Fighting over gas: A race against pipes

ABSTRACT. This paper analyzes the conflict of how to share gas profits between Russia and Ukraine by using a two period bargaining model. The paper focuses particularly on how two major pipeline projects will affect the relative bargaining positions of countries involved. I find that the timing of completion of the pipelines has substantial consequences on the bargaining outcome and that neither party can afford a breakdown of negotiations.

KEYWORDS: *bargaining power, subgame perfect, gas-transport, international relations*

JEL CLASSIFICATION: C72, C78, F51

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1. INTRODUCTION

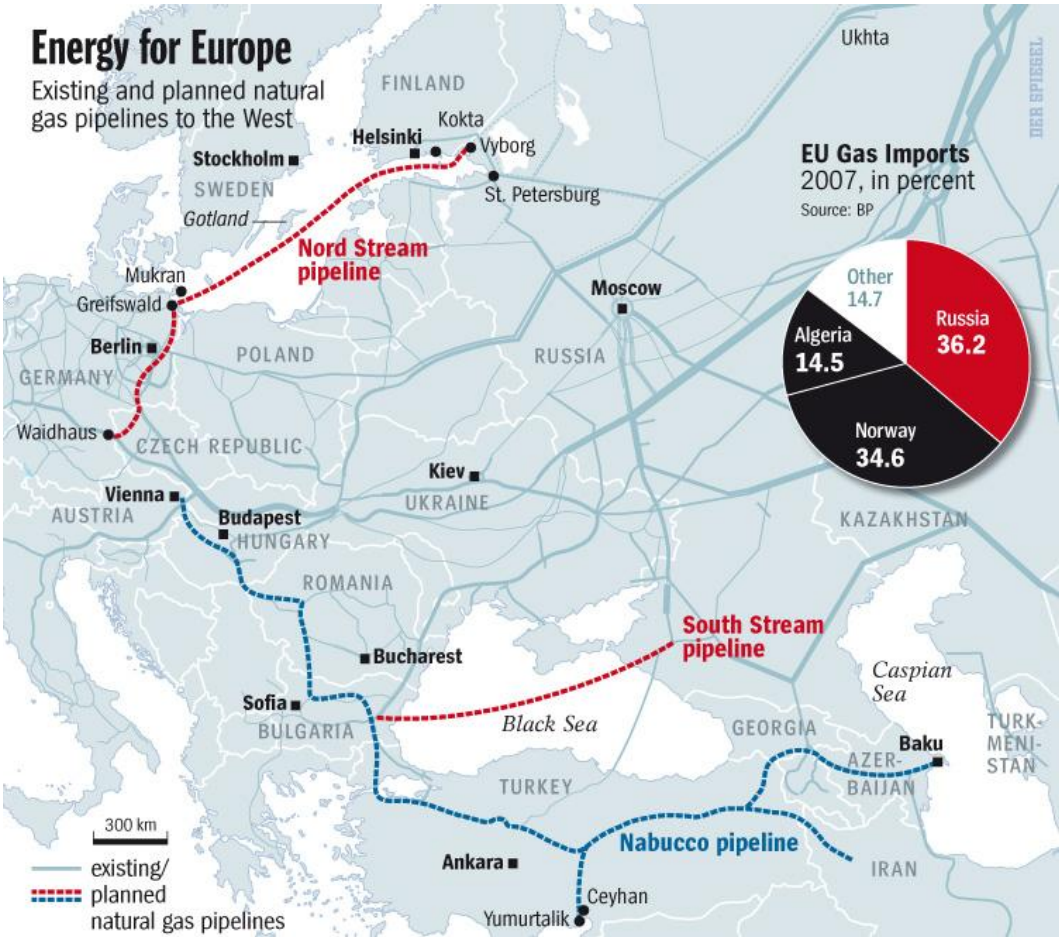
Natural gas from the Russian Federation covers around 30% of Western Europe's gas consumption. Over four decades, through cold war, economic collapse, and political turmoil, Russia worked hard to improve its name as a secure gas supplier. During this period, Russia and its partners have constructed a vast and extensive network of pipelines that transport the gas from Russia’s production facilities, via transit countries such as Ukraine, to its West-European customers. However, from January 2006 onwards, most notably in January 2009, several conflicts arose between Russia and Ukraine about debts, prices for Ukraine's gas imports and transit tariffs. This escalated to the point where supplies on the major transit route were completely cut off. For two weeks in the middle of winter European gas consumers were held hostage in the dispute and some Eastern European countries faced a humanitarian disaster as heating systems failed. Eventually, Ukraine and Russia reached an agreement but in the next few years (2006-2009) the conflict and bargaining developed into an annual ritual. The situation as described above is unsustainable, unpredictable and unacceptable for all parties involved. The EU, Ukraine and Russia failed to establish a stable and long-term solution for their gas relations and instead they engaged in continuous bargaining over prices and transit fees. The crises tainted Russia’s reputation as a reliable supplier but it also illustrated the powerful position of transit countries such as Ukraine in the Eurasian supply chain for natural gas. Therefore, the topic is of high relevance in the European discussion on supply security and the EU-Russian Energy Dialogue.

