**Journal of Energy and Economic Development,**
**Niroo Research Institute.**
**Vol. 1, Issue. 2, Autumn 2022, Pages 50-66**
**Journal Homepage: https://jeedev.nri.ac.ir**

# Caspian Basin Natural Gas Transfer: A Cooperative Game Theory Approach

Soroosh Baghdadi *[1]

*1. Allameh Tabatabai University, Tehran, Iran*

**Original Article**

**Abstract.** This research uses a game theory approach to study the probable scenarios of gas transmission from the Caspian basin to Europe. Due to the growing importance of climate change, the use of natural gas, as the cleanest fossil energy, has been expanded. We first analyse the position of the Caspian basin resources on the world energy market and the current projects. We then develop the most probable scenarios for the next 30 years. We estimate each player's bargaining power using the Shapely value in the most probable scenarios and analyse the outcomes in the context of the international political economy. The results indicate that geopolitics plays a key role in countries' bargaining power on regional energy markets, followed by their production capacity. The results also show that the southern export route is more economical than the Trans-Caspian pipeline.

***Keywords:*** *Cooperative game theory, Caspian basin, Energy economics, Gas pipeline*

***JEL Classification:*** *C78, C71, Q40, F50*

## 1. INTRODUCTION

In recent years, due to the growing importance of global warming, the use of natural gas as a bridge between fossil energy and green energy has been expanded. Natural gas resources, as the least polluting hydrocarbon energy, have an unbalanced distribution around the world. Four of the six regions have become natural gas net exporters, and Europe and Asia-Pacific are net importers (BP statistical review, 2019).

*Corresponding author E-mail addresses: sr.baghdadi@gmail.com*
*Received Date: 2022-10-10; Revised Date: 2023-01-09; Accepted Date: 2023-01-23*
*https://doi.org/10.30503/jeedev.2023.363025.1022*

Europe faces a severe crisis due to the decline in domestic production and conflicts with its leading gas supplier, Russia. One of the central policies of the European Union to deal with this crisis is to diversify its gas imports. Due to the challenges in 2022, such as the Ukraine war and the European energy crisis, the southern gas corridor plan is under investigation in Europe. This research uses a cooperative game theory model to investigate the feasibility of European gas imports from Central Asian countries and Iran as diversification candidates for pipeline gas imports. The following table displays the Caspian bordering countries' (except Russia's) natural gas information.

Table 1. Natural gas information

| Caspian Bordering Countries | Natural Gas Reserves (TCM) | Natural Gas Production (BCM, 2018) |
|---|---|---|
| Iran | 31.5 | 238 |
| Turkmenistan | 19.5 | 61 |
| Kazakhstan | 2.7 | 24 |
| Azerbaijan | 2.1 | 18.8 |

Source: BP statistical review (2019)

Despite the EU's efforts to develop renewable energies, natural gas and its derivatives continue to serve as an important energy resource. However, more than 70% of European natural gas consumption is imported, 40% of which comes from Russia. To address the political challenges and uncertainty, the European Union has developed a strategy to reduce its dependence on Russia, including improving energy efficiency, adopting coordinated policies, and diversifying natural gas imports (IEA,2022). Therefore, the Caspian Basin is seen as an alternative energy source to meet the EU's needs for natural gas. Central Asian and Caspian Basin energy can be transported to European markets through different routes.

First, the western route transports oil and gas from the Caspian littoral states to Europe via Turkey and Georgia. It is supported by the United States, Turkey, Azerbaijan, and Georgia. The Baku-Novorskiy oil pipeline (1500 km), Baku-Supsa, Baku-Tbilisi-Ceyhan (1730 km), the Tangiz-Novorskisk pipeline, the Baku-Erzurum gas pipeline, and the Caspian consortium are the most significant energy transmission lines on this route.

Second, the northern route transports Kazakh oil, gas through the Black Sea, and is supported by Russia. The Atiro-Samara pipeline starts at the port of Atiro in Kazakhstan and reaches Samara in Russia via the Russian Inland pipelines to Belarus, Poland, and Hungary.

Third, the Trans-Caspian Pipeline connects Turkmenistan to Azerbaijan, after which gas will flow to Europe through another pipeline passing through Turkey. The pipeline passes through Turkey, Bulgaria, Romania, and Hungary and eventually arrives in Austria, aiming to transport gas from Iran, Iraq, Azerbaijan, and Turkmenistan to Europe (Jafarzadeh et al., 2014).

The eastern routes to China and India are not economically viable due to their length and the landlocked nature of the region. Therefore, the fourth phase of the Central Asia-China pipeline has been delayed several times, and China tends to increase imports from Russia. The southeast route also has problems due to widespread insecurity and lack of infrastructure in Afghanistan and Pakistan and impassable geographical barriers in Afghanistan.

The tense regions of Nagorno-Karabakh and the Kurdish regions of Turkey, the long distance, and the need to cross the Caspian Sea to join Turkmenistan and Kazakhstan prove serious Challenges (Farajirad et al. 2014). The northern route will lead to Russia's dominance of Europe's energy routes, and the southern route is not feasible due to US opposition.

Russia, Norway, and Algeria supply most of Europe's natural gas. However, the share of gas in the European energy basket is increasing, and Europe is paying particular attention to the gas of the Caspian countries to diversify its resources. Nonetheless, recent political developments in the Caspian Sea and countries' agreements on its legal regime have posed threats and opportunities for the bordering countries. To transfer the region's energy resources, the countries surrounding the Caspian Sea can continue the status quo, take actions that will lead to a conflict, or follow a cooperative strategy.

If the global shift towards multipolarity continues, the cooperation scenario becomes more likely since the legal framework is established. Furthermore, Europe seeks to reduce its dependence on Russia's energy exports as the tension between the EU and Russia is increasing. Due to recent developments and calculations that have been made regarding the costs and risks of the proposed pipeline projects; the Caspian littoral states will likely have to choose between two options for gas exports to Europe:

1- Implementing the Trans-Caspian project and joining the South Gas Corridor (SGC) project

2- Passing through Iran before joining SGC

We compare the economics of the above-mentioned options and measure countries' bargaining power in probable scenarios. We also review the factors that will enhance the bargaining power of the countries involved in the energy transfer project. Given the interdependence of Caspian Sea countries' strategies and decisions, the cooperative game theory seems to be an appropriate approach to analyse possible scenarios.

