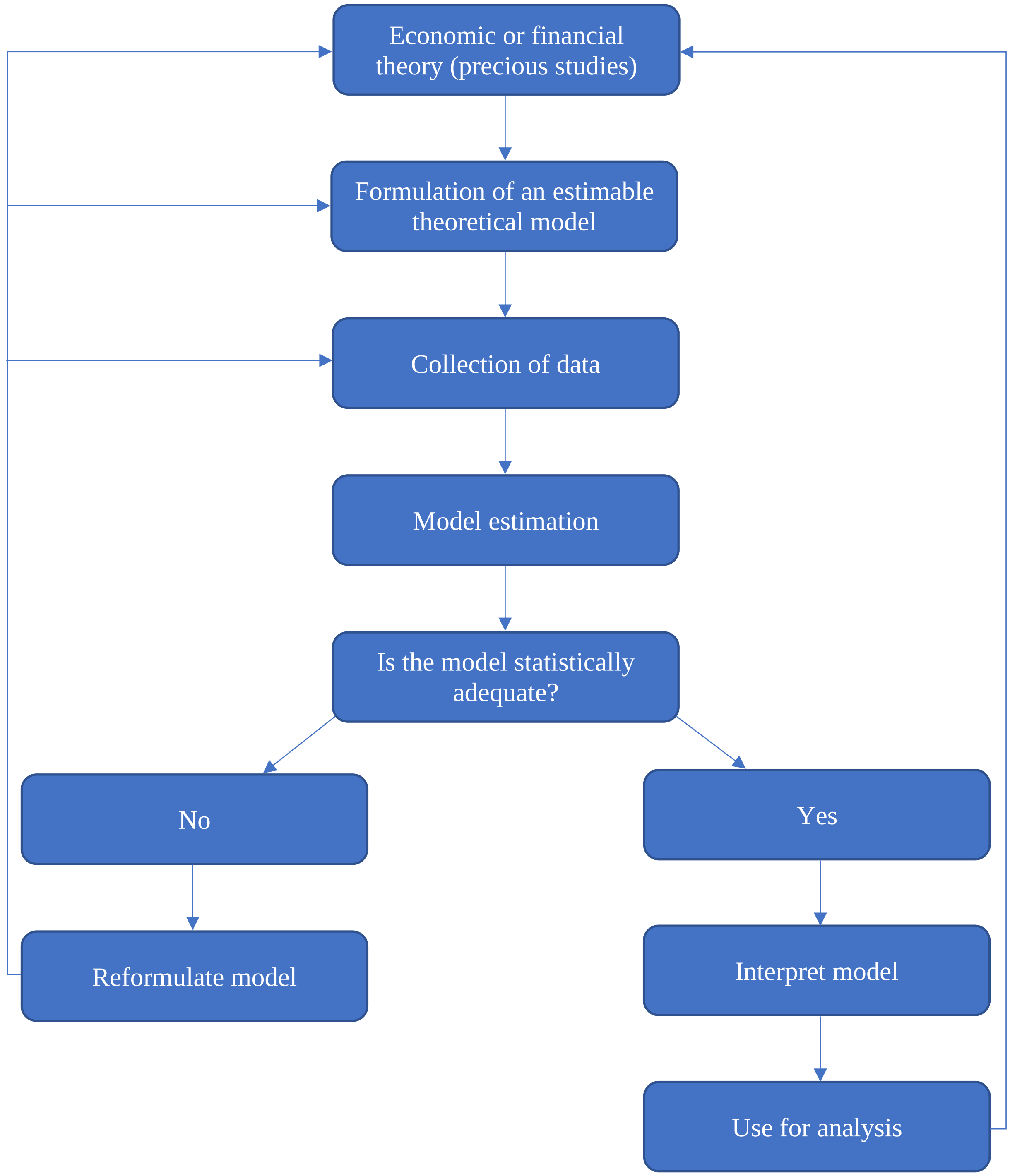
There are 3 types of data which econometricians use for analysis:

1. Time series data - set of observations collected over a given period of time at regular interval

2. Cross-sectional data – observations on multiple phenomena at single point in time
3. Panel data – combines both time series and cross-sectional dimensions, where selected units are observed across time (Bubáková, 2014)

According to Brooks (2014), a formulation of econometric model involves next steps:

Figure 1: Formulation of econometric model



4. Theoretical part

Theoretical part of diploma thesis is devoted to review of natural gas characteristics and its use, world production and export, role of Russian natural gas export on international trade. Data provided in this part is primarily taken from various secondary sources for research purposes such as International Energy Agency (IEA), World Trade Organization (WTO), Gas Exporting Countries Forum (GECF), Ministry of Energy of the Russian Federation.

4.1. History of natural gas

Many years ago, habitants in various regions of ancient Greece, Persia and India noticed that there was some highly flammable natural resource coming from underground. These flashes of gas flames have sometimes been a foundation for cultural myths and religious beliefs in these countries. Therefore, people had been aware of natural gas a long time ago, however only in the 20th century this type of commodity have been applied in many sectors of economy and became a vital natural resource for population. (SPE, 2013)

The modern history of the development of world gas processing can be divided into four stages:

1. *First stage* (1920-1940s) is highlighted as the era of natural gasoline since gas factories were usually built with aim to extract gasoline – motor fuel component and preparing for further transportation. These plants had specific equipment for gas topping, removal of mechanical impurity from it and drying.
2. *Second stage* (1950-1970s) is called the era of liquefied gases: besides producing gasoline, gas plants started to mine propane and butane. These types of chemical compounds were used as household fuel and raw material for petrochemical industry. Moreover, gas production manufactories have developed absorption processes, including low temperature separation and condensation.
3. *Third stage* (from the beginning of 1970s) is a period of ethane. Engineers have begun to derive an ethane fraction natural gas fields and apply the process of deep gas cooling down to -80 – 100 ℃.
4. *The fourth stage* (from the beginning of 1990s) is the era of liquefied natural gases and gas chemistry – production of hydrogen, synthetic liquid fuels, polyolefins etc.

(Tarakanov, Manovyan, 2010)

4.2. Natural gas components

Mineral deposits of natural gas are generally located in deep underground rock formations and contain a variety of different types of hydrocarbon. Most gas components are flammable, however noncombustible elements are also presented in the minority such as carbon dioxide (CO_2), nitrogen (N_2) and helium (He). These substances are usually considered to be contaminants, which are often removed during gas production. (Speight, 2017)

The major largest component of this natural resource is methane (CH_4) – organic compound of carbon and hydrogen atoms, accounting from 70% to 98% of total composition. It is widely used as a fuel for generating an electricity at gas-fired plant or at industrial manufactories and provides power to motor cars. The following component is ethane (C_2H_6), which is used as a raw material for petrochemical industry, producing plastic supplies for other synthetic products. Propane (C_3H_8) and butane (C_4H_{10}), which are also parts of natural gas, on a par with previous component serve as a feedstock for upstream petrochemical manufacturing. Moreover, a compressed mixture of these chemical substances at different proportions stored in the cylinder forms Liquified Petroleum Gas (LPG) and it is commonly utilized as cooking gas at households. (Speight, 2017)

Therefore, all components that can be found in the structure of natural gas are listed in the table below:

Table 1: Components of natural gas

Name of chemical compound	Formula	Volume in %
Methane	CH_4	>85
Ethane	C_2H_6	3-8
Propane	C_3H_8	1-5
Butane	C_4H_{10}	1-2
Pentane	C_5H_{12}	1-5
Carbon dioxide	CO_2	1-2
Hydrogen sulfide	H_2S	1-2
Hydrogen	N_2	1-5
Helium	He	<0.5

Source: Speight, 2017

A pure natural gas has neither color nor smell. When it leaks, it distributes upward and disappear into thin air immediately. Thus, it is quite complicated to monitor an unintended probability of gas leak, which can be insecure for environment and people's health. For easier detection of gas leakage, specific odorants, such as thiol and ethanethiol are added since it is ideally compatible with methane. These components have unusual strong unpleasant smell, reminiscent of "rotten eggs". (Cooper, 2016)

4.3. Sources of natural gas

Natural gas is produced in almost every country nowadays. It is extracted from small pores underground at depth of 1000 meters and more using boreholes. Generally, there are two types of gas production: *conventional and unconventional*. To understand which method gasmen should use, they must look at geological formations, where gas is located and provide a broad mapping through modern techniques such as passive and reflective seismic, magnetic and gravity analysis to identify a selected area of potential field as "prospective". Initially, gas and oil industries were focused on mining of conventional natural gas, which is usually found in the place with porous areas, making easier to extract it from the ground. (QER Report, 2015)

Depending on the type of bore hole, there are different production processes that can be used for gas extraction from underground reservoirs. Natural gas from a bore hole, which was drilled mainly for purpose of oil exploitation is called *associated gas* or *conventional natural gas*. Sometimes, after being extracted from underground, associated gas is pumped back down into well to ensure a pressure for subsequent crude oil production. On the opposite side, there is *a non-associated gas* or *unconventional natural gas* produced from a well that is drilled only on purpose of natural gas extraction without or little oil production. Usually, this type of gas contains less impurities thus it does not require as much further processing as associated gas. In case of impure natural gas, a certain number of handling steps is applied to improve gas quality and achieve an allowable level to consumers. (Hilyard, 2012)

Conventional natural gas is usually produced from well-researched geologic fields such as limestones and sandstones thousands of meters below the ground. This type of gas is concentrated in so called distinct geographic zones "basins", where Northeast and Southeast are the most productive areas of natural gas. (Devold, 2013)

By contrast, unconventional natural gas refers to a reasonless and not economically efficient production, unless some advanced technologies will be used in order to compensate expenses and stimulate a formation of gas-bearing areas. Reservoirs, at which gas is extracted, can be at different forms: deep or shallow, with high or low pressure and temperature, with one or more layers. Therefore, geologists distinguish six main types of unconventional natural gas:

1. **Deep gas** is usually located considerably deeper than conventional gas - around 4500 meters and deeper underground, making a production of such natural gas economically unprofitable.
2. **Tight gas** can be found in impenetrable hard rock, sandstone or non-porous limestone. As well as deep gas, it requires expensive tools for gas extraction.
3. **Shale gas** is commonly located in deposits of shale. It often can be met in so-called “sandwich” part, a thinner zone of shale. This type of unconventional gas is usually stored in fractures that were naturally created or it can be swallowed onto organic surface of shale. Until recently, the production of shale gas was economically unfavorable due to a lack of permeability of shales to pass a gas flow to a wellbore. However, a development of modern techniques such as directional and horizontal drilling or multistage hydraulic fracturing makes it possible to produce.
4. **Coal-bed methane** is extracted together with a coal. In the past, it was hazard for coal-mining industry to produce such type of unconventional natural gas since a high concentration of methane could lead to dangerous conditions for coal miners. However, with a development of safety technologies, this form of gas is becoming more and more popular to extract.
5. **Gas in geopressured areas** is extracted from natural geological formations, where pressure is higher than the average at similar depth. In such areas, layers of clay are compressed on the top of sand so water and natural gas, which is contained inside of clay, are embossed by it and located at more porous deposits.
6. **Methane hydrate** is commonly considered to be a potential type of unconventional natural gas for long-term production. It can be met in large amounts in the Artic and deep marine sediments, below the seabed. The world reserves of methane hydrate are difficult to estimate, however geologists assess it in the range from 7000 to 75000 trillion cubic feet.

(Hilyard, 2012)

It should be noted that possibility of transition from unconventional to conventional methods has been always existed due to the fact that technologies and geologic information are developing, becoming more and more advanced every year. Consequently, these changes might lead to the start of gas extraction at deep reservoirs and should be done on regulatory basis interacting with certain gas policies of a country. After natural gas is extracted, it goes upward to the wellhead and connects to reservoir for gas storage and processing. This stage contains elimination of various contaminants of pure gas and fluids from hydrocarbons in order to produce dry high-quality "sales gas". (Devold, 2013)

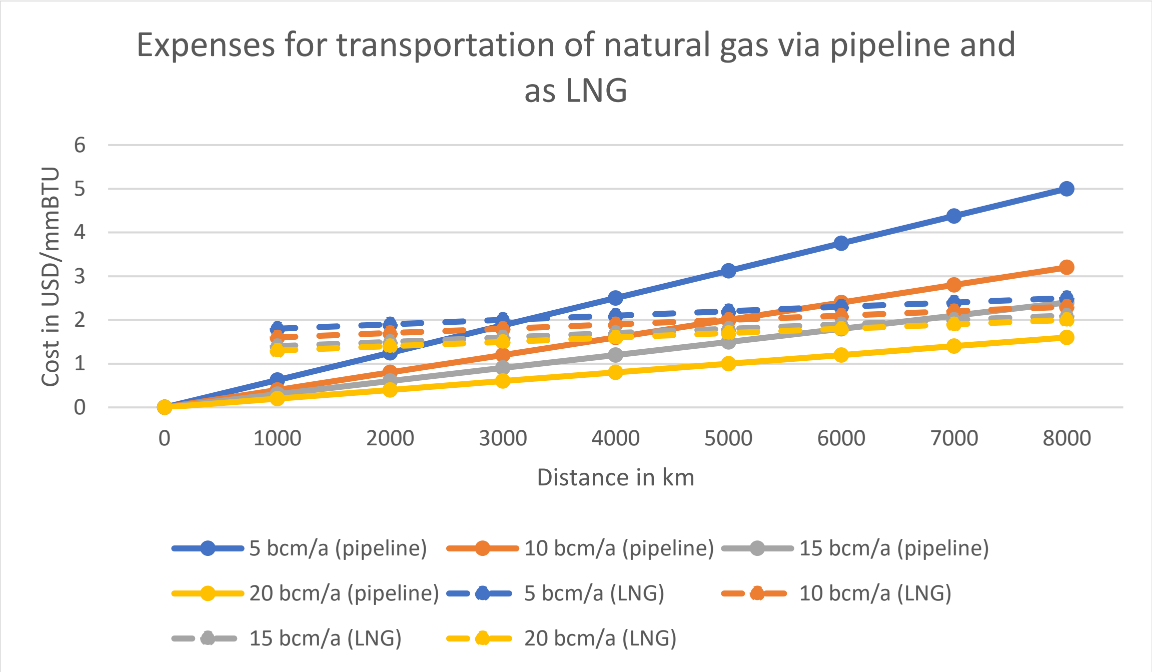
4.4. Gas transportation

Most of proven gas reserves are concentrated in the Russian Federation, USA and the Middle East, while other developed and developing countries are considered to be constant consumers in the world, making gas resources geographically remote from demand centers where it is vitally needed. Since some deposits are far from consumption points, it is necessary to transport a commodity over long distances thus many various networks for gas transportation were created. Nowadays, thanks to modern technologies, barriers of transporting large volumes of gas are gradually vanishing. (World Bank, 2000)

Natural gas delivering can be provided either through pipelines or stored in special tankers. Besides facilities from supply centers to demand destination, it is also required to develop major transportation infrastructure. Usually expenses for gas transportation are higher than expenses for other commodities. It is explained by lower energy content of natural gas per volume thus costs are directly dependent on pipeline characteristics such as diameter of pipe, input and output pressure, natural conditions of pipeline construction such as rivers, swamps, oceans etc. Therefore, a selected commodity has a competitive disadvantage in costs of transportation due to remoteness of consumption regions. (Messner, Babies, 2012)

The graph below shows a correlation between distance and cost of transportation via pipeline and as LNG:

Figure 2: Expenses for transportation of natural gas via pipeline and as LNG



Source: Schwimmbeck, 2008

According to the graph, expenses via pipelines of different capacities vary more than expenses when using LNG method with changing distance. The price of gas transportation by tankers is significantly lower than the price of delivery through pipeline, so LNG suppliers can benefit from savings on shipping costs. Compassion of delivery costs of selected methods shows that as transportation distance increases, expenses using LNG approach increases at much lower rate while onshore and offshore pipe-laying leads to significant rise of expenses for natural gas transportation, making the LNG market more attractive to global gas industry. Therefore, onshore pipeline transportation is approximately twice cheaper than offshore. Moreover, it is highly connected to waterways such as oceans and sees - the only condition of tanker's operation, thus, offshore fields and fields, which are close to the shore are more convenient for gas delivering. As a result, two largest market in Atlantic and Pacific regions serve for LNG transportation. However, despite above listed disadvantages, one of the strengths of this method is flexibility of transporting. Unlike immobile pipeline system, which consist of rigid bracings, tankers can ply between loading and unloading points. In 2019, pipelines contributed about 53% of natural gas trade, while the share of LNG tankers was accounted for 47% of total gas traded. Therefore, tanks to modern technologies, we might observe an increasing trend in using LNG. (Messner, Babies, 2012)

