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Oil Transit from the Caspian Region: What Opportunities are there for Georgia?

By

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Acknowledgments

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Abstract

The objective of this paper is to study the effects of cost factors involved in the transportation of Caspian region crude oil. The region is landlocked and far from the major petroleum consumer markets of OECD countries. However, proximity of Caspian and central Asian countries to the booming China has in the last decade loosened the location constraints. Despite the high transportation costs and transit time on various modalities of pipeline, short sea and railway routes used to get the petroleum to the markets, Caspian oil is playing a stabilizing role in the markets and will increasingly do so in the following decade to come.

It is no wonder the giant oil producing companies grew keen to set up their businesses in the regional energy sector since leading oil producers of the area, Kazakhstan and Azerbaijan, gained independence and opened the oil sector for investments. Pace of development in these countries is largely dependent on the efficient and stable recovery practice of their vast oil and gas reserves. The picture is charged by the active involvement of world and regional power states. The USA, EU and Russia backing of various transportation routes affect the pattern of oil flow directions. The competition in new route initiatives is also intensifying. At present, existing pipeline routes to the north (Russia), South (Azerbaijan, Georgia, Turkey) and East (China) offer ample capacity to the major oil producers of the region. Based on costs of transportation and available capacity they can select most cost efficient ones. However, quantified route and transit country specific risks can also be accounted for. Risk indexes and Network flow analysis is applied to measure the effects of socioeconomic and concentration factors in optimizing the export routes. Model scenarios show that the diversification among pipeline routes with more quantity of oil allocated to the northern direction and considerable weight given to southern corridor railways mode might be the best choice.

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Abbreviations

ADDY	Azerbaijan Railways
AIOC	Azerbaijan International Oil Corporation
ASN	Atyrau – Samara - Novorossiysk Pipeline
BN	Baku – Novorossiysk Pipeline
Bpd/mbpd	barrels per day / million barrels per day
BTC	Baku-Tbilisi-Ceyhan Pipeline
CASPAR	Caspian Shipping Company of Azerbaijan
CNPC	China National Petroleum Corporation
CPC	Caspian pipeline Consortium
ECTS	Energy Charter Treaty Secretariat
FSU	Former Soviet Union
GR	Georgian Railways
KMG	KazMunaiGaz (State oil and gas Company of Kazakhstan)
KTZ	Kazakhstan Railways
MEP	Middle East Petroleum
RTC	Rail Tank Carrier
SOCAR	State Oil Company of Azerbaijan
TCO	Tengizchevroil
Tpa	Tons per annum
WREP	Western Route Early Pipeline (Baku – Supsa, Georgia)

-Safety and certainty in oil lie in variety and variety alone-

Winston Churchill, 1914

1. Introduction

The objective of this thesis is to evaluate the effects of real costs in the selection of optimal export routes and modalities from oil exporting country major production fields on the example of the case of Caspian basin crude oil transportation sector.

Hence, we examine what could be the optimal logistical flow directions of Caspian crude oil at minimum cost and risk in the short and the medium terms when quantified micro and macroeconomic, political and social factors are applied within network flow problem model.

Petroleum is by far the most traded commodity worldwide. Access to and development of the oil reserves is an imminent priority of economic and geopolitical policies of the major world established and rising powers. No surprise, it is a subject of complex geopolitical and economic games to secure the steady flow of crude oil supplies to the markets. The interests of the oil rich countries, oil well developer and multinational energy companies, traders, net consumer economies are intersected at the crude oil and oil products global supply and demand equilibrium. Events associated with the physical supply or expected demand of petroleum to the markets cause the highest price volatility. In the 1970s, the decision of the Organization of Petroleum Exporting Countries' decision, controlling more than half the global crude oil supply, to manipulate the prices of the commodity and reduce the globally significant quantity of daily supply from their fields led to the supply shock that sent the global economy into high prices and recession. On the other hand, world financial meltdown and economic crisis of 2008, subsequent with slump in demand and growth brought all time record high oil prices down to the long forgotten bottom levels within a few weeks.

According to the oil multinational company ENI CEO “Maritime transport is the cheapest mode of transport, the main question is consequently to determine which port is economically most attractive” (Raballand, 2007) Indeed, Central Asia and Caspian region is far from an open sea port and this increases the transportation costs of getting the commodity to the markets. It has been estimated that transportation costs from the region are six times higher than from the Middle East. (Babali, 2007)

Generally energy transit routes, crude oil supply routes among them, are characterized by multi risk factor effects that may define the overall attractiveness of any route. For instance, European Union is concerned with the energy security in the mid and long term, and therefore prudent with selecting a set of routes that will provide safe and stable supply of oil and especially natural gas. There are economic, socio economic, geopolitical, and energy intrinsic factors influencing the security and sustainability of any energy corridor.

1.2 Research Methodology

This thesis was done primarily through desk research, interviews with several transport professionals and experts in the countries discussed.

Transportation and logistics costs data needed as an input for the network flow model is rather sensitive and had to be acquired from various sources. Often published figures are rounded, and may differ in conversion values (for example, Barrel to metric ton conversion factor is either 7.88 or 7.33 depending on the specifications of oil grades). However, speaking with different transport professionals, researchers and regulatory body employees it has been verified that data used from the reports are reflecting the reality.

Primary data on transportation costs have been obtained from Georgian Railways and minor part of data from Azeri Railways contractor forwarding companies. I have also used production and export figures from the report provided by Transport Administration of Georgia. A web based tariff calculation system of the Russian Railways was a very useful tool to derive needed rail tariffs from various oilfield locations in Kazakhstan to the destination points in Russia.

Secondary sources have been acquired from the research materials and selected publications of the energy research and security institutes, international organizations and recognized independent consulting agencies. BP statistical review, OECD and World Bank reports and databases have been used for production figures on oil industry.

Data on the transport costs collected belong to different years and publication dates are different, however the sticky nature of the oil transportation prices market of the Caspian Sea crude oil permits to assume the applicability over longer periods of the available transportation rates used in pipelines, railways, short sea routes.(ES, 2007)

Management science quantitative tools can be employed by the decision making parties in the transportation of crude oil. The parties involved are: states, petroleum companies, pipeline operating companies, railway operating, short sea shipping and port holding companies. In order to find the least cost shipping method for the transportation of crude oil, exporting country producers need to find the optimal ways in order to do the short and medium term planning. Such approach may assist them to make proper decisions. The oil companies of exporting countries of the Caspian Sea basin, may analyze all given information, formulate the constraints, and apply network flow model to find the least cost routes to deliver oil to the ports, other pipeline systems, or the final consumer's premises.

By conducting sensitivity analysis under various scenarios decision making party may analyze the negotiating power with the others parties involved, on how much the price of transportation can be increased. Pipeline operating companies may decide how much to increase the capacity of the pipeline, or the railway companies to decide how much to alter the tariff.

1.3 Literature Review

Flow of the highest demanded commodity through various countries also is highly correlated to geopolitical and country specific influences. Various studies have been done in the last years related to assess energy security viability, and within its context the stability of shipping energy commodities from exporting country to the consumption markets has been scrutinized.

Sales(2009) has laid out the framework for quantifying the risks associated with the energy exporting and transit states. Defined at the national level, some socioeconomic factors are indexed and assigned to the countries that make up the supply corridor of natural gas and oil along the route to the destination country. This model is especially useful for the case of pipeline transport. The study, conducted for the European Union energy council, provides extensive list of indexes for the energy security of more than 150 countries. In addition, as a part of this study a website containing the index database was developed and user friendly interface to compile the aggregate risk index for any geographically possible existing and user desired energy corridors considering countries' and other constraints individual risks.

Tevzadze (2004) studies the economic viability of various routes of oil export from landlocked areas based on monetary cost aggregation of oil transportation routes. He also reviews other significant geopolitical influences on and economic benefits from the projects. The study is done ex ante and incorporates many hypothetical assumptions.

Energy Charter Treaty Secretariat based in Brussels is an organization of oil producing and transporting countries. The aim of the organization is to coordinate common energy policies on European continent and set common playing field towards energy security.

In 2007 a conference on the Eurasian oil pipeline tariff methodologies was held in Brussels. Conference participant handbook contains detailed tariff and cross border pipeline information in Europe, FSU and Caspian region. It was important source for this thesis to select and make use of tariff data regarding former Soviet Union and Caspian Region provided there.

World Bank Study (2008) on the South Caucasus corridor for oil and oil products has extensive information on production quantities, pipelines details and insights in the railways and Caspian shipping operations obtained through interviews and various cross references that are otherwise not published. The study indicates the perspectives and possible future new pipeline developments.

Chapter 2 Global Petroleum Resources Development and Transportation

2.1 Characteristics of Upstream Development Stage

Petroleum has the largest energy coefficient among the sources of primary energy and due to this feature poses relatively less environmental hazard. It is easy for storage and transportation in large or small quantities and is accessible to the most remotely located human operated equipment. Compared to other fossil fuels it has the advantage of being the best source for auto motion.

Words crude oil and petroleum are used interchangeably. The quality of the crude oil is dependent on the sulfur content. Low sulfur grades are known as 'sweet' and 'light'

Petroleum is an essential good for manufacturing and maintaining sustainable level of life in industrialized parts of the world. It has been observed that demand for oil grows in line with GDP growth. It is translated into high inelasticity of demand, at least in the short and medium terms. Such categories of goods are usually perfect target for taxation at high rates. Most countries levy excise tax or export tariff on the production and export of crude oil and consumption of derived products. Their tax revenues represent a stable source of income for the treasuries in oil exporting countries.

Elasticity of demand for petroleum is a function of many factors. It depends on the income level, government policies and technology. However, in the short run it is inelastic. As the prices of oil fluctuate in markets, the petroleum needs cannot be adjusted to such volatilities, as the economies and households have invested in the equipment from heating devices to power plants and are bound by long term fixed costs. It is better to pay higher price in the short run.

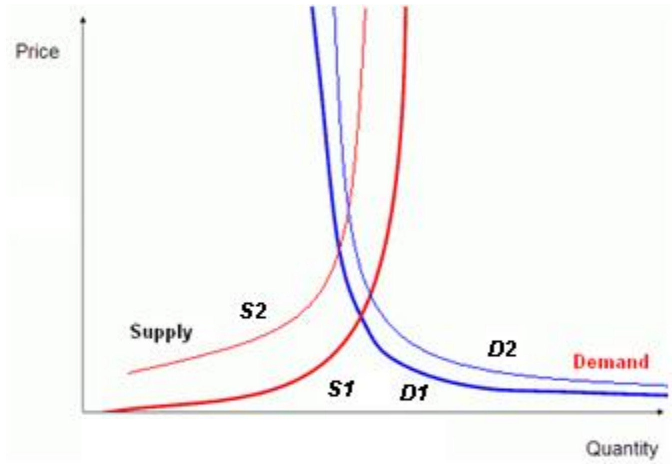


Figure 1 Inelasticity of Petroleum Market Equilibrium / Source: Adapted/ Mankiw

The supply of petroleum is bound by the constraint of production capacity. At certain points of time, world supply capacity is just above the growing demand. In such cases, minor supplied quantity change causes larger price fluctuations leading to inelastic demand.

When demand and supply curves intersect at their steeper parts, there is a pressure on them to shift. As depicted in figure 1, such equilibrium in the market is known as 'peak oil' and it may take a few years for the production to adjust and thus the supply curve move to the right or the demand curve should move to the left triggering recession, or even a prolonged recession.

The process of developing an oil well through to supplying petroleum product for the consumer needs is divided into an upstream and downstream cycles in the petroleum industry terminology. The part of this process up to the refinery stage is named as upstream. The second stage from the refinery up to the consumption is known as downstream production. In the meantime, oil has to be transferred by various transport means and stored in many cases at several locations before finally reaching a refinery.

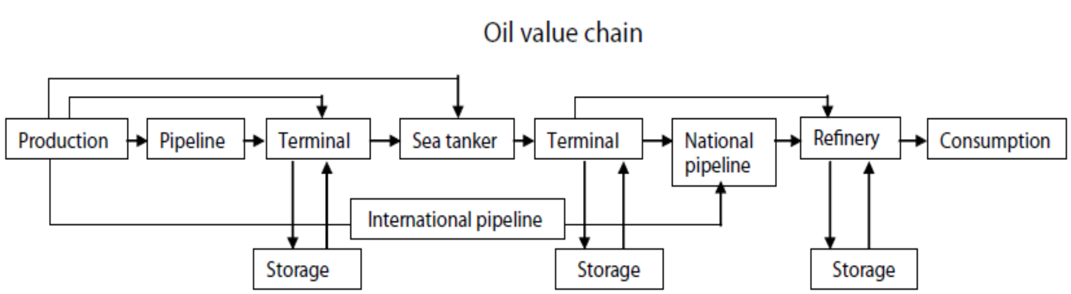


Figure 2 Upstream and Downstream oil production processes/ Source: Adapted ECTS

The reference to the oil resources and oil reserves imply different things. Often reported in the media oil reserves represent the proved oil deposits that can be extracted at a given technological capabilities. Resources refer to the oil deposits estimated to exist and be recoverable in the foreseeable future, again with the available technological means. Production starts where the reserves of oil are proved to be worth extracting.

As shown in figure 2, the upstream supply chain of crude oil encompasses processes up to delivering it to a refinery where it is distilled into various grades of products, ranging from high grade fuels to heavy low grade ones. The upstream process of the most important commodity differs from most of other natural resource development cycles by a set of characteristics. Few other commodities feature similarities, including natural gas that is another highly demanded good serving growing global energy needs. These characteristics could be described as follows:

(i) The finiteness of a Natural Resource

First of all, the production costs of oil differ from site to site. Middle East is known to have the cheapest extraction and production costs of oil and offshore rigs of the North Sea usually bring more added cost into the value of oil. Besides the quality, role is played by the cost of location and accessibility of the resource and its transportability to the markets. The cost differences given by the quality of the production site and by its location relative to markets give rise to differential rents. This is known as the Ricardian Rent in the economics that is used to explain the uniqueness of natural resources versus man manufactured goods. (ECS, 2007b)

Oil reserves are finite, but the knowledge of the limits of finiteness is not based on absolute surety. Currently it is estimated that the world production peak is expected to ease after 2030 and lead to downturn of the daily supply within 50 years. However, such opinion would not be challenged if proved oil reserves were a constant number. The reserve-to-production ratio is proved international reserves divided by annual production, normally expressed in years. It is commonly used as an index to denote scarcity in oil and gas resources. According to BP statistical review, since the late 1980s the world RP ratio for oil has been just above the 40-year level (40.2 years in 2005), remaining in narrow fluctuation even during a period of substantial growth of oil and gas production. But these figures should not be used as an indicator of the remaining time-span for the oil. In reality, technological advancement and market prices of oil determine the exploration viability of new fields. In short, unconventional energy reserves turn into conventional ones in simultaneously with the improvement in drilling technology. This may cause to consider that reserve- to-production ratio is not static and depends on the new explorations and consumption rates of petroleum.

(ii) Resource ownership and production Risks

Because of the high value of the resource, two sides in the extraction process characterize oil production..It is usually the government that represents the national interests and a production site operating company who exclusively deals with the government or its representative agency over negotiating best profitable terms. Petroleum contracts, as they are known to the public, are mostly of four types. The main differentiating feature for them is the level of risk assigned to each one of the signing parties.

Concession: Grant of ownership and exploration rights to the petroleum exploration company. The risk of finding, extracting and transporting oil is born by the company. Government gets royalties, and may be entitled to the shareholder rights of the exploratory company.

PSA (production sharing agreements): As the term indicates Governments do not relinquish the ownership rights of the resource sites and producing companies at their own risk and if oil is found, operate on their own. If the oil well is found promising, it has to be developed at a certain rate in time and produced volumes are shared.

Joint venture: In this type of agreement both, government and producing company jointly bear risks and expenses and profits from developing, extracting and selling of petroleum.

Service Agreement: This is the least risky form of contract for the production companies. All risks are assumed by the governments. The production companies plainly are hired to apply the know-how by providing a paid service for a certain period of time.

Hence, based on the risk- reward magnitude of a production site or of an entire country oil producing companies and governments enter in the agreements. This relationship is illustrated in the following table:

Table 1 Types of Oil Production Agreements with Foreign Companies

Contract	*Producing Company*	*Government*
Concession	*All risk/all reward*	*Reward based on production volumes*
PSA	*Exploration risk/share in reward*	*Share in reward*
Joint Venture	*Share in Risk/reward*	*Share in Risk/reward*
Service Agreement	*No risk*	*All risk*

Source: Bindemann,1999

2.2 *Characteristics of Transportation within Upstream Petroleum Supply Chain*

Petroleum is the most transported commodity in the world with highest ton-mile coverage. It is also one of the diversely transported commodities with multimodal means. Tanker ships, pipelines, railways are the transport means that carry enormous amount of petroleum daily to the terminals for storage and refineries for further processing into petroleum products.

This section looks at the important economic features of the crude oil transportation modes.

2.2.1 *Global Tanker Shipping Market*

In late 1870s Nobel brothers took an almost adventurous decision to invest money in the exploration of prospective oil fields in Azerbaijan, then within Russian Empire, on the western side of the Caspian Sea. Year 1878 witnessed the first oil tanker ship ever with deadweight of 500 tons to carry out shuttle voyages to the Iranian port of Neka where it was further transshipped to the Persian Gulf and shipped worldwide. After almost a century and half, present Caspian Shipping market has not evolved much and can by no means compare with the global one in structure and size.

Nowadays, over 36% of the world sea born cargo is comprised of crude oil. This number has fallen from the 50% indicator a few years ago.

“72% of world GDP is generated in industrialized countries and 60% of oil is produced in developing countries, there is a substantial amount of oil that has to be transported internationally.’ (Haralambides, 2010)

Wijnolst (2008) evaluates the size of the crude oil tanker fleet as over 264 mln tons of deadweight serving the voluminous task of satisfying market needs for petroleum. For the past decade, tankers have transported over 7 bln ton miles of crude annually.(ton-miles is the measure of effective demand for transport) as shown on figure 3.

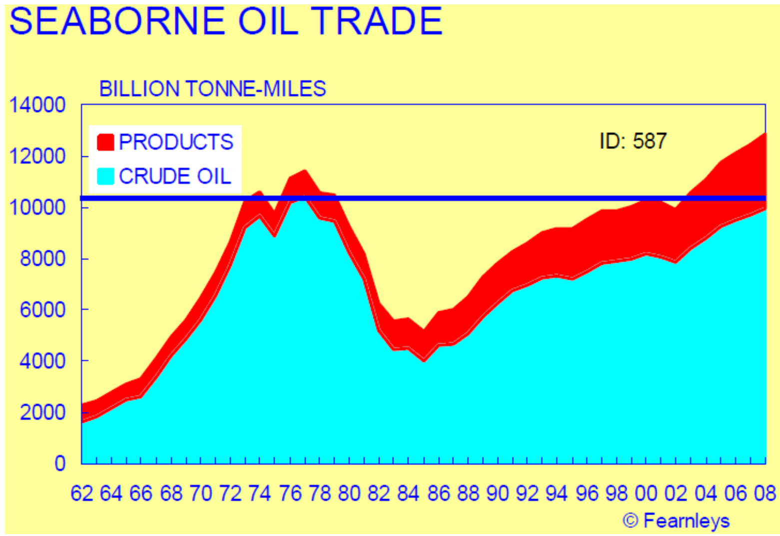


Figure 3 Importance of Petroleum in Bulk Shipping

It must be noted at this point that, as a derived type of transport demand, tanker global demand and supply tightly follow the crude oil demand and supply fluctuations. Freight rates in the tanker market are the most volatile of all ship type segments. The major factor behind such volatility is the shipping market's high sensitivity to political and socioeconomic events. The most recent global economic crisis in 2008 led to the dramatic drop in the demand for oil around the globe. Freight rates collapsed over a short period from soaring levels of summer 2008, when petroleum market price had skyrocketed to all time record of 147 dollars. Political and military crises and events of 1960s related to nationalization of, or the war close by, Suez Canal had revolutionizing effects on the tanker shipping. Closure of the Canal diverted most oil traffic around the Cape hope. There was a sudden shortage in tankers, which led to soaring freight rates. Such a shortage created the need for larger vessels for higher economies of scale. Due to these events extra large crude carriers VLCC and ULCC tankers had been born. The 1990 Iraqi invasion of Kuwait created tanker boom shortly due to the fact that traders started to use tankers for storage of oil. (Stopford, 1997)

In terms of concentration of the market, tanker shipping is highly competitive. It can be interpreted from the market share size of the top 20 companies. If these companies were to merge they would still control only 30% of the market. It is featured by low entry barriers, many competitors, relatively lower fixed costs, easy exit option. The industry is saturated and has all the qualities of highly competitive industry.

Despite some country maritime regulations, such as allowing access to the ports by the ships with registered flags within the same country, shipping and generally tanker shipping face no anticompetitive industry constraints. However, there are certain geographical constraints, straits on the very important sea routes of oil transportation that pose disruption or limitation to vessel traffic either due to physical or political reasons, Rodrigue (2004) analyzes the constraints in the capacity that these straits affect on the shipping of oil from the supply areas. They are known as ‘chokepoints’.