The rest of the paper is organized as follows. Section 2 presents a review of previous studies; followed by the theoretical framework in Section 3 Regional gas resources and their outlook are discussed in Sections 4 and 5 respectively. Section 6 presents the game structure. Section 7 shows the results. Finally, a conclusion is inferred.

## 2. RESEARCH BACKGROUND

Akbarian (2003) analyses the geopolitical condition of energy markets and argues that the pattern of energy flow will be moving from the Middle East to Central Asia, with the most demand for energy from emerging economies. This study concludes that Iran's route in the Caspian region to transfer energy to global markets is the most viable option economically, politically, and geographically. Svetlana Ikonikova and Giggsbert Zwart (2010) use the Shapley value to calculate market power and find that regulations increase the power of domestic buyers over foreign buyers. Hubert and Ikonnikova (2011) examine the Russian gas transmission lines, using a cooperative game theory, and calculate engaged countries' bargaining power by the Shapley value. They conclude that the most viable option for Russian exports is direct supply through the Black Sea. Hubert and Cobanli (2012) study three pipelines (Nabucco, North Stream and South Stream), using a cooperative game theory, and show that the North Stream pipeline has more strategic value than the South Stream pipeline, and the Nabucco pipeline will not benefit the EU much, although it will reduce Europe's dependence on Russia. Jafarzadeh et al. (2014) investigate the cooperation between gas exporters in the Caspian region and Iraq, using a cooperative game theory. The study shows that the direct export of gas by Iran, Azerbaijan, and Turkmenistan to Europe is not a feasible option. These countries are encouraged to join the export coalition for the Nabucco pipeline. Khorami and Sheikhmohammadi (2015) investigate the strategic clash between Russia and Europe, using game and graph theories. The results show that LNG is extremely significant for ensuring European energy security.

Austevik and Golmira Razayeva (2017) studied Turkey's energy market and demand based on its population, geographical location, and the government's desire to become a significant player on the gas transit route to Europe. Orazgaliyev and Eduardo (2019) examine conflict and cooperation in the Caspian Sea. They model the case as a prisoner's dilemma involving five claimant countries and interests of power (the US, the EU, and China) with two different outcomes. In the northern region of the Caspian Sea, neighbours have decided to solve their problems over ownership of oil fields and opted for cooperation. In the southern parts of the Caspian Sea, however, neighbours have failed to agree and cooperate despite decades of efforts. Using analytical narratives, the authors suggest that strategic calculations could help in explaining the different outcomes. Countries act according to their rational best interest, given international anarchy. They conclude that in the northern part of the Caspian Sea, geopolitical and economic considerations are the main factors for cooperation. Because of the complex situation of oil and gas resources and pipelines in the Caspian region, the study does not provide universal implications.

## 3. THEORETICAL FRAMEWORK

Our subject of study has different dimensions and can be investigated from several perspectives, using an interdisciplinary approach based on energy economics, game theory, and international political economy.We incorporate political risk variables into the model and analyse the results using the international political economy approach.

A gas pipeline is a network that enables countries to trade. Its design determines not only the flow of trade but also the countries' power in trade. Therefore, countries seek to design the gas transmission network to provide them with maximum benefits and bargaining power. The more difficult it is to replace the resources and transmission lines under a country's control; the more potent that country is (Hubert and Cobanli, 2014).

The idea that dominance over trade routes increases a nation's power was first theorized by Hirschman in 1969, but there was no generally accepted approach to determining power relations within networks until Myrson (1977) proposed the use of cooperative game theory for transmission structure analysis, and specifically the Shapley value as an indicator of (Jackson and Wolinski, 1996). Jackson (2008) extended the idea to public networks and outlined this approach on two levels. At the first level, players in a non-cooperative game can change the network architecture by adding or removing channels. At the second level, the final reward is determined using cooperative games based on the existing network.

The majority of gas transmission lines operate under comprehensive and negotiated contracts. These contracts are designed to ensure the efficient use of existing capacity. The contract with transit countries also covers transfer tariffs. The participants’ shares of the payoff are determined by negotiations within the network. The cooperative game theory framework can therefore be used to identify the best decisions and responses of each party and the outcomes (Hubert and Cobanli, 2014). The cooperative game theory approach to the study of natural gas networks was first proposed by Hubert and Ikonnikova (2011). This approach has been applied to different cases that were mentioned in the previous section.

### 3.1 Game Theory

Game theory studies the optimal actions and responses players can take that will lead to specific results. It models the interactions between self-interested agents and predicts the outcome accordingly. (Brown, K. L., & Shoham, Y., 2008). Games can be played cooperatively or non-cooperatively. In non-cooperative games, players seek to maximize their interests independently. However, in cooperative games, instead of competing, players agree on choosing specific strategies to achieve the most favourable outcome. These agreements, which are formed between two or more actors, are called coalitions. The condition for cooperation among the players in a coalition is that the benefits of cooperation must be greater than the benefits of competition. Cooperative game theory searches first for possible agreements between players and then divides the coalition's outcome (Abdoli, 2012).

The structure of cooperative games consists of non-cooperative games. The first step in making cooperative games is to transfer non-cooperative games to cooperative ones, called characteristic functions. The number of coalitions in an n-player game is determined by S = $2n{-}1$. In which N = {1, 2, …, n) denotes players of a game. S denotes the alliances and |S| denotes the number of coalition members.

Sc denotes those who do not participate in the S alliance. If S and Sc ally, a collective coalition will be formed, denoted by N. The outcome of the coalition is denoted by V, known as the characteristic function. It represents all possible coalitions and the maximum outcome of each. The characteristic form of the game with n players shows the player with (N, V), in which N = {1,2, …, n} and V represents the outcome of each alliance in the game. A coalition is formed only if the payoff in the coalition is greater than or equal to the sum of the payoff players obtain without the coalition.

$$(S) + (T) \leq (S \cup T) \quad (1)$$

To transfer the strategic form to the characteristic form, we must first obtain all possible game coalitions and payoffs. $a = (a1. \ldots . an)$ denotes the members of coalition strategic choice and $V(S) = \sum_{i \in s} Ui(a1 \ldots . an)$ denotes each coalition payoff equals the sum of the payoffs of all coalition members. In cooperative games, if all players join a collective coalition, that will be the maximum possible payoff.

$$V(S) = \sum_{i=1}^{n} Ui(a1. \ldots . an) \quad (2)$$

The characteristic function indicates the outcome of each coalition in the game. After forming the coalition, the critical concern is how to divide the outcome of the coalition among the members. The distribution of consequences among members should be such that no other coalition is more profitable to the coalition members. In this case, there is a possibility of the dissolution of the coalition. The allocation of a consequence that satisfies the coalition members is called rational allocation. Xi represents the extent of the value assigned to player i of the division of the coalition.

