

Trade Relations in the European Gas Market Before and after the Russo-Ukrainian War: From a Game Theory Perspective

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Abstract: Europe is increasingly dependent on Russian natural gas imports. As Ukraine is the main transit country for gas trade between the two sides, the military conflict between Russia and Ukraine, which started in 2014 and has not stopped yet, has led to Europe's gas trade with Russia receiving an impact. Due to the importance of natural gas and the fact that this war was the largest in Europe since World War II, the trade relations between the European and Russian natural gas markets before and after the Russo-Ukrainian war and the diversification of natural gas in Europe have been studied by many scholars. This paper uses a review to summarize and sort out the relevant literature based on game theory to study the gas market trade relations in Europe before and after the Russo-Ukrainian War. According to these scholars, the trade relations between Russia and Europe in the gas market will continue to cooperate despite the impact of the Russo-Ukrainian war. The interruption of gas exports to Ukraine and the construction of pipelines bypassing Ukraine are acceptable to Russia and Europe. Iran, Azerbaijan, Turkmenistan, and Iraq, along with the United States, should actively invest in expanding their gas export capacity to have the opportunity to serve as an alternative to Russian gas and make Europe less dependent on Russian gas imports. This paper provides an understanding of the implications of the Russian-Ukrainian conflict for the world in terms of gas trade. This paper provides a reference for related studies, and to understand the impact of the Russian-Ukrainian conflict on the world from the perspective of the gas trade.

Keywords: europe gas market, Russian-Ukrainian war, game theory, Russia, gas trade

1. Introduction

Europe, the world's second-largest user of natural gas, is not only not producing enough gas to support its domestic demand but is on a downward trend [1]. This has resulted in Europe being heavily dependent on imported gas, with pipeline gas from the Russian Federation accounting for over 40% of the European Union's (EU) imports [2]. Much of this Russian gas exported to Europe needs to transit Ukraine, through Ukrainian transport pipelines. But the conflict between Russia and Ukraine has made this route fraught with uncertainty. Even in 2009, Russian gas deliveries to Ukraine and via Ukraine to Europe were cut off due to a lack of agreement on gas tariffs between the two sides

[3]. The Russian military conflict against Ukraine from February 2014 to the present has increased European concerns about energy security.

The crisis in Ukraine erupted in November 2013, before the formal military conflict between Russia and Ukraine. Before the Ukraine crisis, Russia and Europe's geopolitical situation was comparably steady. Russia and Europe were engaged in several commercial gas agreements to enable complementary energy supply and demand. The political and economic unrest in Ukraine, a country used as a transit country, dramatically impacted the reliability of Russian exports, which limited the market share of Russian gas in Western Europe market. Therefore, before the Russo-Ukrainian war, Russia had already started building gas pipelines to bypass the politically unstable Ukraine, such as the Yamal-European pipeline [12]. The Ukrainian crisis intensified political differences between Russia and Europe, which hindered the exchange of energy between the two parties, and the South Stream pipeline project was halted from continuing construction as a result [12]. However, after the Ukraine crisis, the two sides continued to cooperate on the gas market. In 2014, a hybrid war between Russia and Ukraine, known as the Russo-Ukrainian War, broke out and continued until February 2022, when a full-scale invasion of Ukraine was started by Russia. During this period, Russia cut back on many of its gas supplies to European countries, with the share of gas supplied from Russia to the EU dropping from over 40% in 2021 to 20% by mid-2022 [10], which led to a significant increase in gas prices. Russia's politicization of gas supply is demonstrated by several cuts in gas exports to the European market due to the conflict with Ukraine [5]. Moreover, Europe's overdependence on Russia has made it urgent to diversify its gas suppliers. As the threat of a Russian invasion of Ukraine intensifies, the European Commission and the United States are both examining whether Europe can reduce its dependence on imported Russian gas and find new alternative supplies in case Russia further reduces or, in the worst-case scenario, stops supplying gas to the EU altogether [11].

The Russian-EU gas problem is a problem of decision-making, cooperation, and competition. Game theory happens the study of mathematical models of strategic interaction between rational decision-makers [14]. Applying game theory analysis to the EU-Russia gas market interaction allows us to describe and analyze the strategic interactions between the EU and Russia. Thus, the cooperation and competition in the gas trade between Russia and Europe before and during the Russo-Ukrainian conflict has been studied by numerous scholars using game theory. And with the escalating Russian-Ukrainian war, the energy security of European gas supplies is greatly affected by Russia. The question of whether there are suitable alternatives to natural gas in Europe from the perspective of game theory has become an issue that many scholars are studying.

In this paper, we summarize the literature on the impact of the Russian-Ukrainian war on European gas imports from a game-theoretic perspective and analyze whether there are viable alternatives to compete with Russia.

2. Before the Russo-Ukrainian War

Due to Ukraine's political and economic volatility as a transit nation, Russian exports were already less reliable after the fall of the Soviet Union. Both Russia and the EU were concerned about the reliability of Ukraine and tried to find alternative transit routes. Belarus was considered a new route for Russian gas exports to the EU.