As shown on figure 4, Suez Canal linking the Mediterranean with oil rich Red Sea, besides a long time record of being political dispute matter has the narrowest point of only 300 meters. Despite continuously ongoing expansion works this route is considered as one of the most congested. In terms of congestion as well, Bosporus ranks first with at least 50,000 tankers passing every year. It is the main route for Caspian and 30% of Russian oil exports. Bosporus dissects the middle of Turkish city Istanbul. It connects the Black Sea with the Marmara Sea and gets as narrow as 800 meters at certain point. Both banks are densely populated, and due to accident and oil spill risk Turkish government tries to control the traffic volumes from and to the Black sea ports. It has restrained the night navigation and allows passage of up to smaller deadweight VLCC tankers. Bosporus is followed by Dardanelle strait, which connects Marmara Sea with the Mediterranean. It is an intense traffic passage from the highly industrialized Marmara Sea area of Turkey. Additional traffic from and to the Black Sea ports puts an extra pressure on both, Bosporus and Dardanelle straits.

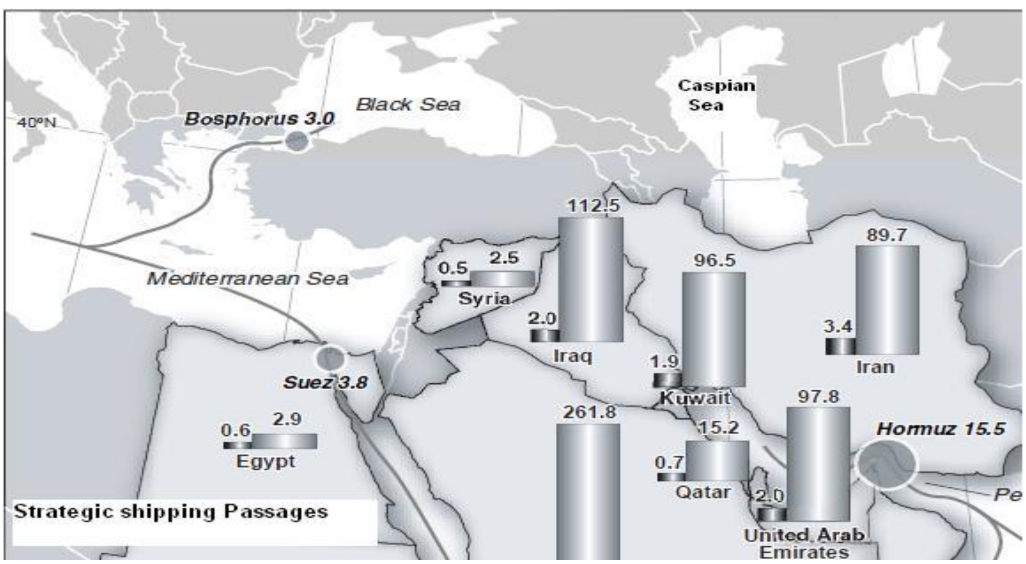
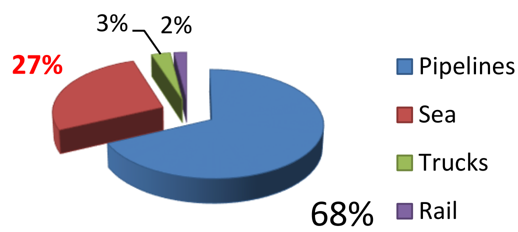


Figure 4 Strategic Shipping Passages – Chokepoints / Source: Rodrigue (2004)

2.2.2 Pipelines

Pipelines are extremely important and extensive mode of transport over long distances. As illustrated in figure 5 pipelines are key to oil supply chain of US domestic market. They are built to conveniently transport many types of liquid bulk and operate all year round continuously supplying the commodity to the destination point. Petroleum and petroleum products, however, are dominating the mode. The longest pipeline stemming from east Siberia spans to Western Europe for 9.344km to deliver crude oil to the markets. Crude oil pipelines have become especially important after the World War 2 when industrialization gathered pace and demand for oil kept increasing at an accelerating rate, It is usually not affected by terrain conditions because of pumping stations alongside secure uninterrupted flow oil. Pipelines connect in the logistical hubs, or terminals, where sorting, storage and further transshipment with another mode of transport are carried out.

Fig. 5 US domestic Crude oil Modal Share



Source: API

Pipelines that extend from the source, oilfield, to the sending terminal are known as gathering pipes with small diameter. Main Pipelines connecting to the sea ports or logistical hubs transporting large amounts of oil, more than 50,000 bpd are termed as 'trunk pipelines'.

Pipelines transport oil in batch and mixed quantities. Transneft, Russian pipeline system giant, was constructed for the supply of centrally planned economy of USSR. Original oil grades were pumped through in mixed manner and final grade was determined at the output point. Transneft has limited capacities of operating a so called 'quality bank' where oils of various sorts would be delivered according to customers' needs. In case of batch transportation, mixed quality losses are prevented.

Pipeline projects have four main specifications: Economies of scale, Project long life, involvement of governments and vulnerability to market failure (API, 2001)

- Economies of scale in pipelines is achieved through the diameter size and number of pumping stations, also with the help of chemical additives which are inserted into the system together with the liquid and improve the viscosity flowing specifications. Higher grade quality of oil possesses better viscosity features.

- Pipelines are built for an operating life of at least 20 years. They require a large upfront investment and are expected to make return on investment within half projected period. At that, operating costs are low.

- Crude pipelines often have to cross borders of various countries thus are influenced by geopolitical factors. Middle Eastern and Caspian pipelines construction routes serve not only the reasons of economies but also the political ones. However, it is the economies behind every cross border pipeline that is the driving factor.

- If market demand changes substantially it is not easy to adjust the pipeline capacities. Once built, they are not flexible to change direction either, in case consumer market concentration shifts to other regions or supply source faces constraints. Some of Russian oil domestic pipeline directions built in Soviet times lay idle and in operable condition due to loss of importance in transport demand to that area.

2.2.3 Railways

Railway has been the first transportation mode to carry the crude oil in large quantities. Trains revolutionized the transportation of bulk liquids over large distances just as they brought about industrial revolution. End of 1860s saw climbing demand for the US oil market. The usual wooden barrels would not be sufficient in terms of time, spillage, and quantities to deliver. Invention of the rail tank cars allowed speeding up and improving the processes. An example illustrating this trend was in the US and Russia, where distances had been quite long to deliver petroleum to refineries or landlocked areas to the port for maritime transshipment.

Although pipelines have overshadowed railways in land transportation of oil and in general, liquids, by higher economies of scale, safety and environmental, the latter still has emerged as a solution to many new barriers that came along with the pipelines. Pipelines require very large upfront investment expenditures, while railways are relatively less costly to implement. The latter is more cost intensive than maritime or road transport sectors. As mentioned in section 2.2 although pipelines offer economies of scale their re-routing is impossible. Railways on the other hand can be flexibly extended to new locations.

According to J.P. Brooders (Vopak presentation, 2010) railway mode will increasingly play a decisive role in the development of oil terminals at new markets before a specific pipeline construction comes to reality. In contrast, long distance cross-border pipelines are, as mentioned, expensive to build and affected by geopolitical factors.

Railways can also accommodate the flow capacities of the cargo. The number of tail tank cars (RTCs) per train block can flexibly be changed, thus avoiding the diseconomies of scale during any trip by rail operator.

Below shown table 2 summarizes the pros and cons of each mode for petroleum transportation. Although it is more accurate for the US market, most points generally would apply as well. In case of Caspian region oil transportation one could say the railway carries higher weight in moving petroleum tanks over long hauls due to remoteness from the open sea ports.

Table 2 Summary of petroleum Transport Modes

	Pipeline	**Marine**	**Rail**
Volumes	Large	Very large	Small
Materials	Crude / Products	Crude / Products	Products/crude
Scale	2 mln tons	10 mln tons	100K tons
Unit costs	Very low	Low	High
Capital costs	High	Medium	Low
Access	Very limited	Very limited	Limited
Responsiveness	1-4 weeks	7 days	2-4 days
Flexibility	Limited	Limited	Good
Usage	Long haul	Long haul	Medium haul

Source: Rodrigue(2004)

2.3 Summary

The Energy International Agency (EIA) past estimates of 'peak oil' situation in the world energy market balance to arrive in 2010 has not been justified. Yet, with 85 million barrel per day global consumption has been alarming for environmentally aware minds and the world's biggest economies for which satisfying the demand of petroleum remains crucial fuel for growth. The initial stage of exploration, extraction and delivery of oil to the refinery is termed as an upstream development of petroleum which has been widely studied. It is comprised of complex legal contracts involving national interests, multinational energy companies, and organization of logistical supply chain. Transportation of oil is multimodal and each mode has its advantages at different periods of time and different geographical places. Global transportation costs have generally decreased to an average 2% of the total value of goods delivered across the globe. As the price of petroleum has been increasing due to countdown period to the peak oil point, analysis of oil logistics components and related cost optimizations is becoming growingly demanded. Transportation of petroleum represents major part of the crude oil logistics.

Chapter 3 Leading Caspian Oil Exporter States

3.1 Main Export Markets for Caspian oil

The magnitude of the Caspian petroleum reserves cannot be compared to that of the Middle East area, but exceeds the reserves of the North Sea or the US. The world oil demand is set to increase over the next decades. The growth comes at the

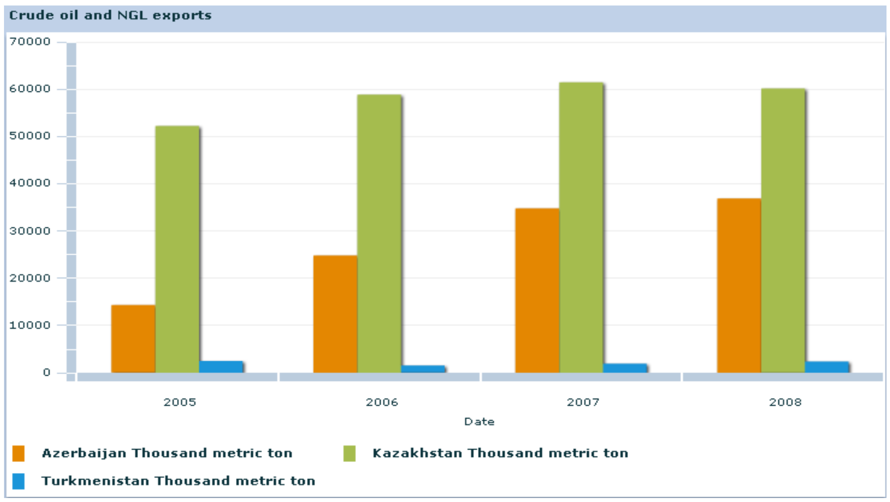


Figure 6 Azerbaijan, Kazakhstan, Turkmenistan Crude oil Exports / Source: IEA library

expense of the pace of developing economies, such as China, India, Brazil. Chinese oil demand has grown on average at 4.5% per year.

Until now, Caspian oil has not played crucial role in the supply of these markets. But sustainable supply of petroleum from this origin is believed to be playing a stabilizing role in case of disruptions from other major producing areas or crisis affecting the global market. However, the crude oil exports to the world's largest oil consuming markets of OECD countries are important for the region itself. As of 2009 Azerbaijan and Kazakhstan, with proved oil reserves of 7bbl (955mln mt) and 30bbl (4bln mt)[1] respectively, exported over 350 mln mt of crude oil and ranked among the top twenty oil exporting countries in the world. Another Caspian producer Turkmenistan does not compare in terms of production and export of oil with the latter two but it possesses enormous natural gas reserves which makes it just as important energy exporting state. Still, this thesis paper focuses on Azerbaijan and Kazakhstan, whose oil exports are drivers of regional growth and largest part of those trade flows are established with the OECD countries markets. Eighty four and fifty five percent of Azerbaijan's and Kazakhstan's crude oil exports respectively have been delivered to the European and North American OECD member countries.

[1] Barrels are converted at the rate of 7.33barrels per metric ton (EIA)

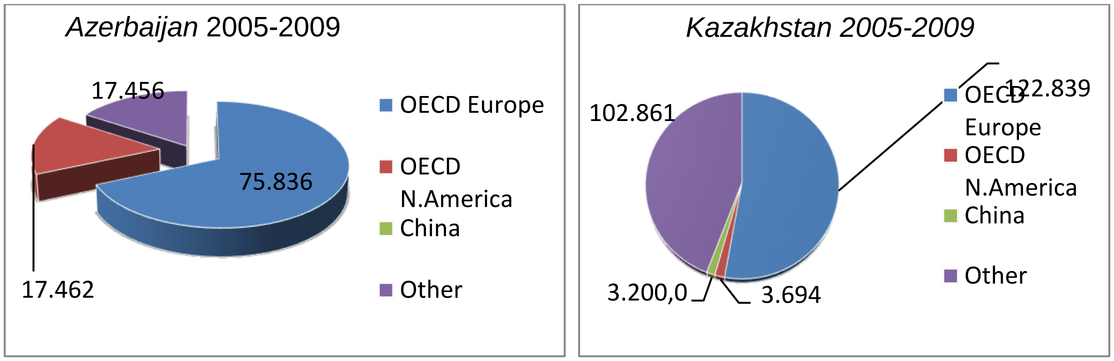


Figure 7 Azeri and Kazakh crude (000 tons) export markets / Source: OECD / own adaptation

OECD member countries total petroleum import exceeded 6.200 mln tons in the period of 2005-2009. Shown in figure 1, Azerbaijan and Kazakhstan share in this amount comprised 3% and 4.2% respectively. China's role in the exports from Kazakhstan is not important at the moment, but considering the growth potential and insatiable demand for fossil fuels by both China and India, seems to be an indicator of potential in the Eastern supply routes. The significance of petroleum exports in the economy of Azerbaijan can be indicated by the 9.3% GDP growth rate the country achieved during the global economic and financial crisis despite the slump in demand and prices of crude oil from late 2008 to mid 2009. This rate even overtook the growth of China in the same period which ranked 4th behind Azerbaijan. (CIA factbook,2009)

3.2 Review of the Caspian Basin Oil Production Sector

Caspian Sea Basin energy resources have become of intense interest to the large energy consuming economies since the beginning of the 20th century. However, European entrepreneurs had been interested in the Azerbaijan oil resources as early as the beginning of the 17th century and the first oil rich British trader is mentioned in the sources of those days. At the dawn of 20th century Azerbaijan under Czarist Russia became the largest producer of crude oil in the world with 11.5 mln tons annual extraction due to efforts and investments made by the Swedish brothers Nobel and German industrialist Rotshield. They managed the exploration, extraction and transportation of oil to the West and Asian markets. Similar to nowadays, oil transportation from Baku to the Mediterranean Sea and the Persian Gulf at that time also relied on the political stability of the area and the security of the transit routes. (Transparency, 2008)

At present, especially after the collapse of the Soviet Union since 1991, Caspian Basin country energy reserves have come under scrutiny at the supranational, national and oil producing multinational companies' levels. The collapse of the USSR was followed by political and economic crisis in the transitional period of the littoral states of the Caspian Countries. Lack of investments in the previous period in the oil extracting industry was caused by the political decision of the Soviet Union to keep strategically important production far from NATO attack threat and moved the oil extraction business to the Central Russia, Urals and West Siberia. However, with the arrival of new circumstances need for investments in the energy production had to be inevitably carried out by the foreign oil multinationals. These companies lost no time to enter Azerbaijan and Kazakhstan.

Among the former Soviet Union countries (further FSU) Russian Federation still remains the largest petroleum producer with an average production of 8.5 mbd per day. But its production rate is slowing down while the rate of production in the Caspian states led by Azerbaijan and Kazakhstan more than doubled from 1 mbd in 2000 to 2.3 mbd in 2008. (ECS, 2007b)

3.2.1 Azerbaijan Oil Consortiums

The Country's production levels reached 915 thousand bpd by 2009 growing on average at 4% yearly for the past five years. Reserve-to-production ratio reflected 21 years of remaining reserves if production continued at the same rate.

Most of Azerbaijan's oil exploration activities are carried out through PSAs with foreign energy multinationals. There are over 30 large and medium sized oilfields in the country's onshore and Caspian Sea offshore areas. There is still more potential for further exploration. But the territorial division of the Sea by littoral states thus far remains unresolved. Although Ministry of Energy and Industry of Azerbaijan is responsible for handling exports and exploration contracts, it is the state owned oil and natural gas company SOCAR directly involved in the production of oil and natural gas, operating the pipeline system and managing the exports of crude oil and products. It participates in all the PSAs on behalf of the state.

SOCAR is a member of the consortium AIOC (Azerbaijan International operating Company) which has signed contract with the state on the extraction of oil throughout the country's oilfields. Other members include: British Petroleum (BP), Chevron, Devon Energy, Statoil Hydro, Turkiye Petrolleri, Amerada Hess, ExxonMobil, Inpex, and Itochu.

On behalf of the consortium, BP is the operating company of the BTC (Baku-Tbilisi-Ceyhan) pipeline and SCP (South Caucasus gas pipeline). BP investments in the Azerbaijan oil sector are largest among the foreign multinationals.

Most of Azerbaijan's oil resources are located offshore in the Caspian Sea, 60 km away from capital Baku and is connected to the oil terminal onshore with under-sea pipeline system. AIOC is operating the drilling and export activities in the ACG (Azeri-Chirag-Guneshli) fields which are the biggest of Azerbaijan's oil reserves and account for over 80 percent of Azerbaijan's oil output. The ACG fields yearly output amount over 41 million tons yearly and is increasing.

3.2.2 Kazakhstan Oil Consortiums

Kazakhstan's oil production sector has evolved through concluding the PSA agreements with various oil giants since the independence was gained in 1991. Since 2008 the country has officially announced that all the following investment projects would follow joint venture structure. By following this strategy, Kazakhstan wants to assert more control of its vast resources by taking more risk and respectively getting more profit from the extraction works.

More assertive stance of the state is also reflected in revising the law "On Subsoil Use" in 2007. The parliament approved the changes allowing the country to retrospectively change the oil contracts if they were deemed to threaten country's interests. Kazakh government also introduced a crude oil export tax in 2007, covering medium and small producers. It was set at 20$ per ton. After a brief suspension in 2008 it reintroduced the tax at double rates and made subject to taxation all foreign and local oil companies and consortiums.

Oil yearly output has reached 1.5 million barrels per day in 2008 while consumption remained low at 239 thousand barrels per day. Its reserve to production ratio is much higher from Azerbaijan, currently at 70 years of remaining production at current rates.

Similar to Azerbaijan, Kazakh government has assigned the responsibility of presenting its interest in the oil and gas production contracts with foreign investors to the state run oil and gas corporation "Kazmunaigaz" since 1997.

There are three main consortiums in Kazakhstan's oil production sector that control about 80% of the country's reserves.

The largest grouping so far is "Tengizchevroil" (TCO). The consortium is managing the Tengiz field in North Western Kazakhstan. The field was developed in 1993 according to the 40 year concession agreement between the Kazakh government and Tengizchevroil. Tengiz has the deepest oil wells in the world of 12,000feet deep. Its reserves are estimated at 9 billion barrels by the consortium members. Tengiz has produced about 20 million tons of petroleum in 2008.

The second largest operating oilfield of Kazakhstan is Karachaganak located also in north western Kazakhstan's borders with Russian Federation. It is run by the Karachaganak international Organization. The PSA was signed to develop the oil field for 40 years. The site produced up to 11 mln tons of crude oil in 2008.

The Chinese oil company (CNPC) and Kazmunaigaz consortiums are jointly developing other onshore fields of Aktobe in North Kazakhstan, Mangistau in Western Kazakhstan, and Kumkol in Central part of the country. The latter is controlled by CNPC through its subsidiary Petrokazakhstan In total their annual production in 2008 reached 14 million tons.

It must be mentioned that finding enormous Kashagan offshore field in 2000 in the Kazakh part of the Caspian Sea was titled as "the most important discovery for the last 30 years in oil producing countries."(EIA, 2007) The field is estimated to hold up to 16 bln barrels of crude oil. This is a quarter of Saudi Arabia, richest proved resource owning country globally. At Kachagan field production is set to start in 2015 and the extracted oil's main destination route is planned to be Atyrau-Kumkol-China pipeline. It has been argued in researches that eventual distribution of the rest of the Kachagan oil will largely shape the Caspian transportation patterns after 2015.

Below we summarize the consortiums that are in charge of the largest producing oilfields that will be focused on in later chapters.