4.4.1. Pipelines

Pipelines are one the most used methods for gas transportation nowadays, which requires a large amount of financial investments thus, to pay back these investments, gas should flow at maximum capacity through pipelines. Gas companies use modern computer-based control systems to monitor gas delivery processes. Such transportation of natural gas is provided by high pressure compressors or pump, which push it through pipelines. Sometimes demand on natural gas can vary due to different factors so it is impossible to predict the amount of commodity needed every day. In this case, gas can be stored in reservoirs, aquifers or underground salt caverns. If there is a decrease in gas production, this storage is used as a source to cover volumes needed for consumers. (Hilyard, 2012)

In the pipeline method, expenses regarding transportation are directly dependent on available capacity of a pipeline through which natural gas is delivered. Moreover, gas leaks that can occur during pipeline transportation might decrease efficiency of gas usage. It is estimated that gas leaks lead to losses of approximately 1% of natural gas produced in western countries. (Messner, Babies, 2012)

Pipelines trade:

In 2019, pipeline trade decreased by 4,3% or 25 billion cubic meters. The highest drop in pipeline exports was in Africa and Europe. In North America, there is a quite contradictory situation: Canadian exports declined by 12,9% while USA to Mexico flow rocketed by 12%. In the CIS, Turkmenistan and Uzbekistan decreased their exports by 10% and 23% respectively; Russia was affected slightly with only 0,5% of fall as it is one of the largest exporters in the world. South America and Asia also faced a drop in pipeline exports. A completely different situation was seen in the Middle East, where export of natural gas via pipelines increased by 10,6% thanks to Iran. As for imports, Europe was influenced the most among other continents with a 6,5% fall in 2019. The UK, France and Spain imported 35%, 26% and 15% respectively less than in previous year. Moreover, imports if natural gas through pipelines declined in North America as well, accounting for 5,2% of dip. On the other side, import among CIS countries soured by 10% as Ukraine, being a transition point for Europe, imported more gas. Countries of Middle East and Africa also increased their imports by 7,8% and 2,2% respectively. An overall decline in trade of gas via pipelines can be explained by increasing competitiveness from LNG market. (Global Gas Report, 2020)

4.4.2. Liquified Natural Gas (LNG)

LNG transportation is noted for its requirements of sufficient amount of additional energy for gas delivering. The first LNG tankers that were used as a global commercial chain in gas transportation, arrived at the United Kingdom and France from Algeria in 1964. Since then, it is expected that this method of natural gas transportation will contain more than 50% of overall trade in natural gas by 2030. LNG approach is believed to be as less efficient due to demand in additional energy. Therefore, expenses for long distances are more preferable rather than for short since it is not as economically favorable as pipeline system. This might be considered as cost-effective only for more than 3000 km paths. (Messner, Babies, 2012)

LNG is represented by transformed liquid form of primarily methane so it can be easily stored and transported on tankers. The composition of LNG could also contain the following chemical compounds such as ethane propane and butane, however methane still is represented by more than 90%. Usually, the volume of LNG is significantly lower and accounted for 1/600th of the volume in conventional structure. (Devold, 2013)

There are three main stages in LNG transportation chain, which includes liquefaction process, LNG delivery using tankers to import terminals and transformation of LNG back into gas form so thereafter it can be transported through pipelines to destination points. The first stage requires to get rid of admixtures since LNG is purchased and sold on the basis of its heating value, while these elements might negatively affect on it. After natural gas is cleaned, it is placed to the storage at LNG plant and then loaded onto ship, which is docked alongside jetty. Once tanker is arrived at LNG terminal, gas from the ship is pumped back to onshore storage, where it is pressurized and sent to pipelines. (Hilyard, 2012)

LNG trade:

LNG market is becoming more and more popular each year, being a driving force for the growth of international gas trade. In 2019, world LNG imports increased by 13%, accounting for 482 billion cubic meters in total. Europe's imports increased by 76% and are accounted for 117 billion cubic meters, leading with the greatest growth rate among other continents. Australia and Qatar were the biggest importers with 102 and 107 billion cubic meters respectively. On the other side, North and South America together with Middle East decreased their demand in LNG imports compared to 2018. (Global Gas Report, 2020)

4.5. World natural gas reserves

Natural gas reserves are an amount of commodity in the bowels of the Earth, which was established by geologists during mineral exploration. Evaluation of natural gas reserves is quite complicated due to its location deep underground and the accuracy of estimation sometimes could differ with the real number thus specialists provide and extensive usage of geological tools for identification of actual natural gas reserves.

The term "proved reserves" assumes a presence of hydrocarbons underground, which were identified and confirmed by drilling. Therefore, when a bore was drilled, it can be extracted by companies for commercial purposes from this time in case that production of discovered natural gas will be economically efficient. Usually, it contains a 90% of probability that these proven reserves will be produced. Some organizations interpret this term differently. For example, British Petroleum statistical review include liquids associated with natural gas (NGLs) as oil reserves, while others do not. (J. Mitchel, V. Mitchel, Marcel, 2012)

The table below shows leading countries in the amount of natural gas reserves which were proven by geologists:

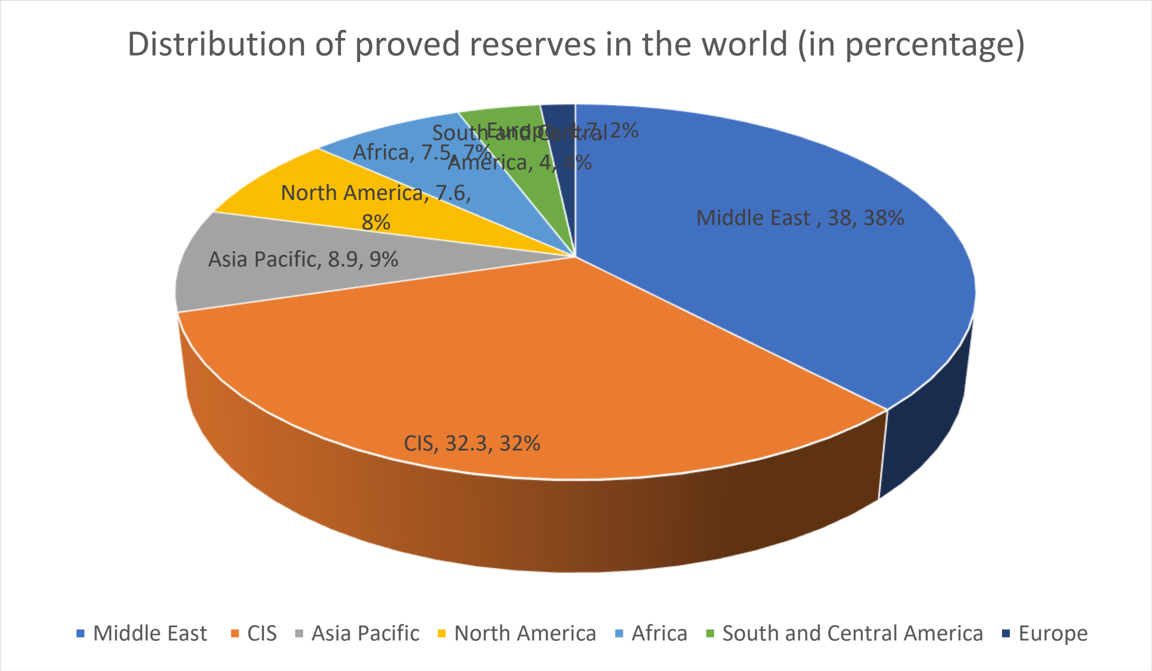
Table 2: Natural gas reserves by country

Country	**Total proved reserves (trillion m^3)**	**Share of total (%)**	**Reserve-to-production ratio**
Russian Federation	38,0	19,1	55,9
Iran	32,0	16,1	131,1
Qatar	24,7	12,4	138,6
Turkmenistan	19,5	9,8	308,5
US	12,9	6,5	14,0
China	8,4	4,2	47,3
Venezuela	6,3	3,2	238,0
Saudi Arabia	6,0	3,0	52,7
United Arab Emirates	5,9	3,0	95,0
Nigeria	5,4	2,7	109,4

Source: British Petroleum Statistical Review of World Energy, 2020

According to British Petroleum report (2020), total proved reserves in the world are estimated at 198.8 trillion cubic meters, of which Russia takes the top place with 38 trillion cubic meters. The largest reserves are also located in the Middle East - Iran and Qatar with 32,0 and 24,7 trillion cubic meters respectively. Another post-soviet country Turkmenistan takes the fourth place in the leaders of gas reserves with number of 19,5 trillion cubic meters. Moreover, this country has the highest Reserve-to-Production ratio (this number is represented by the length of time that these reserves can be served for production if it continues at the same volume level as this year) thus they can produce natural gas for more than 300 years. Overall, distribution of proved reserves in the world is shown in the chart below:

Figure 3: Distribution of proved reserves in the world



Source: British Petroleum Statistical Review of World Energy, 2020

As we can see from the chart, main natural gas fields are located in the Middle East (especially in Qatar and Iran) and CIS (especially in Russia and Turkmenistan), accounting for 75,6 and 64,2 cubic meters respectively. These regions have also the greatest Reserve-to-Production ratio, which means that with current level of natural gas production, they can last to produce longer than other regions as for example Europe that has the lowest reserves of natural gas.

4.6. World natural gas production

In 2019, global production of natural gas increased by 3,4% compared to 2018, which amounted to 132 billion cubic meters. The United States of America was the biggest producer with 929 billion cubic meters of gas output, representing almost two-thirds (64%) of total production growth in 2019. Extraction of shale gas specifically soared by 10% since most high volumes of natural gas were produced in Appalachian and Permian basins. Gas production in the United States is stimulated by an increasing export potential of LNG and a strong commitment to capture larger share of natural gas market. Unlike Russia and Saudi Arabia, the USA is not bound to obligations of price reduction on commodity and can freely boost production during a period of increasing popularity of shale gas. (Global Gas Report, 2020)

The second largest producer of natural gas was the Russian Federation with 679 billion cubic meters of gas extracted in 2019, from which 94,7 billion cubic meters of associated petroleum gas (APG). The growth rate was accounted for 1,5% compared to previous year, despite a decline in domestic consumption in the European part of Russia due to exceptionally warm winter in 2019. Such growth can be explained by rapid increase in production of LNG, which was represented by 29,5 million cubic meters of output with 47,7% of surge compared to 2018. (BP Statistical Review, 2020)

The highest growth in supply of natural gas was observed in countries of the Asia Pacific region – Australia and China. China's government pushed to increase domestic production by 9,9%, while Australia was focused on expansion of LNG transportations. As for Middle East, the production of natural gas there rose by 3,2%, where Iran, Qatar and Saudi Arabia were the largest suppliers in this region with 244,2, 178,1 and 113,6 billion cubic meters of output extracted in 2019, respectively. Despite a dipped output by 8,1% of largest producer in Africa – Algeria, supply in this region increased by 1,2% thanks to climbed production in Egypt.

On the other side, we can see that natural gas supply in Europe dropped by 6,9% in total, due to a significant decline of production in Norway by 5,7%. There was also a decreased output from the Groningen field in the Netherlands, which negatively affected European production of natural gas. Moreover, South America saw a decrease in natural gas extraction by 1,2% due to decline in Bolivia and Venezuela. (Global Gas Report, 2020)

In the table 3 below, there are leading countries in 2019 by natural gas output with additional information about growth rate compared to previous year and share of total gas market:

Table 3: Natural gas production by country

Country	Production (billion m^3)	Growth rate (%)	Share of total (%)
US	929,0	10,2	23,1
Russian Federation	679,0	1,5	17,0
Iran	244,2	2,4	6,1
Qatar	178,1	0,9	4,5
China	177,6	9,9	4,5
Canada	173,1	-3,3	4,3
Australia	153,5	18,0	3,8
Norway	114,4	-5,7	2,9
Saudi Arabia	113,6	1,4	2,8
Algeria	86,2	-8,1	2,2

Source: British Petroleum Statistical Review of World Energy, 2020

4.7. World consumption of natural gas

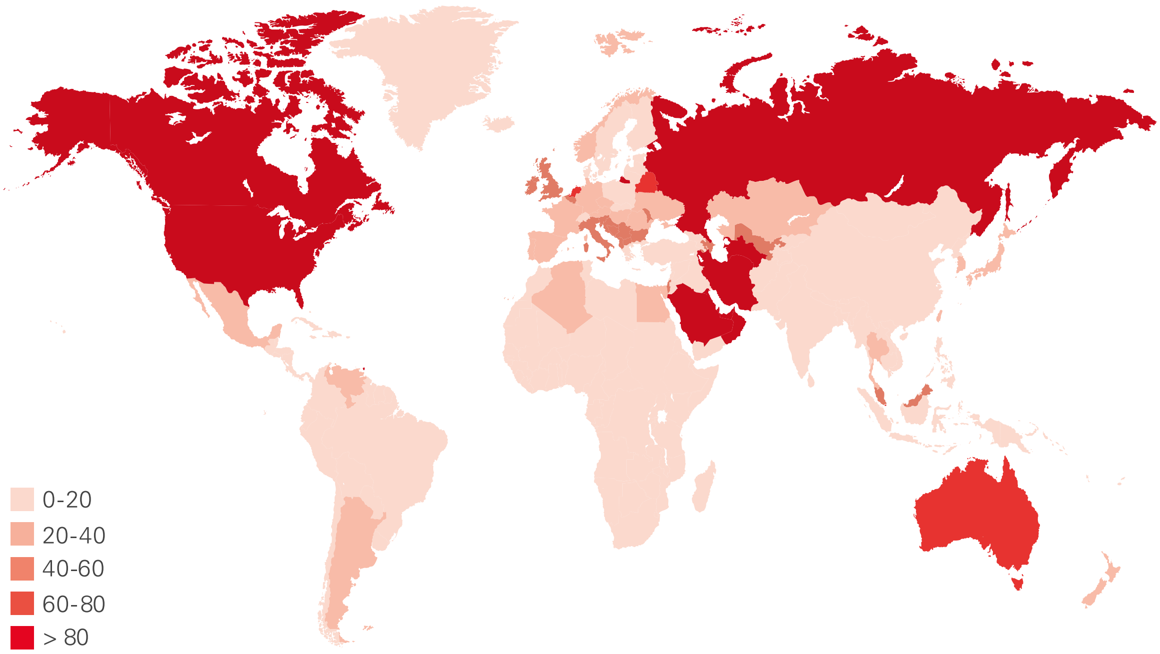
There was a continuous growth in demand of natural gas from 1995, however in 2008 showed a negative trend in commodity consumption, since the world faced a global economic crisis. The volume of this natural resource demanded increased from 96 to 124 trillion cubic meters during a 14-year period. However, in 2009 consumption dropped to 120 trillion cubic meters since energy markets were negatively affected by Great Recession. After this fall, demand was levelled off, and it is expected to grow in subsequent years as natural gas has a comparative advantage in ecological purity among other fuels. (Hilyard, 2012)

In 2019, the growth of global gas consumption was at slower tempo compared to previous years, representing 2,3% of increase or 87 billion cubic meters, which was below a 10-year average. This was resulted mainly due to slowdown in economic growth of China and mild weather during the winter, which leaded to lower demand of households heating. The largest demanders of natural gas by annual increase were USA with 30% and China with 27% of global growth (China's growth were 8,6% due to introduction of air cleaning and coal-to-gas policies used in industrial and residential sectors, while the U.S. had 3,1% of growth in 2019). Along with China, Europe is the second continent, which tries to implement approaches that allow switching from coal to gas in power industry with demand growth of 1,2% in 2019. Furthermore, in the Middle East and Africa demand of natural gas also rose by 3% and 3,2% respectively thanks to increased consumption for power generation.

On the other hand, natural gas demand dipped by 0,6% in the CIS states since economic growth of these countries was slower than the average. Moreover, we can observe a negative trend in consumption of gas in South American countries, accounting for 2,2% of decrease. This is explained by a decline in use of natural gas for power stations. Warm winters also affected consumption of gas in the Russian Federation, where was the largest decrease among other states, amounted for 10 billion cubic meters of natural gas. (Global Gas Report, 2020)

On the Figure 3 below, there is a map of countries, showing natural gas consumption per capita in 2019 (values are represented in gigajoules per capita):

Figure 4: Natural gas consumption per capita



Source: British Petroleum Statistical Review of World Energy, 2020

4.8. Oil and gas dependent economies

As we recently discovered, most of proved reserves of natural gas are located in the CIS and the Middle East at the moment. Countries of these regions attempt to limit of gas supply to make the consumption of these reserves last longer, avoiding early depletion. Therefore, by implementation of modern and advanced technologies in the petroleum industry, these economies are able to support high production of natural gas and prolong its use in various sectors.

