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Can the US and Europe Contain Russian Power in the European Energy Market? A Game Theoretic Approach

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Can the US and Europe contain Russian power in the European energy market? A game theoretic approach

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ABSTRACT

The Russian history of politicization of natural gas supplies led Europe to seek alternatives. US LNG is considered to be a viable alternative for Europe, which positioned the US as a strong competitor against Russia. In a game theoretic approach, we model this strategic decision-making process in simultaneous-move and sequential games. Our findings indicate a mixed strategy equilibrium: Europe cannot commit to diversify in the face of Russian advantages, and Russia cannot fully resist the temptation to politicize its supplies to Europe. The US might attempt to intervene in the European commitment problem through implementing sanctions on Russian gas sales. We find that in any case episodic Russian politicization remains likely in equilibrium.

1. Introduction

Many energy security studies council avoidance of excessive dependence on one supplier [1–3]. For Europe this implies reducing dependence on Russian natural gas by diversifying suppliers both via pipeline and through LNG regasification terminals. The urgency of such diversification was brought home in the last two decades by Russian politicization: repeated Russian supply interruptions and Russian demands aimed at achieving political and economic ends using the leverage provided by Russia's dominant supply position. The central question of this paper is whether, and to what extent, the U.S. shale gas boom, combined with European and U.S. strategic policy actions can contain Russia's capacity to politicize its position as a supplier to the European gas market.

Historically, there are three main regional natural gas markets: Europe, North America and Japan. These markets have become increasingly integrated [4] through the global LNG market, in which the U.S. is becoming a significant player [5]. Fifty six U.S. LNG export applications have been approved in the lower 48 states, with a total approved capacity of 58.16 bcf/d for FTA countries and 30.52 bcf/d for non-FTA countries [6] – an annual LNG export capacity of 21,228 bcf for FTA countries and 11,140 for non-FTA countries. While not all approved facilities are likely to be developed, the approved capacity is larger than the entire global LNG trade in 2017.

The shale gas boom in the U.S. has transformed parts of the global energy market. The U.S. shift from net importer [7] to net exporter (illustrated in Chart 1) [8–10] has altered global natural gas markets [11–13]. European natural gas demand and U.S. LNG exports are arguably a perfect match [14,15].

As the U.S. shale gas boom developed, studies and policy papers discussed using the U.S. shale gas boom to help European allies [7,17], evaluated feasible alternative destinations for the U.S. LNG exports [18,19] and considered Russia's counter-strategies to prevent U.S. LNG competition in its markets [20,21]. And some of these possibilities have begun to be realized. U.S. and European LNG terminals have been developed, with support from a variety of investors and governments.[1] Russia has in turn developed new pipeline routes for export to Europe that increase export capacity and reduce reliance on Eastern European transit corridors along with developing natural gas liquefaction capacity and pipeline capacity to Asian markets [7]. The China-Russian Power of Siberia pipeline with 38 billion cubic meters supply annually [22] was expected to start in late 2019, and Russia has attempted other deals [23].

These developments have been examined in the literature on the global natural gas market. The economic literature includes models of global and regional gas market dynamics [11–13,24]. The overall market is complex and best modeled using agent based models [24,25]. In addition to Europe, the other developing major import market is the Asia-Pacific region, which projections indicate may become a very large market in the long run [26–29]. Climate change constraints are expected to catalyze rising Asian demand as well [27].

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[1] Although Qatar is one of largest LNG exporters by itself, it made a significant investment in a U.S. LNG export facility. It also invested in LNG regasification facilities in other countries like Poland.

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A few studies in the literature look at the trilateral competition and cooperation between Russia, European countries and the U.S. in detail. Medlock, Jaffe, and O'Sullivan [12] study the impacts of U.S. LNG in the global gas market with a detailed analysis of its outcome in the European gas market in "liberalization" and "North American export push" scenarios. Their findings indicate that U.S. LNG does not necessarily save the European gas market only by pushing American exports. Rather, it would secure Europe better and make Russia worse in a liberalization scenario, in which the global gas market is assumed to be liberalized by unwinding all long-term contracts between 2020 and 2025 and making international capital flow more liquid, which promotes the growth of the market globally. Price projections suggest U.S. LNG will help Europe and other U.S. trading partners in the liberalization case as it provides low-priced natural gas. Guo and Hawkes [24] use game-theoretic market equilibrium and contract-driven investment in the global gas trade using agent-based simulation to understand how U.S. LNG would affect the global gas market in conservative North-American and aggressive North-American investment scenarios. The aggressive scenario is found to be better for the European energy market while the conservative scenario is expected to make Europe worse off by causing gas supply tightness. These studies suggest European energy security gains from expansion of U.S. gas exports under more liberalized market conditions.