Table 3 Major Caspian Consortiums

Azerbaijan		
Oil Field	***Consortium***	***Shareholders***
ACG Azerbaijan	*AIOC*	*BP (34.14%), UNOCAL 10.28%, INPEX10%, SOCAR 10%, Statoil 8.56%, ExxonMobil 8%, ITOCHU 3.92%, others (15.1%)*
Kazakhstan		
Tengiz	*TCO*	*Chevron (US) 50%; ExxonMobil(US) 25%; Kazmunaigaz 20%; LukArco (Russia) 5%*
Karachaganak	*KIO*	*Agip (Italy) 32.5%; BG (UK) 32.5%; Chevron (US) 20%; Lukoil (Russia) 15%*
Aktobe	*CNPC-KMG*	*CNPC and Aktobemunaigaz (88%)Others 12%*
Mangistau	*KMG*	*Mangistaumunaigaz (KMG subsidiary)*
Karazhanbas	*Nations Energy*	*Nations Energy*
Kumkol	*CNPC*	*North: Turgai Petroleum: Petrokazakhstan (CNPC - 50%), and Lukoil (50%). South: PKKR, owned by CNPC*

Source: EIA, 2009

3.3 Summary

In view of growth in production in recent years, two Caspian production leaders, Azerbaijan and Kazakhstan have achieved significant results in accelerating their productivity and increasing exports. Countries' attractiveness for foreign capital in the oil and energy sector has been stable and many largest oil companies including the 'six majors" are present, but the governments are increasingly carrying out policy to achieve more freedom in controlling their national energy resources. International oil majors presence has helped them to improve the technologies, establish contracts with biggest markets. Growing Chinese demand and geographical proximity has facilitated to open up the new West East route and the Chinese state oil Company to actively get involved in the oil development projects of Kazakhstan.

Chapter 4 Caspian Petroleum Transportation Network

4.1 Stakeholders

"*Caspian countries are very interested in diversifying their export markets but a lack of alternative export infrastructure and disagreements over new export routes create serious obstacles to fulfill this goal.*" (Papava, 2009)

Landlocked position has largely affected the shaping of Caspian oil transportation network into oligopolistic and monopolistic markets. The system spans for thousands of kilometers and is comprised of multiple modes of transport including pipelines, tankers, exporting ports, and railway companies. As mentioned in the previous chapter Kazakhstan and Azerbaijan oil production is led by international consortiums. They are the main stakeholders in having a reliable, safe and economically reasonably priced transportation of the crude oil to importing countries. Infrastructure and transport owning companies, although most of them corporatized, are clearly under governments' strong supervision and regulations. Logistics and forwarding companies and port authorities seem to have more diverse ownership structure but play the game with the same rules as the fixed asset patrons. For these entities, at the end it all comes down to exporting nation government ultimately set the game rules. At last, importing country governments seek to influence the direction of oil flows through the system so as to secure the short term and medium smooth supply for themselves. Long run disruptions are not feasible, because of possible damage to all parties' interests. (Raballand, 2007)

The following section will describe the main technical and capacity specifications of the Caspian oil transit network. It is mostly based on the information released in the study of Caspian oil export capacities done by Energy Charter Secretariat (2008).

4.2 Caspian Shipping Market

Located at the heart of main transit routes in western Eurasia, Caspian Sea does not have any access to the oceans. In this sense, it is a lake. It is surrounded by five littoral states: Kazakhstan, Russia, Azerbaijan, Turkmenistan and Iran.

After the disintegration of the Soviet Union, Caspian tanker fleet was allocated to the country of its home port. The largest shipping company, Caspian Shipping Caspar, had registered its vessels in Baku and they were therefore assigned to Azerbaijan. This left other two littoral countries, Kazakhstan and Turkmenistan without a fleet.

As of now Caspar remains the biggest shipping company in the region, particularly for dry cargo. Caspar fleet is fairly aged, with an average age of over 20 years. Most of the vessels are in poor condition and few comply with international conventions or modern operating rules. In total, 86 tankers are sailing on Caspian Sea. Forty of them are managed by Meridian Shipping; 46 belong to others. Meridian Shipping, owned by Middle East Petroleum (MEP), has been contracted by Caspar to manage the Caspar fleet. Meridian Shipping currently has a monopoly for shipping to and from the Azeri ports. One of the main freight forwarders on the Caspian (and the only one serving Baku), Cross Caspian is also controlled by MEP.

Until recently Caspar transported around 90 percent of all cross-Caspian oil shipments. Such ownership structure clearly indicates that the shipping market was highly concentrated. Eventually, the lack of competition resulted in relatively high freight rates; the freight rate does not fluctuate widely and stays in the range of 7-12 US dollars per ton of crude oil. While it is cheaper to ship petroleum from Baltic ports to Rotterdam, usually not exceeding 6 US dollars per ton - Some twenty to fifty percent lower than equivalent rates outside the Caspian. (World Bank, 2008)

There are no large scale shipyards around the Caspian Sea coastline to supply operating companies with tanker vessels. However, ships with deadweight up to 12,000 m/tons can enter the sea sailing in spring and summer months from the Black Sea through Volga River into the Caspian. But the navigation period is limited and duration too long due to frost water and lot of locks to be passed en route. The market to non-Azeri ports has recently become more competitive with the arrival of three new shipping companies. A Turkish company, Palmali, manages a total of around 100,000 dwt of modern tankers under the Russian flag. Another company, Volgotanker, operates small tankers with a total deadweight of 50,000 tons between Kazakhstan and Russian River ports. Kazakhstan established a shipping company based in Aktau port and runs six vessels with a total deadweight of 15,000 tons.

Despite the new entrants in the Caspian shipping market whose activity is mainly affecting shipping freight rates between ports of Kazakhstan and Russia, freight rates between Kazakhstan and Azerbaijan ports remains expensive and is still under the influence of oligopolistic market system.

One of the main reasons for nurturing such a market is corruption among the high rank state officials whose interests are embedded in the offshore registered companies such as MEP. They enjoy high profits evading tax payments in Azerbaijan or Kazakhstan. This element of a thriving “crony capitalism” in regional states is a weak link in the overall supply chain of Caspian resources to Western direction. (Guliev et al. 2009)

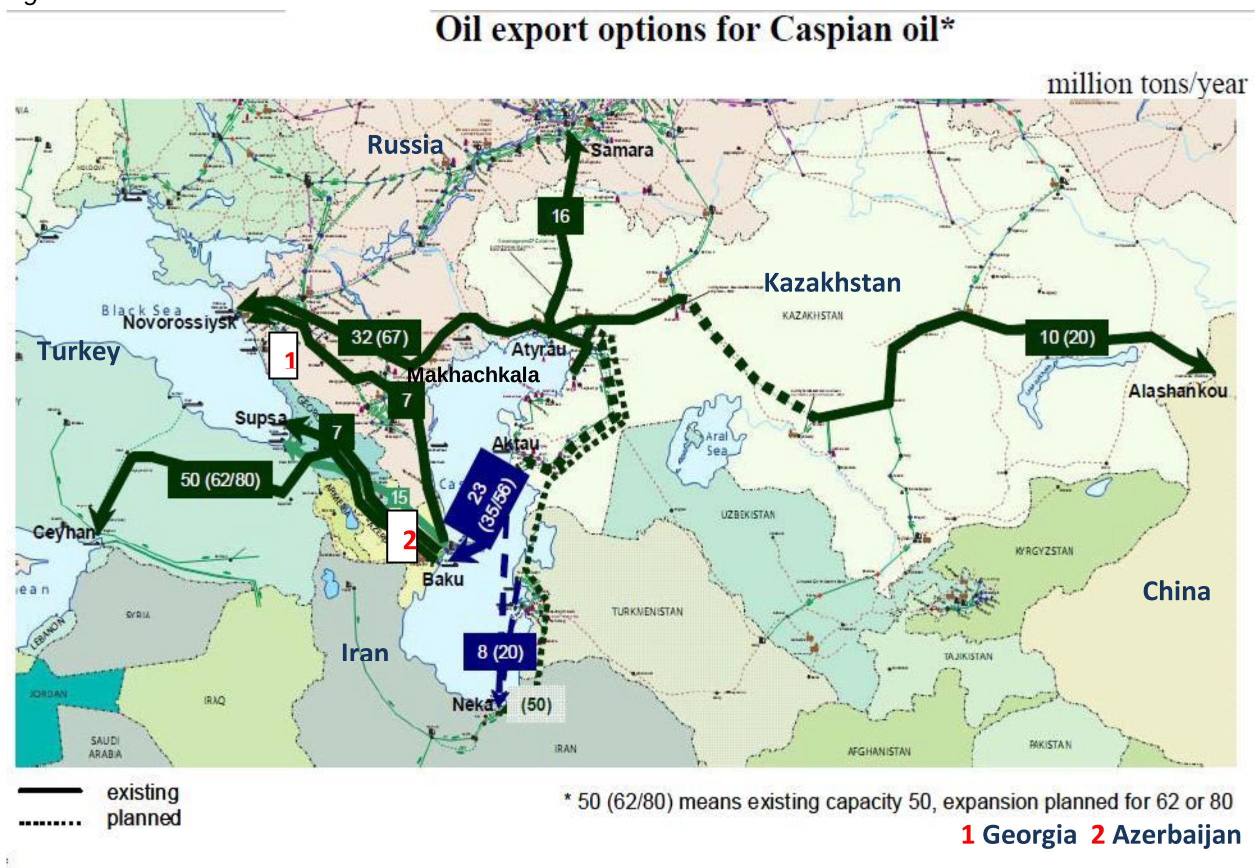
4.3 Caspian Oil Pipelines

Most of the pipeline system in the Caspian basin was part of the USSR pipeline network. It is still considered as one of the most complex crude oil transporting structures in the world. Caspian basic pipeline system was developed mainly in late 70s through to 1985 and has an east west direction. Similarly gas transportation system of today’s Russia was developed towards east west direction and is even more a complex network. (ECTS, 2007)

After the collapse of the USSR the pipelines naturally were assigned to the respective country of location. In indication of transparency the new states established national oil production and transportation companies as a sign of corporate approach and openness to investments from multinational energy companies.

Currently pipelines in the Caspian and FSU states are functioning under three types of management structure: fully state owned and controlled, state owned and operated by a consortium under agreement, owned and operated by the state, private entities and other country governments jointly.

Figure 8



Source: ECTS 2007

4.3.1 Pipelines from Northern Caspian

North Caspian basin is the origin of three systems of pipelines through the territory of Russia: The Atyrau-Samara, Kenkiyak-Orsk pipeline (temporarily closed since 2007) and the Caspian Pipeline Consortium (CPC). In the old days, the majority of oil exports in Kazakhstan solely entered Russian pipeline system ("Transneft") on the Atyrau-Samara pipeline. It had a capacity of 12 million tons per annum for many years (currently increased to 20 million tpa). At present, exports from Kazakhstan on this route are limited. There is annual quota of oil exports from Kazakhstan to Russian pipeline system and the special tariff agreement with Russia on transport fares. Although not the primary export route for Kazakhstan, "Transneft" is guaranteed up to 16 million, but no more, tons per year of Kazakh oil over the next 15 years under the intergovernmental agreement of 2002. About 15 million tons a year flows through the

Atyrau-Samara pipeline. The rest is provided through the Caspian Sea and loaded into the "Transneft" in Makhachkala, Russia.

The second group of export pipelines is the Kenkiyak-Orsk line, which carries oil from the Aktyubinsk fields to the Orsk refinery in Russia and the Karachaganak-Orenburg pipeline, which carries condensate to Orenburg. The pipeline has the capacity of 6.5 million tpa. It is used for an oil swap arrangement in which Kazakhstan supplies oil to the Orsk refinery in Russia and receives an equivalent amount of Russian oil through the Omsk-Pavlodar pipeline for processing at the Pavlodar refinery in Kazakhstan. From 2006 though, this pipeline has been conserved. (figure 10, Kaztransoil map)

The 1580-km Caspian Pipeline Consortium (CPC) pipeline was launched in 2001. It links the Kazakh fields to a terminal north of Novorossiysk. CPC was built up by the governments of Russia, Kazakhstan, and Oman in cooperation with a consortium of international oil companies. Oman later sold its share to Russia. It operates outside the immediate control of Transneft. The initial capacity of the CPC pipeline was nominally 28 million tpa. Two feeder pipelines from Kenkiyak and Karachaganak have been constructed independently, and in 2005 throughput grew to 31 million tons. Throughput has since increased even further, to around 35 million tons in early 2006, by using drag reducing chemicals. Consortium members have agreed to share the pipeline capacity between the Kazakh and Russian non-Caspian oil by 27.5 and 7.5 tpa respectively.

Increase of the pipeline's capacity to 65 million tpa is in the plans of CPC's shareholders. Expanding the pipeline is turning out difficult, however. Russia appears to be trying to assert control over the pipeline in various ways, including legal steps related to license conditions, and is keen to increase the tariff from the current $30 per ton to at least $38 per ton. Russia has also taken steps to transfer its shares in CPC to Transneft, the direct competitor of CPC. This follows an announcement of the Bosporus bypass pipeline and suggestions that Kazakhstan might more actively develop routes through Azerbaijan. The timing of the expansion was announced to be 2015 (CPC website)

4.3.2 Pipelines from Baku – Southern Caspian

Currently, three pipelines operate from the western shore of the Caspian: Baku–Novorossiysk, the Baku-Supsa, and the BTC pipelines. The Baku–Novorossiysk pipeline (known as the Northern route in Azerbaijan) was created by reversing an existing Soviet pipeline that previously had delivered Russian crude to the Baku refineries, and extending it to the AIOC terminal for off-shore oil at Sangachal terminal. Subsequently, a bypass to avoid Chechnya was also constructed. The route passes close to the Russian port of Makhachkala, to which it is also connected, thus allowing access for crude oil from the eastern side of the Caspian.

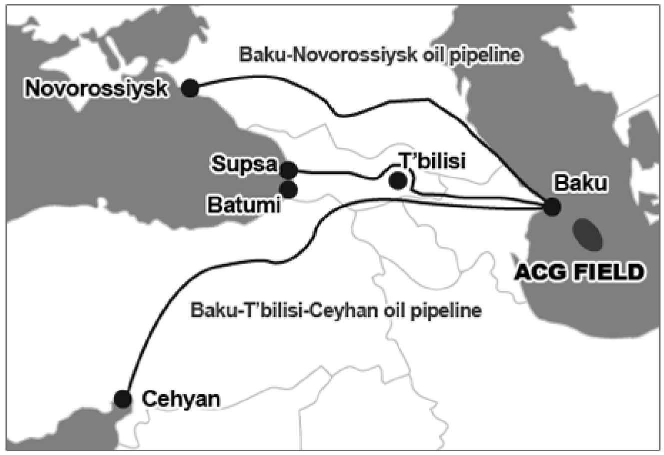


Figure 9 Azerbaijan Pipelines / Source: SOCAR

Baku–Novorossiysk pipeline is 720 mm in diameter and has a reported capacity of 6 million tpa. This could be expanded to around 15 million tpa by adding additional pumping stations at a cost of approximately US$ 300 million. The oil exported from Azerbaijan is not physically transported to Novorossiysk through this pipeline. Instead, Transneft receives the Azerbaijan crude into its system and then supplies an equivalent volume of lower-quality (Urals or West Siberian) crude at Novorossiysk. Transneft does not operate a "quality bank." Producers such as AIOC that feed higher-quality crude into the system are not fully compensated for the quality of their crude, thereby introducing a hidden cost into their use of the network. The tariff on the Baku- Novorossiysk pipeline, including port costs, was reported to be about $15.60 per ton in 2007.

The Baku-Supsa pipeline (known as the "Western route") was built in 1998 by refurbishing a partially constructed product pipeline in Azerbaijan and connecting it to a disused crude oil pipeline running from northwest of Tbilisi to Batumi. This was also refurbished as far as Supsa, where an off-shore loading facility was constructed. The pipeline diameter is 530 mm with a capacity of 7 million tpa. As with the Northern route, the capacity can be increased to about 10 million tpa by adding further pumping stations (at an estimated cost of US$ 100 million). The Baku-Supsa pipeline was closed in mid-2006 because of corrosion and a landslide but was reopened late in 2007.

The BTC pipeline opened in mid-2006. It runs parallel to the Western route as far as Georgia but then turns south through Turkey to Ceyhan on the Mediterranean coast. This pipeline has a 1067 mm diameter and is capable of transporting around 50 million tpa of crude oil. It is currently moving some 41 million tpa. Capacity can be increased to

60-65 million tpa by employing drag reducing chemicals and to 80 million tpa by also adding additional pumping capacity.

The BTC pipeline is owned by a consortium which is similar to the ACG consortium. As Kashagan in Kazakhstan is developed, it is likely that the 15 percent of the pipeline owned by Conoco/ENI/Total will be used for their production (assuming a solution is found to transporting it across the Caspian). It is used in the interim for other Kazakh oil, but most importantly for the largest oilfield Tengiz crude. (ECTS, 2007b)

4.3.3 Cross Caspian Pipeline

Kazakhstan has negotiated space in the BTC pipeline for future Kashagan oil production. But how to deliver that oil to Azerbaijan remains as yet unanswered. Construction of a direct subsea Trans Caspian pipeline connection from Aktau to Baku has been proposed as one alternative. However, Russia and Iran oppose the construction of any pipelines crossing Caspian seabed for political reasons and environmental risks the pipeline would pose to the Caspian ecosystem. Given the difficulty of constructing the Trans Caspian pipeline without approval of all littoral states, the pipeline is unlikely to be built in time to handle the boost in Kashagan production. Thus, transportation by tanker across Caspian remains the likely means of moving oil from Kazakhstan to Azerbaijan at least for the foreseeable future.

4.3.4 Pipeline to China

The 962 km eastern section of the Kazakhstan-China pipeline provides the first direct link between oilfields in Central Kazakhstan and the Chinese market. It links Kazakhstan's South Turgay basin, Kumkol fields, to refineries in western China. Deliveries began in July 2006. The initial capacity (and throughput) of the line is 10 million tpa. In addition to production from the Kumkol fields (now majority owned by (CNPC), Kazakh oil was also delivered by rail for insertion into the pipeline from fields in the northwest of the country (Aktobe), also being developed by CNPC.

In addition to the segment that operates east to China, the pipeline has a separate segment, completed in 2003 that runs westward from CNPC's Aktobe field to Atyrau near the Caspian Sea. The final stage of the pipeline project will connect the two sections and allow oil flow either east to Atyrau or west to China. The final phase of construction was completed in December 2009, with the further capacity expansion to 20 million tpa planned in 2015.

4.3.5 Other Pipeline Routes

The total capacity of the existing and currently planned pipelines (including the uncertain CPC expansion) described above is about 175 million tpa. This is ample capacity which could handle the foreseeable increase for oil exports from the region. Thus, most of the growth in production during this period can potentially be transported by pipeline. However, a gap exists between Kazakhstan, which will supply most of the additional crude, and the three pipelines starting in Azerbaijan. This gap will either have to be handled by a direct pipeline from Kazakhstan to Azerbaijan or through shipping to the western or southern shores of the Caspian.

Several options have been proposed for pipelines to transport oil from Kazakhstan and/or Turkmenistan across the Caspian to Azerbaijan. The alternative would avoid Iranian or Russian territory and connect with the export pipelines flowing westwards. For example, a 2002 study of alternative routes recommended the use of barges for volumes up to 7.5 million tpa and a pipeline (or pipelines) for higher volumes.

The route was from Aktau to either Makhachkala (if capacity on the Baku-Novorossiysk pipeline were available) or to a point close to the Azeri-Russian border and on to Baku. Russia and Iran are opposed to the construction of any pipelines crossing the Caspian, apparently on environmental grounds but almost certainly also for geo-political reasons. It appears, as mentioned above, that any west-bound Kazakh export oil that does not use the Transneft or the CPC pipeline will therefore need to be shipped across the Caspian. (WB, 2008)

Another pipeline initiative actively promoted by Russia is the Burgas –Alexandroupolis project. According to the plan, it will start from the Black Sea port of Burgas in Bulgaria and will span about 290 kilometers to the Greek port of Alexandroupolis in the Aegean Sea. Kazakhstan and other Russian oil would be supplied by tanker shuttle system from Novorossiysk (Russia) from across the Black sea north east. The draft of the port Alexandroupolis allows mooring vessels larger than Suezmax size (above 120k tons dwt), and most importantly allowing the oil to bypass Turkish Straits of Bosporus and Dardanelles. However, Bulgaria has halted the project due to environmental issues on the ground of expected intensified traffic in Burgas port, which is close to the country’s resort areas.

Another Bosporus and Dardanelle bypass project was offered by Turkey itself. It would start from the Turkish Black sea port of Samsun towards the Ceyhan port in Mediterranean. This pipeline would bring the Caspian and Kazakh oil to the already operating large oil transshipment hub of Ceyhan where BTC pipeline reaches from the northeast. The project is still under review due to ambiguity over Russian or Georgian Route expansion plans over the route capacities that should bring the quantities to the port.

4.4 Black and Mediterranean Sea ports in the Caspian oil Supply Chain

The main ports on the Black Sea for the processing of petroleum and petroleum products are Batumi, Supsa, Kulevi and Poti on the Georgian coastline and Novorossiysk in Russia.

Batumi

In 2007, Batumi Port handled 1 million tons of dry cargo (largely imports) and transshipped 12 million tons of oil and oil products. In recent years traffic has lowered, as crude traffic has diverted to Iran and other rail routes. The port is currently operating at nearly 80 percent of its capacity and has plans to expand. This would increase capacity from 15-16 million tpa to 28 million tpa, of which 25 million tpa would be for oil. A new container terminal (12 meter draught) is under construction. The terminal can handle vessels of 20,000 – 50,000 dwt at its three jetties and Suezmax up to 130,000 dwt at an offshore loading buoy mooring. It has current rail discharge capacity of 600 RTCs per day.