It is already expected that during the next several decades, the consumption of nonrenewable fuel sources will be gradually displaced by renewable energy inventions such as solar panels, electric cars etc., which means that demand for crude oil and natural gas might fall in the future. The government revenues also might decrease since exports of natural resources are amounted for a significant proportion of the GDP. Thus, oil and gas dependent states face the issue undiversified structure of their economies as high dependence on petroleum sector exists.

Most of oil and gas dependent economies need to increment reserves in order to support future supply at the same level. However, high production of natural resources makes the diversification of the economy complicated thus the transition from oil-based economy to might cause many obstacles. After the second oil price shock in 1979, global oil and gas market dropped by 10% compared to other fuels with a significant decline in consumption of energy commodities. As a result, large volumes of crude oil and natural gas were abundant. Since then, OPEC members reduce the production to support world prices on these raw materials. (J. Mitchel, V. Mitchel, Marcel, 2012)

4.8.1. Resource curse

It is commonly believed that in the modern economic theory large reserves of natural resources are the “curse” of resource-dependent economy, inevitably slowing down and destroying the economic growth of the country. Undoubtedly, economic development based on resource-planning production can generate various risks. Therefore, the term “resource curse” relates to the failure of mineral dependent countries to take full advantage from natura resources including certain challenges only these states might face. The theory assumes that these resource-rich countries are inclined to be subjected to authoritarian form of governance, have more conflicts with other states and slower economic growth. Overall, economists highlight some following consequences of the resource curse:

- **Taxation** of oil and gas companies in rich-resources countries leads to lower dependency on citizens' taxes. Consequently, as state revenues consists of more resources production rather than ordinary citizens' investments, the government is becoming less responsive and does not satisfy people's needs.
- **Military conflicts** can be a result of continuous competition for natural resources, which have interests from many different groups of population.
- **Inefficient government expenses** could cause an economic decline of the country as debt might increase due to unstable revenues from sales of raw materials. Moreover, such states are inclined to invest more in wages of government official or subsidize domestic extraction of natural resources rather than contribute to education and healthcare systems.
- **Gender inequality** is caused by general conditions of petroleum manufacturing, where, for example, women have less chance to succeed and as a result, there are less women in the government.
- **Undeveloped institutions** are often the reason of stealing money without being caught. Some oil or natural gas project is not regulated on under the terms of government budget thus, as a result, financial resources can be taken over.
- **Insufficient utility of resources** is commonly the subject of discussion between government and petroleum companies about the responsibility of environmental damage and sharing of profits.
- **Environmental damage** refers to all ecological events that leaded to pollution of the nature on the territory of resource activity.
- **Social discontent** assumes the possible conflict between government and citizens of the country as an environmental balance could be disturbed through extraction, production and processing of natural resources.

(Natural Resource Governance Institute, 2015)

There was a research evidence that in a 30-year period starting from 1960, countries with low reserves of natural resources had three times higher growth rate of income per capita than rich-resources states. (Polterovich, Popov, Tonis, 2010)

4.8.2. Dutch disease

A Dutch disease is another special consequence of resource curse. A rich-resource country, especially developing one, can benefit from a discovery of additional new mineral deposits or increased price on traded commodity, which leads to a resource boom. Earnings from production and exports of natural resources can cause inflation or sometimes hyperinflation, appreciation of local currency etc. so labour force transfers from non-petroleum sector to resource industries, where cash inflows and outflows contains significant amount of money. As a result, there is a significant decrease in the volumes of output of manufacturing sector. Among negative influence, we can point out a soar of salaries, causing a decrease in competitiveness, which results in growth of import volumes. This effect from this transition can be seen as in the next couple year as after a decade. The negative examples of Dutch disease can serve countries like Russia and Venezuela. However, there are some countries that were able to cure this phenomenon in the last decades such as Norway or Chile. (Natural Resource Governance Institute, 2015)

Does the Russian Federation have Dutch disease?

Before answering this question, we can confidently say that the Russian Federation have always have all preconditions for being exposed to a Dutch disease. According to a study conducted by International Monetary Fund (IMF) in 2007, there were four primary factors determined, which confirmed a presence of such phenomenon: an influence of local currency (Russian ruble) and oil prices, deindustrialization processes, an expansion of service sector, a rise in growth of salaries. As for the first symptom, it was found out that if Russian brand of oil Urals increases by 1%, then national currency ruble becomes stronger by 0.5%. Second factor explained that manufacturing industry grew slower than other economic sectors in Russia since 2001, supported by third symptom, where amount of service increased. Last but not least, salaries' growth hit a peak since 2000, showing high results in all sectors of the economy. (Oomes, Kalcheva, 2007)

However, despite the identification of many factors that can tell us about an existence of Dutch disease, it is hard to conclude so due to unavailability to check all possible dependence on these symptoms. It means that there might be other factors, which caused such symptoms. Furthermore, it is widely known that in the last year Russian ruble, significantly depreciated, opposing to signs of Dutch disease.

4.9. Major gas fields in Russia

As we have recently discovered, the Russian Federation owns the largest proved reserves of natural gas in the world nowadays and takes the 2nd place in gas production. Most of these reserves are concentrated in West Siberia, especially in the Nadym-Pur-Taz region and the Yamalo-Nenets autonomous district, accounting for more than one-third of total Russian reserves. Compared to gas reserves in other countries, these places are characterized by an abundance of large fields. In 2011, there were around 28 largest fields with more than 840 gas deposits, which amount for approximately 70% of total reserves. The extraction of natural gas from the fields in Russia are characterized by specific obstacles for the development that industry might face such as reduction of highly productive reserves under commercial purposes, harsh weather conditions with extremely cold winters and long distances between production and consumption centers. In general, despite a gradual depletion of some current fields, natural gas industry in Russia has a sufficient potential in resource base at high rate of production. The major largest natural gas fields are listed below:

1. **Urengoy field** is considered to be the largest in Russia, which is located on the territory of Yamalo-Nenets district with more than 1300 wells. It was discovered in 1966 and the production there has started in 1978, making this place to be one of the oldest natural gas fields in Russia. The maximum output was achieved in 1987 and represented 276,2 bcm. The total volume of reserves was estimated at 10,9 tcm, however the resources there are already more than 70% depleted.
2. **Yamburg field** is represented by deposits located beyond Arctic circle in the sub arctic zone of Yamal. The field was discovered in 1969 and reserves are evaluated at 8,2 trillion cubic meters. The Yamburg gas is located at depth of 1-3 kilometers, while the first 400 meters underground is represented by permafrost
3. **Bovanenkovo field** one of the youngest and promising fields. The production activities have begun in 2012 and it is located near the coast of the Kara see at tundra climatic zone with 4,9 trillion cubic meters of gas deposits.
4. **Shtokman field** is located in the middle of Barents Sea, where average depth is represented for around 340 meters. The volume of reserves such as natural gas and its condensate is estimated for 3,94 trillion cubic meters. Due to specific conditions and undersea location, the extraction of resources is not performed at full capacity, however there are plans for achieving it in the following years.

5. **Zapolyarnoe field** is the fifth largest natural gas filed in Russia, which was found 80 km from Urengoy deposits in 1965. The volume of gas deposits is accounted for approximately 3,5 trillion cubic meters.

(Mitrova, 2014)

4.10. Largest producers

In 2013, there were around 260 gas producing companies in Russia, however only three of them represent a significant domestic gas market share. The largest producer Gazprom owns approximately 17% of world reserves and more than 70% of Russian gas deposits. More than half of company's assets are owned by the state. Founded in late 1980s, Gazprom started to develop rapidly, providing more than half of Russia's demand for blue fuel and exports it into around 30 countries nowadays. In 1999, the federal law "On gas supplies" was introduced, which allowed company to provide natural gas to consumers domestically in the Russian Federation and transport it abroad. This leaded to acquiring a monopolistic position on the gas market due to a presence of an exclusive right to export internationally via pipelines and LNG. However, in 2013, the transportation through tankers was abolished, letting other gas companies to deliver natural gas as LNG. Theoretically, other producers could sign an agreement with monopolist, however Gazprom has an ability to prevent these supplies, creating a dependence from decisions of monopolist. At present, Gazprom exploit around 130 gas fields and with more than 7000 production bore holes.

Novatek is the oldest gas supplier, which takes the second place of largest gas companies in Russia. By implementing an aggressive policy on domestic market, the company acquired and merged with other smaller gas producers to cope with competition against major monopolist on Russian gas market. Currently, the company serves for 36 licensed regions (9 of them can be used for gas extraction) with total annual output of more than 50 billion cubic meters. Compared to Gazprom, Novatek is focusing more on production of wet gas with high composition of condensate.

Rosneft is the third largest Russian gas enterprise, focusing on extraction of associated petroleum gas as core activity of this company is crude oil production. As well as Novatek, it merges and acquire other smaller gas companies such as ITERA and TNK-BP with total annual production of 25 billion cubic meters. The company aims to expand its domestic market share up to 20% and extract around 100 bcm by 2020 (Mitrova, 2014)

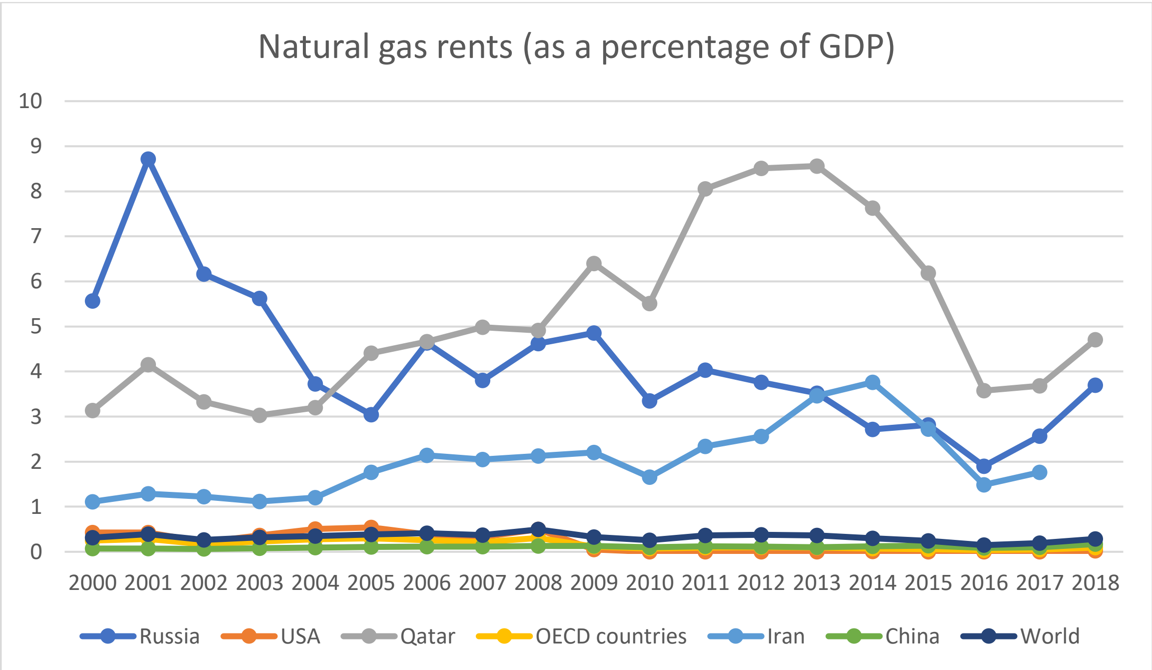
4.11. Natural gas rents

The significance of the Russian natural gas sector is more about revenues that government receives from exports of this commodity thus the economy is not dependent on selling it abroad only, but the total value of gas supply. This value was highly appreciated in 2000s, when gas prices reached their peak and it significantly improved an overall economic situation in Russia. Gas production increased from 307 in 1996 to 470 million tons per year in 2005, amounted for more than 50% of growth.

Thanks to boom of gas prices in 2000s, which stabilized the Russian economy, the government contributed to creation of private oil and gas companies to attract new investments and implementation of advanced technologies for increasing of natural resources extraction. Therefore, it was an extraordinary godsend in Russia, how increased gas price in combination of the rapid rise of gas output were the fundamental factors of determining total natural gas rents. (The Brookings Foreign Policy Studies, 2006)

On the Figure 7, we can observe natural gas rents of Russia and other gas- and non-gas producing countries. These rents are represented by the difference between value of natural gas supply at world prices and total production expenses.

Figure 5: Natural gas rents (% of GDP)



Source: Worldbank

4.12. Taxation of mineral sector in Russia

The mineral industry is commonly considered to be the foundation for the economy of the Russian Federation, making a crucial contribution to country's revenue and formation of the state budget. A chosen tax policy has a significant impact on distribution of income from natural resources production. Generally, taxation system related to mineral sector is conceptually different from levying other sectors due to large income rents and high investment risks. The basic principle assumes that owner of natural resources (often, it is a state) must receive the greatest amount from resource production profits. However, companies, who work in mining industry, are subjected to additional risks connected to exploration activities, time lag between costs and production, mineral price fluctuations etc., which sometimes different in nature and size compared to other sectors of the economy. In this case, gas companies and government should reach a consensus about choosing a proper distribution of income from to extraction of natural resources by applying certain tax tools. Therefore, for such oil and gas dependent states like Russia, it is significantly important to build an effective system of taxation of natural resources sector to provide rents for the country and meet the need of long-term development, maintaining sufficient incentives for future investments.

Gas companies in Russia pay only two types of severance taxes: export duty and tax on the production of natural gas. The taxable object is recognized as products from mining industry, extracted from subsoil, which corresponds to either national or international standards. If a mineral does not meet any of these standards, then company's standards are taken into account. From 2014, a new structure of natural resource taxation was introduced, which considers the following factors such as gas composition, macroeconomic indicators, price levels on gas markets, conditions for the development of deposits and expenses for transportation of natural gas. The previous existing scheme did not include neither lifecycle stages of resources extraction, nor changes in the price development of the market and processing conditions thus companies carried an excessed tax burden. (Kashirina, Zhuravlev, 2016)

The current tax base can be represented by two components: the amount of mined minerals during the extraction of crude oil, natural gas, coal etc. or costs of extracted minerals as well as during a production of other natural resources. The estimated value of extracted mineral is determined by the taxpayer on the basis of tax accounting data, considering all incomes, direct and indirect expenses, which are provided for recognizing a tax base for corporate income tax. Consequently, a tax base is not defined by a state, but a taxpayer directly. The tax rate is multiplied by the base value of the fuel units, gas production complexity factor and it sums up with indicators related to transportation of the commodity. It can be calculated according to natural resource weight or occupied volume. For example, in 2018, the tax rate was 42 rubles for one ton of produced natural gas or 35 rubles for a thousand of cubic meter of extracted gas. Meanwhile, Russian gas company Gazprom pays significantly more taxes (since export duties are added), accounted for 40% of tax difference compared to its competitors, due to an exceptional right of transporting natural gas abroad. (Federal Taxation Service)

The table 4 shows the share of total tax payments receives from oil and gas production in Russia compared to total tax payments credited to the state budget in a 5-year period from 2014 to 2018:

Table 4: Share of tax payments received from oil and gas production in Russia

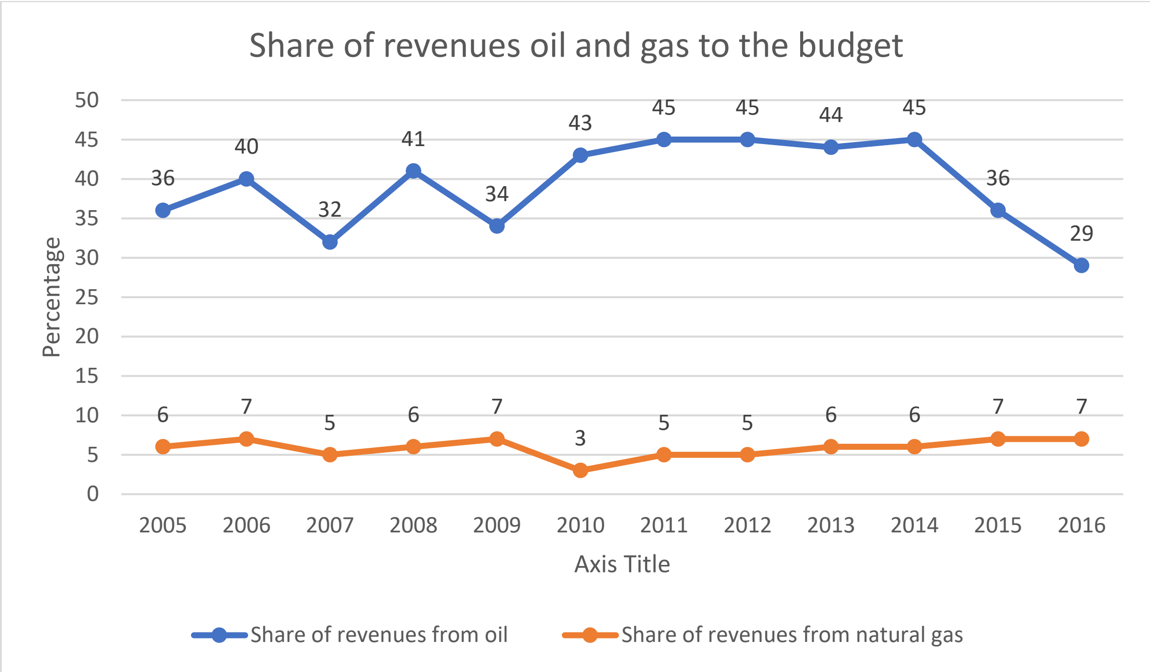
Year	Total tax payments received from oil and gas production (thous. rubles)	Total tax payments credited to the state budget (thous. rubles)	%
2014	3 643 162 810	12 606 291 943	28,9
2015	4 100 925 059	13 707 085 995	29,9
2016	3 565 706 402	14 387 742 053	24,8
2017	4 625 234 826	17 194 238 140	26,9
2018	7 393 168 170	21 148 837 494	34,9

Source: Federal Taxation Service of Russia

It is important to mention that it does not show total revenues received from crude oil and natural gas production, which are accounted for a higher contribution, but only a share of taxes gained from mining industry. According to the table 4, we can see that percentage of tax contributions from resource production to the total tax payments credited to the government budget increased by 6% from 2014 to 2018. During this period, total tax collection increased by 67,8%, while payments related to oil and gas production soared by 102,9%. Therefore, it is evident for us that tax income from oil and gas production is considered to be a significant component in formation of the state budget of the Russian Federation.