The rational allocation has two conditions. The first condition is the efficiency condition, which means that the total value assigned to the members is equal to the value created by the establishment of the coalition.

$$\sum_{i=1}^{n} Xi = V(N) \quad (3)$$

The second condition is individual rationality, which states that the share of players in the outcome of the coalition should be greater than the outcome of acting alone.

$$Xi \geq V(\{i\}) \quad \forall i \in N \quad (4)$$

The rational allocation formula is shown below.

$$\{X = (X1، X2، \ldots ، Xn); \sum_{i \in N} Xi = V(N)، Xi \geq V(\{i\} \forall i \in N\} \quad (5)$$

### 3.2 Shapley value

There are several methods for uniquely rational allocation, the most important of which is the Shapley value. The Shapley value can be considered the strength of a player in the coalition, in return for which the player receives the payoff. The value assigned to the players is presented in the value function vector. The following value function shows the value assigned to each coalition member.

$$\emptyset(V) = (\emptyset1(V). \emptyset2(V). \ldots . \emptyset n(V)) \quad (6)$$

$\emptyset i(V)$ Indicates the value of player i in the cooperative game with the characteristic function V. the following equation calculates the value assigned to each player.

$$\emptyset i(V) = \sum_{i \in s} \frac{(|s|-1)!\,(n-|s|)!}{n!} \big(V(S) - V(S - \{i\})\big) \quad (7)$$

|S| denotes the number of members of the coalition, and (V (S) -V (S - {i})) is the increase rate of the outcome of the coalition S. To calculate the above-mentioned relation, we must first find all the coalitions in which the players are present using the attribute form and then use the attribute function to calculate the reduction of the consequence of the specified alliances if i leaves the coalition. In other words, the same brought or achieved by the player related to the coalition (Abdoli, 2012).

## 4. CASPIAN BASIN GAS RESOURCES

Iran is located between the world's two most significant oil and gas reserves, the Persian Gulf and the Caspian region. Iran's gas reserves are estimated at 31.5 trillion cubic meters (BP statistical review, 2019). The Iranian gas industry program has developed based on four principles: domestic consumption, exports, injection into oil reservoirs to increase recovery, and gas conversion into products. In recent years, Iran exported gas to Turkey and Azerbaijan. While its gas imports have been mainly from Turkmenistan. However, Iran has not been able to play an influential role in the global gas market.

Azerbaijan's natural gas reserves are estimated at 2.1 trillion cubic meters, mostly in the Shah Deniz field. Until 2006, Azerbaijan was a net importer of natural gas but has since become a significant regional gas exporter due to a reduction in consumption and an increase in production (Jafarzadeh et al., 2014). In 2018, the country produced about 18.8 billion cubic meters of gas per day. (BP statistical review, 2019). Azerbaijan exports to Iran through the Baku-Astara pipeline, to Russia through the Megomo-Mozdak pipeline, and to Turkey. Gas pipeline infrastructure to Turkey and then Europe has developed significantly over the past several years (Sadeghi, 2011). Turkmenistan is one of the top four countries with the largest conventional gas reserves (19.5 trillion cubic meters) globally. Its unique territorial location and connection to Russia's natural gas pipelines make Turkmenistan an essential player in the region's gas supply and exports to Europe. Turkmenistan's gas reserves are mainly located in the Shatkik and Dolatabad regions, east of the Caspian Sea, near the Amu Darya River. Turkmenistan exports gas to Iran, China, and partially through the Russian transmission network to Europe.

Kazakhstan has about 1 billion cubic meters of gas reserves and produced about 24 billion cubic meters of gas in 2018 (BP statistical review, 2019). More than 90% of its investment in the exploitation and production of the oil and gas industry has been provided by foreign investors (Sadeghi, 2011).

## 5. GAS CONSUMPTION AND PRODUCTION OUTLOOK

Since the beginning of the century, the demand for natural gas has grown by an average of 2.7 per cent annually due to its environmental and economic benefits. According to the IEA forecast, the share of gas in the world energy demand basket will increase to 24% by 2040. 62% of the demand growth will be from OECD countries. Furthermore, European gas demand will reach more than 590 billion cubic meters per year. The United States will remain the world's largest gas consumer, with North American gas demand reaching 1,170 billion cubic meters. Russia, the world's second-largest gas supplier, will produce 475 billion cubic meters. The two emerging economies, China and India, will experience demands of up to 708 and 171 billion cubic meters, respectively. The most significant increase in demand will be in the Middle East, which will grow by about 80% to 794 billion cubic meters. A large part of which will supply the energy needed to generate electricity for desalination applications.

It is estimated that 48% of the increase in natural gas supply will come from unconventional resources. North American production will reach 1328 billion cubic meters in 2040 and most of it will be produced from unconventional resources. Russia's gas production will increase to more than 800 billion cubic meters, and China's gas production will increase to 343 billion cubic meters. Production growth will be slow in the Middle East, with Saudi Arabia and Iraq producing 157 and 80 billion cubic meters of gas, respectively. Iran would also supply 315 billion cubic meters to the world market (IEA Outlook, 2020).

## 6. THE GAME STRUCTURE

### 6-1 Players

The players involved in the game are shown by i = 1, …, N, where N = {IR, AZ, TU, KA, TU}, including Iran, Kazakhstan, Azerbaijan, Turkmenistan, and Turkey, the players that form the coalitions are the final set of coalitions for the characteristic function.There are several scenarios in which coalitions can be formed in this game. Turkmenistan, Kazakhstan, and Azerbaijan compete to form a coalition to supply gas to the west through Iran. Since none of the scenarios is practical without Turkey's participation, Turkey is the most significant player on the western route. In this direction, Iran, Azerbaijan, Turkmenistan, and Kazakhstan compete to form alliances to provide gas to western markets through Turkey. On the western route, possible scenarios are examined from a practical point of view. Russia is unlikely to join any of the coalitions for political and economic reasons. This is because it has made every effort in recent years to maximize the amount of energy transferred from its route to the European market. Russia's primary goal is to make European energy security more dependent on itself to have stronger leverage against Europe. As a result, Russia's participation in the game has been ignored due to the high probability of opposition.