But is expanded U.S. and global LNG supply enough? Despite a growing U.S. role, Russia retains a powerful position. The marginal cost of pipeline-delivered Russian gas will be lower than the cost of U.S. and most other imported LNG except perhaps Qatari and Nigerian LNG for the foreseeable future because of the much higher transport costs entailed by liquefaction, shipment, and regasification [30]. This price advantage gives Russia enduring leverage in the European market.

We base our scenarios for the future of European, Russian, U.S., and global interaction in this natural gas market on findings of prior simulation and game theoretic studies. We then use game theory to study how political and economic factors strategically interact to shape whether and in what contexts Russia can extract political leverage from its role as a key natural gas supplier to Europe. We move beyond prior studies partly by placing politics more at the center and examining emerging additional moves (e.g. U.S. sanctions). We also expand beyond previous studies by modeling the credibility dilemmas concerning politicization and diversification that imply ongoing cycles of cooperation and conflict between Russia and Europe even in the face of substantial global LNG market development.

While we affirm prior studies concerning the potential role of U.S. export capacity in discouraging Russian politicization of gas supplies we also highlight the enduring challenges associated with preventing a dominant supplier with low marginal costs from extracting concessions. Our analysis offers a cautionary note that even a large and liquid international market combined with U.S. sanctions is unlikely to fully deter Russian politicization. This reflects cost-challenges for the sustainability of European diversification, and unreliability in equilibrium of Russian promises not to politicize or exploit its market power.

2. Strategic context

Game theoretic models are particularly useful when they provide insights into counter-factual possibilities that shape the strategic incentives of the players. The sections below develop our game and scenarios. Section 3 examines the core game, and Section 4 embeds this game in a broader political and economic context.

Our core analysis involves the Nash equilibrium of a strategic form game (Chart 2) played between Europe and Russia. In the core game, Russia decides whether to politicize natural gas exports to Europe by exploiting market power for political and economic ends, and Europe decides whether to use potentially costly policy levers to diversify natural gas suppliers in order to resist Russian pressure or not.

Russia and Europe move simultaneously: neither knows the other's choice when it moves.[2] The relative ranking of the associated payoffs (*a, b, c, d* for Russia and *e, f, g, h* for Europe) and the associated Nash equilibria depend upon broader global gas market conditions, as we will discuss in Section 3 scenarios. Each scenario begins with a draw that determines the differential between Russian pipeline gas prices and alternative energy supply options, the availability of export/import capacity, and the presence of sanctions restricting Russian gas imports into Europe.

We then generalize the game by considering prior moves by the United States, Russia, Qatar, and other LNG suppliers that could help set the conditions of the core Russia-Europe game in Section 4. Fig. 1depicts the full game examined there, in which Russia selects its pricing policy, and the U.S. chooses whether to impose sanctions, jointly setting up play of various scenarios in the core game.

3. The core Russia-Europe game

3.1. Russia's options and payoffs

The European natural gas market is important for Russia. Russian state-owned Gazprom makes almost half of its total natural gas sales to EU countries through pipelines (7865 bcf out of 16,817 bcf total natural gas exports).[3] Natural gas sales accounted for 3% of the total GDP while oil exports' share was 14% in 2013. The share of total natural gas exports in total export revenue of Russia is 14%. European countries constitute half of this 14% [31,32]. If European customers boycotted natural gas from Russia the direct effect would be a 1.5% decrease in total GDP. It is very likely that "the EU and Russia will remain strongly interdependent in the gas sector for at least another 10–15 years" [33].

Russia has a history of politicizing its natural gas sales by cutting its exports to the European market in 2006 [34], 2009 [35] and 2014 [36]. Russia argues that the aim was to punish Ukraine, not the European market. Ukraine has been a transit route for Russian natural gas exports because it holds the most feasible transit route between Russia and Europe. Being a transit country gave Ukraine the opportunity to get Russian natural gas although Russia aimed to send it to the Western European countries. Russia does not want Ukraine to have such a power because of its natural gas debts to Russia. Therefore, Russia has moved to develop two alternative pipelines; the Nord Stream and the South Stream. The Nord Stream project was completed in 2012 as two pipelines that have 1940 bcf transport capacity annually. An expansion of this pipeline (Nord Stream II) aimed to double this capacity by the end of 2019 [37,38]. South Stream was cancelled by Russia in December 2014. Instead, Russia decided to increase the capacity of the existing Blue Stream, which moves Russian natural gas to Turkey. The projected capacity of the new pipeline project, which is called the Turkish Stream, is announced as 2225 bcf per year. It has the same goal as the South Stream; moving Russian natural gas to Europe while keeping the Ukraine out of the trade. Although contemporary political events between Turkey and Russia temporarily affected this project's status [39] Turkey attempted normalized political relations and the Turkish Stream project went on [40]. These daily policy changes depending on contemporary political events, show how daily foreign policy issues and energy assets are related in Russian politics. In other words, they indicate how Russia tends to politicize its energy exports.