The difference between share of revenues from oil and gas to the budget is illustrated in the figure below:

Figure 6: Share of revenues from oil and gas to the budget



Source: Ministry of Finance of the Russian Federation

According to the graph above, we can see that revenues from oil extraction dominated in the formation of the state budget, accounting for more than one third of total revenues during a given period. However, in 2015, the share of oil revenues significantly plummeted by 20%. Meanwhile, gas sector was less profitable, however more stable than oil industry. Values fluctuated in the range from 3% to 7% during a 12-year period. The highest decline was seen in 2010. Overall, we can observe a positive trend for gas industry supported by increased consumption of such commodity and negative trend in oil sector, which is allegedly explained by economic sanctions towards Russia due to Ukrainian crisis, introduced in 2014.

There were many discussions in Russia about replacing the current taxation system by introducing tax on financial performance and additional income. Its effectiveness is conditioned by geological and geographical characteristics, which will ultimately be reflected on income, i.e. it provides a differentiation of tax burden, depending on conditions of gas production. The use of such taxation method allows gas companies taking into account gross net income with costs of production and enterprise will not face economic obstacles due to production in unprofitable gas fields. It should be noted that such taxes are not common in world practice, however it is partly used in the UK, Norway, Australia and some provinces of Canada. In practice, countries that switched to such taxation system failed to fully implement all positive aspects of tax scheme since significant growth in gas production was not achieved. One of the biggest disadvantages of tax on financial results and extra earnings is that the state budget is replenished in the case of high profitability of oil and gas projects. As a result, being responsible for the whole country, the state will carry more risks than oil and gas companies since it will not gain from resource rents if there will be no profit-making projects. Furthermore, there is a risk of an increase in the real cost of project, which allows companies to redistribute resource in their favor as growth in expenses sometimes is not directly dependent on enterprises. For example, the state budget of the UK covered some project costs and deterioration of operating conditions in the North Sea, which resulted in complete reduction of income from tax on financial results. As for advantages, we can distinguish a reduction of companies' tax burden, accounting for their financial performance. However, it will significantly damage the budget of the state, which directly depends on taxes from mineral production and export duties. Overall, this type of taxation is aimed to transferring some negative effects of various risks from gas companies to the state. (Kashirina, Zhuravlev, 2016)

The possibility of introducing tax on financial results and additional income in Russia was firstly announced in 1997 during amendments of the second part of the Tax Code in the State Duma. The essence of it was similar to what other countries have applied, however transition to this tax system can be carried out voluntarily by the request of taxpayer. Nowadays, it makes more sense to use this tax only for new oil and gas fields, especially with high costs and deposits that are hard to reach. On fields that already developed, this tax technique will not be that effective as such place is not generating high profits and it does not require tax incentives to attract investments since they were already done. Economists highlight the following advantages of introducing tax on financial results and additional income in Russia:

1. Rejection of previous modern taxation system, which focused on taxes, which are levied regardless the results of companies' financial activities
2. Simplification of tax administration
3. Stimulation of production of hard-to-reach gas condensate

(Kashirina, Zhuravlev, 2016)

4.13. Pricing of Russian natural gas

Gas prices in Russia are primarily regulated by the government. Historically, the state set a certain price level for Gazprom since it was almost the only supplier in the 1990s. Nowadays, there are more gas producers such as Novatek and Rosneft, which compete with the largest gas enterprise in Russia. Level of gas prices of these companies is not regulated by the government. However, since Gazprom takes more than 60% of Russian gas market, price levels that are set for Gazprom determine an overall general level of gas prices in Russia.

Prices on natural gas can be divided into two types: wholesale and retail prices. The first type is represented by the value of a gas from a distribution station in a certain region. The level of wholesale price is dependent on the region: the further it is from the places of gas production, the higher this price. Currently, maximum price level is approximately 400 rubles higher than the minimum. The retail price consists of wholesale price, which summed with tariffs of gas distribution and sales organizations, payments for supply and sales services and surcharge for calorie content. At the end, the value added tax is added to retail price. These prices are regulated by Federal Antimonopoly Service of Russia (FASR).

Export prices for European market are dependent on various factors, such as supply and economic cycle, however it is evident that gas prices are highly correlated to prices on crude oil in Europe. World economic crisis of 2008 and the subsequent stagnation stage of the economy leaded to a decline in consumption of electricity and natural gas. Consumers began to look for a cheaper source of energy. One of these sources was coal, despite it is not environmentally friendly fuel. Therefore, cheap coal and slowdown of economic growth were the main causes of decrease in demand of natural gas, which leaded to rapid negative price adjustments. Furthermore, since the European energy market is starting to undergo changes associated with growing role of renewable energy sources such as solar and wind energies, supported by decreasing prices on coal, the future position of gas is undefined.

Thanks to increasing competitiveness on the global energy market, including gas industry, lower prices on natural gas are the crucial factors in selling the commodity. During price uncertainty period, it is suggested to allow market setting the prices, which cover marginal costs in the long run since Russia has the lowes cost of production of natural gas. (Henderson, Mitrova, 2017)

4.14. The Energy Charter Treaty

The Energy Charter Treaty is international agreement, which is primarily focused on providing a multilateral foundation for cooperation in energy sector among 53 country members. The ECT was came into force in 1998. The main idea is to contribute to a security and sustainability in energy industry with a condition of resources preservation. It is also aimed to assist members entering global markets with commercial purposes, protect foreign investments, provide reliable transportation of energy resources, creating favorable conditions for investors, eliminate market barriers and ensure a fair competition in energy industry. This agreement also accepts the rights of parties to own natural resources, provide an exploration and extract it from underground without violation of international laws. Moreover, member countries agree to reduce a negative effect of environmental pollutions in energy sector. According to this treaty, a contaminant must cover all costs of pollution without any exceptions. There are also conferences collected, which brings all participants together on a regular basis for discussions about issues in energy collaboration. (European Commission, 2020)

The Russian Federation signed the ECT in 1994, before it entered into force. In Russia, an application of declaration was temporary tool in development of multilateral cooperation in energy sector. In 2009, the country announced about refusal to be a contracting member. However, a current participation the Charter activities is continuing, even though contributions have not been paid to the budget of the ECT from 2010. This was primarily caused by gas conflicts between Russia and Ukraine. Continuous disagreements between these neighboring countries increased risks in supply disruptions to the EU and pushed parties to find ways of cutting a dependency from the Russian natural gas. (Pominova, 2014)

In 2009 Russia refused to ratify the ECT. Nowadays, being a member of the treaty that obliged to protect investments, Russia uses the ECT as a place for discussions and negotiations about prioritized topics of the organization, despite the focus of the ECT to perform duties in front of other contracting participants. Russia’s declared strategic interests of development and cooperation in the energy sector coincide with goals of the treaty, meaning that the country has intention to participate in multilateral agreement. Therefore, the subsequent participation and contributions to the budget of the ECT can be considered if the following conditions of abiding by the rules of the organization will be satisfied.

4.15. The Gas Exporting Countries Forum

The GECF is intergovernmental association of states –leaders in reserves, production and export of natural gas. In 2008, the ogranisation was established in Moscow, where ministers of energy of member states signed the agreement on functioning of the forum in opposition to the ECT, which was approved in the Charter of the GECF. Nowadays, participating parties are represented by 12 countries, which owns for 73% of natural gas reserves and provided 42% of global production. The main goal is to provide a stability and security of gas supply and demand on global markets. The most signficant result of the GECF's works was approval of the Long-term Strategy in 2016, which members agreed to adjust on a regular basis and prepare a 5-year plan for its implementaion. The Strategy is primarily focused on pormotion of natural gas as "fuel of choice" with great potential to achieve sustinable energy development and ensure access to the energy in the world. The key tasks of the GECF for the near future also include strengthening of international positions and development of communications with major players on global energy market. (Ministry of Energy of the Russian Federation, Ministry of Foreign Affairs of the Russian Federation)

4.16. The impact of COVID-19

The coronavirus pandemic of 2020 has become a "black swan" that negatively influenced the dynamics of global energy markets as world oil and gas consumption rapidly declined. Industrial and commercial industries were affected more than residential sector. For example, the demand of natural gas in the power sectors has decreased since most factories were shut down due to local virus outbreaks, while electricity use in residential areas has remained at the same level or slightly increased as most people stayed at home isolated on quarantine. Thus, an overall decrease in global gas demand seems to be modest compared to crude oil, with only 5 to 10 percent below of prognosed levels. Despite an insignificant slump, world gas prices warn about approaching the industry to the crisis. (Deloitte, 2020)

According to Mckinsey & Company assessments (2020), the current crisis will have as short-term as long-term effects. A recover of gas industry depends on supply-demand performance and decisions made by government, regulators and investors. However, there is a strong evidence that pandemic will become a catalyst for shifting in esosystem of gas industry. Updated estimates show global gas demand will hit a peak by 2030 and after that a prevalence of renewable sources of energy will demolish long-term demand.

5. Practical part

This chapter aims to provide a deep analysis of statistical relationship between export of Russian natural gas and selected economic indicators supported by output from Gretl software. Data for analysis was taken in the period from 2000 to 2019 annually from public sources such as International Energy Agency, the Central bank of Russia and Rosstat. The selected period was chosen since during this time GDP of Russia Federation has soared by 6,5 times from approximately 260 billion USD in 2000 to 1700 billion USD in 2019.

After the collapse of USSR in 1991, newly formed country of Russia faced a deep recession. During a 9-year period, Russia lost about 30% of its real GDP, with exception of 1997 year, when the results were more positive to the economy with number of 1,4%. The country had an extremely high inflation rate, reaching maximum over 2000% in 1992. Foreign direct investments (FDI) were also not matching the size of Russian economy. Thus, it is estimated that foreign capital outflow in the period from 1992 to 1999 accounted for 150 billion USD. A new country's debt to other countries significantly increased as Russia declare itself as a successor of the USSR. As a result, the local currency significantly devalued. (Cooper, 2009)

Moreover, this time is also characterized by economic transformations made under the direction of Yeltsyn-Gaidar government (Boris Yeltsyn at that time was a current president of the Russian Federation, while Yegor Gaidar was a Prime Minister of Russia). Idealists thought that these reforms might stimulate the economy to rapid recover after transition from central-planned to market economy, but it did not happen. American politician Bernie Sanders (1998) described the economic performance of Russia in the 90s as "tragedy of historic proportions" accompanied by high inflation rate, mass unemployment, increased government debt etc. which might lead to economic collapse of the country. Consequently, mood of western observers was not promising towards Russia. (Shleifer, Treisman, 2005)

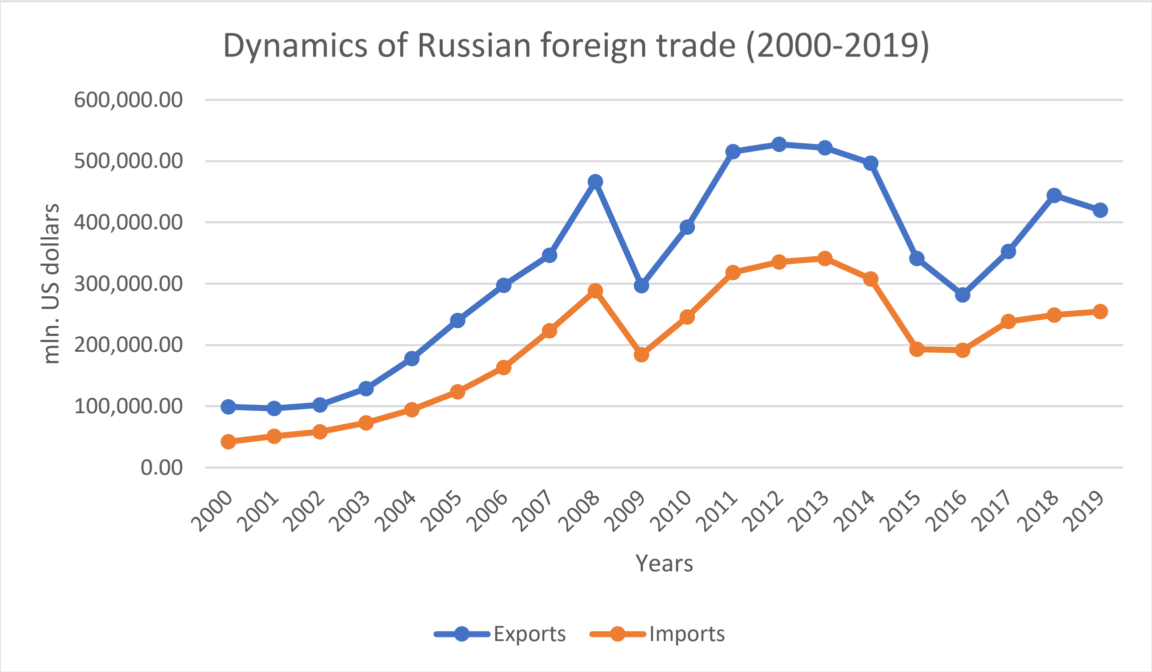
Despite certain issues arising from the reconstruction of the economy, Russia reached economy growth by 2000s. This was also supported by shocks of world prices for oil. Since Russia is highly dependent of earnings in foreign currency, the event leaded to increase in budget of the country and timely debt repayment. From this moment, improvement made in 90s and high oil prices leaded to a certain degree of economic stability, meaning that a state has potential to increase exports of goods and expansion of directions in foreign trade. Thus, a selected period will be suitable to see the performance of Russia in natural gas sector.

5.1. Balance of trade

According to Sherlock and Reuvid (2008), balance of trade is the difference between monetary value of goods exported from a country and monetary value of goods imported to a country at certain period. Generally, it includes all paid and executed transactions. If value of exports exceeds value of imports, then a country has trade surplus, which means that there were more goods sold abroad than goods transported to the country from other trade partners. If value of imports exceeds value of imports, then country has a trade deficit, which means that state buys foreign goods more than ships local goods abroad. The main goal of the trade balance is to meet an equilibrium or have a surplus in trading accounts so that country can pay off its debt.

The dynamics of foreign trade in a crucial factor for the development of the Russian economy. The graph below shows volumes of exports and imports from 2000 to 2019:

Figure 7: Dynamics of Russian foreign trade



Source: own elaboration based on data from Central Bank of Russia

As it can be seen in the graph above, the Russian Federation has a positive trade balance during given period - value of export outweigh value of imports. Since the beginning of 21st century, we can see a rapid increase in trade until 2008, while in 2009 there is a deep decline due to a Great recession economic crisis, which also negatively affected the economy of

Russia. After quick recover, the turnover between Russia and other countries started to process at negative growth rate in 2014. It can be explained by economic sanctions, imposed against the Russian Federation by many countries for invasion of Ukraine. Therefore, the trade in 2016 declined to the post-crisis level of the year 2009.