### 6.2 Characteristic Functions

We consider the gas supply profit function as the characteristic function for Iran, Azerbaijan, Turkmenistan, and Kazakhstan. Profit is defined as the net present value of gas supply for each country. The minimum number of players required to form a gas supply coalition is two, as it needs one producer and one transmitter.

The net present value is calculated for both southern and western routes to calculate the total profit of gas exports of the mentioned countries to Europe. We use the characteristic function presented by Jafarzadeh et al. (2021) but augment it by adding the political risk variable. The characteristic function is defined as the gas supply profit function as follows:

$$\mathrm{NPV} = \sum_{i=1}^{t} \frac{\mathrm{NPV}}{(1+\mathrm{pr.r})^{t}} \tag{8}$$

$$\mathrm{NPV}_t = \mathrm{Income} - (\mathrm{Capex} + \mathrm{Opex}) \tag{9}$$

$$\mathrm{Capex} = \mathrm{lc} + \mathrm{d} \tag{10}$$

$$\mathrm{Opex} = 0.08 * \mathrm{Capex} \tag{11}$$

$$\mathrm{Income} = \mathrm{P} * \mathrm{Q} \tag{12}$$

| | |
|---|---|
| l = Pipeline length (km) | Q = Capacity (1000) |
| c = Cost of building a pipeline per kilometre | r = price per 1000 cubic meters of gas |
| d = upstream design cost | pr = political risk |

Political risk is considered a factor that increases the discount rate. In the calculations, the highest political risk of the countries along the pipeline route is considered the political risk of the route. As an example, in the cooperation scenario between Turkey and Azerbaijan, the highest political risk in the transit route is 0.52, and since we assumed that political risk increases the interest rate, 1.52 has multiplied the interest rate.

### 6-3 Assumptions

To calculate the profit function, we have used the following assumptions:

Table 2. Assumptions

| Title | Unit of measurement | Quantity |
|---|---|---|
| Pipeline capacity | Billion cubic meters per year | 30 (average) |
| Downstream part design | Million dollars | 300 |
| Onshore pipeline construction cost per Inch (CAPEX) | Thousand dollars | 86.8 |
| Offshore pipeline construction cost per Inch (CAPEX) | Thousand dollars | 101.9 |
| Annual operational cost (OPEX) | Per cent of total capital cost | 8 |

Source: Annual Pipeline Economics Special Report (2016)

Gas prices are assumed based on the average price of gas delivered to Germany in the ten years leading up to 2018. It is $8.17 per million BTU or $313 per thousand cubic meters. Gas transmission and payment methods are different. Some countries inject between 3 and 8 per cent of the transferred gas into their internal network for gas transmission fees. Some also receive a fee for every 1,000 cubic meters of transmission per 100 kilometres. Russia, for example, receives $1.09 per 1,000 cubic meters per 100 kilometres for its transport to Ukraine under a 2004 agreement to transport Turkmen gas from its territory. The Czech Republic receives $2.7 for every 1,000 cubic meters of Russian gas transmission to Germany per 100 kilometres (Young et al., 2012). In addition, Ukraine received $3.05 per 1000 cubic meters of gas transmission per 100 kilometres in 2013 (Jafarzadeh et al., 2014). We chose $3.1 per thousand cubic meters per 100 kilometres, which is Russia's gas transport fee through the Ukrainian pipeline.

We use the 10-year average of the political risk index of the countries participating in each coalition in different scenarios using the International Country Risk Guide (ICRG). It covers the political, economic, and financial risks of more than 140 countries annually since 1979. The index includes factors such as government stability, socioeconomic condition, internal conflicts, external conflicts, ethnic and religious tensions, corruption, the military's politics and economy, the state of investment, the quality of government bureaucracy, and the rule of law and order.

## 7. RESULTS

This section calculates the present value (NPV) of gas transmission projects in different scenarios. Net present value as the main outcome of cooperation is used to calculate the player's bargaining power in different scenarios. Revenues and costs of viable projects are estimated and the net present value is calculated at an interest rate of 10%. The life of the project is 30 years, of which the first five years are construction years and the next 25 years are operation years. We calculate the net present value of the scenarios using Excel software and the countries' bargaining power (Shapley value) using R software. An example of how to determine net present value is provided in the appendix.

### 7.1 Status quo Scenario

In the status quo scenario, the countries' characteristic functions and their bargaining powers are analysed based on the existing infrastructure, without considering future projects and creating new capacities. Turkmenistan exports gas to Iran. Iran and Azerbaijan also export gas to Turkey. In 2018, Iran exported about 7.6 bcm of gas to Turkey, which has a transfer capacity of 14 bcm at the moment. Moreover, in 2018, Azerbaijan exported about 9 bcm to Turkey through the South Caucasus pipeline with a capacity of 25 billion cubic meters. The capacity of the Turkmenistan-Iran gas pipeline is about 20 bcm per year, but only 2 billion cubic meters are being used at the moment (BP statistical review, 2019). Given the unused capacity of transmission lines, these countries' ability to export to Europe and their bargaining power can be calculated. Under the current situation, and with the existing infrastructure, Iran, Turkmenistan, and Azerbaijan can export gas to Europe via the southern (Iran-Turkey) route.

Table 3. Functions

| | |
|---|---|
| 1 - V(TU) = 0 | 9 - V(IR, TN) = 0 |
| 2 - V(IR) = 0 | 10 - V( AZ, TN) = 0 |
| 3 - V(AZ) = 0 | 11 - V(TU, IR, AZ) = 8.1 |
| 4 - V(TN) = 0 | 12 - V(TU, IR, TN) = 8.4 |
| 5 - V(TU, IR) = -4.3 | 13 - V(TU, AZ, TN) = 0 |
| 6 - V(TU, AZ) = 7 | 14 - V(IR, AZ, TN) = 0 |
| 7 - V(TU, TN) = 0 | 15 - V(TU, IR, AZ, TN) = 22.1 |
| 8 - V(IR, AZ) = 0 | |