The Batumi Oil Terminal used to be operated by Greenoak Holdings since 1999. The company also leased all other berths from the Batumi Port Authority. In June 2006, Greenoak took over the management of the Port in a 49 year concession. In February 2008, the owner sold Batumi Oil Terminal and Batumi Port to the Kazakh State Company KMG. Terminal's current storage capacity is 570,000 tons.

Crude oil and refined product come from Azerbaijan (including some from AIOC) and crude oil from Kazakhstan. A forwarding company, Petrotrans, is responsible for all transport and logistics, replacing the previous arrangement in which customers would have to separately deal with the oil terminal, Batumi Station and Georgian Railways.

A closed refinery is located close to the Batumi port area. The refinery was supplied through a pipeline from Baku to Batumi, which had fallen into poor condition. In the late 1990s, Mitsui Corporation Japan had plans to rebuild this refinery as a modern facility with a capacity of 2 million tpa, but this project was never carried out. In March 2007, it was announced that that Kazmunaigaz would develop a new 5-7 million tpa refinery at a cost of about US$ 1 billion. This is expected to be fed with Kazakh crude. However, Kazakhstan slowed down the plans after Georgian Russian military conflict in 2008, by taking careful position in considering the project to have increased risks.

Poti

In July 2007, the Georgian Ministry of Economy announced a tender to concession the Port of Poti with an adjacent land of 400 hectares for 49 years for development of free economic zone.

The concession was awarded to the Abu-Dhabi registered company, Rakeen investments. This was the first case of FSU port being privatized. It signaled the Georgian government's dedication to welcome the foreign investments in the country's promising port sector.

The port handled 6.9 million tons in 2006. This included 1.25 million tons of liquid cargo (mostly light oil products) and 2.6 million tons of general cargo. The remainder is bulk traffics such as sugar. Seventy-five percent of the cargo is transit traffic to/from Azerbaijan and Armenia, while 15 percent is to/from Central Asia.

The berths have draughts of 8-10 meters, which can be deepened by continuous dredging up to 11.5 meters. The port has reached its capacity of 7 million tons per year and is now developing extension areas. Some 80 hectare of vacant land belonging to the port are planned to be developed into a free trade zone by the Government of Georgia.

Poti Oil Terminal, adjacent to the port, is owned by Channel Energy, a joint venture of Poti Port (25 percent) and Delta Group from Turkey (75 percent). The terminal works on light oil products (gasoline and kerosene) only, mostly transit traffic from Azerbaijan to Europe, and from Europe to Armenia. The terminal occupies 2 acres with 8 tanks and has a total storage capacity of 103,200 tons. Its design capacity is 3 million tpa. The daily rail tank-car (RTC) discharge capacity is 10,000 tons (48 RTC simultaneously). The terminal feeds one dedicated berth, which allows loading of 35,000 ton vessels, and one berth shared with the ferry terminal. The terminal complies with international quality standards, ISPS safety and environmental protection, including a full oil spill contingency plan that is regularly reviewed and updated.

Kulevi

Another case of foreign direct investment in Georgia's port sector is Kulevi. It is a newly developed harbor close to Poti port launched into operation in 2007. It is owned by a consortium of SOCAR (51 percent), Middle East Petroleum (34 percent) and Georgian individual investors (15 percent). The port operates two berths (13.6 m and 6.13 m deep, which accommodate Aframax 100,000 dwt ton and handy 40,000 ton vessels respectively). An offshore buoy mooring located 4 km from the shore in an area which is 17.1 m deep will allow the loading of Suezmax 120,000-150,000 dwt ton vessels.

Kulevi handled 4-5 million tons of crude oil in 2007, increasing to 7 million tons in 2008. Its planned annual capacity is 10 million tons, comprising 3 million tons of crude oil, 3 million tons of diesel and 4 million tons of fuel oil. The port capacity can be readily increased to 20 million tpa in the future. Kulevi plans to expand to handle oil products from Kazakhstan, Turkmenistan and Azerbaijan, and to add a dry cargo terminal. Construction of an oil refinery is also under discussion.
The oil terminal has storage capacity of 275,200 tons (50 percent for crude oil, 25 percent for diesel and 25 percent for fuel oil). This could be increased to 326,800 tons. The terminal is linked to the main railway network by a private 14 km branch line. The terminal can discharge four 42-RTC trains simultaneously.

Due to full private Georgian and foreign capital contribution timely construction and operation of the Kulevi oil terminal has been made possible. Faced with environmental and issues with international financing sources, the terminal construction was at risk to be postponed for unknown time. However, private interest and state facilitation to the project encouraged private investors to go ahead and launch the construction of the terminal in 2002. By the end of 2006 the port construction was reaching the end and the timing was perfectly utilized by the government who made negotiations with the state of Azerbaijan to sell the majority shares in the port and terminal. This was a strategic acquisition by Azerbaijan which has vast oil and gas resources landlocked in the Caspian region and needing access to the open sea routes. By offering favorable conditions to the Azeri state oil company, Georgian government made good effort to secure the oil cargo flows by railway through the country as well as stable local employment and investment inflows.

Supsa

Supsa, the terminal of the Western Route pipeline (WREP), is a modern oil terminal with an off-shore mooring point capable of handling Suezmax vessels of 150,000 dwt. The terminal is owned by the Georgian Pipeline Company and has four 40,000-ton capacity reservoirs. The pipeline extends from the terminal to the single buoy mooring. Prior to the opening of the BTC pipeline, the port was handling up to 7 million tpa, stayed inoperative due to refurbishment works until 2007 and resumed service at full capacity from the second half of 2007.

Novorossiysk

Two oil ports are located near Novorossiysk, one in the port itself and the CPC owned one nearby at Yuzhnaya-Ozereyevka. The Novorossiysk port is one of Russia's main ports, situated in non-freezing bay. The port includes a general cargo area and the

Sheskharis oil harbor and terminal. In 2007, the port handled 80 million tons in total, of which 28 mln tons was dry and fluid cargo, and about 52 mln tons of oil and oil products, of which about 47 mln tons was crude oil. Some 95 percent of oil capacity and 90 percent of dry cargo capacity were used in 2007. The terminal handles about 30% of Russia's export oil shipped via sea terminals.

Sheskharis is connected to the most important oil-producing regions of Siberia, Kazakhstan and Azerbaijan. The main berth of the terminal was built in 1978 and has been operating for years without overhaul. It has a very deep draft—24 meters—and can accommodate VLCC vessels (up to 250,000 dwt). The length of the mooring for the oil terminal is 2.2 km. It is fed by the part of the Black Sea pipelines of Transneft JSC, which also feed Odessa and Tuapse and had a total capacity of around 65 million tpa. The depth at dry cargo terminals is 13.5 meters, which will allow the port to handle Panamax vessels. The length of the mooring lines for bulk cargo terminal is 4.5 km. General cargo specializes in the processing of grain, sugar, metal scrap, fertilizers, refrigerated cargo, as well as wood.

Novorossiysk Commercial Sea Port (NCSP) is a state owned holding entity which has over 50 percent of shares of the largest stevedoring and service companies of city Novorossiysk and Kaliningrad Region such as: Novoroslesexport OJSC, Novorossiysk Ship-Repair Yard OJSC, IPP OJSC, Fleet of Novorossiysk Commercial Sea Port PJSC, Novorossiysk Grain Terminal OJSC and Baltic Stevedoring Company LLC. NCSP plans reconstruction of berths as well as overhaul of basic technological equipment of Sheskharis oil terminal. The port's overall annual throughput is expected to increase to 110 million tons by 2012.

The CPC terminal is separate institutionally and physically from Novorossiysk port. It is owned and operated by Caspian Pipeline Consortium (Russian government 31%, Kazakhstan government 19%, and 50% between Chevron-Texaco, Lukoil, and other petroleum companies). The oil terminal is linked to the CPC pipeline. The CPC terminal has a capacity of 30 million tpa that can be increased to 67 million tpa if the pipeline is expanded.

Mediterranean port in Turkey – Ceyhan

The destination point of the BTC pipeline is located in the south eastern Turkey's Mediterranean coast, at oil terminal of the port of Ceyhan. The oil terminal was a large transshipment point for the Iraqi oil connecting to the oilfields in Kirkuk with crude pipeline delivering up to 20 million tpa. After the outbreak of the second gulf war in 2003 and subsequent turbulence in Iraq the pipeline stalled operation due to safety reasons. With the launch of BTC pipeline the terminal resumed operations in 2006.

Ceyhan oil terminal houses 7 crude oil tanks with floating roofs – capacity of one million barrel each. Crude export Jetty is 2.6 km in length with simultaneous loading of two ULCC tankers of up to 350,000 ton deadweight each. The terminal is operated by BOTAS international, a Turkish state owned company also responsible for operating the BTC pipeline on the territory of Turkey. Ceyhan oil terminal has an annual throughput capacity of 50 million tpa of crude oil.

It should be noted that BTC pipeline also currently has capacity of 50 million tpa, but if further expansion occurs up to 80 million tpa, the Ceyhan port surrounding empty plots of 1.5 square km allow accommodating further expansion of the oil terminal.

4.5 Georgian, Azerbaijan, and Kazakhstan Railways

Railway operating companies play an important role in the transportation of crude oil and oil products across the FSU countries. Railways bear especially important role in the moving of petroleum from the landlocked Caspian states which have no direct access to the world markets by sea. The existing network of pipelines that bring the vast majority of crude oil from these states to the destination points are supplemented by the railway operators of these countries who provide carriage of the “swing” supply capacity.

Two national railways, Azerbaijan Railway (ADDY) and Georgia Railway (GR) transport oil and oil products between the terminals in Azerbaijan and the ports on the Black Sea. Although separate organizations, they effectively operated as a single railway for transit traffic for over a century and have identical infrastructure and operating standards and use identical rolling stock. Since the breakup of the Soviet Union, they have both divested many of their previous ancillary businesses and both are now primarily railway operators to the exclusion of other activities.

Organizationally, ADDY remains a state organization, with its General Manager reporting directly to the Council of Ministers and the Government having a final say in determining railway policy. ADDY is vertically integrated, responsible for both infrastructure and operations. Georgia has commercialized its railway. GR however remains 100 percent owned by the state. Both ADDY and GR have profitable freight operations which cross-subsidize passenger and lead to an overall profit for the railway as a whole.

Kazakhstan Railways (KT) is government founded joint stock company with subsidiaries, operating as rolling stock owner / operators and another entity for infrastructure management. It is the largest employer in this Central Asian state with about 80 thousand employees. Its rolling stock count is the biggest after Russia’s in the FSU-over 50,000. The network reach of the KT is however not diverse, although has access to main oilfield areas, where additional tracks can be easily laid due to flat terrain in most of the country. KT carries out temporary shipper role for oil transportation before gathering pipelines are constructed to an oilfield. In case of Chinese supplies, KT was used to deliver petroleum to the Atasou terminal from Kumkol Fields where it was pumped into the Atasou-China pipeline. Since the end of 2008 the pipeline was connected with the Western part complete construction. KT also delivers small quantities to the Russian refinery near Kazakh border.

4.6 Summary

Within the transportation sector of the Caspian oil some modalities are characterized by oligopolistic market structure. Both, sea and railway services are subject to price rents charged by the operating companies or sub-contractors. Pipeline operations are however the top priority of governments and energy giants. Two major pipelines are competing, CPC in north crossing Russia to the port of Novorossiysk and BTC in the south, cross border pipeline through Azerbaijan, Georgia, Turkey. Both pipelines are operated by international consortiums involving governments and they are central nodes in the competition of routes to bring large amounts of Kazakh oil to the western markets.

Among the port developments, Georgia has pioneered in the Black sea FSU region the introduction of private terminal operators in its ports along with Azerbaijani and Kazakh states run companies' ownership of the two oil hubs of Batumi and Kulevi.

The capacity of the current network of pipelines is ample to carry annual flows of oil to the Black Sea and Mediterranean Sea. Railway capacities have increased due to reconstructions but organizational problems remain. Moreover, the Chinese direction, due to direct pipeline construction to the Chinese refineries is playing an increasing role in shaping the future vector of Caspian exports.

Chapter 5 Costs: Tariffs and Risks in the Transportation of Caspian Oil

In this chapter we will define the costs related to the transportation of oil. In addition to transportation costs, there might be many other factors influencing the decision of route selection for transporting the oil. Tariffs can be adjusted and they usually are according to the interests of the shipper and service provider parties. In the longer term, however, there are costs which should be accounted for stemming from risks associated with a specific route of transportation. Quantification of risks has been done by certain studies.

5.1 Geopolitics

The matter of energy transport routes, especially pipelines, has been a major issue in the geopolitics of the Central Eurasian and Caspian region. The West has lobbied transportation projects that carry Caspian energy bypassing the Russian territory, such as the BTC, whereas Russia has used its power to keep almost all Central Asian energy exports under control and to stop any important shift in Caspian energy exports. For instance, Russia has signed in 2002 intergovernmental agreement with Kazakhstan on guaranteeing up to 16 million tpa crude oil flow from Kazakh fields through Transneft system at very low transit tariffs. To divert some oil quantities to this route, Kazakh state pipeline operating entity, on its part has to put pressure on foreign owned companies by setting quotas on other routes.

In fact, as mentioned in chapter 3, the quality of oil through Transneft system deteriorates due to its mixing with high sulfur containing (low grade) Urals oil. Urals is traded in European markets in high volumes and is one of the benchmark pricing grades. However, due to its inferiority its price always stays below North Sea Brent (another benchmark grade) Most of Kazakh and Azeri oil grades extracted from the Caspian Sea basin have similar qualities with Brent and even trade at minor premium to the Brent.

Table 4: Benchmark grades price differences

	2003	2004	2005	2006	2007	2008	2009
Brent price USD/bbl	28.83	38.27	54.5	65.14	72.40	97.26	61.70
Urals price USD/bbl	27.07	34.13	50.3	61.22	69.20	94.83	61.10
price difference	1.76	4.14	4.2	3.928	3.23	2.42	0.53
source: OECD							

According to the table 4, average difference between Brent and Urals was 2.9 USD a barrel. These hidden costs Kazakh and Azerbaijani producers incur can be accounted for in our model.

The region has become a playing field for Russo-Western, mostly US, competition over the access to the vast Caspian resources and control of the exporting routes. In the meantime, a booming economy of China with its accelerating energy demand added more intensity to the complex geopolitical game. Pursuing a balanced foreign policy and declared will to diversify its export routes, Kazakhstan state is increasingly promoting sending resources eastwards. The country producers have already begun to deliver the crude to China through the newly built Kumkol – Alashankou pipeline.

Azerbaijan is somewhat in a less favorable geographical location for export options; Russia and Iran are the major powers trying to exert their power in the region. But leverage capability of Iran has diminished since a strong US policy to block Iran due to its nuclear development policy are working and exports to Iran from Caspian region are very limited. Notably, unless Iran had problems in international relations, it would absorb more of Azerbaijani and other Caspian oil production. In reality, FSU country exports to Iran remain insignificant, up to 2% annually. (World Bank, 2008) Azerbaijan has also taken into consideration Russian interests and signed contract with Russia in 1996 on transportation of 2 mln tpa of oil through the Baku-Novorossiysk pipeline connecting with low grade Urals oil filled Transneft system. However, Azerbaijan has a very favorable westward route access through Georgian Black Sea ports where it has already acquired its own one, Kulevi.

Although Azerbaijan and Kazakhstan are both politically stable states with sustainable economic and social development, their statehoods still depend on vertically integrated elite run political systems.

Georgia, a very important node in the East West energy transit route, has been struggling with territorial integrity since gaining independence in 1991. The country was swayed by corruption and spiraling down economy until 2004, when the Western oriented government came to power and started implementing reforms, privatization, and institutional decentralization. Quick actions bore fruit in economic and social development, as well as reliability in transit role. However, strong US and Russian interests in energy transit have intersected in the country as well. Once Russia is trying to divert most Central Asian and Caspian resource through its territory, Western powers prefer to have bypass supply routes. The geopolitical chess game even grew into military clash between Georgia and Russia supposedly over ethnic conflict in North of Georgia, and ended in five days with Georgia losing the control over part of its territory to Russia. But the "red lines have been drawn" and with the EU monitoring mission and international focus in the area there is little chances and reasons for further military escalation.(WP, 2009) Georgia can concentrate on carrying on with reforms it had before the war. The energy game will be played solely at diplomatic and economic levels in the foreseeable future.

5.2 Transportation Company Tariff methodology review

5.2.1 Transit Tariffs in Pipelines

The introductory articles of Energy Charter Treaty state (1991):

“In a world of increasing interdependence between net exporters of energy and net importers, it is widely recognized that multilateral rules can provide a more balanced and efficient framework for international cooperation than is offered by bilateral agreements alone or by non-legislative instruments. The Energy Charter Treaty therefore plays an important role as part of an international effort to build a legal foundation for energy security, based on the principles of open, competitive markets and sustainable development.”

Based in Brussels, Energy Charter Treaty Secretariat is a supranational body with 58 member-states and a goal to coordinate and promote the cooperation between them. Info from ECTS published handbook (2007) on energy pipeline Tariff methodologies in Europe and FSU is summarized below.

Tariffs are the only way of charging clients for the services rendered in pipeline business and are revenue generating measure for the operators. Besides, there are charges for overtime storage and rerouting of cargo but they comprise smaller amount of oil transported. The unit measure is given in currency per kilometer or 100 kilometer per ton. There are many ways of calculating tariffs. Two radically different cases can be reviewed briefly: privately owned pipeline tariffs in competitive environment and state owned pipeline tariffs set by government regulatory agencies.

In a competitive environment, pipeline operators set tariffs based on the predetermined profit rate, which is compared to the market profit levels and included in the total tariff rate together with costs and profit tax. Private oil pipelines are built after calculating these costs.

In a government owned pipeline systems tariffs are calculated after the construction and all other refurbishment costs are counted. In Russian and Ukrainian state owned systems tariffs also include security, taxes, and maintenance expenses.

Delivery costs break down into fixed and variable costs. Fixed cost element is high in the pipelines operations, such depreciation, wages, payroll taxes. As the capacity of the pipeline underutilized fixed cost per unit grows. Variable cost element grows as the capacity utilization is increased. It is mainly consisting of pump station power supply. As the capacity utilization grows, fixed cost steeply fall thus driving down the total unit transportation cost. Hence, pipelines are vivid example of systems demonstrating economies of scale. (ECS, 2007b)

In the former Soviet Union countries, where state run pipeline systems are widely present, each country has introduced own regulations on access to oil transporting systems. For instance, according to Russian law oil producing companies can get access to the Transneft system according to the quota of their production and pipeline capacity availability. In Kazakhstan, by law pipelines are public transportation means and any a consumer owning certain amount of crude may request access for transportation.

There are two main types of tariff setting methodologies in the former soviet states for the government owned pipelines: long-term and negotiated tariff contracts.

Large producers with guaranteed annual output get from 5 to 10 years duration contracts securing stable rates. Transportation company gets steady revenue source. Negotiated tariffs exist for those producers interested in upgrading a specific pipeline section capacity. Revenue generated from the markup on their tariffs is used for upgrading the pump stations or changing the whole small segments of a section.

As of cross border tariffs, they are largely influenced by political, or geographic factors rather than by purely economic decisions. Russia-Ukraine, Russia-Kazakhstan, Azerbaijan-Russia cross border rates are influenced by these principles.

5.2.2. Railway Tariffs

Passenger railway services are usually loss making in FSU countries. But Railways are profitable overall due to freight transportations. Russian, Kazakh, Azeri, Georgian railways carry large amounts of cargo. For the Caucasian railways around 90% of cargos are liquids, oil and oil products in largest amounts. Tariff measure of oil transportation is calculated as a base rate per kilometer multiplied by coefficient depending on the cargo type and distance to be travelled. Russian Railways often apply temporary damping pricing tariffs to transit oil cargos from Kazakhstan in order to gain more market share. Kazakhstan largely discounts service for oil transportation from oil well locations to terminals where limited pipeline infrastructure exists inside Kazakhstan, giving railways a complementary status to the oil transportation sector. Caucasus state railways tariffs are publicly available but only large subcontractors who transport at least 4 million tpa of oil are entitled to special volume tariff of 5 USD per ton.

5.3 Transit Risks

5.3.1 EU Energy Related Socioeconomic Risks Study

Quote on energy security defines the concept underlying the discussions and actions taken by the various parties of interest.

“Energy security, broadly defined, means adequate, affordable and reliable supplies of energy” (IEA, 2007: 160-161).

The Major oil consuming market, still in the form of OECD country economies, has especially prioritized the issue. It is a material issue on the agenda of OECD states foreign and trade policies. European Union, whose own energy resources are passing the peak, has funded many projects to evaluate the future of European energy security and factors associated with it. Although consensus on the many existing strategies and tactics on the energy security is not reached among researchers and policymakers around Europe, the above mentioned quote refers to three unarguable elements; Adequate supply is interpreted as the amount of energy(oil) available, affordable means the price of it including the delivery costs; reliability is a component related to numerous factors, or risks, that may influence any energy supply chain and should by no means be ignored by decision makers.

This section draws parallel between the energy security of the importing countries and energy export route security of the producer countries. Security of energy corridors as they are known equally concerns both ends of the supply chain, customers and providers, and definitely the middle point, transit countries and locations the energy commodities have to pass en route. Hence, it is equally feasible for the companies of exporting country to use the similar approaches to those of the importers.