Russia's ability to politicize natural gas is contingent upon its market power, and the need to protect its market position may curtail Russia's

[2] Simultaneous moves are used here to reflect the difficulty Russia has committing to a specific course of action (e.g. not politicizing), and the difficulty Europe has committing to diversify (as illustrated by the development of the Nord Stream II, for instance). Europe and Russia also move simultaneously in order to avoid biasing results by placing once first, as this preserves the maximum range of possible equilibria and reflects the difficulty each has committing to a particular course of action.

[3] Pipelines move the vast majority of the Russian natural gas: although LNG exports are expanding (174.4 bcf in 2016) they remain modest [31].

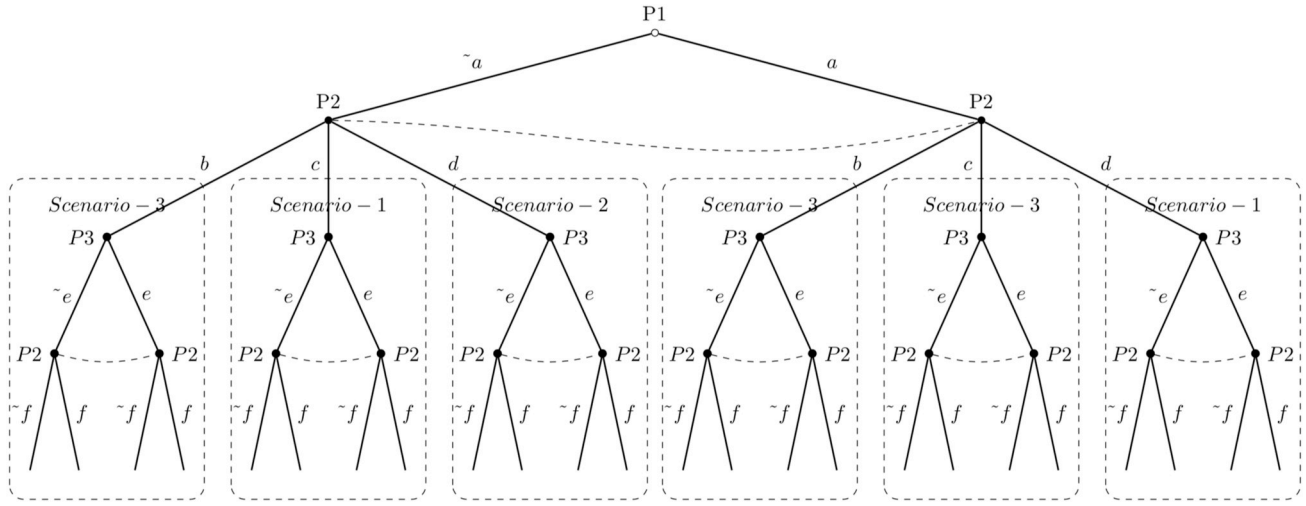

Fig. 1. Game tree of the full game.

opportunities to politicize. Russia has complied with buyer requests to renegotiate and reduced its prices in order to secure its market position in the European natural gas market [32]. Russia also has ability to implement a strategy that will hurt itself in the short term, but will provide benefits in the long term by actuating a price war in an attempt to deter competitors from entering its current markets [21] although as global LNG capacity develops, Russia may not be able to avoid having global LNG prices partially contain its opportunities to both set prices and impose political conditions.

3.2. Russia's payoffs

We consider two Russia versions with differing payoffs, a "benign" and "belligerent" Russia. The only difference in the payoffs across the two involves how highly Russia values politicizing. In the benign Russia scenario, Russia prefers to avoid politicizing if politicizing leads Europe to diversify. Hence the ranking of the payoffs for Russia is $a>c>d>b$ and Russia prefers moderating its behavior in order to maintain its market position. In the belligerent Russia scenario, Russia prefers to press ahead with politicization even if it believes that politicization will drive European diversification so the payoff ranking is $a>b>c>d$. This second type of Russia may behave defiantly as during the period of Western sanctions following the conflict in Ukraine. It may want to demonstrate how strong it is by resisting policy change when threatened by the U.S. and Europe [41].