The above-mentioned functions show the value of gas exports in different forms. Kazakhstan has been removed from the equation as it has no pipeline to transport gas to Turkmenistan, and then to Iran. The first four functions indicate the forms in which each country enters the game individually. Due to the need for at least one gas exporter and a transmitter, these functions are not feasible, and their outcomes are zero. Function 5 shows the cooperation between Iran and Turkey through which Iran's gas will be exported to Europe with a present value of -$4.3 billion. In other words, this case is not economically viable. Function 6 shows Azerbaijan's gas exports to Europe via Turkey with a net present value of $7 billion. Function 7 indicates the export of Turkmen gas through Iran to Turkey, which is not feasible as Iran is not a participant in the coalition. As a result, the value of the function is zero. Functions 8 and 9 also show bilateral cooperation between Iran, Turkmenistan (two by two) and Azerbaijan. Without Turkey's participation in these alliances, gas exports are not feasible, and the result is zero. Function 12 represents the cooperation between Iran, Turkey, and Turkmenistan in which Iran and Turkmenistan export gas to Europe through Turkey. The present value of this function is $8.4 billion. Function 13 shows the cooperation between Turkmenistan, Azerbaijan, and Turkey, which is not feasible due to Iran's absence. Therefore, the present value of this function is zero. Function 14 is not feasible due to the absence of Turkey in the coalition. Function 15 shows the cooperation between Iran, Turkey, Azerbaijan, and Turkmenistan in exporting gas from the southern route pipeline (Iran's route), which is worth $22.1 billion. The Shapely values obtained from the above data are as follows:

$$\{TU, IR, AZ, TN\} = \{7.1, 5.9, 5, 4.5\} \quad (13)$$

Since all countries need Turkey for their transit route, Turkey has the highest bargaining power. Iran has the second highest bargaining power, because of its production volume, geographical location, and distance to the consumer market. Turkmenistan has the lowest bargaining power, due to its complete dependence on other transit countries.

### 7.2 Pars Pipeline Establishment Scenario

The Pars pipeline project is designed to transport 35 to 40 bcm of gas annually from phases 20 and 24 of Iran's South Pars field to Europe via a pipeline about 1740 km long. Upon implementation, Europe can meet about 25% of its gas needs in the coming years from Iran. The pipeline passes through Turkey to Greece, Italy, Switzerland, and then to Austria and Germany.

Table 4. Functions

| | |
|---|---|
| 1 - V(TU) = 0 | 9 - V (IR, TN) = 0 |
| 2 - V(IR) = 0 | 10 - V (AZ, TN) = 0 |
| 3 - V(AZ) = 0 | 11 - V (TU, IR, AZ) = 31.3 |
| 4 - V(TN) = 0 | 12 - V (TU, IR, TN) = 31.6 |
| 5 - V (TU, IR) = 19 | 13 - V (TU, AZ, TN) = 0 |
| 6 - V (TU, AZ) = 7.0 | 14 - V (IR, AZ, TN) = 0 |
| 7 - V (TU, TN) = 0 | 15 - V (TU, IR, AZ, TN) = 54.2 |
| 8 - V (IR, AZ) = 0 | |

The first four functions are zero because no country can act individually. Function 5 shows the Iran-Turkey coalition, which is worth $19 billion. Function 6 shows the cooperation between Azerbaijan and Turkey, which is worth $7 billion. Functions 7, 8, 9, and 10 indicate coalitions of pairs that are not practical due to the lack of territorial access to the destination market. Function 11 shows the cooperation between Iran, Turkey, and Azerbaijan, which would lead to the export of 31.3 bcm of gas to Europe. Function 12 shows the cooperation between Iran, Turkmenistan, and Turkey with a present value of $31.6. Function 13 is not practical due to the Trans-Caspian pipeline's absence. Function 14 is not practical due to Turkey's absence. Therefore, its present value is zero. Function 15 shows the coalition of all four countries: Iran, Turkey, Azerbaijan, and Turkmenistan, with a present value of $54.2 billion. According to these results, the Shapely values are as follows:

$$\{TU, IR, AZ, TN\} = \{20.9, 19.8, 7.2, 6.7\} \quad (14)$$

The results indicate that Turkey has more bargaining power than other countries because, without its participation, no scenario would be feasible. After Turkey, the countries with the most bargaining power are Iran, Azerbaijan, and Turkmenistan. It can be concluded that implementing Iran's proposed gas transmission project will increase its bargaining power. Turkmenistan has the least bargaining power because it cannot export gas to the European market through Turkey without the participation of other countries.

### 7.3 Azerbaijan New Projects Scenario

BP developed the Shafaq-Asiman gas field, which has reserves equal to the Shah-Deniz field. Moreover, the Shah Deniz 2 project adds 16 billion cubic meters of gas production to Azerbaijan annually. Therefore, Azerbaijan may reach an export capacity of 25 billion cubic meters per year in the coming years (Oxford energy Institution, 2021).

Table 5. Functions

| | |
|---|---|
| 1 - V(TU) = 0 | 9 - V(IR, TN) = 0 |
| 2 - V(IR) = 0 | 10 - V(AZ, TN) = 0 |
| 3 - V(AZ) = 0 | 11 - V(TU, IR, AZ) = 15.9 |
| 4 - V(TN) = 0 | 12 - V(TU, IR, TN) = 8.4 |
| 5 - V(TU, IR) = -4.3 | 13 - V(TU, AZ, TN) = 0 |
| 6 - V(TU, AZ) = 15.3 | 14 - V(IR, AZ, TN) = 0 |
| 7 - V(TU, TN) = 0 | 15 - V(TU, IR, AZ, TN) = 28.8 |
| 8 - V(IR, AZ) = 0 | |

Source: Research Findings

The above-mentioned functions provide the net present value of gas exports in different modes. The first four functions are not possible. Therefore, their present values are zero. Function 5 shows the cooperation between Iran and Turkey, which yields the same result as the status quo scenario. Function 6 shows the cooperation between Turkey and Azerbaijan when Azerbaijan's upcoming projects are in operation. The net present value of this function is $15.3 billion. Functions 7, 8, 9, and 10 are not feasible due to Turkey's absence. Function 11 indicates the cooperation between Iran, Turkey, and Azerbaijan, which is worth $15.9 billion. Function 13 shows the partnership of Turkey, Azerbaijan, and Turkmenistan, which is not possible without the Trans-Caspian pipeline. Function 15 describes the cooperation of all four countries when upcoming projects are executed. The net present value of this function equals $28.8 billion. The Shapley values from the presented data are provided below:

**{TU, IR, AZ, TN} = {12.8, 8.4, 10.7, 9.6} (15)**

Considering that all other countries need to be on Turkish soil, Turkey has the most bargaining power. Azerbaijan is next on the list as it has more export capacity. Turkmenistan has the least bargaining power because it is not possible to export gas through this route without the participation of other countries.