Risk is a probability of occurring for one or another event. Probabilities are based on frequency of past occurrence of an event. Uncertainty is the unknown environment when no past experience exists with estimating the probability in objective manner. (Haralambides, 2010)

Caspian countries already have routes going through Russia, Georgia, Azerbaijan China and their risks can be estimated. Building a pipeline or railway connection through Afghanistan would be a decision with uncertain outcome. Current highly explosive situation in Afghanistan would not allow assuming any probability of risk levels.

Many authors have described several types of risks in their works. Some of them are commonly referring to the same type of risk as one of the factors, For example, an economic factor. Some writers mention geological, technical, geopolitical, environmental risks. In a more detailed form risks, such as possibility of accidents, conflicts, terrorist attacks, restrictions on export, weather conditions are described by others. European Commission (2010) paper focused on physical, economic, social, environmental risks. Most of the studies focus on qualitative analysis of occurrence of such risks. (Sales, 2009)

Authors of the European Union funded project “Re-access” study on quantifying energy risks suggest that energy corridor risks are associated with four main types of socioeconomic variables. Economic, Political, social, and energy specific pertaining to a country can be quantified based on various underlying variables they are related to.

Each type of risks is comprised of variables that are usually measurable, indexable and the results publicly available. In this sense, risks arising from the specificities of each country influence the reliability of the route. Total risk factor of a country shows a cumulative effect on the country risk level and countries involved in a route contribute to the total risk of the corridor.

Since diversification of supply routes is a priority for both Caspian countries, it is a question of what principles to diversify by. Azerbaijan and Kazakhstan oil producers should account for the price of transportation (tariffs) and transit country specific factors (risks) that make up the total "cost" of the corridor. The name route and corridor are used interchangeably in this chapter but corridor usually refers to the energy route connecting producer countries with the importer countries. Our basic search is to analyze route desirability up to the open sea ports from producing Kazakhstan and Azerbaijan.

The socioeconomic factors of energy risk can be categorized as follows:
- Economic factors of energy risk: All economic variables with an actual or potential direct impact on energy. This group can be viewed as including economic and population growth, the weight of energy in the country's sources of revenue, and trade relations.

- Risk intrinsic to the energy sector: This type mainly concerns the existence of energy resource reserves in barrels (size of resource fields) and in relative terms (ratio of reserves to output), and the reliability of the data on such reserves. Finally, resource recovery policy, which sets output levels, is often influenced less by technical or economic considerations than by political ones. An example are the resource recovery policies of the USSR in the 1970s and 1980s, which brought about a decrease in output in the 1990s due to over-usage of fields, since output was planned without regard to technical recommendations.

- Political risk: Political risk is present if the political decisions of any economic or social agent may affect the functioning of the energy system. The most significant such risk is political violence, in the form of external conflict, international war, internal conflict- civil war, coup d'état, terrorism or violation of human rights. Other political variables affecting energy risk are those relating to the political regime, institutional quality, domination of the rule of law, membership of international bodies, international political alliances, and so on. The political variables most closely linked to the energy sector include membership of OPEC, whether the energy producing companies operating in the country are public or private (national or international), use of energy as a political weapon and involvement in multilateral energy deals.

- Social risk: This category includes all measuring variables relating to the living conditions, social well-being and cultural values of a given country or geographical location. At the same time, in this category is included social equality, and social and labor conflicts.

In short, economic and energy factors are specifically related to energy sector while the social and political risks have a broader coverage, but still important and representative of a transit country.

Quantification of risks has been developed by applying factor analysis to the variables described above with Z-score and regression analysis. Consistent data of last decade was collected for the chosen factors. The data relied on indexes developed by UN, IMF, RBS, and various supranational and monitoring organizations. Risk level was determined for each factor for 158 countries. Table 5 summarizes the socioeconomic risk factor indexes for selected transit countries of Caspian and Central Asian oil transportation.

Table 5. Selected Country Socioeconomic Risks

Type and Level of Risk ranked 0-100					
Countries *(ordered from less overall risky to highest one)*	Socio Political	Intrinsic Energy	Political Institutional	Economy driven	**Single average of Risk**
Russian Federation	59,6	1,8	58,6	36,1	**39,0**
Kazakhstan	70,2	7,7	45,6	49,8	**43,3**
Turkey	48,2	61,1	49,5	28,2	**46,8**
Azerbaijan	70,6	15,8	54,3	55,0	**48,9**
Georgia	58,0	71,3	48,6	33,3	**52,8**

Source: Marin Quemada (2008)

5.3.2 Concentration Risk

Existence of transit countries on the routes of oil transportation from Kazakhstan and Azerbaijan are unavoidable. In a simple world, it would be more desirable for each exporter to avoid leaving its exports to routes passing through one stable state. But in reality there are risks of various types with different high and low indicators in every surrounding country. The risks are lowered when a route passes through the different countries, and preferably distributed as much evenly as possible among these countries, so that interests of many intersect and the probability of taking unilateral disruptive actions by any one is lowered. Le Coq et al. (2009) also suggest incorporating into indexes the route lengths per transit countries as an indicator of technical damage risk. In order to measure the concentration risk of the Kazakhstan and Azerbaijan export routes we could apply the Gini index individually to each one of them by using the transport route lengths.

At this point it needs to be emphasized that some studies such as (Paltseva, 2009), and (Marin Quemada, 2008), suggest measurement of energy diversification risk level for the importing countries based on various index methods. The latter work has been one of the extensive and encompassing recent attempts to measure the exposure to non-diversification, or higher concentration of energy supply sources. In particular, It is of utmost importance for the EU to have an integrated energy policy. For the member countries to decide on such policy tool, to know how much each country contributes to the overall energy risk would be a helpful tool at the negotiations table.

Regarding the study focus of this paper, Caspian countries' diversification choices are even more complicated. Landlocked barrier is exacerbated by high risks of various types around the neighboring countries. Kazakhstan and Azerbaijan producers both need to evaluate the risk magnitudes together with the prices they pay for transportation of oil in each route.

One of the measures of diversification, or concentration is the Herfindahl -Hirschman index (HHI), which is widely used among businesses and policy makers. It is used for combining information about the market shares of all participants in the market. The US and Japan antitrust monitoring bodies publish this index frequently to demonstrate to the businesses the level of index above which an industry concentration could be subject to prevention. The H-index is calculated by the summing the squares of market shares of the firms.

While HHI index calculation magnifies the effect of top largest share representatives in the sample, the Gini index, that is another measure of concentration, emphasizes unequal distribution of shares among all elements. Graphically, It compares the Lorentz curve which combines cumulative distributions of two related variables, for instance number of ports and relevant shares for each one of them, and with the line of perfect equality assuming all these ports had exactly equal shares in the market. Economists, geographers have used Gini coefficient to assess equality of income distribution among various groups of population, or other phenomena as industrial location concentration. In transport economics it is used to measure traffic concentration for a terminal or route.

Various methods to calculate the Gini coefficient exist depending on population and sample parameters. Rodrigue explains a formula widely used in transport sector, as follows: (p.186, 2006)

$$G = 1 - \sum_{i=0}^{N} (\sigma Y1 + \sigma Y2)(\sigma X2 - \sigma X1)$$

Where X is a proportion of variable (traffic) if it was equally distributed among the elements,

Y is the actual proportion of traffic among the elements,

σXs and σYs are the cumulative shares of Xs and Ys (as percentages) and N is the number of elements.

Both Gini coefficient and HHI values range between 0 and 1. A highly concentrated (unequal) market has a value of 1. As the number of market participants grows the index value falls. Lower value shows higher diversification. For the purpose of this chapter we measure the Gini index for each route using their lengths in km in each country as market shares. Thus, relative concentration level between these routes can be illustrated.

In the above equation, X is the hypothetical equal share of a country in total distance per route; Y is the actual distance of total route section in each country. σXs and σYs will be the cumulative shares of total distance ranked from the largest to shortest one.

Pipeline technical specifications data was used for route length in each country up to the port, for railway routes, Russian railways online tariff calculation software gives detailed info on each route by country. Hence the following results were derived in table 6:

Table 6. Caspian Oil Routes concentration Index among Transit Countries (Gini index)

				PORTS			
OILFIELDS	*Novo (CPC)*	*Novorossiysk Terminal 2*	*Novorossiysk Rail*	*Supsa(WREP)*	*Geo Black sea*	*Ceyhan BTC*	*China Pipeline*
ACG oilfield							
Gini Coefficient	*0.523*	*0.268*	*0.341*	*0.053*	*0.070*	*0.518*	*0*
Tengiz							
Gini Coefficient	*0.395*	*0.216*	*0.356*	*0.302*	*0.289*	*0.603*	*0*
Karachaganak							
Gini Coefficient	*0.158*	*0.062*	*0.061*	*0.528*	*0.528*	*0.581*	*0*
Aktobe							
Gini Coefficient	*0.214*	*0.104*	*0.065*	*0.291*	*0.291*	*0.727*	*0*
karazhanbas+mangistau(Aktau)							
Gini Coefficient	*0.147*	*0.054*	*0.267*	*0.242*	*0.308*	*0.721*	*0*
Kumkol							
Gini Coefficient	*0.010*	*0.068*	*0.093*	*0.610*	*0.598*	*0.849*	*0*
Source: own results							

Chapter 6 Optimization of Export Routes for Large Oil Producers

6.1 Introduction and Problem Formulation

The problem of transporting landlocked Caspian oil to the markets has been mostly qualitatively studied weighing pros and cons of each route to deliver the commodity to markets. Many factors and interest vectors intersect at the core of making a right decision. In the beginning of 2000s there was a lot of speculation about the possible routes of Caspian oil exports would take. Eventually the infrastructure developed by the influence of one or other factor and today's system allows the Caspian oil producers to make more choices as of the route the oil export should be exported to the ports. In the short-term, relatively speaking of the costs related to transportation, the primary indicator should be the tariffs of oil pipeline systems and railways connecting the region with Black sea and Mediterranean seas. Thus, the key question in defining the route is:

How can Caspian Basin major oil producers optimize their export routes based on minimum costs of transportation per ton of crude oil for each destination?

Management Science offers the tools to measure optimality choices and to offer in quantitative way a solution to the real life problem. The analysis begins with the observation of a real-world system and from it a management science problem is seen. Major parameters and variables of the system should be found and extent to which they can be controlled should be defined.

Eventually, the crucial part of a management science, or operations research, problem starts with building a model. Written, name it qualitative definition of the problem should be formulated that later will translate into quantitative definitions. This section attempts to define the problem, express it mathematically and using spreadsheet solutions to find the optimal minimum cost level that correspond to the quantities allocated to each port/destination.

Markland (1989) expounds that a usual quantitative problem should contain the following elements:

- *A set of Decision variables*, these are the unknowns which are to be determined by solving the model. Decision is made based on the results.
- *The objective Function* measures the acceptability of the results if a decision is made.
- *Constraints* are defined to limit the size of the decision variables based on economic, technological or physical limits to the system.
- *Constants* are known values that relate decision variables to the constraints.

One of the directions in the management science is model based analysis in linear programming. Linear programming is a class of management science that mathematically expresses the problems and as an objective sets minimization or maximization of quantities. Based on the above component definitions for the quantitative problem, we can formulate the problem of distributing oil flows to the export directions in simple mathematical terms.

A special section of linear programming, namely transportation problem modeling, also called Network Flow Analysis is used to solve optimal transportation problems. We try to use this tool to define the decision variables, objective function, constraints and constants. That should lead to finding minimum cost scenario through iterating process. It will be discussed below.

The transportation problem arises in planning the allocation of goods from several supply locations to several demand locations. Usually, quantities of goods available at origin locations are limited and demanded quantities at destinations are known. The objective is to minimize the cost of shipping goods from the supply location to the demand points.

Assumptions

Assumption Underlying the following model is that the major oil corporations operating in Kazakhstan and Azerbaijan are trying to minimize the cost of transportation despite the fact that all of them participate in at least one of the pipeline companies and have privileged access for the own pipelines. However, each one of them has different daily oil production rate and in order not to stop the oil flow they will ship it whenever the route capacity is available. The demand is considered stable. According to 2007 export/production ratios 82% and 92% respectively of Azerbaijan and Kazakhstan extracted crude had been exported (OECD database). We apply these ratios to the export supply of specific fields grouping under consideration.

Table 7. Azeri and Kazakh Export/production ratios

2007	*Azerbaijan*	*Kazakhstan*	*Total*
Production	42,597	67,125	109,722
Exports	34,780	61,455	96,235
E/P ratio	*0.82*	*0.92*	

Source: OECD

The calculated exported quantities from the specific oilfields represent 62% of the total exports. This ratio is applied to the demanded quantities by ports/terminals. Since the ports used in our model export crude oil only from these Caspian regions, (except Novorossiysk which is also main hub for domestic Russian exports, but the official export quantities and pipeline capacities for Kazakhstan and Azerbaijan are known, the same ratio to identify the demand for allocated quantities in Novorossiysk is applied.

Major Oilfields Share in Total Oil Exports (2007)

Table 8	*Production tpa*	*Export tpa*
ACG oilfield	*23,000,000*	*18,860,000*
Tengiz	*14,000,000*	*12,880,000*
Karachaganak	*10,000,000*	*9,200,000*
Aktobe	*6,000,000*	*5,520,000*
Mangistau	*8,200,000*	*7,544,000*
Kumkol	*6,100,000*	*5,612,000*
Total	***67,300,000***	***59,616,000***
Total Official Exports		*96,235,000*
Share in exports		*0.62*

Source: OECD/Own adaptation

The rates applied are from 2007. The rates are usually long term and apply in medium terms, especially on pipelines. This scenario is taken due to the fact that in 2008 and 2009 world economic crisis hit hard the global demand for petroleum and the last quarter of the year was not representative of the demand under usual economic conditions in Europe and North America, as it is in the normal sequence of cargo flows.

In addition, Baku- Supsa pipeline underwent refurbishment in 2008 and restarted operation late that year. Prior to that, most importantly, earlier in summer Russo-Georgian military conflict over North Georgian province occurred due to which BTC pipeline passing though Georgia was halted and Georgian Railways operations disrupted due to explosions on the tracks. Although it did not last long, disruption took the crude transit operations a month to be resumed.

Formulation: Caspian oil production starts with various oil wells at various fields (*Supply origins*) spread throughout Azerbaijan and Kazakhstan.

First, Kazakhstan fields supply is described. The yearly production volumes are different at these fields according to the production capacity and reserves. *(Supply quantities)* The upstream transportation inside Kazakhstan is handled by the pipelines in majority. Kazakhstan Railway services with tank cars are used in the locations with no gathering (local) pipeline connection to the trunk (main) pipeline system.(Route Capacity constraints) By them oil is transported to the direction of North of Kazakhstan, Atyrau, and to the west Aktau port which are also pipeline and railway transshipment hubs for various further directions. China oriented crude is forwarded from Kumkol in central Kazakhstan by pipeline directly to Alashankou where it crosses the border and is delivered to the customer! (*Demand Destination*)

Regarding the western routes, from Atyrau oil is transshipped via CPC North West towards Novorossiysk CPC terminal (Demand Destination), or North, Atyrau-Samara pipeline (Capacity constraints) to the direction of Novorossiysk state terminal, Russia (Novo2), Notably, although physically the terminals are located close to each other (range of 20km) we consider them separately, because of independent routes followed and different discharge terminals.

-From Atyrau, Kazakhstan, crude oil can also flow down south to Aktau port and be transshipped across the Caspian Sea to Makhachkala port of Russia, or one of the Baku Caspian Terminals of Azerbaijan. Oilfields located (Supply origins) close to Atyrau directly supply oil into the trunk pipeline system or can send to Atyrau by rail for transshipment into Russian pipeline system mentioned above.

From Makhachkala oil is shipped through the connection with Baku-Novorossiysk line. There is also possibility of railway shipment as well towards Novorossiysk port state terminal (Demand Destination). From Baku crude oil is either pumped into the BTC pipeline, or WREP pipeline to Supsa (Georgia), or Azeri Railways connecting with Georgian Railways and reaching one of the Georgian terminals on the Black Sea – Batumi; Kulevi; Poti. - (Demand Destination)

As of Azerbaijani oil, here the picture is more straightforward. The only large supply origin under focus is offshore in the Caspian Sea and is a group of various fields located close to each other; Supply origin can be viewed as the single one. Oil here, takes the route either

-North, Baku-Novorossiysk pipeline, to, Again Novorossiysk (Demand destination), or

-South-West BTC pipeline (Capacity Constraint) to Ceyhan, Turkey (Demand Destination), or

-West, WREP Pipeline (Capacity constraint) to Georgian Supsa port (Demand destination), or

- by Azeri-Georgian Railway connection to one of the Black Sea Ports of Georgia. (Demand Destinations)

Each route has a cost of transportation. In order to compile the cost of the whole route, most of them were comprised of various modes of transport. Shipping rates for each mode was added up to derive the total transportation cost per ton of oil shipped from supply to the destination point. Joint Online tariff calculation databases of Russian and

Kazakh railway companies, information from supranational organization reports (ECS, World Bank) for pipeline and shipping company operators, and bulletins from the Caspian and FSU energy market monitoring group, Argus Media had been used to find out the applicable rates for 2007 period.

The map hereunder illustrates the possible transit routes towards the West and East directions, as detailed above.

Figure 10 Kazakhstan Pipelines / Source: Kaztransoil

6.2 Decision Variables and Objective Function

Based on the definitions above we need to find the quantity flows of cargo from each supply point to each destination as a result of which, the cost of transportation would be kept at minimum.

In mathematical terms, the transportation problem seeks to minimize the total shipping costs of transporting X quantity of goods from m number of origins (each with a supply Si) to n number of destinations (each with a demand Dj), when the unit shipping cost from an origin, i, to a destination, j, is Cij. These connotations will be used further in definitions.

We can set the decision variable X11 denoting the quantity of petroleum to be shipped from origin S1, in this case from the ACG fields of Azerbaijan, to the destination D1, Novorossiysk CPC terminal. The rate, C12, is 55.98 dollars per ton of crude delivered to the demand destination.

Table 9. Input Variables - Supply/Demand quantities and transport cost per ton in USD

		DEMAND DESTINATIONS D j								
		1	***2***	***3***	***4***	***5***	***6***	***7***	***(9)*82% or 92%***	***9***
SUPPLY ORIGINS Si	***Oilfields***	*Novorossiysk (CPC)*	*Novorossiysk Terminal 2 (ASN, BN)*	*Novorossiysk Rail*	*Supsa(WREP)*	*Geo Black sea by rail*	*Ceyhan BTC*	*China Pipeline*	***Supply for Exports thousand tpa***	***Annual oilfield production tpa***
1	ACG (Azer)	55.98	15.60	29.17	3.62	26.83	24.19	-	***18,860,000***	***23,000,000***
2	Tengiz(Kaz)	30.67	17.24	48	15.12	40.33	41.01	-	***12,880,000***	***14,000,000***
3	Karachaganak(Kaz)	36.28	17.53	84.87	34.39	43.94	39.65	-	***9,200,000***	***10,000,000***
4	Aktobe(Kaz)	34.79	15.88	83.22	41.8	42.3	45.26	22.6	***5,520,000***	***6,000,000***
5	Mangistau(Kaz	48	26	48	15.1	38.3	35.689	-	***7,544,000***	***8,200,000***
6	Kumkol(Kaz)	99.4	84.1	84.97	41.9	65.1	62.47	15	***5,612,000***	***6,100,000***
(8)*62%	***Demand Capacities for consortium tpa***	***17,050,000***	***14,260,000***	***2,480,000***	***4,340,000***	***9,920,000***	***27,900,000***	***6,200,000***		**59,616,000**
8	***Total Demand Port/pipeline Capacities tpa***	***28,000,000***	***23,000,000***	***4,000,000***	***7,000,000***	***16,000,000***	***45,000,000***	***10,000,000***		

Source: Own Elaboration

The linear programming formulation in terms of the amounts shipped from the origins to the destinations, Xij, can be written as:

$$Min \sum_{i=1}^{n} \sum_{j=1}^{m} Cij\, Xij$$

Subject to $\sum$ Xij <= Si for each origin i

$\sum$ Xij = Dj for each destination j

Xij > 0 for all i and j

6.2.1 Constraints and Constants

There are 6 origin and 7 destination points chosen in the problem. Thus we get a large number of combinations of constraints to work with. We differentiate between capacity constraints and artificial constraints. The latter exists due to government regulation on quota or undesirability of the route.

As shown in Table 8, given supplied quantities from the origins represented 62% of the total Kazakhstan and Azerbaijan Exports, since we are reviewing only the major oilfields and consortiums. Hence we decrease the total demanded capacities of ports by equal amount and set the total demands accordingly.