4. Europe's choice to diversify

Europe faces increasing import demand and vulnerable natural gas supply security [42]. Over time Europe has come to rely heavily on imports [19] to meet its natural gas demand in the face declining local production as illustrated in Chart 3. Increased dependence brought security challenges including changes in supply of natural gas (e.g. Libya), the non-uniform pricing of Russian Gazprom, insufficient storage capacity, oil-based natural gas price structure, and increasing LNG competition, especially Japan's increasing LNG demand after the 2010 Fukushima nuclear disaster [43].

As Chart 4 shows, Europe is heavily dependent on Russian gas. Russia is the leading supplier of the EU countries, providing 27.7% of the total EU countries' natural gas supplies [44].[4] In some countries like Hungary, Estonia, Finland, Latvia, and Slovakia,[5] all natural gas demand is met by Russia. Germany, which consumes the largest amount of natural gas among the EU countries, receives 48.9% of its total natural gas supplies from Russia [44]. Germany's locomotive position for European industry makes sole dependence on Russian natural gas particularly problematic. Some argue that Russia is less likely to shut down gas supply to Germany because of high import dependency [2]. However, import dependency could increase German vulnerability to Russian politicization. For Europe, reducing dependence is most critical if Russia keeps politicizing and diversifies its own buyers [1,3], but diversification may come at a cost.

Europe's diversification options include most centrally and most immediately substitution of other natural gas supplies using LNG imports and pipelines from other sources where feasible. The cost of such substitution depends both on the availability of relevant capacity and infrastructure, and on the relative prices for alternative energy supplies versus Russian pipeline gas [45,46].

5. Energy market scenarios

We examine three scenarios involving Russian politicization and European diversification under different global LNG market and policy contexts. These scenarios build on the literature in which scholars have studied global models of the natural gas market. table 1

Scenario 1 assumes that the Russian gas price and the global LNG prices available to Europe as a substitute are comparable (whether both being high or low), and both global liquefaction and European regasification LNG infrastructure is adequate to substitute cheaply from Russian gas to other sources. This is the likely pattern if prices is set from a common global referent such as spot prices. It would arise if Russian prices adjust with shifts in global or European LNG prices. This scenario could also arise if global natural gas exporters cooperate to set prices as has been explored in the literature under the rubric of a

[4] The other major natural gas suppliers of Europe are Norway, Algeria and Qatar. Their total supply percentages are 26.8%, 8.4% and 5.1% respectively in the total natural gas supply of the EU-28 countries [44].

[5] Hungary and Slovakia's percentages of Russian supplies in total net supplies is more than 100% because they re-export some amount of natural gas bought from Russia.

Chart 1. U.S. Natural gas net exports (billion cubic feet) [www.eia.gov] [16].

Chart 2. Core Russia-Europe game matrix.

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

possible GasOPEC [47,48].

In this context, the costs for Europe of substituting LNG for Russian natural gas are relatively modest. Hence, the European ranking of the alternatives is $g \succ h \succ f \succ e$. Europe's first choice is for Russia to provide reliable low cost supplies without politicizing (g), but because Europe has low cost alternatives, its second preference is to diversify (h), even if Russia is not politicizing. Europe's least preferred alternative is to not diversify in the face of Russian politicization.

To illustrate the payoffs in numeric form, Chart 5 translates the ordinal payoffs from Chart 2 into numeric quantities from 1 (least preferred) to 4 (most preferred).

The Nash equilibrium in the benign Russia version of Scenario 1 is a mixed strategy equilibrium – both players are expected to play a combination of their strategies: Europe will sometimes (or partially) diversify, while Russia will sometimes (or partially) politicize. This reflects the incentives for Russia to politicize to take advantage of market power when Europe is not (sufficiently) diversified, and the incentives for Europe to take advantage of readily available outside options when Russian politicization becomes too onerous. By contrast the belligerent Russia payoffs lead to a pure strategy Nash equilibrium. The belligerent Russia has a dominant strategy: to politicize, and in response to consistent politicization, Europe prefers to diversify.

This game highlights the commitment problems faced by both Russia and Europe. If Europe could commit to diversification, it could prevent Russia from politicizing in the benign Russia scenario. But if Russia isn't politicizing at-the-moment (or versus certain countries) this commitment to diversifying can be difficult to maintain. For instance, in 2019 it appeared that the economic benefits to Germany associated with for making money as a hub for Russian gas trade were helping drive German policy away from diversification despite objections from some other European states. While Germany stood to gain benefits from becoming a major hub for Russian gas with Nord Stream 2, other countries (including alternative transit corridors like Ukraine and Poland) stood to suffer economic penalties, and Russia appeared to be rushing to complete Nord Stream 2 and Turk Stream pipelines ahead of contract renewal with these countries.