5.2. The structure of exports and imports

Being an oil and gas economy, the structure of Russian trade remains unchanged for many years. According to Federal State Statistics Service, in 2019, export of goods from Russia contained:

- 63,3% of mineral products
- 12,5% of metals and precious stones
- 6,5% of machines and transport units
- 6,4% of chemicals
- 5,9% of food products and agricultural raw materials
- 3,0% of wood and pulp products
- 2,0% of other goods
- 0,3% of textiles

At the same year, the structure of imports to Russia was represented by:

- 46,2% of machines and transport units
- 19,6% of chemicals
- 12,2% of food products and agricultural raw materials
- 7,7% of metals and precious stones
- 6,7% of textiles
- 3,9% of other goods
- 2,1% of mineral products
- 1,5% of wood and pulp products

Based on information above, we can sum up that Russia's main export goods are mineral products such as oil, gas etc., while long distances make machines and transport units the most imported goods in the Russian trade.

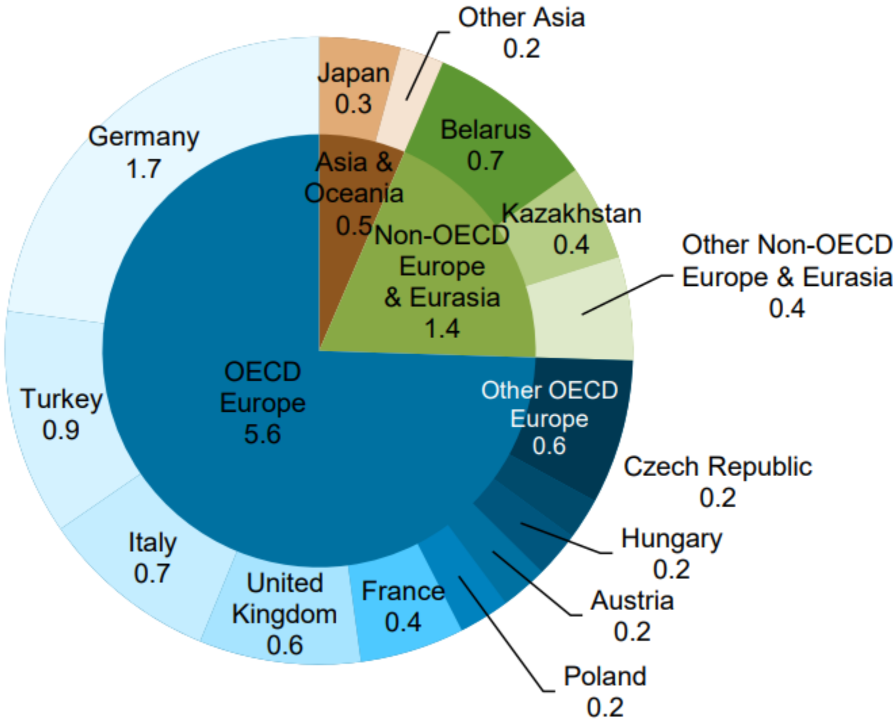
5.3. Russian natural gas trade

As we have recently discovered, Gazprom company was in monopoly position until recently. In 2006, a federal law №117 "On gas exports" gave the company an exclusive right to export natural gas via pipelines. As gas market was expanding, other growing companies such as Novatek and Rosneft expressed their wish to transport their commodities abroad. Thus, the second largest gas company in Russia Novatek initiated a discussion about total exclusion of LNG exports performed by Gazprom, arguing that this proposal would provide a strong position of the country on the LNG market. At the end of 2013, the government officials approved these initiatives and made amendments to the current law on gas exports, which showed great improvements in transition to market conditions. However, despite changes has been undertaken, liberalization of LNG exports is far from effective and it was evident that the government of the Russian Federation has no plans to fully waive of monopolistic competition from Gazprom side. (Mitrova, 2014)

Until recently, another biggest consumer was Ukraine, bordering by Russia on the east. In a 3-year period, from 2013 to 2016, the volume of natural gas imported by Ukraine from Russia has plummeted to zero. This was primarily caused by bilateral conflict between these countries, started in 2014 after the invasion of the Crimea, supported by ongoing disputes about prices on gas and unpaid invoices, which usually triggered by inability to pay and accumulated debts from Ukrainian gas company Naftogaz. Despite these arguments, Ukraine is still considered to be a transit state for transportation of natural gas from Russia to countries in Europe so interruption of supply might lead to shortfalls in some states as not all of them has alternative providers of gas. However, reliability of gas exports to Europe is the crucial factor when seeking ways of delivery thus to avoid risks related to transiting Russian natural gas through Ukraine and provide a sustained supply of natural gas, the following Gazprom projects of Nord Streams with higher pipeline capacity have been developed and supported by European consumers. (Pirani, Yafimava, 2016)

Russia exports approximately 30% of total gas produced. In 2016, most of natural gas was exported through pipelines to Europe, amounting for around 90% of total gas delivered, while the rest of it was transported as LNG to Asia. The largest importers were Germany, Turkey, Belarus and Italy. On the Figure 7, the chart displays major trade directions of Russian natural gas supply in 2016 (values are represented by trillion cubic feet):

Figure 8: Russia's gas exports by destination



Source: U.S. Energy Information Administration, 2017

As we can see, revenues from Russia's natural gas exports are highly dependent on the European gas market even though it contributes not as large as earnings from crude oil. Russia's imports to the OECD countries in Europe are accounted for one-third of total natural gas demand. Moreover, some closely located to Russia European countries such as Finland or Baltic states are almost fully dependent on imports of Russian natural gas. However, introduction of policies related to transition towards renewable energy which resulted in that consumption of natural gas in the OECD states has not grown or remained flat and sanctions imposed due Ukrainian conflict forced the Russian Federation to draw the attention to particularly LNG exports in Asian market, supported by higher growth rate in demand of gas in this region. (British Petroleum Statistical Review of World Energy, 2020)

Despite a large natural gas possession, Russia also imports gas from Central Asia since it is the cheapest way to compensate a shortage of supply. However, when export price from this region tied with European export price, gas purchase from Central Asian states became inappropriate and accounts for less than 30 bcm of imported volumes each year. Russia keeps this trade relationship since it provides an energy for south-east region of Russia and helps Gazprom to transport part of this gas to Europe with avoiding export duties. (Mitrova, 2014)

5.4. Data collection

According to Chatterjee and Hadi (2006), after formulation a problem, we are required to collect relevant economic data for construction an econometric model, that can explain or predict a dependent variable. In my estimation, the following dataset represents a relationship between endogenous and exogenous variables that has a possible influence on gas export in Russia. Therefore, dependent variable is natural gas export, while independent variables contains average natural gas export prices, natural gas production, average rate USD/RUB and natural gas demand in OECD countries. Columns are represented by chosen variables for our model and rows are represented by time units, i.e. years.

Table 5: Dataset

Year	Natural gas export	Unit vector	Average natural gas export prices	Natural gas production	Average rate USD/RUB	Natural gas demand in OECD countries
	y	x_1	x_2	x_3	x_4	x_5
2000	193,9	1	85,84	528,5	28,14	1416
2001	180,9	1	98,25	526,2	29,17	1399
2002	185,5	1	85,69	538,8	31,35	1439
2003	189,4	1	105,51	561,5	30,69	1451
2004	200,4	1	109,05	573,3	28,81	1476
2005	209,2	1	151,36	580,1	28,30	1487
2006	202,8	1	216,00	595,2	27,17	1491
2007	191,9	1	233,66	601,6	25,58	1549
2008	195,4	1	353,69	611,5	24,86	1567
2009	168,4	1	249,27	536,2	31,83	1522
2010	177,8	1	268,48	598,4	30,36	1627
2011	189,7	1	338,88	616,8	29,39	1623
2012	178,7	1	348,33	601,9	31,08	1656
2013	196,4	1	335,87	614,5	31,85	1654
2014	174,3	1	313,81	591,2	38,61	1624
2015	185,5	1	225,26	584,4	61,07	1652
2016	198,7	1	156,95	589,3	66,08	1695
2017	213,0	1	181,49	635,6	58,29	1719
2018	223,0	1	223,11	669,1	62,69	1806
2019	220,6	1	189,44	679	64,73	1841

Source: own elaboration based on data from FSSSR (Rosstat), IEA and Central Bank of Russia

5.5. Declaration of variables

Econometric modelling refers to the development of mathematical expressions that can describe the behavior of selected variable. These variables can be dependent or endogenous and independent or exogenous. The first type of variables is usually denoted as $\boldsymbol{y_i}$ and second type is expressed as $\boldsymbol{x_i}$. Construction of the model implies a description of how the mean of endogenous variable related to certain values of exogenous variables, while the variance of response variable is considered to be unaffected by changing conditions. (Rawlings, Pantula, Dickey, 1998)

Our subsequent one-equation model consists of six variables, including one response variable, one unit vector and four explanatory variables:

Endogenous variable:

***y* – natural gas exports,** represented by total Russian gas exports at the end of each year; expressed in billion cubic meters.

Exogenous variables:

$\boldsymbol{x_1}$ ***– unit vector***

$\boldsymbol{x_2}$ ***– average natural gas export prices***, represented by world average prices on export of natural gas; expressed in US dollars per thousand cubic meters

$\boldsymbol{x_3}$ ***– natural gas production****,* represented by total production of natural gas in the Russian Federation at the end of each year, expressed in billion cubic meters

$\boldsymbol{x_4}$ ***– average rate USD/RUB***, represented by an average of exchange rate of US dollar and Russian rubble, expressed as a ratio

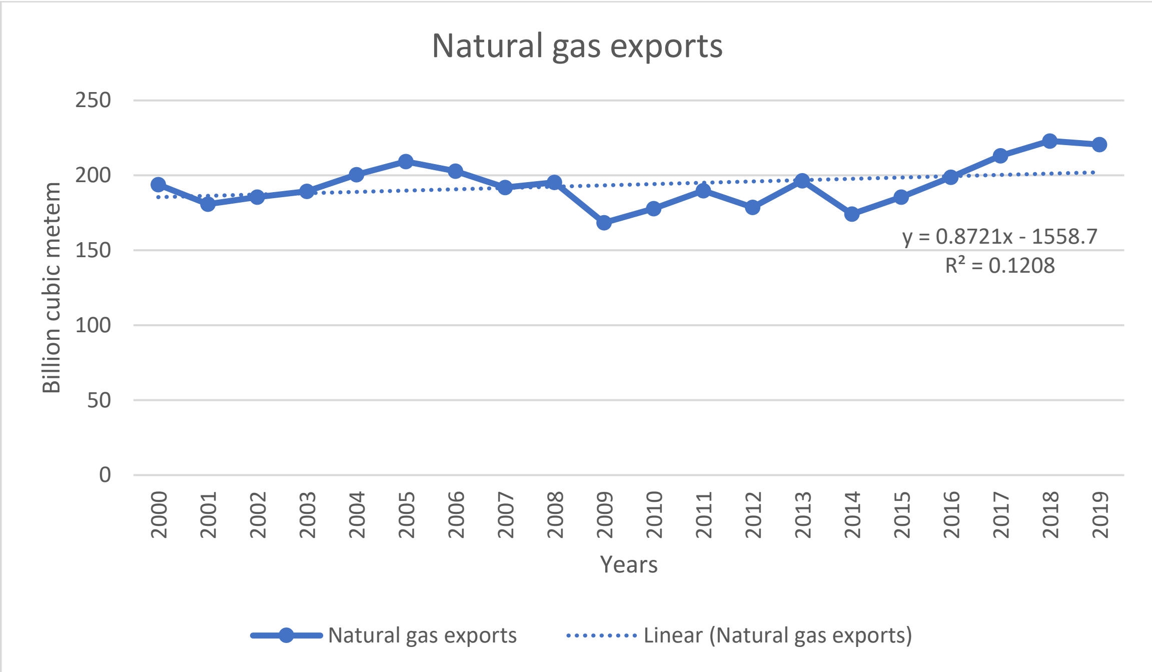
$\boldsymbol{x_5}$ ***– natural gas demand in OECD countries****,* represented by consumption of gas in OECD countries, expressed in billion cubic meters

5.6. Analysis of chosen variables

This part deals with descriptive analysis of selected variables.

5.6.1. Natural gas exports

Figure 9: Natural gas exports



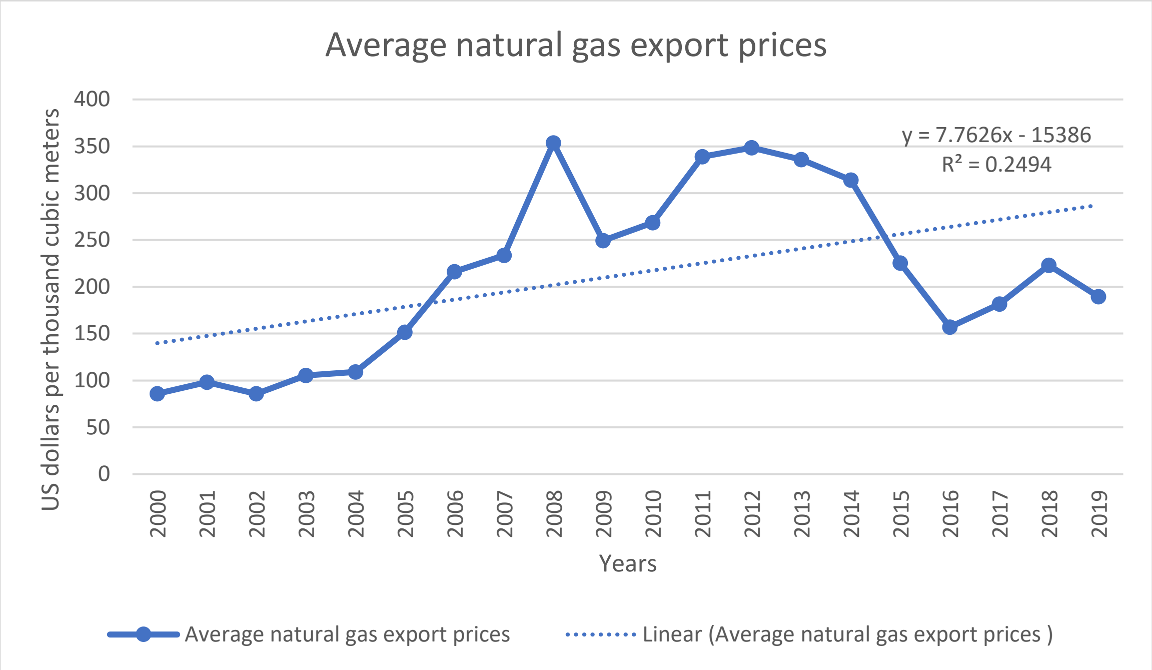
. Source: own elaboration based on data from Federal State Statistics Service of Russia (Rosstat)

Trend function: y = 0,8721x – 1558,7. *Coefficient of determination* R^2 = 0,1208

Russia is showing quite stable trend in the gas transportation to other countries with slight deviation due to various economic factors. The volume of natural gas exports fluctuated in the range of 150 and 250 billion cubic meters in 20-year period. The first decline of Russian gas export is seen in 2001. During this year, demand in OECD countries also decreased, making it the possible explanation for drop in 2001. After insignificant decrease, a positive trend in gas transportation had been followed until 2005. In June 2006, the government of the Russian Federation introduced an act 117 of federal law, which gives partially state-owned company Gazprom an exclusive right to export natural gas. Therefore, other small companies, which exported inconsiderable amount of nautral gas, have been denied their right to export, letting a monopolistic competition in natural gas market. In 2009, the amount of exported natural gas plummeted by approximately 14%, hitting a low with 168,4 billion cubic meters. The world crisis started of 2008 negatively affected economy of every country thus demand in natural gas decreased as a consequence. In the following years, gas market was in recovery after an economic shock, so fluctuations occurred. A decline in 2014 can be explained by sanctions from other countries towards Russia that caused a dip in gas exports.