### 7.4 Trans Caspian project

The Caspian Sea legal agreement signed in 2019 makes it possible to implement the Trans-Caspian Pipeline (TCP) project, which aims to transport natural gas from the Central Asian region to Azerbaijan and then to Turkey and European countries. The convention will allow Turkmenistan, Kazakhstan, and Azerbaijan to implement the Trans-Caspian project without including Russia and Iran. The initial plan was presented in 1996 by the United States to decrease Europe's dependence on Russia's gas resources. The proposed underwater pipeline has an annual transit capacity of 30 to 32 bcm and a length of approximately 300 km. The following table indicates the Shapely values of this project’s players.

Table 6. Functions

| | |
|---|---|
| 1 - V(TU) = 0 | 9 - V(IR, TN) = 0 |
| 2 - V(IR) = 0 | 10 - V(AZ, TN) = 0 |
| 3 - V(AZ) = 0 | 11 - V(TU, IR, AZ) = 8.1 |
| 4 - V(TN) = 0 | 12 - V(TU, IR, TN) = 8.4 |
| 5 - V(TU, IR) = -4.3 | 13 - V(TU, AZ, TN) = 32 |
| 6 - V(TU, AZ) = 7 | 14 - V(IR, AZ, TN) = 0 |
| 7 - V(TU, TN) = 0 | 15 - V(TU, IR, AZ, TN) = 38 |
| 8 - V(IR, AZ) = 0 | |

Functions 1 to 4 cannot be implemented. Function 5 shows the net present value of Iran-Turkey cooperation, which is equal to the status quo scenario. Function 6 shows the cooperation between Turkey and Azerbaijan. The result is the same as the status quo scenario. Function 7 depicts the cooperation between Turkmenistan and Turkey, which is not feasible due to the absence of Azerbaijan on the Trans-Caspian route. Functions 8 to 10 show the coalitions (two by two) between Iran, Azerbaijan, and Turkmenistan, which are not feasible due to Turkey's absence. Function 11 shows the cooperation of Turkey, Azerbaijan, and Iran. Function 12 represents the cooperation of Iran, Turkey, and Turkmenistan. The results of these two functions are the same as the status quo scenario. Function 13 shows the cooperation between Turkmenistan, Turkey, and Azerbaijan, which is worth $32 billion. The Shapely values for participants in this project are as follows:

**{TU, IR, AZ, TN} = {12.8, 8.4, 10.7, 9.6} (16)**

The results show that in this case, Turkey's bargaining power is higher than all other countries due to its geographical location. After Turkey, Azerbaijan has the most bargaining power due to its geographical location and proximity to the customer market. Turkmenistan has the lowest bargaining power, as it cannot export without the participation of other countries.

### 7.5 Joint project of Iran, Azerbaijan and Trans-Caspian projects with Kazakhstan adjoining

Kazakhstan can join the coalitions for exporting gas to Europe by constructing a new gas transmission pipeline connecting to the Turkmenbashi terminal. The capacity of this pipeline is estimated as 20 bcm, and its length is 710 km from Kazakhstan’s Kashan to Turkmenbashi in Turkmenistan. (BP, 2019)This scenario has the following characteristic functions:

Table 7. Functions

| | |
|---|---|
| 1 - V(TU) = 0 | 17 - V(TU, IR, AZ) = 39.6 |
| 2 - V(IR) = 0 | 18 - V(TU, IR, TN) = 0 |
| 3 - V(KA) = 0 | 19 - V(TU, KA, AZ) = 0 |
| 4 - V(AZ) = 0 | 20 - V(TU, KA, TN) = 0 |
| 5 - V(TN) = 0 | 21 - V(TU, AZ, TN) = 41 |
| 6 - V(TU, IR) = 18.6 | 22 - V(IR, KA, AZ) = 0 |
| 7 - V(TU, KA) = 0 | 23 - V(IR, KA, TN) = 0 |
| 8 - V(TU, AZ) = 15 | 24 - V(IR, AZ, TN) = 0 |
| 9 - V(TU, TN) = 0 | 25 - V(KA, AZ, TN) = 0 |
| 10 - V(IR, KA) = 0 | 26 - V(TU, IR, KA, AZ) = 0 |
| 11 - V(IR, AZ) = 0 | 27 - V(TU, IR, KA, TN) = 47.7 |
| 12 - V(IR, TN) = 0 | 28 - V(TU, IR, TN, AZ) = 64.3 |
| 13 - V(KA, AZ) = 0 | 29 - V(TU, KA, AZ, TN) = 56.5 |
| 14 - V(KA, TN) = 0 | 30 - V(IR, KA, AZ, TN) = 0 |
| 15 - V(AZ, TN) = 0 | 31 - V(IR, TU, AZ, KA, TN) = 81.1 |
| 16 - V(TU, IR, KA ) = 0 | |

Source: Research Findings

Function 6 represents the net present value of cooperation between Iran and Turkey, which is $18.6 billion. Function 8 shows the cooperation between Azerbaijan and Turkey with a net present value of $15 billion. In this case, Azerbaijan develops the Shafaq Asiman and Shah Deniz 2 projects. Functions 9 to 15 indicate two-by-two cooperation between countries, which is not feasible. Function 16 shows the coalition of Turkey, Iran, and Kazakhstan, which is not practical. Function 17 presents the cooperation between Iran, Turkey, and Azerbaijan, which is worth $39.6 billion. Function 18 shows the cooperation between Turkey, Iran, and Turkmenistan, assuming the establishment of the Trans-Caspian pipeline, which is not feasible. Functions 19 and 20 are not feasible. Function 21 depicts the $41 billion cooperation between Turkey, Azerbaijan, and Turkmenistan. Functions 22 to 25 show non-viable cooperation. Function 27 depicts the Turkey, Iran, Kazakhstan, and Turkmenistan coalition, which is worth $47.7 billion. Function 28 shows the cooperation between Turkey, Iran, Turkmenistan, and Azerbaijan, which is worth $47.7 billion. Function 29 shows the cooperation between Turkey, Azerbaijan, Kazakhstan, and Turkmenistan with a value of $56.5 billion. Function 30 shows the cooperation between Iran, Kazakhstan, Azerbaijan, and Turkmenistan, which cannot be implemented.

Function 31 represents the cooperation of all five countries, resulting in a present value of $81.1 billion. The Shapley values for the five players in this project are as follows:

**{TU, IR, AZ, TN, KA} = {29, 22, 15, 23, 6.5} (17)**

Turkey has the most bargaining power due to the need of other countries for its transit route. Following Turkey, the countries with the most bargaining power are Turkmenistan, Iran, Azerbaijan, and Kazakhstan. The results indicate that the more a country is dependent on another country, the less bargaining power it has. In contrast, the more production capacity a country possesses the more bargaining power it has.