When Russian gas lacks a cost advantage (Scenario 1), there are nonetheless opportunities for politicization, although (as the mixed strategy equilibrium suggests) this politicization is likely to be episodic, with European efforts to diversify similarly punctuated by periods of increased reliance on Russian gas. In this scenario, Europe will vacillate between efforts to protect itself from the political and economic risks that accompany dependence on Russian gas and the acceptance of those risks. Russia in turn will alternate periods of politicization with periods in which it is a relatively reliable supplier offering fuel at a competitive price.[6]

Scenario 2, illustrated in assumes that diversification away from Russian gas is more costly for Europe. Here Russian gas prices are substantially lower than global LNG prices or global LNG infrastructure or supplies are inadequate such that Europe cannot substitute from Russian gas to other sources without paying a significant premium. This is akin to the low U.S. production scenarios developed by Guo and Hawkes [24]. It could also arise if contracts are written to lock in a low cost of Russian gas relative to available alternative European import supplies. Other developments (e.g. Panama Canal expansion or spikes in Asian demand) could also contribute on the margins [49,50].

Because in this context Europe's cost of substituting LNG for Russian natural gas are relatively high, Europe is willing to accept a degree of Russian politicization without diversifying. Hence, the European ranking of the alternatives is $g \succ h \succ e \succ f$. Europe's first choice is for Russia to provide reliable low cost supplies without politicizing (g), but because Europe lacks low cost alternatives, its least preferred alternative is to attempt to diversify in the face of Russian politicization: accepting a degree of Russian politicization is preferable to a costly but at least partly futile attempt to diversify in the face of politicization.[7]

The Nash equilibrium for both versions of Russia's payoffs in Scenario 2 involves Russian politicization accompanied by European abdication in the form of failing to diversify. When the costs of

[6] In repeated play, the Nash threats folk theorem implies the possibility of more cooperation – Russian play of not politicizing and European play of not diversifying would be sustained by mutual recognition of the advantages of this outcome over the uncertainty of the mixed strategy.

[7] Arguably we might also expect somewhat different Russian rankings of the alternatives in this scenario. Because Russia has a sufficient price advantage that its customers will not leave even in the face of politicization, 'benign' Russia's payoffs might well shift in this scenario to $a \succ c \succ b \succ d$ since even if Europe attempts to diversify, Russia's market power means it can still potentially extract political concessions. However, changing the ranking in this way has no effect on the equilibrium outcome.

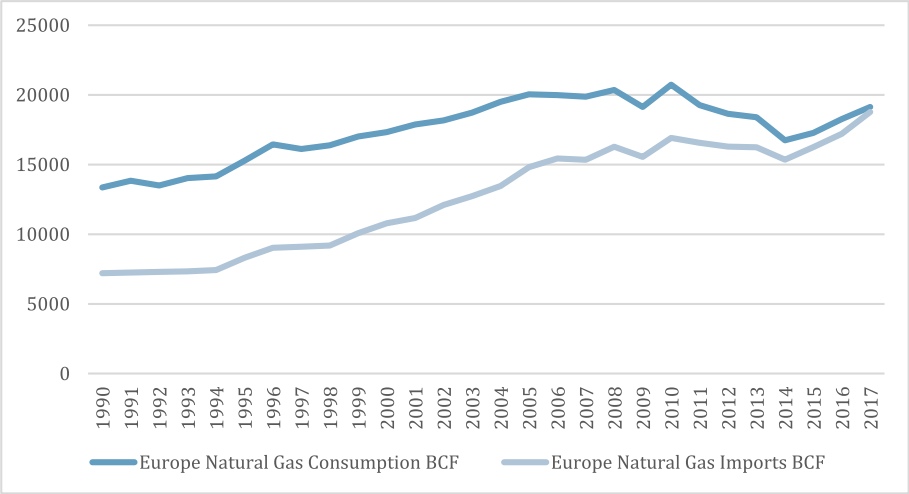

Chart 3. Europe's natural gas consumption and imports between 1990 and 2017 [42].

diversification are sufficiently high relative to the cost of Russian gas, Russia can potentially exploit the differential by politicizing gas supplies to Europe. Russia can extract political or economic concessions from Europe as a condition for continuing to provide pipeline gas under favorable terms.

Scenario 3, illustrated in Chart 7, assumes that the cost of Russian gas is high relative to the cost of diversifying. It might perhaps arise in the context of an extreme version of the Guo and Hawkes [24] high U.S. production scenario, if augmented by surprisingly successful gas field development elsewhere (e.g. in the eastern Mediterranean). It could also arise if Russian delivery contracts with Europe lock in a high price for Russian gas. The scenario could also arise in the presence of European or U.S. sanctions that raise the effective cost of using Russian sources.