5.6.2. Average natural gas export prices

Figure 10: Average natural gas export prices



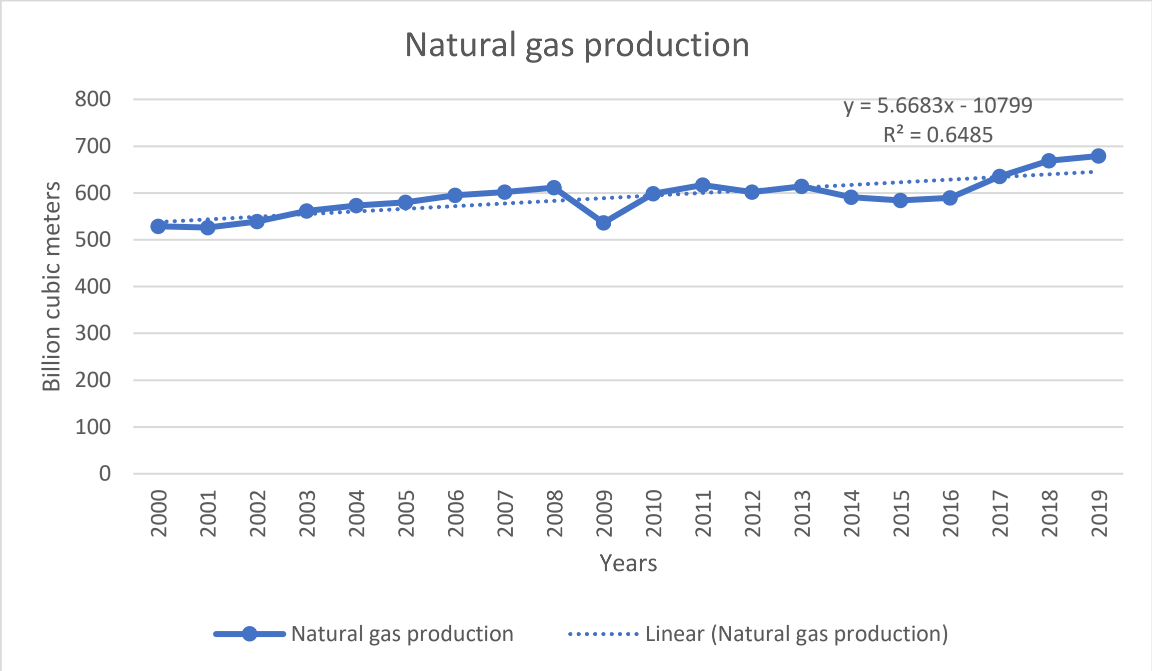
Source: own elaboration based on data from Federal State Statistics Service of Russia (Rosstat)

Trend function: y = 7,7626x – 15386. *Coefficient of determination* R^2 = 0,2494

During a given period average export prices of natural gas fluctuated with wide a spread since crude oil and natural gas industries are commonly known for their shocks in prices. Prices on selected commodity rapidly had quadrupled from 2000 to 2008. However, in 2009, we can see a dramatic fall in natural gas prices by more than 100 USD per thousand cubic meters, explained by Great Recession, as we also observed analyzing previous variable. After this year, price had been recovering until 2012. In 2013 we can also see a slight decline in gas prices continued until 2016. In 2016, export value of natural gas decreased below 160 USD per thousand cubic meters, which can be explained by a supply deficit on the gas market. Overall, average export price on natural gas had decreased twice in a 4-year period, hitting a low in a last decade.

5.6.3. Natural gas production

Figure 11: Natural gas production



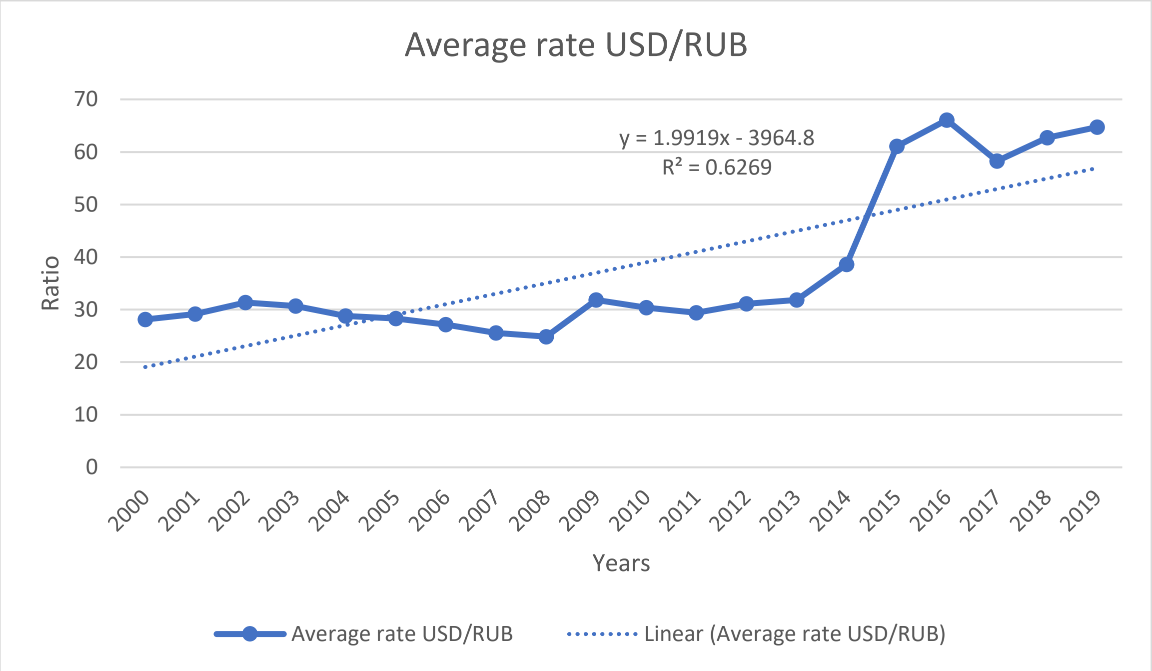
Source: own elaboration based on data from Federal State Statistics Service of Russia (Rossta)

Trend function: y = 5,6683x – 10799. *Coefficient of determination* R^2 = 0,6485

Production of natural gas in Russia shows a quite stable trend during a 20-year period. After a gradual growth in the volume of gas extracted from the ground until 2008, we observe a 12 % decline in the following year, caused by world financial crisis. However, in 2010, Russia was able to recover quicky to the previous level of natural gas production. After this period, the number of natural gas produced had remained stable until a slight drop in 2014. This can be explained by economic sanctions towards Russia from other countries due to Ukrainian crisis.

5.6.4. Average rate USD/RUB

Figure 12: Average rate USD/RUB



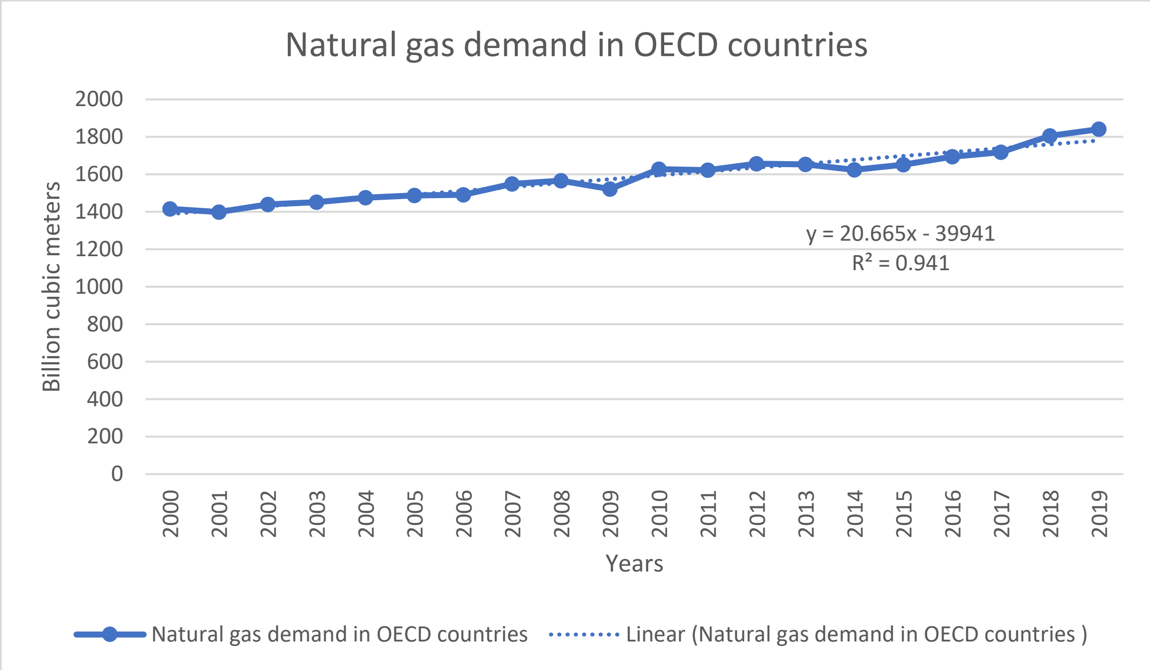
Source: own elaboration based on data from the Central Bank of Russia

Trend function: y = 1,9919x – 3964,8. *Coefficient of determination* R^2 = 0,6269

US dollar to Russian ruble exchange rate is considered to be an important factor in the development of the Russian economy. As it has been already clarified, the exports significantly exceed import in the trade of Russia among other countries. According macroeconomic theory depreciated national currency contributes to increase in revenues of exporters, while strong exchange rate leads to rising the amount of imports and declining of export volumes thus Russian exporters might lose their export earnings. Moreover, weak national currency might cause inflation growth as country pay more to import a foreign good thus local producers could start to substitute these imports and increase domestic output. Average exchange rate of dollar and rubble was relatively stable until 2014 and slightly fluctuated in the range from approximately 25 to 32 rubles for USD, with exception of 2008, when, as it has been mentioned before, economic crisis occurred. From 2014 to 2016, the local currency depreciated by more than 70%. During 3-year period investors were not confident in the economy so many of them sold their Russian assets and bonds, which leaded to the significant capital outflow and resulted in devaluation of the ruble. This was caused by economic sanctions from other countries against Russia during the Ukrainian crisis.

5.6.5. Natural gas demand in OECD countries

Figure 13: Natural gas demand in OECD countries



Source: own elaboration based on data from the International Energy Agency

Trend function: y = 1,9919x – 3964,8. *Coefficient of determination* R^2 = 0,6269

The Organization of Economic Co-operation and Development (OECD) is an international organization contributing principles of democracy and free market economy aimed to cooperate on world problems. Nowadays it includes 37 member countries. Negotiations about membership of Russia along with other countries have started on 16th of May 2007. As ministers of the OECD noted that the Russian Federation was a "special case" due to country's previous relationship with the organization. However, on 12th of March 2014 due to Russian-Ukrainian conflict the accession process was suspended. (OECD, 2014)

According to the graph below, the demand of natural gas in the OECD countries has been continuously growing throughout the given period with the exception in 2009, when consumption of gas decreased by approximately 3%. There is also as slight decline in 2014 since this year was recorded with above average temperature throughout a period that contributed to reduction of natural gas usage in residential and industrial sectors. Overall, the demand has increased from 1,416 to 1,841 trillion cubic meters during a 20-year period, which accounted for 30% of growth.

5.7. Multiple linear regression model (LRM)

Linear regression model (LRM) is widely used in econometrics. It assumes that there is a linear relationship in dataset among observations of predicted variables and regressors. Model with one independent variable is simple linear regression model, while model with two and more independent variable is called multiple linear regression model. (Chatterjee, Simonoff, 2013)

The mathematical expression of multiple LRM is represented by the following equation:

Formula 1: Linear regression model equation

$$\boldsymbol{y_i = \beta_o + \beta_1 x_{1i} + \beta_2 x_{2i} + I + \beta_n x_{ni} + \varepsilon_i,}$$

where

$\boldsymbol{y_i}$ … *dependent variable*

$\boldsymbol{x_{ni}}$ … *independent variables*

$\boldsymbol{\beta_n}$ … *coefficients of parameters*

$\boldsymbol{\varepsilon_i}$ … *a random component or error term*

5.8. Assumptions of LRM

To match our sample data in the model with large population and provide an estimation with making possible prognoses, we are required to have an appropriate linear regression model. There are some following assumptions that must be checked whether they are correct or not in order to meet our requirements. (Young, 2017)

These assumptions include:

1. **Linearity**. In the straight-line equation that we use in our model, we suppose that "average" sample in the data is linear. Using the wrong equation, predicted values will consistently lose a true sample of expected values of dependent and independent variables.
2. **E(u_t)=0**, i.e. the expected value of errors is equals to zero. A contravention of this assumption might cause issues with estimation of β_0 parameter.

3. **Normality of residuals**, i.e. errors are normally distributed with a mean of zero ($\varepsilon_i \sim NID(0, \sigma^2$, where NID stands for "normally and independently distributed). This assumption is especially important for construction of confidence or prediction intervals and hypothesis tests thus a violation of it will lead to wrong results.
4. **Homoskedasticity of residuals**, the variance of errors is constant (Var (ε_i) = σ^2 for all i). If this assumption is not met, then least squares estimates method is not as appropriate as it could be for parameter estimation. Moreover, an existence of heteroskedasticity might cause inaccurate confidence and prediction intervals.
5. **Independence of residuals (no autocorrelation)**, i.e. errors are not correlated to each other (Cov ($\varepsilon_i, \varepsilon_j$) = 0 for $i \neq j$). Such deviation usually occurs in time series, where errors in data that are close to each other in time are also similar to each other. Disregarding of this assumption leads to doubtful valuation of robustness of the regression and indicates of incorrectly specified model thus final conclusion could be misleading.
6. **The absence of perfect multicollinearity.** This assumption is related to high correlation among independent variables, which leads to instability in the regression coefficients.

Therefore, a foundational stage of any regression analysis is to avoid misleading results by checking eligibility criteria of each assumption and identify its correctness. (Chatterjee, Simonoff, 2013)

5.9. Economic model

Sometimes we are required to describe a behavioral relationship among various indicators. To test our economic theory in the form of mathematical equation, economic model is constructed. An economic model can serve as a starting point for future econometric analysis. (Wooldridge, 2012)

Based on our data, the economic model can be written in the following form:

Formula 2: Economic model

$$\boldsymbol{y = f(x_1, x_2, x_3, x_4,),}$$

Where

$\boldsymbol{y}$ … *natural gas exports*

$\boldsymbol{x_1}$ … *average natural gas export prices*

$\boldsymbol{x_2}$ … *natural gas production*

$\boldsymbol{x_3}$ … *average rate USD/RUB*

$\boldsymbol{x_4}$ … *natural gas demand in OECD countries*

5.10. Econometric model

After an economic model is specified, we can proceed to the next step of building an econometric model. The difference between these models is a presence of stochastic variable (error term) in econometric model.

Formula 3: Econometric model

$$\boldsymbol{y_t = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \gamma_4 x_{4t} + \gamma_5 x_{5t} + u_t},$$

Where

$\boldsymbol{y_t}$ … *natural gas exports* (endogenous variable)

$\boldsymbol{x_{1t}}$ … *unit vector* (exogenous variable)

$\boldsymbol{x_{2t}}$ … *average natural gas export prices* (exogenous variable)

$\boldsymbol{x_{3t}}$ … *natural gas production* (exogenous variable)

$\boldsymbol{x_{4t}}$ … *average rate USD/RUB* (exogenous variable)

$\boldsymbol{x_{5t}}$ … *natural gas demand in OECD countries* (exogenous variable)

$\boldsymbol{u_t}$ … *error term* (stochastic variable)

5.11. Correlation matrix

Dependence among exogenous variable can be identified through calculation of correlation coefficient. According to Wooldridge (2012), it is defined as a measure of linear association among selected variables.

To test whether two independent variables are positively or negatively related to each other, correlation analysis can be performed. Compared to regression, correlation analysis is less powerful tool in identifying relationship among variables since it measures only an association and have a small use in predictions. (Montgomety, Peck, Vining, 2012)

There are some different correlation statistics, which could diagnose the correlation coefficient, but the most common used is the Pearson correlation coefficient:

Formula 4: The Pearson correlation coefficient

$$\boldsymbol{r} = \frac{\sum_{i=1}^{n}(\boldsymbol{x_i} - \overline{\boldsymbol{x}})(\boldsymbol{y_i} - \overline{\boldsymbol{y}})}{\sqrt{\sum_{i=1}^{n}(\boldsymbol{x_i} - \overline{\boldsymbol{x}})^2}\sqrt{\sum_{i=1}^{n}(\boldsymbol{y_i} - \overline{\boldsymbol{y}})^2}},$$

Where

$\boldsymbol{n}$ …*sample size*

$\boldsymbol{x_i}, \boldsymbol{y_i}$ … *samples*

$\overline{\boldsymbol{x}}, \overline{\boldsymbol{y}}$ … *sample mean*

Sometimes independent variables are highly correlated to each other. If correlation coefficient is above $|0{,}8|$, then it causes a *multicollinearity* problem. According to Montgomery, Peck and Vining (2012), sources of multicollinearity might include a selected data collection method, constraints on the model, model specification and over defined model. To test whether there is a multicollinearity issue or not, we can construct a correlation matrix or calculate a Variance Inflation Factor (VIF). In our case, we use a correlation matrix proceeded in Gretl application:

Table 6: Correlation matrix

	x_2	**x_3**	**x_4**	**x_5**
x_2	1.0000	0.4700	-0.0907	0.4683
x_3		1.0000	0.5433	0.8858
x_4			1.0000	0.7692
x_5				1.0000

Source: own elaboration based on output from Gretl application

According to the table above, we can see that one of values is accounted for 0,8858, which is higher than $|0{,}8|$. It means that variables x_3 (natural gas production) and x_5 (natural gas demand in OECD countries) are highly correlated between each other. In this case, to avoid an instability in regression coefficient, we are required to perform a multicollinearity elimination.