Among capacity constraints two types are separated: supply and demand constraints. For the supply constraints we take the quantities of oil extracted at each field in 2007. For instance, for the ACG field annual export production was 23 mln tons. This amount will be the right hand side variable of the first constraint which looks like this:

ACG field $X11 + X12 + X13 + X14 + X15 + X16 + X17 \leq 18{,}860{,}000$

Tengiz Field $X21 + X22 + X23 + X24 + X25 + X26 + X27 = 12{,}880{,}000$

Karachaganak Field $X31 + X32 + X33 + X34 + X35 + X36 + X37 = 9{,}200{,}000$

It should be noted that for destination 7, China pipeline which is connected to Aktobe and Kumkol fields in North western and Central Kazakhstan other option routes are excluded due to direct connection with client's market and guaranteed quantities that shareholding status of CNPC allows. For this reasons we leave China tariff cells blank except the two guaranteed routes.

In connection with demand constraints, some modification has been made based on certain facts and assumption. The actual port export capacities on the Black Sea and Mediterranean are not serving only these flows. Novorossiysk terminals also handle huge yearly amount of Russian oil flows from Urals or Siberia.

Based on inter-governmental agreement of 2002 between Kazakhstan and Russia, for 15 years Kazakhstan should keep up to 16 million tons of crude flowing through the Atyrau-Samara-Novo pipeline annually. (16,000,000*62%) =9,760,000

However, the constraint is set for another variable, i.e. Similar to Kazakhstan, Azerbaijan also has an intergovernmental agreement with Russian Federation to send around 2 mln tons yearly. Thus, X12 = (2,000,000*62%)=1,220,000

Overall, we set a demand constraint for Novorossiysk terminal 2 (Sheskharis) $X22 + X32 + X42 + X52 + X62 = 9{,}760{,}000 + 3{,}660{,}000$

Although CPC pipeline has a capacity of 34 million, Russian government uses the right of shareholder participation and pumps up to 6.5 million tons of Russian crude oil from Astrakhan pump station, where the pipeline is passing. Therefore remaining space is allocated for the Kazakhstan flow and constraint will be expressed as:

X21+X31+X41+X51+X61<=27,500,000*0.62%

Constants

As constants (coefficients) we use the prices of transporting crude oil per ton. Tariffs for pipelines, railways and short sea shipping are calculated by specific methodologies for each mode as discussed in Chapter 5. According to supply origins and demand destinations chosen tariff per ton of transporting oil has been added up depending on the shortest route for each mode needed.

For instance, to calculate the cost of transporting oil from Karachaganak field (Kazakhstan) to Novorossiysk CPC port the commodity needs to be delivered to Atyrau hub first and then sent through CPC pipeline. The cost for Karachaganak-Atyrau (8.86USD/ton/1000km x 635km) 5.6 USD; plus (CPC cost) 30.83USD = 36.44 USD Aktau fields –Novorossiysk 2 (Sheskharis) by rail: 9USD (Aktau-Makhachkala by short sea) plus 40USD (Makhachkala-Novorossiysk by rail) = 49USD

Using table 9 to formulate the objective function, it would be expressed as:

$$Min \sum Cij\ Xij = 55.98X11 + 16.43X1 + 29.17X13 + 3.62X14 + 26.86X15 + \\ +24.19X16 \ldots. +62.28X66$$

Showing the *X* amount of crude oil sent to each destination at *C* cost denoted by coefficients.

6.3 Scenario Results

Scenario 1 – All constraints

Taking into consideration the reality of intergovernmental agreements in terms of required quantity quotas on Northern Route pipelines, oligopolistic pricing levels at the Caspian shipping and intermediary involvement in railways, we review the basic scenario.

By data input and setting the remaining parameters in above described style in spreadsheet application, data analysis tool solver gives the following result in a table:

Table 10: Scenario 1- Optimal *Distribution Output under all constraints*

	Novorossiysk (CPC)	***Novorossiysk Terminal 2 (ASN, BN)***	***Novorossiysk Rail***	***Supsa (WREP)***	***Geo Black sea by rail***	***Ceyhan BTC***	***China Pipeline***	***Total***
ACG oilfield (Azerbaijan)	-	1,220,000	-	4,340,000	-	13,300,000	-	**18,860,000**
Tengiz (Kazakhstan)	12,880,000	-	-	-	-	-	-	**12,880,000**
Karachaganak (Kazakhstan)	1,092,000	8,108,000	-	-	-	-	-	**9,200,000**
Aktobe (Kazakhstan)	-	4,932,000	-	-	-	-	588,000	**5,520,000**
karazhanbas +mangistau (Kazakhstan)	-	-	-		-	7,544,000	-	**7,544,000**
Kumkol (Kazakhstan)	-	-	-	-	-	-	5,612,000	**5,612,000**
Total	***13,972,000***	***14,260,000***	***-***	***4,340,000***	***-***	***20,844,000***	***6,200,000***	***59,616,000***

Source: Own Results

The minimum associated cost incurred by the major oil producers in Kazakhstan and Azerbaijan, to send these quantities to the indicated routes would be

Min (Cij Xij) = 1,380,521,724 USD

According to the result, Northern pipelines, CPC and ASN get 48% oil traffic share from the large fields in Caspian and central Asia, South Pipelines, including BTC and WREP 42% in total, while Chinese route is assigned the remaining 10%. Railways are not assigned any quantities from these sources. It must be noted that railways usually carry small quantities from other medium and small oilfields which do not within our scope of discussion.

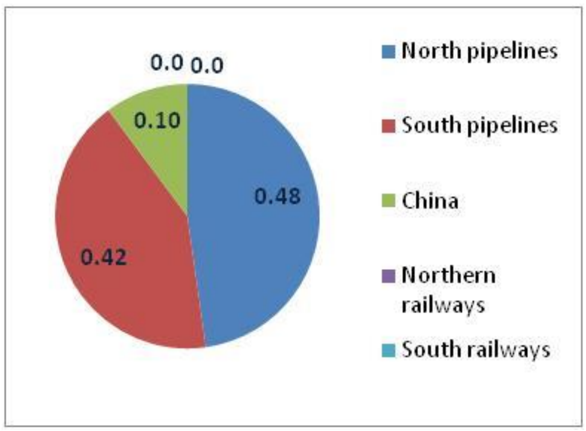


Figure 11 Scenario 1- Actual rates and constraints Source: Own results

The actual distribution of oil export flows in whole Caspian was 52% for Northern Routes and 38 % for Southern routes including railways. The pattern shown on figure 11 is close to the actual pattern of exports. The difference can be explained by medium and small producers' exports preferring Northern Route in 2007.

Scenario 2 – Removing Constraints

Network flow model allows doing sensitivity analysis by variation of constants (prices) or constraints (loosening pipeline quotas and adding hidden costs). We can change each component at a time, ceteris paribus, and observe the effect on the result. As mentioned in chapter 5 above, both governments of Kazakhstan and Azerbaijan have concluded agreements with the Russian Federation to send oil through Atyrau- Samara and Baku Novorossiysk pipelines to keep the system working. The producers also incur hidden costs by mixing the higher quality oil with lower grade Urals when using ASN (Section 5.1). If the agreement date were to expire now and incurred loss of quality is recognized as transportation cost, we could see the effect on total cost and flow distributions. The following table reflects the results by removing the related constraints.

Table 11: Scenario 2. Output with hidden costs and relaxing quota constraints

	Novorossiysk (CPC)	*Novorossiysk Terminal 2 (ASN, BN)*	*Novorossiysk Rail*	*Supsa(WREP)*	*Geo Black sea by rail*	*Ceyhan BTC*	*China Pipeline*	***total***
ACG oilfield (Azerbaijan)	-		-	4,340,000	-	14,520,000	-	**18,860,000**
Tengiz (Kazakhstan)	12,880,000		-	-	-	-	-	**12,880,000**
Karachaganak (Kazakhstan)	202,000	5,030,000		-	-	-	-	**9,200,000**
Aktobe (Kazakhstan)	-	4,932,000		-	-	-	588,000	**5,520,000**
karazhanbas +mangistau (Kazakhstan)	-	-	-	*	-	7,544,000	-	**7,544,000**
Kumkol (Kazakhstan)	-	-	-	-	-	-	5,612,000	**5,612,000**
Total	**13,082,000**	**9,962,000**		**4,340,000**	**-**	**22,064,000**	**6,200,000**	***59,616,000***

Source: Own Results

Minimum transportation costs will be lower for this setting.

Min (Cij Xij) = 1,372,845,088 USD

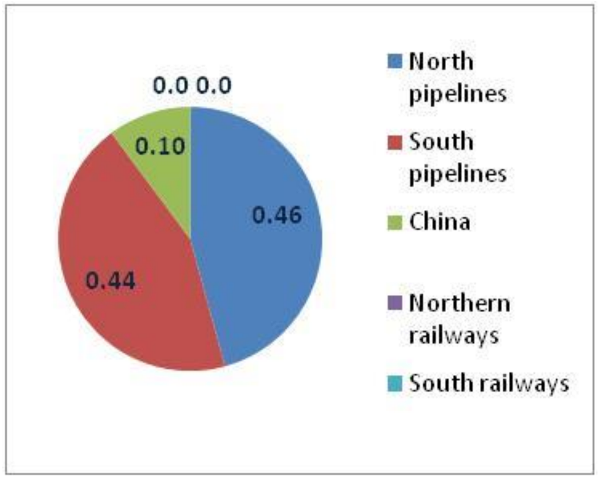


Figure 12 Distribution without quota constraints and included hidden costs

According to the derived results, flow slightly changes in favor of south pipelines, which get 44% of the supplied volumes. Northern pipelines slightly lose the quantities. Chinese direction remains stable.

Scenario 3 - Removing Increased Intermediary Margin

We reviewed the presence of intermediaries at the Azeri and Georgian Railways and oligopoly pricing in the Caspian Shipping. According to World Bank (2008) compared to previous years Caspian Shipping freights were abruptly increased by 3USD/ton while Azeri railway intermediaries also increased margin by 2USD/ton. We would like to observe what would be the effect on the overall distribution of flows, if these obstacles are removed. Since both companies are government owned, it is possible that the regulatory change can swiftly affect operations structure of these companies

Table 12: Scenario 3. ***Caspian Exports without constraints and intermediary price change in 2007***								
	Novoross iysk (CPC)	*Novorossiysk Terminal 2 (ASN, BN)*	*Novoros siysk Rail*	*Supsa(WREP)*	*Geo Black sea by rail*	*Ceyha n BTC*	*China Pipeline*	***total***
ACG oilfield (Azerbaijan)	-	*	-	4,340, 000	3,364,00 0	11,15 6,000	-	**18,860,000**
Tengiz (Kazakhstan)	12,880,0 00	*	-	-	-	-	-	**12,880,000**
Karachagan ak (Kazakhstan)	-	*	*	-	-	9,200, 000	-	**9,200,000**
Aktobe (Kazakhstan)	4,170,00 0	762,000	*	-	-	-	588,000	**5,520,000**
karazhanbas +mangistau (Kazakhstan)	-	-	-	*	*	7,544, 000	-	**7,544,000**
Kumkol (Kazakhstan)	-	-	-	-	-	-	5,612,0 00	**5,612,000**
Total Allocated tons	**17,050,0 00**	**762,000**	**-**	**4,340, 000**	**-**	**27,90 0,000**	**6,200,0 00**	***59,616,000***
Total Demanded tons	**17,050,0 00**	**14,260,000**	**2,440,0 00**	**4,270, 000**	**3,364,00 0**	**27,90 0,000**	**6,200,0 00**	

Source: Own results

And minimum transport costs have been further lowered

Min (Cij Xij) = 1,297,860,448 *USD*

Effect of removing intermediaries in GR and ADDY operations and capping the Caspian Shipping pricing in the final allocation has seen up to 6% allocation of flows to the south railway corridor, south pipelines have 52%, and north pipelines 32%. China keeps the allocation share steady at 10%.

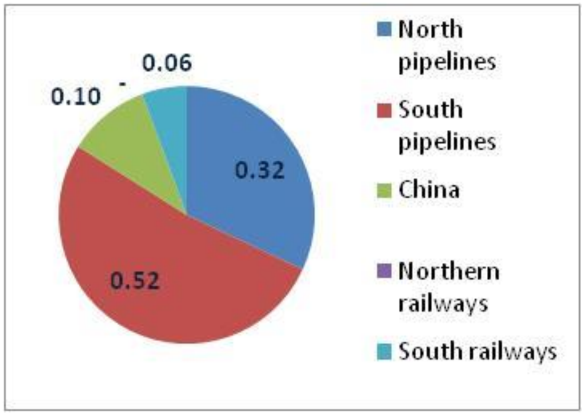


Figure 13 Distribution without constraints and intermediary margin / Source: own results

Apparently, removing the politically influenced constraints on north routes and loosening oligopolistic pricing margins on the south routes changes the picture in favor of BTC pipeline where economies of scale can be enjoyed the most and the quality of oil can be preserved before hitting the markets. Possibility of this scenario without direct political influences is increased due to the fact that Russia-Azerbaijan intergovernmental agreement on Azeri oil export through Transneft system has expired in 2003. It continues to stay in force until one of the parties withdraws from or requests the revision of the terms. (azer.com) Controlling cartel pricing schemes in Caspian Shipping and Azeri railways is also a matter of Azeri government political will. Kazakhstan Russia government agreement on usage of Transneft system expires in 2015, but we have included removal of this political constraint as well to see the whole picture in economic perspective only.

Further is explored the case when besides the political and business environment changes other factors may influence the economic decision on oil flow directions.

6.4 Risk Adjusted Projection

Above mentioned scenarios have been related to the possible changes in quantity distributions based on variation in constraints of intermediary pricing and intergovernmental agreements. Beyond the direct political and economic effects there is broader range of transit country specific socioeconomic factors with longer term implications affecting the stability of energy supply routes. Quantified indexes of country specific risk factors discussed in Chapter 5 are applied (Table 5) This thesis also has added another one, a route concentration risk factor measured by Gini coefficient in the same scale.(Table 6) We try to use them by incorporating into the model with monetary costs. We take average socioeconomic index per country from table 5 and apply to each route, which contains certain number of oil transit countries along with the origin country. Each country average risk factor is aggregated into a specific route. For instance, Tengiz-BTC pipeline route starts in Kazakhstan and crossing the Caspian Sea passes through three countries; Azerbaijan, Georgia, Turkey. Average socioeconomic risk value of each country and the route specific concentration index are aggregated and their averages will be used as a risk adjustment factor of costs. Hence, the 'costs', associated with the risks of possible occurrence of supply disruption, are to be accounted for.

Table 13. Risk adjustment factors

Oilfields	*Novo (CPC)*	*Novorossiysk Terminal 2*	*Novoross iysk Rail*	*Supsa (WREP)*	*Georgia n ports*	*BTC*
ACG oilfield	*0.461*	*0.404*	*0.422*	*0.384*	*0.389*	*0.501*
Tengiz	*0.422*	*0.377*	*0.412*	*0.444*	*0.441*	*0.504*
Karachaganak	*0.362*	*0.338*	*0.338*	*0.489*	*0.489*	*0.500*
Aktobe	*0.376*	*0.349*	*0.339*	*0.442*	*0.442*	*0.529*
Mangistau-Aktau	*0.360*	*0.336*	*0.390*	*0.432*	*0.445*	*0.528*
Kumkol	*0.325*	*0.340*	*0.346*	*0.506*	*0.503*	*0.553*

Source: Own Results

Average of socioeconomic and concentration risk factors for each route are shown in table 13. These indexes will be used to adjust the costs and plug the indexed numbers into the transportation model to see route attractiveness in risk adjusted perspective.

In section 2.2 of this paper the presence of physical constraints on sea routes, called chokepoints, has been discussed. Doukas et.al (2009) suggest the inclusion of chokepoints in the energy risk indexing. It is argued that the index value of this risk should be equal to the country total risk it geographically belongs, or to an average in case of covering more than one country. Bosporus strait is tankers passage point on all energy routes from Kazakhstan and Azerbaijan through Russia and Georgian Black Sea ports. Being located in Turkish territorial waters, the strait is valued the same risk level as Turkey and included in the average as a separate variable.

In Fact, Chinese direction from Kazakhstan is a direct connection with the market. There are no transit countries involved. Hence, energy transit risks are not related to this route and Kazakhstan China corridor costs stay unaffected. The new risk weighted cost matrix per route would look as follows:

Table 14 Risk Adjusted Costs of Caspian oil Transportation								
Oilfields	*Novorossiysk (CPC)*	*Novorossiysk Terminal 2 (ASN, BN)*	*Novoros siysk Rail*	*Supsa (WREP)*	*Geo Black sea by rail*	*Ceyha n BTC*	*China Pipeline*	***Suppl y***
ACG oilfield	81.77	21.90	41.48	5.01	37.49	36.30	-	***18,860 ,000***
Tengiz	45.03	24.20	69.68	20.93	60.86	61.54	-	***12,880 ,000***
Karachaganak	53.23	24.61	120.69	47.60	80.24	59.50	-	***9,200, 000***
Aktobe	50.82	22.29	118.34	57.88	58.97	67.92	22.6	***5,520, 000***
Karazhanbas + Mangistau-Aktau	71.57	35.89	69.68	20.93	53.47	53.56	-	***7,544, 000***
Kumkol	145.14	112.93	107.76	58.00	90.68	93.74	15	***5,612, 000***
Demand Port/pipeline Capacities	***17,050,000***	***14,030,000***	***2,440,0 00***	***4,270,0 00***	***9,760, 000***	***27,45 0,000***	***6,100,0 00***	***59,61 6,000***
Total Demand Port/pipeline Capacities	***27,500,000***	***23,000,000***	***4,000,0 00***	***7,000,0 00***	***16,00 0,000***	***45,00 0,000***	***10,000, 000***	

Source: Own results

The risk adjusted scenario showed the following results:

Table 15 Risk Adjusted Optimal Output

	Novo (CPC)	**Novorossiysk Terminal 2**	**Novorossiysk Rail**	**Supsa(WREP)**	**Geo Black sea rail**	**Ceyhan BTC**	**China Pipeline**	***total***
ACG oilfield	-	-	-	-	6,716,000	12,144,000	-	**18,860,293**
Tengiz	12,880,000		-	-	-	-	-	**12,880,000**
Karachaganak	-	9,200,000	-	-	-	-	-	**9,200,000**
Aktobe	4,170,000	762,000		-	-	-	588,000	**5,520,000**
karazhanbas +mangistau(Aktau)	-	-	-	4,340,000	3,204,000	-	-	**7,544,294**
Kumkol	-	-	-	-	-	-	5,612,000	**5,612,000**
Total Allocated tons	**17,050,000**	**9,962,000**	**-**	**4,340,000**	**9,920,000**	**12,144,000**	**6,200,000**	***59,616,587***
Total Demanded tons	**17,050,000**	**14,260,000**	**2,480,000**	**4,340,000**	**9,920,000**	**27,900,000**	**6,100,000**	

Source: own Results

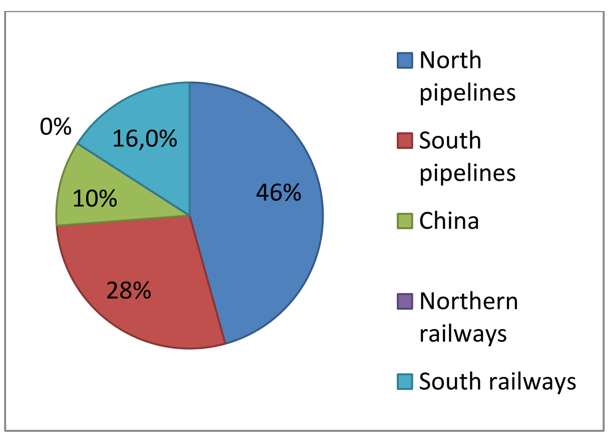


Figure 14 Output with risk adjusted scenario / Source: own results

6.5 Summary

The focus of this chapter was the largest Caspian and Central Asian crude oil producers optimal export options under various scenarios. These companies get the priority in access to the transport infrastructures due to their stable and high volume oil supply potential. As the pipelines show largest economies of scale the producers should seemingly select to occupy the full capacity of pipelines at first. However, various scenario results show that when other than pure business factors are considered the pipelines BTC and ASN (Transneft) show lower capacity filling efficiency; in risk adjusted case 44%.and 69% respectively. This can be partly attributed to high Gini coefficient (inequality) indicator and hidden costs of these largely politically charged projects by Russia and the US. South Caucasus railways show higher efficiency in the economic factor and risk adjusted scenarios, surging from 34% to full capacity utilization under risk factors. Figure 15 illustrates the modal capacity efficiency.

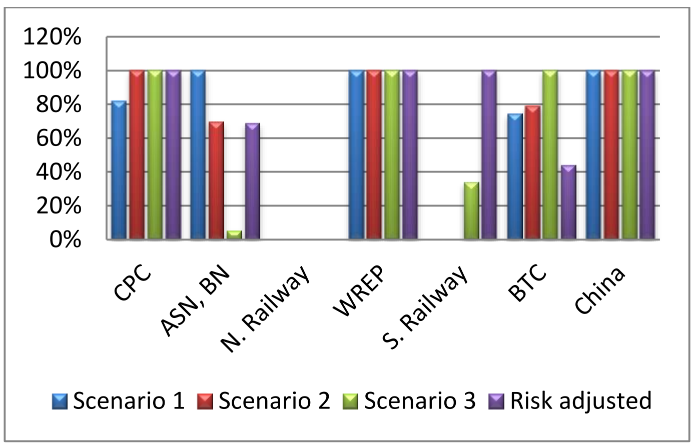


Figure 15 Modal Capacity Efficiency / Source: own results

Notably, the remaining capacity utilization of network can be achieved from medium and small field producers of Caspian and Central Asian States.