The Ukraine crisis emerged in November 2013, just before the Russo-Ukrainian war. The political conflict between Russia and Ukraine led to a triangular relationship of triangular cooperation that was no longer stable.

[7] used the triangular model of cooperation-and-conflict to investigate what possible cooperation scenarios could emerge between Russia, Ukraine, and the EU after the conflict between Russia and Ukraine. In this model, three participants have the option of cooperating or not. An alliance of

the three players can provide the greatest benefit to each party. The ongoing conflict between Ukraine and Russia means that the triangle is broken and both of them have three strategies to deal with it: 1. reconnect with each other; 2. convince or force the EU to break its ties with Ukraine and cooperate only with Russia; 3. bring in a new player, Turkey, to exclude Ukraine and create a new triangle, i.e., three-way cooperation between the EU, Turkey, and Russia. Alternatively, Russia is excluded, i.e., the EU establishes a triangular partnership with two transit countries - Ukraine and Turkey. The authors argue that the scenario where Turkey joins the triangle and Ukraine exits it is more likely to happen, while Russia is excluded and there is less chance that the EU has established a triangular partnership with two transit countries - Ukraine and Turkey.

[8] used a model of the Three Players Export-Transit Game to examine whether gas exporter Russia and the two gas transiting countries Ukraine and Belarus would cooperate after Belarus entered the market. Transit Monopoly, Transit Duopoly, Restricted Transit Monopoly, and Cartel are the four scenarios in which the three players could cooperate. The prices and volumes of gas transit, the estimated benefits for three players, and the resulting import prices for Europe in these four cases are calculated by the demand function for Western European imports from Russia. Cooperation between Russia and Belarus is the most likely outcome. Belarus would benefit from cooperation with Russia. Western Europe will also benefit, but it will be more dependent on Russian gas imports.

[13] based on both cooperative and non-cooperative game theory, the authors analyze whether there will be cooperative links between Russia, Ukraine, and Belarus in terms of payments. The authors use data simulations to analyze the bargaining power of these three countries when negotiating transit fees after the collapse of the Soviet Union. The results conclude that the establishment of the grand coalition of three countries is the best strategy for the three parties, which offers the maximum payments for each player. In addition, the grand alliance benefits Western European customers by providing the largest amount of natural gas at the most competitive price.

[9] The author theoretically derives whether the energy and trade cooperation between Russia and Europe is affected by the Ukraine crisis based on the game of chicken. The authors analyze four scenarios: 1. neither side gives in; 2. Russia gives in, and Europe does not give in; 3. Europe gives in and Russia gives in; 4. neither side gives in to determine whether to continue cooperation. In this energy trade game between Russia and Europe, concessions from both sides are the most likely scenario. It represents the energy trade between Russia and Europe will continue and both sides will compromise with each other to reach a win-win situation.

Also, in [15], the game of whether Russia and Europe will continue to cooperate in the gas sector was studied. The authors conclude through theoretical derivation that a finite number of games will lead to a "prisoner's dilemma". They will reach a steady state (no cooperation, no cooperation). In the case of an infinite number of games, both sides should cooperate to get out of the "prisoner's dilemma". Since the game of energy trade between Russia and Europe is an infinite game, cooperation will be the main trend in the development of trade relations and energy trade between the two sides.

[12] examines how the conflicts between Russia and Ukraine has affected the collaboration on the Russian-European gas pipeline. Using theoretical derivations, the authors study the game mechanism of Russian-European gas pipeline cooperation before, during and after the Ukrainian crisis from the perspective of political and economic interests. Apart from that, a two-level game is used. The first-level game is between the EU and Russia and a second-level game is between the countries within EU. The authors contend that cooperation for mutual gain is the equilibrium option between Russia and the EU following the Ukraine crisis. To further their economic interests, the countries in the EU will also decide to work with Russia to building pipelines.

3. After the Russo-Ukrainian War

The Russia-Ukraine war that began in 2014 has made the trilateral trade cooperation even more precarious. Russia reduced gas supplies to many European countries even before it invaded Ukraine in 2022. This has led to a spike in gas prices. Russia is likely to cut off its gas exports to Ukraine altogether, throwing Russia's gas trade with Europe into greater uncertainty.

[1] examined how the Russo-Ukrainian War affects the bargaining power of the key parties (Norway, Russia as the main supplier, Ukraine, and Germany as the buyer). A model based on a network game is used to analyze three scenarios: 1. the present situation; 2. a reduction in the flow of gas from Russia to Ukraine; 3. a complete disruption of gas from Russia to Ukraine. The authors perform data simulations and theoretical analysis of this model to derive the bargaining power of the four countries in three scenarios. It is indicated that Russia and Germany can accept a complete interruption of gas exports to Ukraine, even if their bargaining power is enhanced, while Ukraine's position in the market decreases with the decrease of gas imports from Russia.