5.11.1. Multicollinearity elimination

Elimination of multicollinearity can be performed by following methods: first differences, relative differences, differences from an average and introduction of a dummy variable. To avoid multicollinearity issues, in our case, we perform 1st differences method for *natural gas demand in OECD countries* variable. Therefore, the consequences of application a chosen technique is a reduction of a period by one year thus a selected dataset is represented by a new time frame from 2001 to 2019. As a result, we have a new modified table, which is listed below:

Table 7: Dataset after multicollinearity elimination

Year	Russia's natural gas export	Unit vector	Average natural gas export prices	World natural gas production	Average rate USD/RUB	Natural gas demand in OECD countries (first differences)
	y	x_1	x_2	x_3	x_4	Δx_5
2001	180,9	1	98,25	526,2	29,17	**-17**
2002	185,5	1	85,69	538,8	31,35	**40**
2003	189,4	1	105,51	561,5	30,69	**12**
2004	200,4	1	109,05	573,3	28,81	**25**
2005	209,2	1	151,36	580,1	28,30	**11**
2006	202,8	1	216,00	595,2	27,17	**4**
2007	191,9	1	233,66	601,6	25,58	**58**
2008	195,4	1	353,69	611,5	24,86	**18**
2009	168,4	1	249,27	536,2	31,83	**-45**
2010	177,8	1	268,48	598,4	30,36	**105**
2011	189,7	1	338,88	616,8	29,39	**-4**
2012	178,7	1	348,33	601,9	31,08	**33**
2013	196,4	1	335,87	614,5	31,85	**-2**
2014	174,3	1	313,81	591,2	38,61	**-30**
2015	185,5	1	225,26	584,4	61,07	**28**
2016	198,7	1	156,95	589,3	66,08	**43**
2017	213,0	1	181,49	635,6	58,29	**24**
2018	223,0	1	223,11	669,1	62,69	**87**
2019	220,6	1	189,44	679	64,73	**35**

Source: own elaboration based on data from FSSS, IEA and CBR

As well as for previous model, we perform a correlation analysis for the selected dataset:

Table 8: Correlation matrix after multicollinearity elimination

	x_2	x_3	x_4	Δx_5
x_2	1.0000	0.4003	-0.1517	-0.0836
x_3		1.0000	0.5285	0.4385
x_4			1.0000	0.2979
Δx_5				1.0000

Source: own elaboration based on output from Gretl application

As we can see, all values from a new correlation matrix are lower than $|0{,}8|$ and we can safely say that there is no multicollinearity in the model. Therefore, our new econometric model can be written in the following form:

Formula 4: Econometric model after multicollinearity elimination

$$y_t = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \gamma_4 x_{4t} + \gamma_5 \Delta x_{5t} + u_t$$

Where

y_t … *natural gas exports* (endogenous variable)

x_{1t} … *unit vector* (exogenous variable)

x_{2t} … *average natural gas export prices* (exogenous variable)

x_{3t} … *natural gas production* (exogenous variable)

x_{4t} … *average rate USD/RUB* (exogenous variable)

Δx_{5t} … first differences of *natural gas demand in OECD countries* (exogenous variable)

u_t … *error term* (stochastic variable)

Based on available data, we can make assumptions about our regression coefficients in the model and then after the whole estimation, check its truthfulness. These assumptions are listed below:

Assumptions of estimated parameters:

- If average exports prices on natural gas ***increase***, then exports of Russian natural gas should ***decrease***.
- If natural gas production in Russia ***increases***, then exports of Russian natural gas should ***increase***.

- If average rate USD/RUB ***increases***, then exports of Russian natural gas should ***increase***.
- If first differences of natural gas demand in OECD countries ***increase***, then exports of Russian natural gas should ***increase***.

5.12. Descriptive statistics

This part is aimed to describe and summarize a selected data by using basic characteristics of information such as mean, median, standard deviation, minimum and maximum values. On the table 7, summary statistics is shown:

Table 9: Descriptive statistics

Variable	Mean	Median	Standard Deviation	Min	Max
y	194.	192.	15.3	168.	223.
x2	220.	223.	89.3	85.7	354.
x3	595.	595.	40.0	526.	679.
x4	38.5	31.1	15.1	24.9	66.1
first_dif_x5	22.4	24.0	36.6	-45.0	105.

Source: own elaboration based on output from Gretl application

5.13. Parameter estimation using OLS

After model is defined, the next step of any econometric analysis to evaluate an unknown relationship between response variable and regressors thus its aimed to identify values of unknown parameters based on collected data. The most common used technique for parameters estimation is Ordinary Least Squares (OLS), which involves method of minimizing squares of residuals. (Chatterjee, Hadi, 2006)

The essence of OLS is expressed in mathematical equation:

Formula 5: The essence of OLS

$$\boldsymbol{min \sum_{t=1}^{n} \hat{u}_i^2 = min \sum_{t=1}^{n} (y_i - \hat{y}_i)^2}$$

Where

$\boldsymbol{\hat{u}}$ … residual value (represented by the difference between actual (y_i) and fitted (y_i) values)

$\boldsymbol{y_i}$ … actual value

$\boldsymbol{\hat{y}_i}$ … fitted value

$\boldsymbol{n}$ … number of observations

As a result of using this technique, we receive the estimated OLS equation as follows:

Formula 6: OLS equation

$$\boldsymbol{\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \cdots + \hat{\beta}_i x_i}$$

Where

$\boldsymbol{\hat{y}_i}$ … fitted value

$\boldsymbol{\hat{\beta}_0}$ … the estimate of intercept β_0

$\boldsymbol{\hat{\beta}_i}$ … the estimate of parameter β_i

$\boldsymbol{x_i}$ … regressor

To calculate regression coefficients of selected variables, we use OLS method from Gretl software:

Table 10: OLS parameter estimation

Name of variable	Parameter value
unitary vector (x_{1t})	−37,4887
average natural gas export prices (x_{2t})	−0,128200
natural gas production (x_{3t})	0,451336
average rate USD/RUB (x_{4t})	−0,194937
first differences of natural gas demand in OECD countries (Δx_{5t})	−0,0685722

Source: own elaboration based on output from Gretl application

Therefore, our estimated econometric model can be written in the following form:

$$\boldsymbol{y_t = -37,489 - 0,128 x_{2t} + 0,451 x_{3t} - 0,195 x_{4t} - 0,069 \Delta x_{5t} + u_t}$$

5.14. Interpretation of parameters

In this part, we interpretate estimated parameters and compare their values with assumptions of regression coefficients:

1. *Interpretation of the intercept* $\boldsymbol{\gamma_1}$: If there is no influence on dependent variables (all independent variables are equal to zero), then exports of Russian natural gas is -37,489 billion cubic meters, else ceteris paribus.
2. *Interpretation of the intercept* $\boldsymbol{\gamma_2}$:: If average natural gas export prices increases by 1 USD per thousand cubic meters, then exports of Russian natural gas decrease by 0,1282 billion cubic meters, else ceteris paribus.

Assumption is ***correct***.

3. *Interpretation of the intercept* $\boldsymbol{\gamma_3}$: If natural gas production increases by 1 billion cubic meters, then exports of Russian natural gas increase by 0,451 billion cubic meters, else ceteris paribus.

Assumption is ***correct***.

4. *Interpretation of the intercept* $\boldsymbol{\gamma_4}$: If average rate USD/RUB increases by 1 unit, then exports of Russian natural gas decrease by 0,195 billion cubic meters, else ceteris paribus.

Assumption is ***wrong***.

5. *Interpretation of the intercept* $\boldsymbol{\gamma_5}$: If first differences of natural gas demand in OECD countries increases by 1 billion cubic meters, then exports of Russian natural gas decrease by 0,069 billion cubic meters, else ceteris paribus.

Assumption is **wrong**.

5.15. Statistical validation

Since regression models are commonly used for explanation of relationship among variables and prediction of some future values, it is significantly important to provide a statistical validation of our model. A perfectly validated equation supported by analysis of the adequacy of the regression model leads to the confirmation that the model can be effectively used in the subsequent estimation. (Montgomery, Johnson, Gardiner, 1990)

Goodness of fit index (R-squared):

Coefficient of determination (R^2) is one of the tools that allows to check the adequacy of the regression model, i.e. it one of the ways to measure the quality of fit. R-squared is represented by the amount of total variability in the response variable $\boldsymbol{Y}$ that is explained by predictors $\boldsymbol{X}$ in the regression model. In general, it shows how the regression line of OLS fits the data. The values of R-squared can be in the range of 0 to 1 thus, if coefficient of determination is equal to 1, then it causes perfect fitting of OLS estimation to the data. Relatively low values of R^2 means that unexplained variations may be included in the error terms of the model, so it does not necessarily lead to useless of utility of the regression and we can still continue to estimate. (Wooldridge, 2012)

The mathematical equation of calculating coefficient of determination is shown in the formula below:

Formula 7: R-squared (R^2) – coefficient of determination

$$\boldsymbol{R^2 = \frac{SSE}{SST} = 1 - \frac{SSR}{SST}},$$

Where
$\boldsymbol{R^2}$ … coefficient of determination
$\boldsymbol{SSE}$ … sum of squares error
$\boldsymbol{SSR}$ … sum of squares regression
$\boldsymbol{SST}$ … sum of squares total

As it can be seen in the Appendix 1, the value of coefficient of determination (R^2) from OLS output in the Gretl software is equal to 0,858049. This means that regressors explain 85,8% of variations in response variable for the sample of 19 observations. In the OLS report, there is also another value corrected R-squared (R^2_{adj}), which is adjusted to the number of independent variables in the model and equals to 0.817492. As well as the normal coefficient of determination, it shows that 81,7% of total variability in the dependent variable is explained by changes in the independent variables.

Significance of the whole model:

An overall significance of the model verifies whether sample data from the model perfectly fits the population. F-test is widely used in analysis of variance (ANOVA) and determination of the importance of selected model. When stating a null hypothesis, each test statistic has Fisher distribution. Thus, null hypothesis for F-test are stated below:

H_0: $\beta_1 = \cdots = \beta_i = 0$ (the model is statistically significant)
H_0: $at\ least\ one\ of\ \beta_i \neq 0$ (the model is not statistically significant)

From OLS output in Gretl software, p-value of F-statistics is equal to 8.14e-06, which is relatively low number. Comparing p-value with the level of significance (0,05), we reject the null hypothesis. Consequently, the whole model is statistically significant.

Significance of regression coefficients:

This part is devoted to test of the significance of an individual regression coefficient in the model. To test the importance of each estimated parameter, we use t-statistic, which is defined by mathematical expression below:

Formula 8: t-statistic

$$\boldsymbol{t_{\hat{\beta}_j}} = \frac{\boldsymbol{\hat{\beta}_j}}{\boldsymbol{SE(\hat{\beta}_j)}},$$

Where

$\boldsymbol{\hat{\beta}_i}$ … estimated parameter

$\boldsymbol{SE(\hat{\beta}_j)}$ … standard error of estimated parameter

Null and alternative hypotheses for significance test are set as follows:

H_0: $\beta_i = 0$ (estimated parameters are not statistically significant)

H_a: $\beta_i \neq 0$ (estimated parameters are statistically significant)

We use OLS output from Gretl to detect an individual significance of each variables:

Table 11: Statistical significance of estimated parameters

Variable	t-statistic	p-value	Significance level (α)	Decision
x_{2t}	−5.740	<0.0001	0,05	*Reject H_0*
x_{3t}	7.292	<0.0001	0,05	*Reject H_0*
x_{4t}	−1.435	0.1732	0,05	*Accept H_0*
Δx_{5t}	−1.389	0.1866	0,05	*Accept H_0*

Source: own elaboration based on output from Gretl application

From Gretl report we use p-values and compare them with level of significance, which we set on 0,05. As a result, we reject null hypotheses for average natural gas export prices and natural gas production thus these predictors are statistically significant. On the other hand, null hypotheses for average rate USD/RUB and first differences of natural gas demand in

OECD countries are accepted, explaining that these regressors are not statistically significant.

5.16. Assumptions verification

This part is devoted to checking assumptions of our econometric model for the subsequent estimation thus autocorrelation, heteroskedasticity and normality of residuals will be tested.

Autocorrelation:

Correlation among residuals at different time periods should be avoided according to the assumptions of the model. Generally, it assumes that there is some additional information in the dataset, which is not used in the model. The correlation under the condition of natural sequence order of observations is called *autocorrelation*. There can be different sources of autocorrelation, including consistency in values of time series, when high values are grouped together, and low values are also are stacked on each other (there is absence of shock phenomenon) or exclusion of a significant regressor etc. The problem of correlation among disturbance terms can cause some unfavorable effects such as inefficient OLS estimation as minimum variance does not exist for regression coefficients, standard errors of estimated parameters and σ^2 are biased and invalidity of significance tests, confidence and prediction intervals. To diagnose the presence of autocorrelation, various statistical tests are used as Breusch-Godfrey and Durbin-Watson tests. (Chatterjee, Simonoff, 2013)

Based on OLS error terms, the mathematical expression of Durbin-Watson statistic is:

Formula 9: Durbin-Watson statistic

$$\boldsymbol{DW = \frac{\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{n}\hat{u}_t^{\,2}}},$$

where

$\boldsymbol{\hat{u}_t}$ … residual

$\boldsymbol{n}$ … number of observations

The values of DW statistic ranges between 0 and 4, considering that value of 2 shows the absence of correlation among residuals. For autocorrelation testing, hypotheses are stated:

H_0: $\rho = 0$ (absence of autocorrelation)
H_a: $\rho > 0$ (presence of autocorrelation)

In the OLS output from Gretl software, DW statistic is equal to 2,148751, which shows that a slightly negative autocorrelation exists, but values in the range of 1,5 to 2,5 are acceptable thus it means correlation among error terms is not found.

Heteroscedasticity:

Another assumption of the consistency of residual variance must be verified. In our model, we would like to have homoscedasticity, avoiding non-constant error variance of all observations in dataset. In case of heteroscedasticity in the model, the accuracy of estimated parameters will be in a doubt as well as their standard errors. To detect such issue, we can use scatter plot or perform Breusch-Pagan or White's tests. (Chatterjee, Hadi, 2006)

Null and alternative hypotheses for Breusch-Pagan test are:

H_0: $\sigma_i^2 = \sigma^2$ (homoscedasticity is present)
H_a: $\sigma_i^2 \neq \sigma^2$ (heteroscedasticity is present)

From Appendix, the p-value of test statistic is equal to 0,850221, which is higher than selected level of significance (0,05) thus we accept the null hypothesis, confirming errors in the model are homoscedastic.

Normality of residuals:

Last important assumption checks whether disturbance terms are normally distributed in the model. Normality of residuals assumes that the population error is independent of regressors and normally distributed with zero mean. As it has been already mentioned, a violation of this assumption will lead to unreliable results of estimation. To diagnose normal distribution of error terms can be done through histograms, box and Q-Q plots of data or proceeding various tests. In our case, we use values from the test performed in Gretl application (Shapiro-Wilk is chosen for normality test).