7. Conclusions

The purpose of this thesis was to evaluate the effects of different costs on various routes of crude oil distribution of the Caspian region countries. Except the monetary costs the goal was to study the effects of political, social and economic risks related to the countries involved in the transit of Caspian oil.

Considering the new realities since 1991 after the fall of USSR western energy companies actively started to seek investment opportunities in the oil rich Caspian region. With the support of western governments various plans and investment opportunities had been studied. Beginning of 21st century saw the 'pipeline dreams' come into reality and oil majors successfully started to implement their plans. Another regional large player, Russia became active to promote Caspian routes through its territory. Pipeline dreams turned into "pipeline games". Major regional crude oil rich countries, Azerbaijan and Kazakhstan had also declared desire to diversify the supply routes. Judging on their landlocked location from consumer markets and open sea ports it was very likely expected that their strategy would be not to depend on a single export route to markets. We have analyzed that diversity in transport modes among pipelines and railways is also optimal for large oil consortiums that have priority in accessing route capacities.

Four possible scenarios have been reviewed. The first three have been related to the effects of possible removal of direct political and microeconomic constraints on the flows of Caspian oil.

Based on network flow analysis model, the base scenario has shown what would be distribution of crude oil flows under minimum transportation cost through extensive networks. It has shown that 48% of the crude oil produced by the largest fields of Kazakhstan and Azerbaijan would have taken north route direction through Novorossiysk port in Russia. 42% of flows should have gone towards the Georgian port and a Turkish Mediterranean port. Direct link with China has guaranteed the latter a maximum of the pipeline capacity from Kazakhstan to Chinese border 10%.

Removing the geopolitical influences which obliges Caspian states to manipulate its producers into allocating oil flows and adding the hidden costs incurred with loss of quality of oil in the Russian Transneft pipeline system has changed the distribution of flows slightly. 46% of the Caspian oil was allocated to the Russian port of Novorossiysk, 7% would go to Georgian port of Supsa and 37% to the Turkish port of Ceyhan. China direction is stable at 10%.

In addition, scenario three reviewed the effect of reversing 2007 surge in the Azerbaijan Railways and Azeri Caspian shipping freights. Cumulative effect of scenarios tends to be positive on the Azeri and Georgian railway share, increasing to 6% but most importantly on the BTC pipeline, with 52%. CPC pipeline had no problem to be filled which constitutes 30% but ASN suffered drop in the supplied optimal quantity to 2% share. When stripping the costs from political reasons, largest pipelines of CPC, BTC and southern railways showed higher competitiveness.

Last but not least, effect of incorporating energy related socioeconomic and route concentration risks in the network have been studied. As the macroeconomic, political, energy and social risks are relatively slow to change compared to the monetary costs of transporting oil, it has been considered to have longer term implications. In that perspective, CPC, ASN (46%) together perform better from BTC(29%), . WREP also gets the capacity full. Such distribution can be attributed to low energy risk of Russian state and good overall socioeconomic index standing. South Railways keep up the market share of 16% mainly due to less favorable performance of BTC route index. The pipeline has higher host country risk ratios and higher inequality of route distribution as well. The south railway corridor has performed well under two radically different approaches. Azeri and Georgian railways keep the market share at 6% and 16% in both cases, under no-political constraints and socioeconomic risks. Having in mind the two Georgian ports ownership, with the railway access for oil transshipment, by Azerbaijan and Kazakhstan is another motivation for large oil consortiums to more actively employ this route.

The Kazakhstan china route has shown best capacity utilization under all scenarios. Need China extend the Kazakhstan China direct pipeline it would absorb much more quantities and drastically change the energy exports balance.

Despite the jostling games between the Western powers and Russia about viability of Routes, it has been shown that diversification could be the key to success not only for the producing country policymakers, but also for the giant international consortiums with investments in the sector, who aim to minimize transportation costs as well. Including socioeconomic risk factors in the analysis implies that there is a limit to the competitiveness of southern route and northern routes keep a slight leadership. Papava et al. (2008) support this view on the status of southern pipeline routes as “supplementary” and harmonization possibility between the existing and new route initiatives to the West. At the same time, economy vectors are shifting. Asian demand for oil, led by China, diminishes the Caspian energy large and small consortiums’ dependence on western routes. Being in the neighborhood with China, turns out to be a great advantage for energy exports.

This thesis has analyzed the optimal export routing of the Central Asian and Caspian crude oil. The topic has been widely discussed with qualitative approaches scrutinizing mostly on geopolitical aspects and less on the economic ones.. But the access to authentic data has been difficult as the style of doing business and revealing precise data is not characteristic of the region and requires patience. Hence, to achieve more precise results and given more time to a future research, production and export data on the sample of oilfields and consortiums can be extended, to include medium and small sized companies of the region. Also, another approach to risk measurement can be taken with focus on the region specific factors and their quantification. The latter concept appears to be promising area to study in relation with the volatile political and economic picture of the Caspian region.

Although many interesting insights can be found in academic and business sources, most of the analysis qualitatively focuses on the westward export of Caspian resources. Growing Chinese presence in the Caspian and Central Asia is a direction that is worth researching in more depth.

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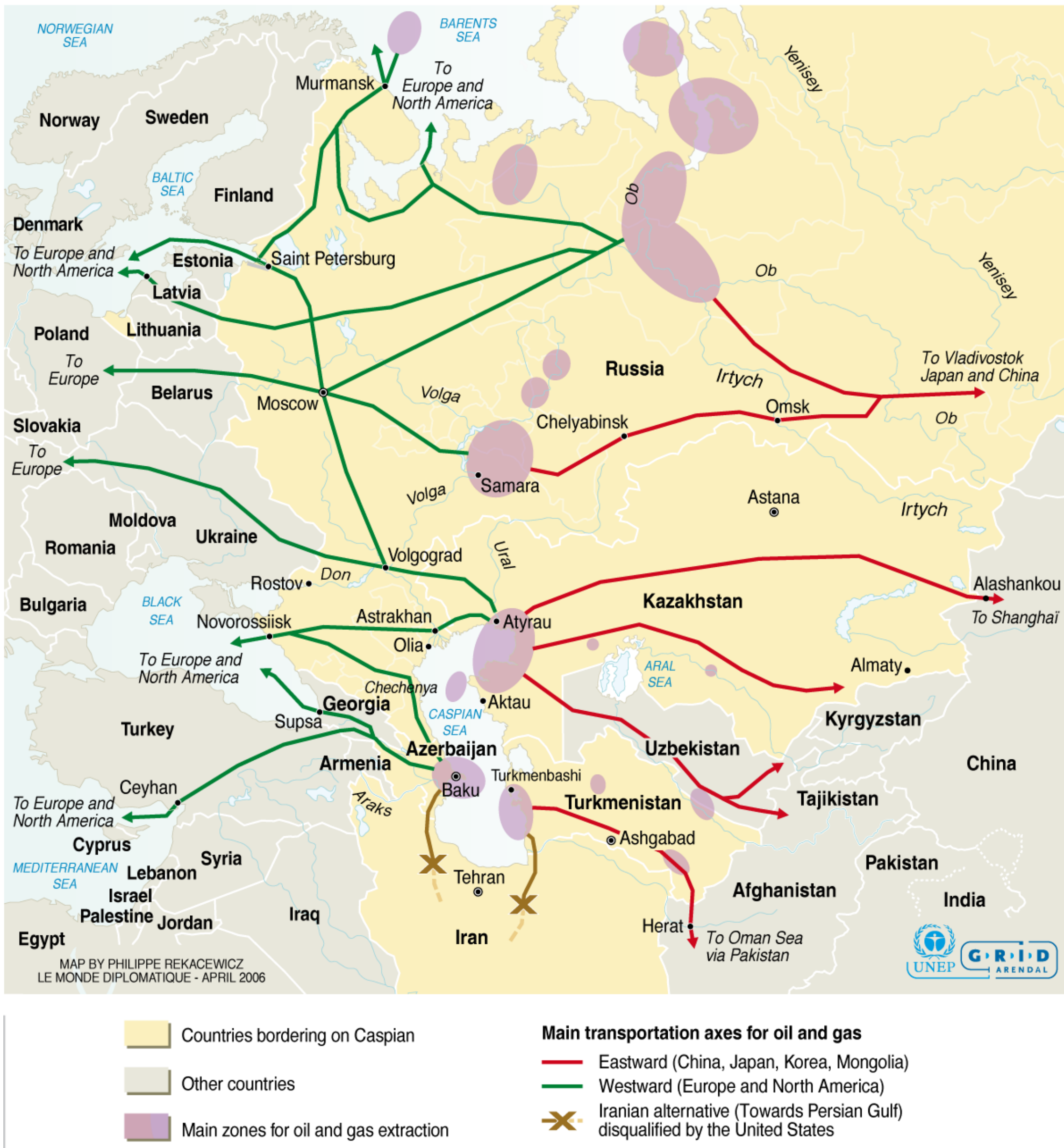
APPENDIX 1

The markets competing for Caspian oil and gas



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APPENDIX 2

Oil Pipelines handling capacity in Caspian Region

Name/Location	Route	Total Length (km)	Current Capacity (estimated)	2007 Traffic	Future Capacity (estimated)
Atyrau-Samara Pipeline	Runs from Uzen in southwestern Kazakhstan to Caspian port of Atyrau linking to Russian pipeline system at Samara	695	20 mln tpa	15.5 mln tpa	25 mln tpa
Baku-Novorossiysk Pipeline (AIOC Northern Route – NREP)	Baku via Chechnya (Russia) to Novorossiysk (Russia), terminating at Novorossiysk Black Sea oil terminal	1400	6 mln tpa	4.4 mln tpa	6 mln tpa
Baku-Novorossiysk Pipeline - Chechnya bypass (with link to Makhachkala)	Baku via Dagestan to Tikhoretsk (Russia) via Dagestan, and terminating Novorossiisk Black Sea oil terminal	283	N/A	N/A	N/A
Baku-Supsa Pipeline (AIOC Western "Early Oil" Route – WREP)	Baku (Azerbaijan) to Supsa (Georgia), terminating at Supsa Port on Black Sea	885	7 mln tpa	5.6 mln tpa	7 mln tpa
Baku-Tbilisi-Ceyhan (BTC)	Baku (Azerbaijan) via Tbilisi (Georgia) to Ceyhan (Turkey), terminating at the Ceyhan Mediterranean Sea port	1780	50 mln tpa	7.7 mln tpa	80 mln tpa
Caspian Pipeline Consortium (CPC)	Tengiz (Kazakhstan) to Russian Black Sea Port of Novorossiysk (Russia)	1580	30 mln tpa	32.3 mln tpa	32-67 mln tpa (expansion delayed)
Iran Oil Swap Pipeline	Loaded onto from tankers via Caspian, the pipeline follows from Neka Port in Iran to Tehran refinery	335	12.5 mln tpa	5.2 mln tpa	18-20 mln tpa
Karachaganak-Atyrau Pipeline	Karahaganak oil field in Kazakhstan to Atyrau (Kazakhstan), connecting to Atyrau-Samara and CPC pipelines	635	7 mln tpa	7 mln tpa	7 mln tpa (can be expanded if needed)
Kazakhstan-China Pipeline (Atashu-Alashanko-Dushanzi section)	Links Central Kazakhstan oil fields in South Turgay to refineries in China (from Aktyubinsk fields to Kumkol connecting to Atasu)	987	10 mln tpa	10 mln tpa	20 mln tpa

Name/Location	Route	Total Length (km)	Current Capacity (estimated)	2007 Traffic	Future Capacity (estimated)
Kenkiyak-Orsk Pipeline	Links Aktyubinsk fields in Kazakhstan to Orsk refinery in Russia	400	6.5 mln tpa	6.5 mln tpa	6.5 mln tpa
Kenkiyak – Atyrau	Links Aktobe fields and Atyrau region with the Atyrau-Samara and the Caspian pipeline system	448	12 mln tpa	N/A	12 mln tpa

APPENDIX 3

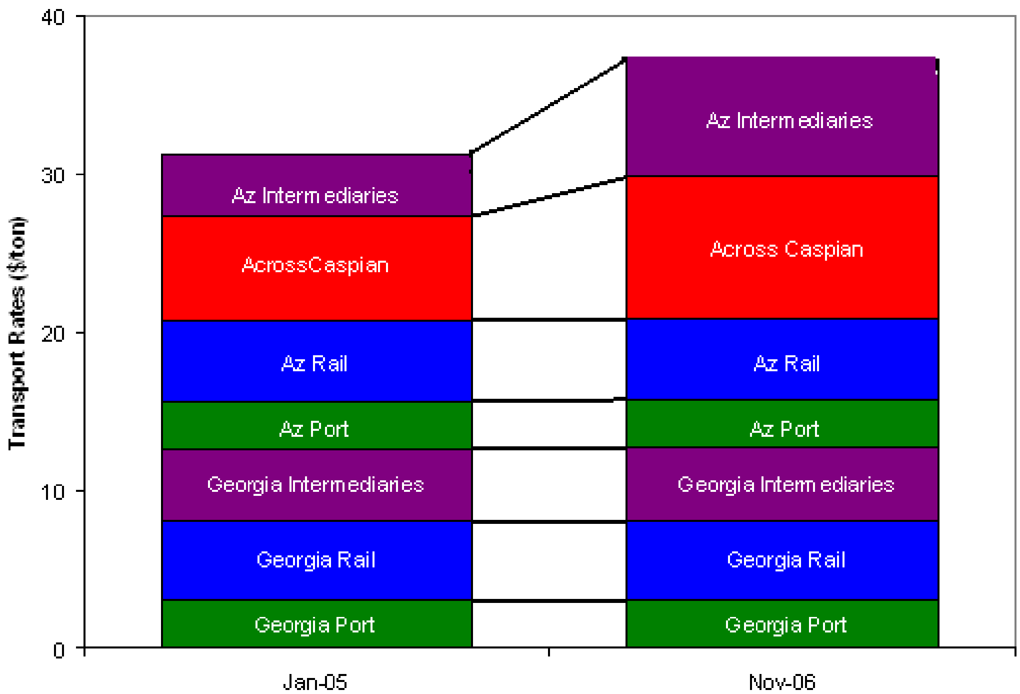
Ports in Caspian and Black Sea Region: Handling Capacity for Oil and Oil Products

Port/Terminal	Location	Ownership	Current Capacity	Future Capacity (estimated)
Azerbaijan				
Baku Port	In city of Baku, Absheron peninsula	Owned by AzerTrans; operated by Middle East Petroleum	6 mln tpa	6 mln tpa (or none if to be moved)
Dubendi Terminal	40km northeast of Baku; natural breakwater	State owned by SOCAR (Azersuns Holding), operated by Middle East Petroleum	10 mln tpa	10 mln tpa
Garadagh Terminal	Outside of Baku city on Caspian Sea	Under construction by Ocean Energy (associated by MEP)	N/A	10-20 mln tpa
Sangachal AzerTrans Terminal	South of Baku City on Caspian Sea	Owned by AzerTrans, operated by Middle East Petroleum	10 mln tpa	10 mln tpa
Sangachal AIOC Terminal	South of Baku City on Caspian Sea	AIOC, operated by BP	50 mln tpa	80 mln tpa
Georgia				
Batumi Port	Adjara region of Georgia in the Black Sea	owned by KazMunaiGaz and operated by its subsidiary Rompetrol	15-16 mln tpa	25 mln tpa
Kulevi Port	North of Poti in the Black Sea	SOCAR Georgia: 51% SOCAR, 24.5% Georgian investors, 24.5% Middle East Petroleum	10 mln tpa	22 mln tpa
Poti Port	Black Sea port town of Poti, between Supsa and	Rakeen Investment (Abu Dhabi) owned; Oil terminal owned by Channel Energy JV (25% Poti Port, 75%	1.5 mln tpa	2 mln tpa

	Kulevi	Delta Group Turkey)		
Supsa Terminal	Terminus of Western Route pipeline in Black Sea	Georgian State Pipeline Company	7 mln tpa	7 mln tpa
Kazakhstan				
Atyrau	Caspian Sea port town in northwestern Kazakhstan	Owned by State	20 mln tpa	20 mln tpa
Aktau Port	Caspian Sea port town in southwestern Kazakhstan	Owned by State Enterprise Aktau International Sea Commercial Port, four oil berths leased to National Shipping Co KazMorTransFlot (49 years)	10-11 mln tpa	10-11 mln tpa
Kuryk Terminal	Town of Kuryk on Caspian Sea, 60 km south of Aktau	Under development by KazMorTransFlot (KazMunaiGaz subsidiary)	N/A	25-40 mln tpa
Russia				
CPC Terminal	Yuzhnaya-Ozereyevka in the Black Sea	Owned and operated by Caspian Pipeline Consotrium (Russian 24%, Kazakhstan 19%, Oman 7%, 50% between Chevron-Texaco, Lukoil, and other petroleum companies)	67 mln tpa	67 mln tpa
Novorossiysk Port – Sheskhrais Tel	Tsemess Bay shore in the North-East part of Black	Novorossiysk Commercial Sea Port Holding Company	50 mln tpa	85 mln tpa

APPENDIX 4

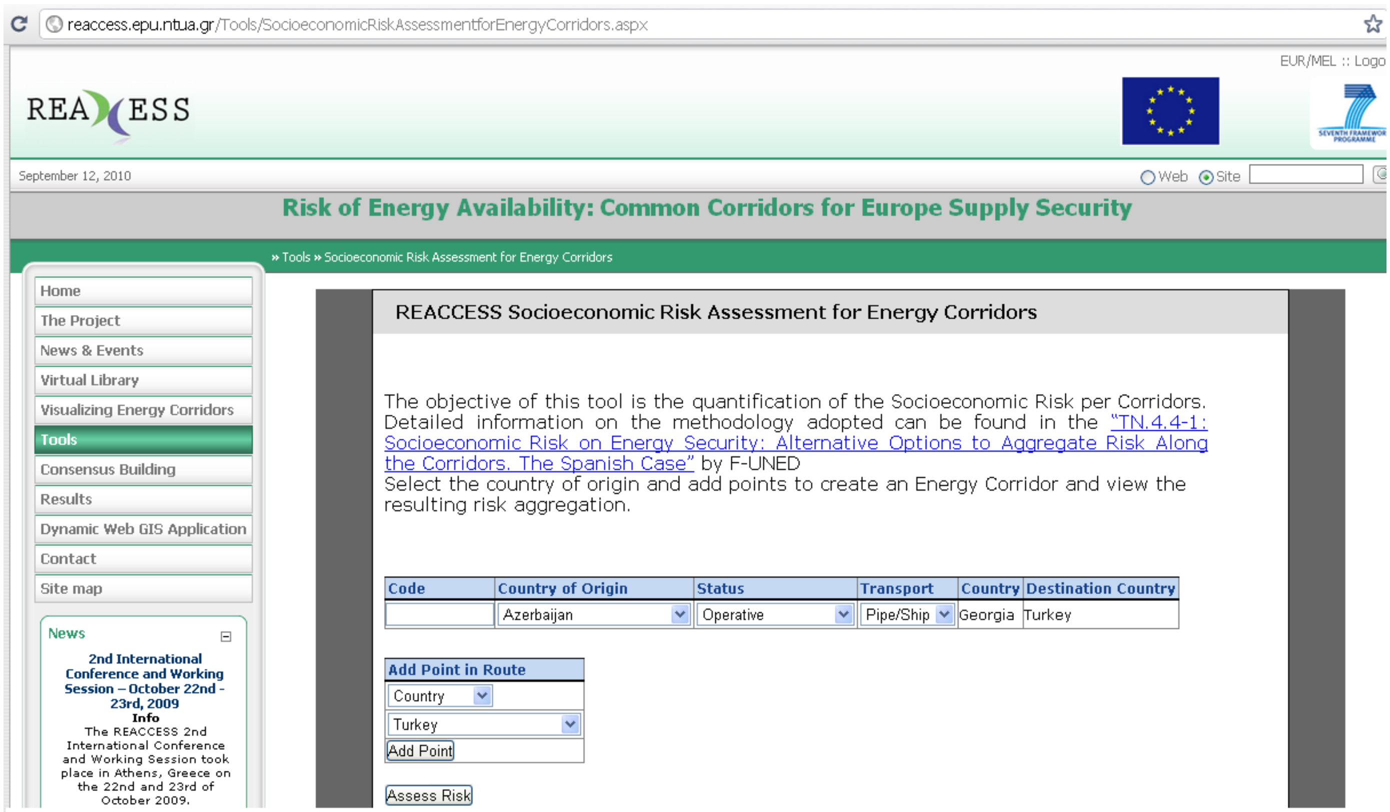
Aktau(Kazakhstan) – Georgian Sea Ports Corridor – Shipping and Railway Freights



Source: Customer interviews, other financial analyses. (World Bank 2008)

Appendix 5

5.1 Web Based tool for Indexing Energy corridors Security



5.2 Kazakhstan-Russia-Black Sea (Bosporus) Route

Code	Country of Origin	Status	Transport	Chokepoint	Destination Country
	Russian Federation	Operative	Pipe/Ship	Bosporus Straits/Dardanelle	Turkey

Add Point in Route
Country
Turkey
Add Point

Assess Risk

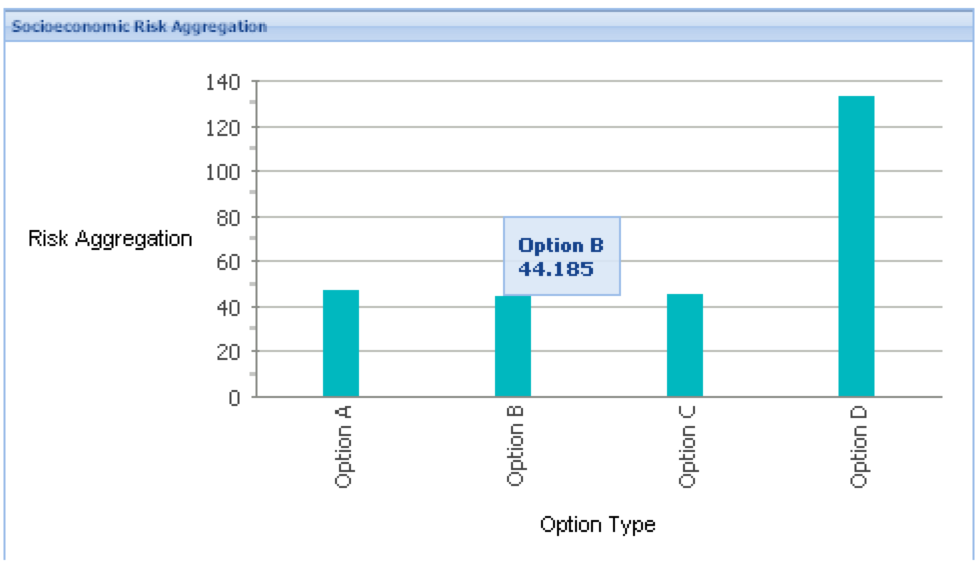
The results are graphically illustrated in the following figure.
The Aggregation Options presented are defined as follows:

Option A: The corridor risk is equated to the highest risk of the individual countries and chokepoints.