Because in this context the costs for Europe of substituting LNG for Russian natural gas are very low, Europe is unwilling to accept any degree of Russian politicization without diversifying. Indeed, Europe's preference is to diversify no matter what Russia does. Europe's ranking in this scenario is $h \succ g \succ f \succ e$, which implies a dominant strategy to diversify.

In this scenario, Europe always chooses to diversify. In equilibrium, benign Russia responds to this situation by not politicizing in order to protect what market share it can. The belligerent Russia responds to this scenario by politicizing, producing a Nash equilibrium at politicize, diversify.

Considered together, the three scenarios highlight key points about the likely extent of continuing Russian politicization, and the potential for European diversification in response. Periodic swings in the global LNG market will create windows of security and vulnerability for Europe. When Russia has a price-advantage relative to alternative fuel sources (Scenario 2), this advantage can be exploited to extract political concessions should Russia choose to do so. When Russia is at a price disadvantage (Scenario 3), its type as either belligerent or benign will be most clearly revealed, with the belligerent type continuing efforts to politicize while the benign type attempts to preserve market position by eschewing politicization in the face of European diversification. When prices are competitive (Scenario 1), a mixed strategy is possible in which both diversification and politicization are episodic.

6. Extending the strategic context

Several actors in the global natural gas marketplace could select strategies that increase the likelihood that one or another of the scenarios described in Section 3 will arise. Consequently, in this section we expand the game to analyze these strategies.

Russia's relatively low cost of production and delivery to the

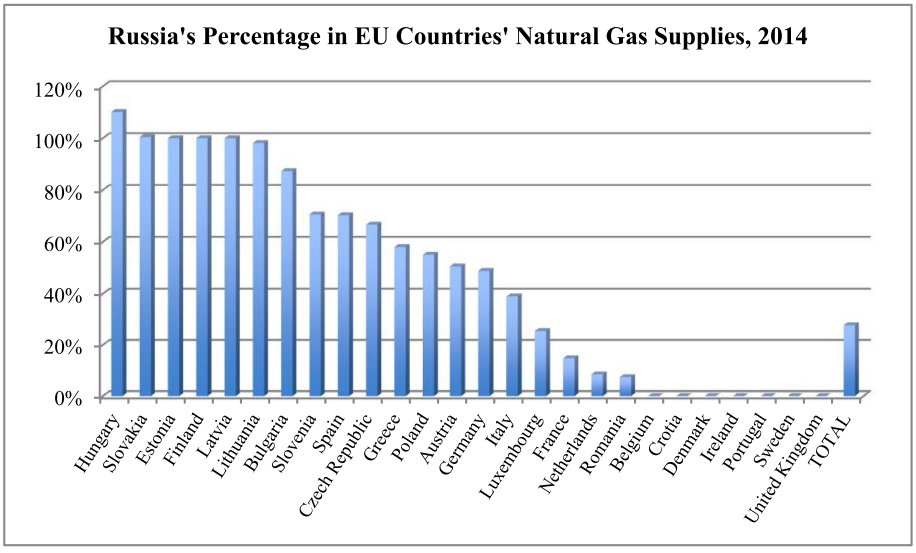

Chart 4. Russia's percentage in EU countries' natural gas supplies in 2014 [44].

Table 1
Three Scenarios of Russian politicization and European diversification.

	The price of Russian natural gas relative to LNG prices available to Europe	Adequacy of European LNG infrastructure to diversify
Scenario 1	Competitive	Adequate
Scenario 2	Low	Adequate/Inadequate
Scenario 3	High	Adequate

Benign Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 1*	*1, 2*
Don't Politicize	*3, 4*	*2, 3*

Belligerent Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 1*	*3, 2*
Don't Politicize	*2, 4*	*1, 3*

Chart 5. Russia-Europe game illustrative payoffs for scenario 1.

Benign Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 2*	*1, 1*
Don't Politicize	*3, 4*	*2, 3*

Belligerent Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 2*	*3, 1*
Don't Politicize	*2, 4*	*1, 3*

Chart 6. Russia-Europe game illustrative payoffs for scenario 2.

Benign Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 1*	*1, 2*
Don't Politicize	*3, 3*	*2, 4*

Belligerent Russia

	Europe	
	Don't Diversify	Diversify
Politicize	*4, 1*	*3, 2*
Don't Politicize	*2, 3*	*1, 4*

Chart 7. Russia-Europe game illustrative payoffs for scenario 3.

Chart 8. Likely scenario outcomes from U.S. and Russian first-stage choices.