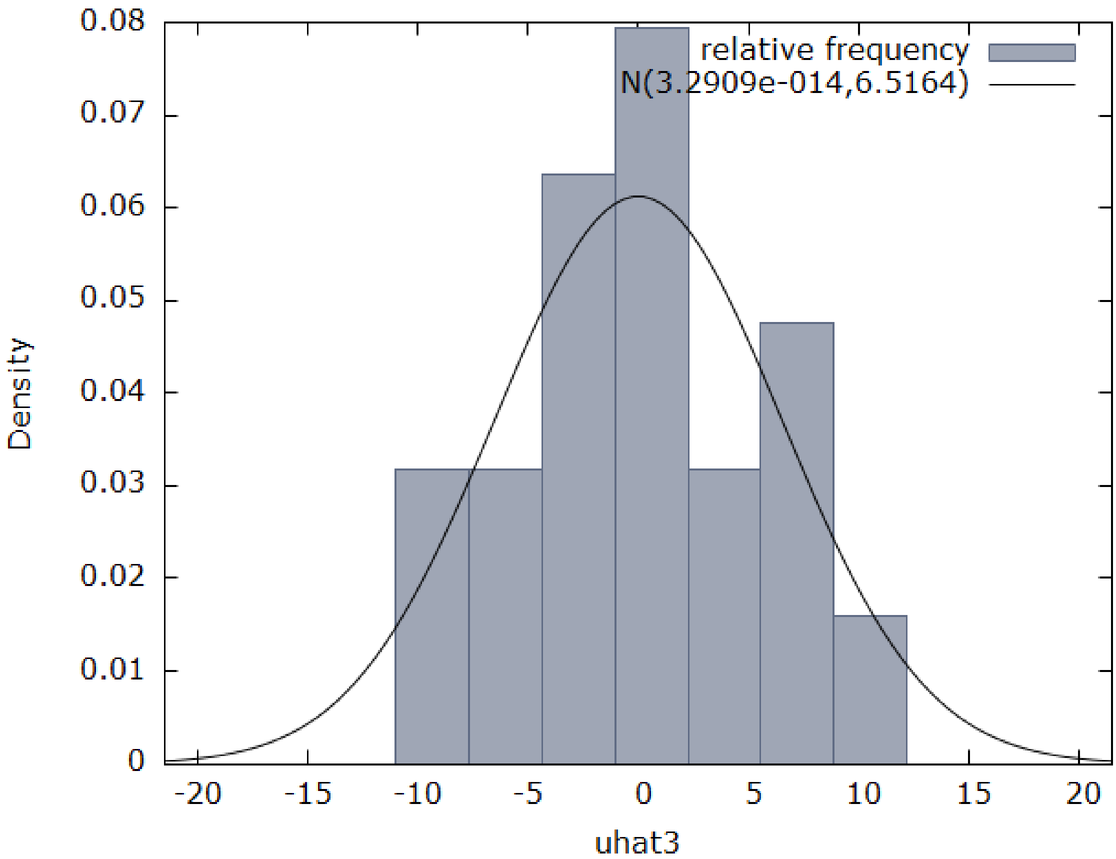
Null and alternative hypotheses for Shapiro-Wilk test are:

H_0: The sample data is not significantly different from normal distribution

H_a: The sample data is significantly different from normal distribution

From the test for normality appendix, we extract p-value of test statistic, which is accounted for 0,715556. Comparing to alpha (0,05), it is higher than level of significance thus we accept the null hypothesis, which means that residuals are normally distributed in the model. To support our results, the histogram of residual distribution is shown below:

Figure 14: Residual distribution



Source: output from Gretl application

The graph of residual distribution explains that errors in the model are distributed normally and corresponds to the line of normal distribution function thus it is evident that this assumption will not violate an estimation of this model.

5.17. Model application

In this part, application of chosen econometric model is performed, by calculating elasticity coefficients of predictors and making prognoses of response variable for the future period.

5.17.1. Coefficients of elasticity

Elasticity coefficients measure percentage sensitivity of one economics variable to the changes of another variable. By applying this technique in econometrics, elasticity of explained variable $\boldsymbol{y}$ with respect to explanatory variable $\boldsymbol{x}$ is the percentage change in $\boldsymbol{y}$ when $\boldsymbol{x}$ increases by 1%. (Wooldridge, 2012)

The basic formula for calculation coefficients of elasticity is:

Formula 10: Elasticity coefficient

$$\boldsymbol{E = \frac{\partial y_t}{\partial x_i} * \frac{x_i}{\hat{y}_i}}$$

Where

$\boldsymbol{y_t}$ … natural gas exports value

$\boldsymbol{x_i}$ … regressor

$\boldsymbol{\hat{y}_i}$… fitted value

For identifying elasticities for all parameters, the common fitted value is calculated for 2019:

$$\hat{y}_{2019} = -37{,}49 \; - 0{,}13 * 189{,}44 + 0{,}45 * 679 - 0{,}2 * 64{,}73 - 0{,}07 * 35 = 229{,}5$$

Now we can calculate value of elasticities for each variable:

1. ***Average natural gas export prices elasticity:***

$$E = \frac{\partial y_{1t}}{\partial x_{2t}} * \frac{x_{2,19}}{\hat{y}_i} = -0{,}13 \; * \; \frac{189{,}44}{229{,}5} = -0{,}1073$$

A selected variable (x_{2t}) is *inelastic* since $0{,}1073 \in < -1; 1 >$

Explanation of elasticity coefficient: If average natural gas export prices increase by 1%, then Russia’s natural gas exports decrease by 0,1073%.

2. ***Natural gas production elasticity:***

$$E = \frac{\partial y_{1t}}{\partial x_{3t}} * \frac{x_{3,19}}{\hat{y}_i} = 0{,}45 \ * \ \frac{679}{229{,}5} = 1{,}33$$

A selected variable (x_{3t}) is *elastic* since $1{,}33 \in < \infty; -1 > \cup < 1; \infty >$

Explanation of elasticity coefficient: If natural gas production increase by 1%, then Russia's natural gas exports increase by 1,33%.

3. ***Average rate USD/RUB***

$$E = \frac{\partial y_{1t}}{\partial x_{4t}} * \frac{x_{4,19}}{\hat{y}_i} = -0{,}2 * \frac{64{,}73}{229{,}5} = -0{,}056$$

A selected variable (x_{4t}) is *inelastic* since $-0{,}056 \in < -1; 1 >$

Explanation of elasticity coefficient: If average rate USD/RUB increase by 1%, then Russia's natural gas exports decrease by 0,056%.

4. ***First differences of natural gas demand in OECD countries***

$$E = \frac{\partial y_{1t}}{\partial x_{5t}} * \frac{x_{5,19}}{\hat{y}_i} = -0{,}07 \ * \ \frac{35}{229{,}5} = -0{,}0107$$

A selected variable (x_{5t}) is *inelastic* since $-0{,}0107 \in < -1; 1 >$

Explanation of elasticity coefficient: If first differences of natural gas demand in OECD countries increase by 1%, then Russia's natural gas exports decrease by 0,0107%.

A total outcome from calculating of elasticity coefficients is summarized in the table below:

Table 12: Summary of elasticity coefficients

	$\boldsymbol{x_{2t}}$	$\boldsymbol{x_{3t}}$	$\boldsymbol{x_{4t}}$	$\boldsymbol{x_{5t}}$
$\boldsymbol{\partial y / \partial x_i}$	-0,13	0,45	-0,2	-0,07
$\boldsymbol{x_{i,19}}$	189,44	679	64,73	35
$\boldsymbol{\hat{y}}$	229,5	229,5	229,5	229,5
E	-0,1073 (inelastic)	1,33 (elastic)	-0,056 (inelastic)	-0,0107 (inelastic)

Source: own calculations

5.17.2. Forecasting

Forecasts are aimed to predict future development of chosen economic indicators. The time period can be represented by day, week, month, quarter, year etc. There are two types of prognose according to forecast horizons that can be performed in the regression models: *one-step-ahead* and *multiple step-ahead* forecasts. The first type is focused on predicting $\boldsymbol{y_{t+1}}$ at time $\boldsymbol{t}$ of the subsequent period, while the second type is represented by forecast of y_{t+h} at time $\boldsymbol{t}$ and positive integer $\boldsymbol{h}$ of concrete future value. Moreover, forecasts can be also recognized according to type of regression models used: *conditional* and *unconditional* forecast. Conditional one is used when we know the value of predictor $\boldsymbol{x_i}$ at time $\boldsymbol{t+1}$ and unconditional is used when the value of regressor $\boldsymbol{x_{i+1}}$ at time $\boldsymbol{t}$ is unknown (Wooldridge, 2012)

Firstly, to obtain future values for response variable $\boldsymbol{y_{1t}}$ (Russia's natural gas exports), we should specify our forecast horizon. The following 3-year period is taken, represented by 2020, 2021 and 2022 years thus time $t = 20$, $t = 21$ and $t = 22$ respectively. Furthermore, since values of explanatory variables for these next years are unknown, we are required to find them by using trend function. Thus, our forecast related to unconditional multiple-step-ahead forecast.

Table 13: Trend functions

Variable	Trend function	R^2
Average natural gas export prices	x_{2t} = 6,8168t + 152,05	0,1845
Natural gas production	x_{3t} = 5,5051t + 539,93	0,6009
Average rate USD/RUB	x_{4t} = 2,1509t + 17,013	0,6422
First differences of natural gas demand in OECD countries	x_{5t} = 1,5456t + 6,9649	0,0566

. Source: own elaboration based on calculations from Excel

The next step is to identify unknown values of independent variables for 2020,2021 and 2022 years.

Table 14: Future values for independent variables

Variable	T=20 (2020)	T=21 (2021)	T=22 (2022)
x_{2t}	288,386	295,2028	302,0196
x_{3t}	650,032	655,5371	661,0422
x_{4t}	60,031	62,1819	64,3328
x_{4t}	37,8769	39,4225	40,9681

Source: own calculations

After future values of regressors were found and shocks were not detected, we can calculate future values of dependent variable:

$$\hat{y}_{2020} = -37{,}49 \ - 0{,}13 * 288{,}39 + 0{,}45 * 650 - 0{,}2 * 60{,}03 - 0{,}07 * 37{,}89 = 202{,}85$$

$$\hat{y}_{2021} = -37{,}49 \ - 0{,}13 * 295{,}2 + 0{,}45 * 655{,}54 - 0{,}2 * 62{,}2 - 0{,}07 * 39{,}4 = 203{,}93$$

$$\hat{y}_{2022} = -37{,}49 \ - 0{,}13 * 302 + 0{,}45 * 661{,}04 - 0{,}2 * 64{,}3 - 0{,}07 * 40{,}97 = 204{,}99$$

Thus, graphical presentation of results of unconditional multi-step-ahead forecast is shown on the Figure below:

Figure 15: Russia's natural gas exports (forecast)

Source: own elaboration and calculations based on data from FSSSR (Rosstat)

6. Results and discussion

In the practical part, we analyzed trade balance, the structure of exports and imports and major export destination countries of natural gas. As we identified, Russia has a trade surplus during a 20-year period and focuses primarily on exporting mineral commodities and importing machines and transport in 2019. In 2016, main import directions of Russian gas were Germany, Italy, Belarus and Turkey. We also examined and analyzed the relationship between exports of Russian natural gas and selected economic indicators. For constructing a one-equation econometric model, we chose four factors that can have a possible influence on volume of gas transported abroad: average gas export prices, gas production in Russia, average exchange rate of US dollar to Russian ruble and consumption of this commodity in the OECD states. At the beginning of estimating the model, we found out a multicollinearity issue, which was eliminated by applying first differences techniques for natural gas demand in the OECD countries variable. The following correlation matrix showed that correlation among regressors is not present. Parameter estimation showed us that we were right about two assumptions stated during the construction of econometric model and wrong about two others. After that, a statistical validation of the model was performed, which was aimed to identify coefficient of determination and diagnose a statistical significance of the whole model and each individual parameter. The value of R-squared was 0,858049, showing that changes in exogenous variables are explained by changes in endogenous variables by 85,8%. Since p-value of F-statistic was equal to 8.14e-06, we rejected the null hypothesis, and it is evident that the whole model can be applied for population. As for significance tests of individual variables, the results explained us that export prices and production in Russia have a statistically significant influence on response variables at level of significance 0,05, while others do not. The following stage of model estimation was to rule out the existence of autocorrelation, heteroskedasticity and abnormal distribution of residuals. The selected tests excluded a presence of these problems and proved the correctness of all defined assumptions. Last but not least, we made a forecast of average Russian gas exports variable for the next 3-year period, including 2020, 2021 and 2022 year. Since future values of independent variables were unknown, we had to identify trend functions for each variable to calculate values for these years thus the forecast is referred to unconditional multi-step-ahead type. According to the results, predictions for 2020, 2021 and 2020 showed a positive trend in increase of exports however the growth rate is low.

7. Conclusion

The primary goal of this diploma thesis was to study foreign trade of Russia, focusing on exports of natural gas. From theoretical part, various transportation methods of natural gas, global gas market and the development of gas sector in Russia were discovered. In practical part, we attempted to find the influence on exports of Russian gas from chosen economic indicators by constructing one-equation economics model. In the model, we could see that average global export prices and total output of natural gas in Russia significantly affect the volume of exports. Overall, exports were increasing during a chosen 20-year period and the main consumption market during these years was located in Europe.

The natural gas sector along with oil industry is vitally important for the Russian economy, determining an economic performance and political stability of the country. It is also one of the most powerful tools of regulating domestic and international policies. As one of the largest producers of world gas supply, the Russian Federation can have a huge market impact in some regions of imports, controlling the flows of blue fuel. However, nowadays the Russian gas sector is standing on crossroad facing various challenges for delivery of this commodity. These hardships might lead to substantial structural changes in production and transporting of natural gas abroad, which will define main trade directions of industry development in the future.

The world pandemic situation has significantly affected oil and gas industries. Exports of natural gas from Russia have decreased by almost 50% than in the same period last year. The drop in exports has also increased the share of LNG supplies, despite a slight decline of 5% in 2020. This can be explained that during the period of decreased demand, the liquified gas can be stored longer until consumption will level off. According to some estimations, LNG transportations will soon outweigh pipeline delivery method, so it is significantly important to develop chains of liquified gas to satisfy a required demand. However, since the EU has an ambitious plans to improve energy efficiency of buildings and industrial factories to together with policies referred to reduction of CO_2 emissions, nowadays Russia should look at Asian markets to conserve supplies of gas at sufficient level, especially China due to high economic growth, large potential in industrial sector and increasing consumption of natural gas in this country. Moreover, the utility of some future global projects conducted by Gazprom such as Nord Stream 2, which had to ensure an additional gas supplies to Europe and compensate its demand, is questioned at the moment since Europe does not have needs in supplementary fuel volumes and it is difficult to predict whether the level of gas consumption in Europe will make it back.

On the other side, as we recently discovered, being an oil and gas dependent economy, the Russian Federation is forced to take a path of economy diversification under the circumstances of the prevailing situation to avoid future consequences of changes in values in the world. These decisions are dependent on authorities of the Russian Federation and can be implemented only by the government of the state.

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9. Appendixes

Appendix 1: Summary statistics (Gretl output)

Summary Statistics, using the observations 2001 - 2019

Variable	Mean	Median	S.D.	Min	Max
y	194.	192.	15.3	168.	223.
x2	220.	223.	89.3	85.7	354.
x3	595.	595.	40.0	526.	679.
x4	38.5	31.1	15.1	24.9	66.1
first_dif_x5	22.4	24.0	36.6	-45.0	105.

Appendix 2: Correlation matrix (Gretl output)

Correlation coefficients, using the observations 1 - 20
5% critical value (two-tailed) = 0.4438 for n = 20

x2	x3	x4	x5	
1.0000	0.4700	-0.0907	0.4683	x2
	1.0000	0.5433	0.8858	x3
		1.0000	0.7692	x4
			1.0000	x5

Appendix 3: Correlation matrix after multicollinearity elimination (Gretl output)

Correlation coefficients, using the observations 2001 - 2019
5% critical value (two-tailed) = 0.4555 for n = 19

x2	x3	x4	first_dif_x5	
1.0000	0.4003	-0.1517	-0.0836	x2
	1.0000	0.5285	0.4385	x3
		1.0000	0.2979	x4
			1.0000	first_dif_x5

Appendix 4: OLS method (Gretl output)

Model 1: OLS, using observations 2001-2019 (T = 19)
Dependent variable: y

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−37.4887	30.6637	−1.223	0.2417	
x2	−0.128200	0.0223343	−5.740	<0.0001	***
x3	0.451336	0.0618974	7.292	<0.0001	***
x4	−0.194937	0.135812	−1.435	0.1732	
first_dif_x5	−0.0685722	0.0493804	−1.389	0.1866	

Mean dependent var	193.7684	S.D. dependent var	15.25331
Sum squared resid	594.4811	S.E. of regression	6.516359
R-squared	0.858049	Adjusted R-squared	0.817492
F(4, 14)	21.15645	P-value(F)	8.14e-06
Log-likelihood	−59.67071	Akaike criterion	129.3414
Schwarz criterion	134.0636	Hannan-Quinn	130.1406
rho	−0.170341	Durbin-Watson	2.148751

Appendix 5: Breusch-Pagan test for heteroskedasticity (Gretl output)

```
Breusch-Pagan test for heteroskedasticity
OLS, using observations 2001-2019 (T = 19)
Dependent variable: scaled uhat^2

               coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const         -6.44990      5.47414      -1.178    0.2583
  x2            -0.00134571   0.00398717   -0.3375   0.7407
  x3             0.0141322    0.0110501     1.279    0.2217
  x4            -0.0143273    0.0242455    -0.5909   0.5640
  first_dif_x5  -0.00491523   0.00881548   -0.5576   0.5859

  Explained sum of squares = 2.73039

Test statistic: LM = 1.365193,
with p-value = P(Chi-square(4) > 1.365193) = 0.850221
```

Appendix 6: Normality test (Gretl output)

Test for normality of uhat1:

Doornik-Hansen test = 0.12535, with p-value 0.939249

Shapiro-Wilk W = 0.967014, with p-value 0.715556

Lilliefors test = 0.119597, with p-value ~= 0.67

Jarque-Bera test = 0.594651, with p-value 0.742802