## CONCLUSIONS

Hydrocarbon energy sources, especially oil and gas, are considered strategic commodities. Most economic relations and, consequently, political relations at the international level are formed around the position of counties on these commodities. Given the growing share of natural gas in the global energy basket in the 21st century, the importance of natural gas is increasing. As a result, it will become one of the most strategic commodities. Natural gas exports have complexities as contracts are often concluded in long-term intervals of 20 to 30 years (Jafarzadeh, 2014). European countries are interested in importing gas from the Caspian Sea region to reduce their dependence on Russia.

However, different interests and political conditions in the region have made it difficult to transmit gas to Europe. Strategic commodity transfer routes should be assessed based on factors such as territorial security, transfer cost, transmission lines' distance, and infrastructure requirements. Politics has been a determining factor in most cases, especially in the Middle East and Central (Etaat, 2009). With the changes in the world system in the 21st century, the share of the economic factor in regional and international competition has increased. However, as long as hydrocarbon energy sources are used as a geopolitical commodity, geopolitical logic prevails over economics. In this study, we use a game theory approach to analyse the Caspian Sea countries' leading strategies and outcomes for exporting their natural gas resources to Europe. According to our study of four possible scenarios for gas transmission in the Caspian countries, a country's bargaining power is determined by how much other countries have to depend on it. Additionally, the geographical location of each country has a significant impact on that country's bargaining power. Production capacity is the second key factor in the country's position in regional and international economic and political bargaining.

Our study shows that Turkey has the greatest bargaining power when all projects are implemented simultaneously. This is because a large amount of gas would pass through this country to Europe. The most promising scenario for Iran is the development of the Pars pipeline and having Kazakhstan adjoin. As a result, a large volume of Iran's gas would flow to Europe. A proposed gas export plan would be feasible if the transmitting countries invested in the required infrastructure. For example, Iran would be able to transfer 33 bcm of gas to Europe if Turkey utilizes Nabucco and TANAP, which increases the bargaining power of both countries. For Azerbaijan, the most promising scenario is that Kazakhstan joins the coalition as part of the proposed project. This is because the volume of gas exports to Europe and the dependence of Eastern Caspian countries and European countries on their transit route would increase simultaneously. The most favourable scenario for Turkmenistan is the simultaneous implementation of all scenarios because an enormous volume of gas from this country would flow to Europe. Overall, our results show that the net present value of the southern route (Iran's route) is higher than the Trans-Caspian route. Iran's gas network currently extends from the Persian Gulf in southern Iran to the Caspian Sea in northern Iran. In the eastern region, it borders Turkmenistan and in the western region, it borders Turkey and Azerbaijan. Moreover, it is possible to reach Qatar's gas fields with less than 150 km of gas pipelines.

## REFERENCES


A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas – Analysis - IEA. (n.d.). Retrieved from https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas

Abdoli, G. (2012). Game Theory and its Applications. Organization for the Study and Compilation of University Humanities Books.

Akbarian, R(2003),Irans oil and gas geopolitics, Journal of Economic Researches,109-130, SID. https://sid.ir/paper/67077/fa

Austvik, O. G., & Rzayeva, G. (2017). Turkey in the Geopolitics of Energy. Energy Policy, 107, 539-547. https://doi.org/10.1016/j.enpol.2017.05.008

Berry, C. A., Hobbs, B. F., Meroney, W. A., O'Neill, R. P., & Stewart, W. R. (1999). Understanding How Market Power Can Arise in Network Competition: a Game Theoretic Approach. Utilities Policy, *8*(3), 139-158. https://doi.org/10.1016/s0957-1787(99)00016-8

Borm, P., Ju, Y., & Wettstein, D. (2015). Rational Bargaining in Games with Coalitional Externalities. Journal of Economic Theory, 157, 236-254. https://doi.org/10.1016/j.jet.2015.01.011

Etaat, Javad, and Nosrati, Hamidreza. (1388). Iran and the energy transmission lines of the Caspian Basin. Central Eurasian Studies, 2(3), 1-22. SID. https://sid.ir/paper/151305/fa

Faraji Rad, A., Shiravand, S., & Diansai, B. (2014). Geopolitics of Energy Transfer in the Caspian Region and their Impact on National Security of the Islamic Republic of Iran. Central Asia and The Caucasus Journal, *20*(85), 97-125.

Hirschman, A. O. (1980). National power and the structure of foreign trade (Vol. 105). Univ of California Press.

Hubert, F., & Cobanli, O. (2015). Pipeline Power: A Case Study of Strategic Network Investments. Review of Network Economics, *14*(2). https://doi.org/10.1515/rne-2016-0011

Hubert, F., & Ikonnikova, S. (2011). Investment Options and Bargaining Power: The Eurasian Supply Chain for Natural Gas. The Journal of Industrial Economics, *59*(1), 85-116. https://doi.org/10.1111/j.1467-6451.2011.00447.x

Hubert, F., & Orlova, E. (2018). Network access and market power. Energy Economics, 76, 170-185. https://doi.org/10.1016/j.eneco.2018.09.020

Leyton-Brown, K., & Shoham, Y. (2008). Essentials of Game Theory: A Concise, Multidisciplinary Introduction. Morgan & Claypool, Williston.

Jafarzadeh, A., Shakeri, A., Ghasemi, A., & Javan, A. (2021). Possibility of Potential Coalitions in Gas exports from the Southern Corridor to Europe: A Cooperative Game Theory Framework. OPEC Energy Review, *45*(2), 217-239. https://doi.org/10.1111/opec.12196

Jafarzadeh, A., Shakeri, A., Momeni, F., & Abdoli, G. (2014). Cooperation Between Caspian Gas Exporters in Gas Exports to Europe with a View to Environmental Considerations in the Framework of Game Theory. Economic Research, Fourth year, 55.

Khorami, M., & Sheikhmohammadi, M. (2015). Modeling and Strategic Analysis of the Energy Battle between Russia and Europe Based on Game Theory. Geopolitical Quarterly, Year 11, 3, 117-138

Matthew O. Jackson, Asher Wolinsky, A Strategic Model of Social and Economic Networks, Journal of Economic Theory, Volume 71, Issue 1,1996,Pages 44-74,

Mehdian, H., & Fakhri, S. (2012). Iran Energy Geopolitics and Western Energy Security. Human Geography Research, *44*(4).