Russia	*U.S.*	
	Don't Sanction	Sanction
High Prices	*Scenario 3*	*Scenario 3*
Competitive Prices	*Scenario 1*	*Scenario 3*
Low Prices	*Scenario 2*	*Scenario 1*

European market gives it substantial potential price flexibility. Russia has complied with buyer requests to renegotiate and reduced its prices in order to secure its market position in the European natural gas market [32]. Russia also has the ability to implement a strategy that will hurt itself in the short term, but may provide benefits in the long term by actuating a price war in an attempt to deter competitors from entering its current markets [21]. Ironically, extensive Russian accommodation in price negotiations could be a warning sign that European political and economic vulnerabilities to future politicization are part of the broader 'bargain'.

Global LNG suppliers could also potentially attempt to influence the relative costs of diversification for Europe either by dropping prices or by paying for the construction of gasification plants in Europe. There is some evidence that they have done so – both Qatar and global energy companies have invested in the construction of regasification plants in Europe. By reducing the costs of diversification for Europe, such investments could help shift from *Scenario 2* to *Scenario 1* or even *Scenario 3*. Both *Scenario 1* and *Scenario 3* are more desirable for global LNG suppliers because they contain European diversification decisions that lead to higher LNG sales. Hence, an equilibrium in which the game

		U.S.	
		Don't Sanction	Sanction
Benign Russia	High Prices	*1, 3*	*1, 3*
	Competitive Prices	*3, 2*	*1, 3*
	Low Prices	*2, 1*	***2, 2***

		U.S.	
		Don't Sanction	Sanction
Belligerent Russia	High Prices	*1, 3*	*1, 3*
	Competitive Prices	*2, 2*	*1, 3*
	Low Prices	*3, 1*	***2, 2***

Chart 9. Expected ordinal payoffs of U.S. and Russian first-stage choices.

remains in Scenario 2 simply because of inadequate global infrastructure is unlikely, and we do not explicitly model the choice to build this infrastructure.

The United States appears to be considering expanded sanctions against Russian natural gas exports[8] [51]. U.S. sanctions, if sufficiently effective, could shift Europe to Scenario 3 in which diversification of suppliers becomes Europe's dominant choice. Since the U.S. appears to fear Russian political influence derived from the gas trading relationship with its European allies and in addition the U.S. and other global LNG providers would potentially benefit from increased European diversification, sanctions aimed at Russian natural gas suppliers could potentially be a desirable tactic for the U.S., although the desirability of this tactic likely depends upon the extent to which imposing sanctions would weaken the U.S. relationship with European countries.

To explore the consequences of Russian pricing choices and U.S. sanctions choices we now model a first stage simultaneous game between the U.S. and Russia with consequences associated with the scenarios likely to follow in the Russia-Europe game already studied. This is the top half of the full game tree shown in Fig. 1. The lower subgames are the scenarios that arise from these choices.

We now make some assumptions concerning the relative ranking of the scenarios for the U.S. and Russia, as summarized in Chart 8. All else equal, Russia would rather play Scenario 1 or 2 and most dislikes Scenario 3. In Scenario 2 Russia has market power and the opportunity to politicize in Europe, and in Scenario 3 Russia is priced out of the European market. Similarly, all else equal the U.S. would rather play Scenario 3 in which Russia is priced out of the European market, and most dislikes Scenario 2 in which Russia is able to use its market power to consistently extract political concessions in Europe. Whether Russia prefers Scenario 1 or Scenario 2 depends in part on the magnitude of the price concessions required to shift Europe to a dominant strategy of not diversifying, and we consider both possibilities below, again labeling these as the belligerent and non-belligerent Russia cases since they reflect the relative benefits Russia believes it can gain from political and economic leverage with Europe.

The ordinal rankings of that result are displayed in Chart 9. We assume that the U.S. and Russia move simultaneously to allow each to optimally select its strategy conditional upon the other's move. The Nash Equilibrium is in bold face.

In the unique Nash equilibrium that arises in this game the U.S. imposes sanctions but Russia counters the sanctions with low prices. In the full subgame perfect Nash equilibrium, the resulting combination of costs and benefits sets up Scenario 1 in the second stage. As discussed above, Scenario 1 has cyclic variation between Russian politicization and non-politicization, and the associated European alternation between efforts at diversification and purchase of Russian gas, as discussed above in the benign Russia case, and a combination of Russian politicization and European diversification in the belligerent case.[9]

7. Conclusion

Fully deterring Russian politicization of its natural gas market to Europe is difficult, even in the context of a large and competitively priced global LNG market. In most scenarios Europe could meet its natural gas supply with LNG, but it is likely to be more expensive than Russian pipeline gas. Russian gas will have lower costs, and thus the Russians could win a price war if they chose. As Scenario 1 shows, this is likely to set up a mixed strategy equilibrium in which Russia and Europe both face commitment problems: Europe cannot consistently diversify in the face of Russian advantages as a supplier, and Russia cannot fully resist the temptation to politicize its supply to Europe. However, the presence of alternative supply does make a supply cutoff or sharp price increase less likely – it moderates Russian politicization by making Scenario 2 less likely.