In paper [14], the authors investigated whether the EU could remove Russia's economic incentive to use its market power to raise gas prices by setting a price cap on gas. The model proposed in this paper is built on a non-cooperative model. In this game, the EU can choose to impose a price cap or pay the high price proposed by Russia, while Russia can choose to accept the price cap proposed by the EU or refuse it, threatening the EU to stop delivering gas. If Russia rejects the price cap, the EU can choose to compromise Russia and continue to deliver the high price or stick to the decision to impose a price cap and accept the consequences of a complete halt to gas deliveries. The authors deduce theoretically and analyze that Russia will accept the EU's demand for a price cap imposed on Russian gas in two cases: if the EU insists on imposing a price cap even after Russia rejects it, or if Russia believes that stopping gas exports will bring worse consequences than accepting a price cap.

[16] used cooperative game theory to analyze the European gas pipeline network and examined the impact and potential outcomes of the Nord Stream 2 project's development. The authors used data simulations to derive cost savings rather than the profits of cooperation for the countries associated with the project to analyze whether their bargaining power is affected by the Nord Stream 2 project. The authors draw the conclusion that the Nord Stream 2 project will benefit Russia and Germany, who will consequently support its implementation, in contrast to the nations of Northeast Europe, who will reject it.

4. Alternative to Russian Natural Gas

The Southern Corridor gas pipeline is crucial for Europe because it will give Europe more options for gas imports and thus lessen its dependence on Russia. Potential producers in this region include Iran, Azerbaijan, Turkmenistan, and Iraq. Turkey is the only country that these nations may use as a transit country for shipping gas to Europe. With the development of the U.S. shale gas boom, U.S. LNG energy is also being considered by many scholars to help diversify Europe's natural gas supply.

In paper [4], a cooperative game theory model is proposed by the authors to analyze whether Iran, Turkmenistan, Azerbaijan, and Iraq can form the best European gas supply scenario. The cooperative game theory approach is used to analyze the different alliances between these four countries for exporting European gas and used data simulations with a hypothetical project NPV approach to calculate their ability to export gas to Europe and their bargaining power. For these four potential producers, they should implement projects to expand their export capacity before other countries, and expand exports to Turkey first and then to Europe to increase their bargaining power.

The authors argues that U.S. LNG can be an alternative to Russian LNG and analyzes it in three different contexts: whether the U.S. sanctions Russia, whether Russia is politicized, and whether Europe is diversified in [5]. The three contexts are 1. that Russia loses its low-cost advantage, 2. that a shift from imports from Russia to diversification will increase costs for Europe, and 3. that diversification will bring Europe to lower costs than gas imports from Russia. The authors set different benefits for four different scenarios (politicization, no diversification), (politicization, diversification), (no politicization, no diversification), and (no politicization, diversification), and discuss the relationship between the magnitude of the benefits under different scenarios to determine the politicization decision as well as the diversification decision for Europe (see Table 1). The conclusion is that U.S. LNG could serve as a supply alternative to Russian exports to Europe, but its cost is too high. Europe would still choose to continue working with Russia.

Table 1: Russia-Europe game matrix.

	Don't Diversify	Diversify
Politicize	a,e	b,f
Don't Politicize	c,g	d,h

[6] investigates how alternative export strategies for U.S. LNG affect the natural gas dynamics in Europe. The authors develop a global scale Gas-GAME model based on an agent-based framework, using data simulation to analyze the strategic decisions between the United States, Russia, and European countries. The authors argue that the US should set its strategy as aggressive. Since when the U.S. remains conservative in its export expansion, there is a gas supply constraint that leads to Europe's continued dependence on Russian gas, but when the U.S. sets its strategy to be aggressive and invests aggressively, it is easier for Western Europe to access global LNG supplies as a substitute for Russian supplies in order to gain greater bargaining power when importing Russian gas.

5. Conclusion

The issue of gas trade between Russia and Europe has always been of interest to many scholars. The escalating conflict between Russia and Ukraine and even the military conflict has led to a huge impact on the Russian-European gas trade. In this paper, we summarize and sort out the literature on the application of game theory to the study of gas trade relations in the European market before and after the Russo-Ukrainian War.

The paper examines this issue from three perspectives: before the Russo-Ukrainian War, after the Russo-Ukrainian War, and alternatives to Russian natural gas. Before the Russo-Ukrainian War, the Russian-Ukrainian partnership with Europe was broken by the political conflict between Russia and Ukraine, and Russia may have established a new partnership with Turkey or Belarus, and Europe would have benefited from it. Russia and Europe still continue to cooperate. After the Russian-Ukrainian war, Russia and Germany could accept a complete break in gas exports to Ukraine and benefit from the construction of the Nord Stream 2 project. Iran, Azerbaijan, Turkmenistan, and Iraq, along with the United States, which have the potential to become new gas importers for Europe instead of Russia, should work to expand their export capabilities and invest aggressively in order to help Europe break away from its dependence on Russian gas imports.

The research in this paper provides references to related studies and provides experience and help in understanding the Russian-Ukrainian situation from a gas trade perspective.

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