Myerson, R. B. (1977). Graphs and cooperation in games. Mathematics of operations research, 2(3), 225-229.

Jackson, M. O. (2008). Social and economic networks (Vol. 3). Princeton: Princeton university press.

Orazgaliyev, S., & Araral, E. (2019). Conflict and cooperation in global commons: Theory and evidence from the Caspian Sea. International Journal of the Commons, 13(2).

Pirani, S. (May 2021). Azerbaijan's Gas Sales Strategy at a Crossroads. The Oxford Institute for Energy Studies. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/05/Azerbaijans-gas-sales-strategy-at-a-crossroads.pdf

Sedghi (2005), Investigation of Oil and Gas Transmission Routes in the Caspian Basin. Iras Monthly, 5.

Sadeghi (2011). Iran and the interactions of the political economy of energy in Central Asia, Central Eurasia Studies, Fifth Year, 17,95-114.

Shirkhani, M. A., & Sharifi, M. M. (2017). Energy Geopolitics, Russia and Turkish Pipeline Diplomacy. Central Eurasian Studies, 1, 117-133.

Sziklai, B., Koczy, L. A., & Csercsik, D. (2019). The Geopolitical Impact of Nord Stream 2. SSRN Electronic Journal. Published. https://doi.org/10.2139/ssrn.3360783

Taher Khani, S. (2011). Introduction to Game Theory. Foreign Policy.

Taheri, A., & Sahranovard, B. (2012). US Energy Strategy in the 21st Century. Quarterly Journal of Political Studies, Fifth Year, 17.

Valizadeh, A., & Hooshi Sadat, S. M. (2013). Brix Energy Geopolitics and the Position of Iran. Politics Quarterly, 99-120.

BP Statistical Review (2019). https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf

The PRS Group, Inc. (2021, September 30). The International Country Risk Guide (ICRG). PRS Group. https://www.prsgroup.com/explore-our-products/international-country-risk-guide/

World Energy Outlook. (2019). IEA. https://www.iea.org/reports/world-energy-outlook-2019

## APPENDIX

Sample calculations related to the net present value of gas transmission projects in different scenarios have been performed over 30 years. The first five years were for design and construction, and the next 25 years were for operation. In the last ten years, the average price of products on the market has been included in the calculations as futures prices. The highest political risk of the countries along the route has been considered a pipeline risk. The current annual costs of the pipeline and the average share of maintenance costs of oil and gas transmission pipelines (8% of the capital cost) are included in the calculations. According to conventional international projects, the interest rate is assumed to be 10%. The cost-sharing ratio for the design and construction years of transmission pipelines is presented in Figure 1. More details are available in Table 8. In the early and final years, the cost ratio is lower than in the middle years.

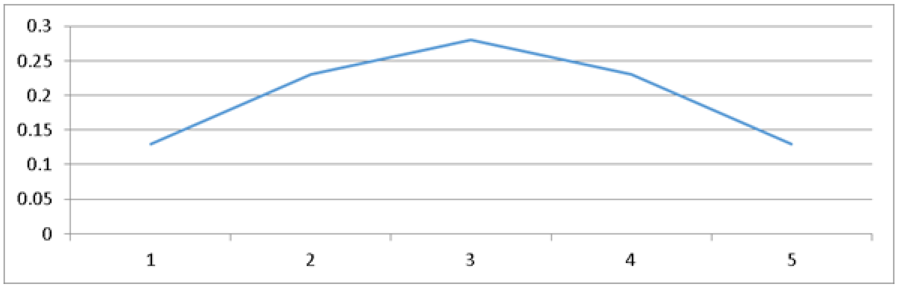


Figure 1. Capital expenditure distribution ratio in the years before the operation

Table 8. Functions

| | |
|---|---|
| $\mathrm{NPV} = \sum_{i=1}^{t} \frac{\mathrm{NPV}}{(1+\mathrm{pr.r})^t}$<br>$\mathrm{NPV_t} = \mathrm{Income} - (\mathrm{Capex} + \mathrm{Opex})$<br>$\mathrm{Capex} = \mathrm{lc} + \mathrm{d}$<br>$\mathrm{Opex} = 0.08 * \mathrm{Capex}$<br>$\mathrm{Income} = \mathrm{P} * \mathrm{Q}$ | l = Pipeline length (km)<br>c = Pipeline construction cost per km<br>d = Upstream design cost<br>Q = Capacity (1000)<br>P = Price (per 1000 cubic meters)<br>PR = Political risk |

Table 9. The net present value of Iranian gas transmission to Europe under the status quo scenario

| **year** | **Pipeline capacity (thousand cubic meters)** | **Quantity (thousand cubic meters)** | **Price (dollar)** | **Pipeline length (km)** | **Pipeline unused capacity (per cent)** | **Income (dollar)** | **Capital cost (dollar)** | **Operational cost (dollar)** | **Profit (dollar)** |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 14000000 | 6400 | 313 | 3750 | 0.46 | 0 | 1704787500 | 0 | -1704787500 |
| **1** | 14000000 | 6400 | 313 | 3750 | 0.46 | 0 | 3016162500 | 0 | -3016162500 |
| **2** | 14000000 | 6400 | 313 | 3750 | 0.46 | 0 | 3671850000 | 0 | -3671850000 |
| **3** | 14000000 | 6400 | 313 | 3750 | 0.46 | 0 | 3016162500 | 0 | -3016162500 |
| **4** | 14000000 | 6400 | 313 | 3750 | 0.46 | 0 | 1704787500 | 0 | -1704787500 |
| **5** | 14000000 | 6400 | 313 | 3750 | 0.46 | 1001600000 | 0 | 239794285.71 | 761805714.3 |
| **6** | 14000000 | 6400 | 313 | 3750 | 0.46 | 1602560000 | 0 | 359691428.57 | 1242868571 |
| **7** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **8** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **9** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **10** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **11** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **12** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **13** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **14** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **15** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **16** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **17** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **18** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **19** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **20** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **21** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **22** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **23** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **24** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **25** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **26** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **27** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **28** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |
| **29** | 14000000 | 6400 | 313 | 3750 | 0.46 | 2003200000 | 0 | 479588571.43 | 1523611429 |

Political risk = 1.52
Upstream design cost = $300 million
The cost of building a pipeline (per kilometre) = $3,417,000
Pipeline capacity = 14 billion cubic meters (annual)
Net present value = 4,314,439,484 (USD)