This study used strategic and extensive form games to analyze the strategic interactions between U.S. LNG sales and sanctions, Russian pricing and politicization decisions, and European energy diversification decisions. In the core game, Russia decides whether to politicize, and Europe decides whether to buy high volumes of Russian gas or diversify its sources. The payoffs and outcome of that game are in turn shaped by the global LNG market and by policy choices. We modeled the U.S. choice to sanction Russian gas suppliers and the Russian choice to set prices as a prior simultaneous move game and used the subgame perfect Nash Equilibrium to determine the equilibrium of the overall extensive form game, one characterized by a mixed strategy between Russia and Europe in which cooperation is complicated.

Consistent with some of the previous literature, the results speak to the importance of global LNG prices and market infrastructure. In the absence of a large and competitive global LNG infrastructure with

[8] Nord Stream 2 pipeline prompted the U.S. consider sanctioning Russian natural gas sales after Russia expanded its pipeline capacity to West Europe. This pipeline hurts the interests of U.S. LNG exporters as it will help Russia to maintain its existing market power in the European natural gas market by providing a long-term contract for cheaper natural gas supply.

[9] Alternative assumptions support the same conclusion about Scenario 1 as an outcome. If imposing sanctions for the U.S. is sufficiently costly, this can shift the equilibrium, particularly if Russia has the 'benign' payoffs. In this scenario, a possible alternative equilibrium emerges in which Russia sets its prices competitively, and the U.S. chooses not to sanction, leading to Scenario 1 in the second round.

export capacity able to facilitate European diversification, Russia's ability to politicize its market power would be considerably more substantial. From this perspective, the increasing supply of global LNG available for export to Europe on relatively competitive terms that the U.S. shale gas boom helped bring about has weakened Russian leverage, and likely reduced the frequency of politicization.

Thereby, the benefits of U.S. export opportunities can remain important even in the absence of major LNG flows from the U.S. directly to Europe. Even if U.S. LNG flows are directed to more profitable markets beyond Europe [52] at times [18,19], retention of the right degree of global market flexibility is key to European energy security, as Medlock et al. [12]. have noted. Appropriate flexibility allows large quantities of LNG to be redirected from Asian to European markets in the event of a reduction in Russian gas flows or a spike in gas prices while (in some scenarios) providing incentives to discourage Russian politicization.

Some of the more novel insights that emerge from this analysis speak to the difficulties of fully containing Russian politicization of its position as a major supplier in the European natural gas market. First, global LNG prices competitive with Russian gas prices are not sufficient to fully contain Russian politicization, even against a relatively 'benign' set of assumptions about Russia's payoffs. Rather they can reduce the incidence of politicization and render it occasional or episodic rather than constant through the mixed strategy in Scenario 1. Second, even the imposition of U.S. sanctions on Russian gas suppliers may be insufficient to fully contain Russian politicization as in equilibrium Russia is likely to adopt a strategic pricing strategy to counter the costs of the sanctions.

A key challenge for Europe that emerges from this model, particularly in Scenario 1, is that of committing to diversification. If Europe commits to diversification in this scenario, a 'benign' Russia avoids politicization. But if Russia is not politicizing, then Europe is best off not diversifying which tempts Europe to back away from commitments to diversify as currently seems to be happening with the development of Nord Stream 2. When Europe is not diversifying, this renders it more vulnerable to politicization and tempts Russia to return to its politicization strategy. As we demonstrate, what results is a mixed strategy equilibrium in which the commitment problems for Europe (to diversification) and for Russia (to not politicizing) generate a pattern of episodic diversification and politicization.

In the face of European commitment problems, one approach for the United States would involve using sanctions to restrict the use of Russian natural gas. As discussed above, the U.S. explicitly threatened sanctions in 2019 in response to the Nord Stream 2 pipeline project. In Section 4 we show that the effectiveness of sanctions as a measure can potentially be blunted in equilibrium by Russian price policy. If Russia exercises enough flexibility concerning price, then U.S. sanctions measures will not be able to prevent the reemergence of the commitment problems and politicization discussed above.

Thus, the overall picture is a mixed one. Even as the U.S. shale gas boom and competitive global markets constrain both its politicization and pricing power, Russia retains a certain capacity to exploit its powerful position as a primary supplier to the European market for episodic exercises in politicization.

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