Option B: The corridor risk calculated as the average of the individual risk of countries and chokepoints

Option C: The corridor risk is calculated as the average between the maximum individual risk and the average of all the individual values of the countries and chokepoints (B)

Option D: The corridor risk is calculated as the sum of the individual risk of the countries and the chokepoints.



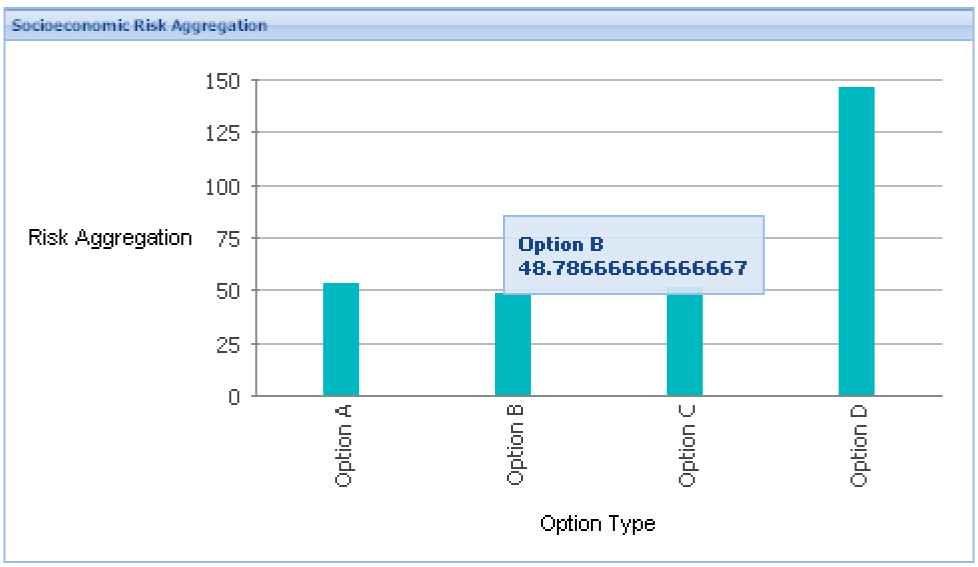
5.3 Azerbaijan-Georgia-Black Sea (Bosporus)

Code	Country of Origin	Status	Transport	Chokepoint	Destination Country
	Georgia	Operative	Pipe/Ship	Bosporus Straits/Dardanelle	Turkey

Add Point in Route
Country
Turkey
Add Point

Assess Risk

The results are graphically illustrated in the following figure.
The Aggregation Options presented are defined as follows:
Option A: The corridor risk is equated to the highest risk of the individual countries and chokepoints.
Option B: The corridor risk calculated as the average of the individual risk of countries and chokepoints
Option C: The corridor risk is calculated as the average between the maximum individual risk and the average of all the individual values of the countries and chokepoints (B)
Option D: The corridor risk is calculated as the sum of the individual risk of the countries and the chokepoints.



5.4 Azerbaijan-Georgia-Turkey (Mediterranean)

Code	Country of Origin	Status	Transport	Destination Country
	Georgia	Operative	Pipe	Turkey

Add Point in Route
Country
Turkey
Add Point

Assess Risk

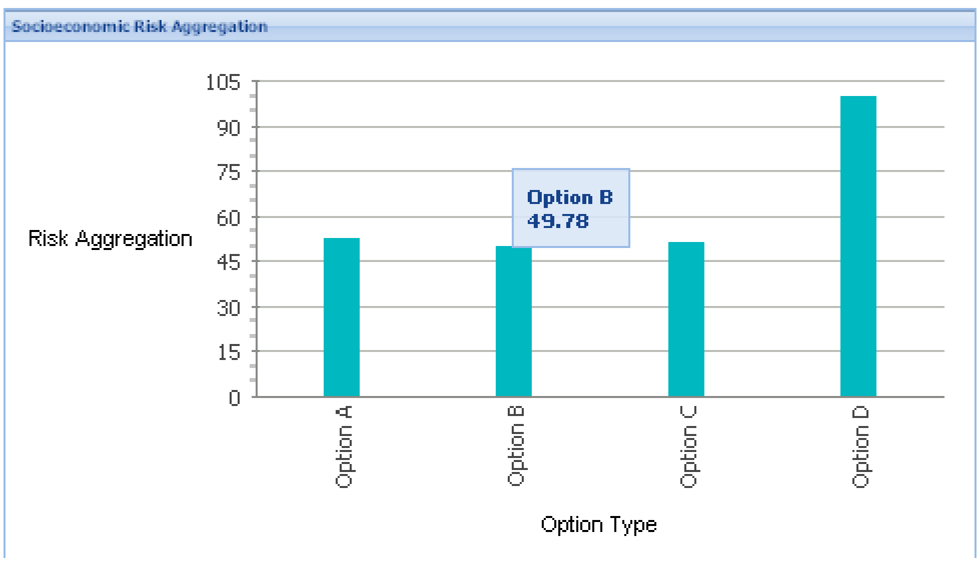
The results are graphically illustrated in the following figure.
The Aggregation Options presented are defined as follows:

Option A: The corridor risk is equated to the highest risk of the individual countries and chokepoints.

Option B: The corridor risk calculated as the average of the individual risk of countries and chokepoints

Option C: The corridor risk is calculated as the average between the maximum individual risk and the average of all the individual values of the countries and chokepoints (B)

Option D: The corridor risk is calculated as the sum of the individual risk of the countries and the chokepoints.



APPENDIX 6

Gini Coefficient Calculations per route

Oilfields	**Novo (CPC)**					**Novorossyisk Terminal 2**					
ACG oilfield		**dist**	**cumul %**	**A(sY1+sY2)**	**A*B**		**dist**	**cumul %**	**A(sY1+sY2)**	**A*B**	
	Rus	1,580	0.624	0.624	0.208	Az	1,083	0.768	0.768	0.384	
	Kz	568	0.849	1.473	0.491	Kz	328	1.000	1.768	0.884	
	Az	383	1.000	2.473	0.824						
B(X)	0.333					0.500					
	total	2,531			1.523	Total	1,411			1.268	
Gini	**0.523**					**0.268**					
risk factors	0.489	0	0.390	0.468	0.461	0.489	0		0.468	0.404	
Tengiz											
	RUS	1,580	0.895	0.895	0.448	Rus	1,535	0.716	0.716	0.358	
	KZ	185	1.000	1.895	0.948	Kz	610	1.000	1.716	0.858	
Equal Share	0.500					0.500					
	Total	1,765			1.395	Total	2,145			1.216	
Gini	**0.395**					**0.216**					

risk factors	0.433	0		0.468	0.422	0.433	0		0.468	0.377	
Karachaganak											
	Kz	1,580	0.658	0.658	0.329	Rus	1,535	0.562	0.562	0.281	
	Rus	820	1.000	1.658	0.829	Kz	1,195	1.000	1.562	0.781	
	0.500										
	Total	2,400			1.158	0.500					
						total	2,730			1.062	
Gini	**0.158**					**0.062**					
risk factors	0.433		0.390	0.468	0.362	0.433	0		0.468	0.338	
Aktobe											
	Rus	1,580	0.714	0.714	0.357	Rus	1,535	0.604	0.604	0.302	
	Kz	633	1.000	1.714	0.857	Kz	1,008	1.000	1.604	0.802	
	0.500					0.500					
	Total	2,213			1.214	total	2,543			1.104	
Gini	**0.214**					**0.104**					
risk factors	0.433		0.390	0.468	0.376	0.433	0		0.468	0.349	
karazhanbas+mangistau(Aqtau)											

	Rus	1,580	0.647	0.647	0.324	Rus	1,535	0.554	0.554	0.277	
	KZ	862	1.000	1.647	0.824	Kz	1,237	1.000	1.554	0.777	
	0.500										
	Total	2,442			1.147	0.500					
						total	2,772			1.054	
Gini	**0.147**					**0.054**					
risk factors	0.433		0.390	0.468	0.360	0.433	0		0.468	0.336	
Kumkol											
	KZ	1,646	0.510	0.510	0.255	Kz	2,021	0.568	0.568	0.284	
	RUS	1,580	1.000	1.510	0.755	Kz	1,535	1.000	1.568	0.784	
	0.500					0.500					
		3,226			1.010	total	3,556			1.068	
Gini	**0.010**					**0.068**					
risk factors	0.433		0.390	0.468	0.325	0.433	0		0.468	0.340	

	Novorosyisk Rail					Supsa(WREP)				
		dist	**cumul %**	**A(sY1+sY2)**	**A*B**		**dist**	**cumul %**	**A(sY1+sY2)**	**A*B**
	Az	1,096	0.841	0.841	0.421	Az	457	0.553	0.553	0.276
	Rus	207	1.000	1.841	0.921	Ge	370	1.000	1.553	0.776
B(X)	0.500					0.500				
	Total	1,303			1.341	Total	827			1.053
Gini	**0.341**					**0.053**				
total risk	0.489	0		0.468	0.422	0.489	1		0.468	0.384
	Rus	1,114	0.856	0.856	0.428	Kz	796	0.438	0.438	0.146
	Kaz	188	1.000	1.856	0.928	Az	653	0.797	1.234	0.411
						Geo	370	1.000	2.234	0.745
B(X)	0.500					0.333				
	Total	1,301			1.356	Total	1,819			1.302
Gini	**0.356**					**0.302**				
total risk	0.433	0		0.468	0.412	0.433	0	0.528	0.468	0.444
	Rus	1,222	0.561	0.561	0.280	Kz	1,666	0.620	0.620	0.207
	Kz	958	1.000	1.561	0.780	Az	653	0.862	1.482	0.494
						Geo	370	1.000	2.482	0.827
B(X)	0.500					0.333				
	Total	2,180			1.061		2,689			1.528
Gini	**0.061**					**0.528**				
total risk	0.433	0		0.468	0.338	0.433	0	0.528	0.468	0.489

	Rus	1,222	0.565	0.565	0.283	Az	840	0.412	0.412	0.137
	Kz	939	1.000	1.565	0.783	Kz	831	0.819	1.230	0.410
						Geo	370	1.000	2.230	0.743
B(X)	0.500					0.333				
	Total	2,161			1.065		2,041			1.291
Gini	**0.065**					**0.291**				
total risk	0.433	0		0.468	0.339	0.433	0	0.528	0.468	0.442
	Rus	1,114	0.767	0.767	0.384	Az	653	0.390	0.390	0.130
	Kz	338	1.000	1.767	0.884	Kz	653	0.779	1.169	0.390
						Geo	370	1.000	2.169	0.723
B(X)	0.500					0.333				
	Total	1,452			1.267		1,676			1.242
Gini	**0.267**					**0.242**				
total risk	0.433	0		0.468	0.390	0.433	0	0.528	0.468	0.432
	Kz	1,784	0.593	0.593	0.297	Kz	2,235	0.686	0.686	0.229
	Rus	1,223	1.000	1.593	0.797	Az	653	0.886	1.572	0.524
						Geo	370	1.000	2.572	0.857
B(X)	0.500					0.333				
	Total	3,007			1.093		3,258			1.610
Gini	**0.093**					**0.610**				
total risk	0.433	0		0.468	0.346	0.433	0	0.528	0.468	0.506

	Geo Black sea					Ceyhan BTC				
		dist	**cumul %**	**A(sY1+sY2)**	**A*B**		**dist**	**cumul %**	**A(sY1+sY2)**	**A*B**
	Az	503	0.570	0.570	0.285	Tr	1,059	0.608	0.608	0.203
	Geo	380	1.000	1.570	0.785	Az	449	0.865	1.473	0.491
						Geo	235	1.000	2.473	0.824
B(X)	0.500					0.333				
	Total	883			1.070		1,743			1.518
Gini	**0.070**					**0.518**				
total risk	0.489	1		0.468	0.389	0.489	1	0.468		0.501
	Kz	796	0.425	0.425	0.142	Tr	1,059	0.387	0.387	0.097
	Az	699	0.797	1.222	0.407	Kz	796	0.678	1.065	0.266
	Geo	380	1.000	2.222	0.741	Az	645	0.914	1.980	0.495
B(X)	0.333					Geo	235	1.000	2.980	0.745
		1,875			1.289	0.250	2,735			1.603
Gini	**0.289**					0.603				
total risk	0.433	0	0.528	0.468	0.441	0.433	0	0.528	0.468	0.504
	Kz	1,666	0.620	0.620	0.207	Kz	1,018	0.344	0.344	0.086
	Az	653	0.862	1.482	0.494	Tr	1,059	0.702	1.047	0.262
	Geo	370	1.000	2.482	0.827	Az	645	0.921	1.967	0.492
B(X)	0.333					Geo	235	1.000	2.967	0.742
		2,689			1.528	0.250	2,957			1.581
Gini	**0.528**					0.581				
total risk	0.433	0	0.528	0.468	0.489	0.433	0	0.528	0.468	0.500

	Az	840	0.412	0.412	0.137	kz	1,577	0.449	0.449	0.112
	Kz	831	0.819	1.230	0.410	Tr	1,059	0.750	1.198	0.300
	Ge	370	1.000	2.230	0.743	Az	645	0.933	2.131	0.533
B(X)	0.333					Geo	235	1.000	3.131	0.783
		2,041			1.291	0.250	3,516			1.727
Gini	**0.291**					0.727				
total risk	0.433	0	0.528	0.468	0.442	0.433	0	0.528	0.468	0.529
	Az	653	0.477	0.477	0.159	Tr	1,059	0.463	0.463	0.116
	Kz	370	0.747	1.224	0.408	Az	645	0.746	1.209	0.302
	Geo	346	1.000	2.224	0.741	Kz	346	0.897	2.106	0.527
B(X)	0.333					Geo	235	1.000	3.106	0.777
		1,369			1.308	0.250	2,285			1.721
Gini	**0.308**					0.721				
total risk	0.433	0	0.528	0.468	0.445	0.433	0	0.528	0.468	0.528
	Kz	2,235	0.674	0.674	0.225	Kz	2,235	0.535	0.535	0.134
	Az	699	0.885	1.560	0.520	Tr	1,059	0.789	1.325	0.331
	Geo	380	1.000	2.560	0.853	Az	645	0.944	2.268	0.567
B(X)	0.333					Geo	235	1.000	3.268	0.817
		3,314			1.598	0.250	4,174			1.849
Gini	**0.598**					**0.849**				
total risk	0.433	0	0.528	0.468	0.503	0.433	0	0.528	0.468	0.553

APPENDIX 7

Socioeconomic Risk components (Marin Quemada,2010)

Social Risk

BRIEF DESCRIPTION OF VARIABLES	EXPECTED SIGN[20]	FINALLY SELECTED
Associational and Organizational Rights (freedom of assembly, open public discussion; freedom for NGO; and the freedom for trade Unions, etc.)	-	X
civil liberties (freedoms of expression, rule of law, and personal autonomy)	+	X
Democracy freedom	-	X
Economic influences over media content	+	X
Electoral Process	-	X
Empowerment rights index (Freedom of Movement, Speech, religion, Worker's Rights, Pol. Participation)	-	X
Control of Corruption	-	X
Duration of compulsory education	-	X
Freedom of assembly and association	-	X
Freedom of Expression and Belief	-	X
Nurses (density per 1000 population)	-	X
Global Peace Index (GPI)	+	X
Human Development Index 2005	-	X
Health expenditure Public (% of GDP) 2004 HDR PNUD	-	X
Health expenditure Private (% of GDP) 2004 HDR PNUD	-	X
Health expenditure per capita (PPP USD 2004) HDR PNUD	-	X

Intrinsic Energetic Risk

BRIEF DESCRIPTION OF VARIABLES	EXPECTED SING[23]	FINALLY SELECTED	TOTAL COMUNALITY[24]	RISK FACTOR LOAD[25]
Herfindahl-Hirschman Index of Energy Imports (SITC Rev 3 group 3)	+	X	0.611	0.420
Inverse total self-sufficiency	+	X	0.723	0.708
Inverse Reserves/production ratio: coal	+	X	0.580	0.444
Inverse Reserves/production ratio: gas	+	X	0.765	0.874
Inverse Reserves/production ratio: oil	+	X	0.807	0.876

Political Risk

BRIEF DESCRIPTION OF VARIABLES	EXPECTED SING[26]	FINALLY SELECTED	TOTAL COMUNALITY[27]	RISK FACTOR LOAD[28]
Ratings "Standard & Poors" (Long-term foreign currency sovereign rating)	-	X	0.882	-0.873
OPEC members	+	X	0.789	0.172
Average state ownership in NOCs included in the 50 major oil & gas companies	+	X	0.815	0.103
Use of energy as political weapon	+	X	0.289	0.014
Political Terror Scale (Average AI & US Dep.State)	+	X	0.847	0.837
Political Stability & Absence of Violence/Terrorism (Estimate)	-	X	0.863	-0.897
Sum of all annual armed conflicts by primary country	+	X	0.709	0.316
Coup d'état event	+	X	0.388	0.621
Corruption Perceptions Index (CPI)	-	X	0.857	-0.905
Ease of Doing Business Rank	+	X	0.756	0.828
OCDE Risk Class. (Participants Arrangement Officially Supported Export Credits	+	X	0.886	0.871
Global Peace Index (GPI)	+	X	0.674	0.728
Total number of terrorist attacks 1998-2004	+	X	0.757	0.255
ICRG Indicator of Quality of Government	-	X	0.822	-0.889
Index of Objective Indicators of Good Governance	-	X	0.635	-0.778
Global Competitiveness Index 2008-2009	-	X	0.103	-0.232

Economic Risk

BRIEF DESCRIPTION OF VARIABLES	EXPECTED SING[29]	FINALLY SELECTED	TOTAL COMUNALITY[30]	RISK FACTOR LOAD[31]
Annual average growth rates of real gross domestic product	+	X	0.650	0.260
Population (Total)	+	X	0.732	0.068
Population growth rate	+	X	0.830	0.681
Population growth rate forecast	+	X	0.856	0.694
Agriculture, hunting, forestry and fishing (ISIC Rev.3 divisions 01-05)	+	X	0.700	0.486
Total Primary Energy Consumption per Dollar of Gross Domestic Product.	+	X	0.768	0.065
Fuel Taxation/Subsidiation (% per litre). Diesel	-	X	0.872	-0.715
Fuel Taxation/Subsidiation. (% per litre) Gasoline	-	X	0.852	-0.705
Fuels imports as percentage of total imports [SITC rev.3 codes 321, 333, 343]	-	X	0.614	-0.154
Number of bilateral trade agreements with EU_Current (09/08)	-	X	0.425	-0.332
Percentage of imports to EU-27	-	X	0.690	-0.594
Relative index of import intensity: China	+	X	0.683	0.384
Relative index of import intensity: India	+	X	0.638	0.216
Relative index of import intensity: Japan	+	X	0.676	0.439
Relative index of import intensity: USA	+	X	0.607	0.146
Relative index of geographical oil imports dependency: China	+	X	0.613	0.268
Relative index of geographical gas imports dependency: China	+	X	0.988	0.073
Relative index of geographical coal imports dependency: China	+	X	0.612	0.134
Relative index of geographical gas imports dependency: India	+	X	0.277	0.120