Initially, Ukraine was the sole transit country upon which Russia had to rely. Both countries were condemned as business partners to each other. The recent political turmoil in Ukraine and uncertainty concerning the future relations between Russia and Ukraine highlight the sensitivity of the issue. It comes by no surprise, therefore, that both Russia and Europe have tried to change the rules of the game, and decrease their dependency on Ukraine and each other. The status quo can be changed by building new pipelines in addition to the existing system. In this paper I will investigate how such projects will change the bargaining power in the negotiations and whether this will result in a more stable set of agreements.

The current and potential benefits of the Eurasian gas trade projects are enormous for all participants, but the complex structure of the gas transit system has created uncertainties on how players shall interact and share the expected benefits of the projects.

I want to focus on two prospective projects in particular: Firstly, Russia and Germany are planning to construct an offshore pipeline, the so-called *Nord Stream* project, through the Baltic Sea. By building this pipeline, Russia would avoid transit of its gas through foreign territory, thus strengthening its export position considerably (Hubert and Ikonnikova, 2004). At this point in time, however, the high costs of the project (up to $ 20 bln) and the lack of proven natural gas reserves in Northwest Russia make the exact benefits of the pipeline uncertain.

The second project I will examine in this paper is the *Nabucco* project, which would connect the EU directly with Turkey and thus surpassing both Russia and Ukraine completely. In contrary to the *Nord Stream* pipeline, this project would reduce the EU's dependency on Russian gas. Furthermore, *Nabucco* rivals with Russia's own attempt to infiltrate the Black Sea region. However, the construction of the EU pipeline is still in an early stage and there is some uncertainty regarding the final benefits. Map 1 provides an overview of the current pipeline network.



Map. 1 (source: Der Spiegel)

I have chosen a theoretical approach and constructed a game theoretical model, based on Stahl's finite horizon bargaining model (1972), as tool to analyze the situation. The bargaining process as formulated by Stahl (1972) is a process whereby two rivals negotiate over the division of a symbolic pie. In my research, the pie represents the potential gas profits and the rivals are Russia and Ukraine. In some cases they face external influence from the EU. The reason why I have chosen for a bargaining model to apply on this situation is that the bargaining perspective quite naturally offers an understanding of political-conflict resolution. The very stuff of politics is frequently bargaining: International politics lends itself well to the bargaining perspective.

I have modeled four scenarios in this study. In the first scenario I find that the construction of Russia's *Nord Stream* pipeline strongly improves Russia's bargaining position compared with Ukraine's. However, when I introduce uncertainty regarding the completion of the pipeline in the second scenario, I find that this would negatively affect Russia's bargaining power. In the third scenario I focus on the influence of the other project, the *Nabucco* pipeline. I conclude that when the EU can make a credible threat to surpass both Russia and Ukraine, the latter relatively holds a better bargaining position. In the final scenario I integrate all of the above situations. In this version of the model, the Nash Equilibrium depends on the probabilities of the construction of *Nord Stream*, *Nabucco* and the profit *Nord Stream* would generate for Russia, though the essence remains the same. When the likelihood that *Nord Stream* is finished on time increases, Russia improves his bargaining position and the opposite occurs when the chance that *Nabucco* will be constructed becomes larger. Furthermore, it matters which prospect seems to be realized earlier. Finally, I find that neither party can afford a breakdown of negotiations nor is it likely that events such as in January 2006 and 2009 will happen again in the near future.

2. RELATED LITERATURE

This section has been subdivided in two parts. The first part of this section is devoted to a general review of the research on bargaining models and related models. Secondly, I mention some of the available studies that have been conducted on the matter of the Eurasian gas supply network.

The first one who investigated an alternate offer procedure was Stahl in his works of 1967, 1972 and 1988. His main result was the finding of subgame-perfect equilibria in models with a finite time horizon by using backward induction (Stahl, 1972). In extension to this, he found that where the horizons in his model seem infinite, he postulated non-stationary time preferences of the two actors that lead to the existence of a 'critical period' at which one player preferred to yield rather than to continue with another offer, independently of what might happen next (Stahl, 1988). From this 'critical period' one can start the backward induction to obtain the subgame-perfect equilibria.

Rubinstein used Stahl's results as stepping stone for his examination of bargaining problems with infinite time horizons. In his model the bargaining takes place over time according to a predetermined procedure of alternating offers and responses of both parties. The parties' incentive to agree lies in the fact that they are impatient. Rubinstein proves in his study that every bargaining game of alternating offers that satisfies the assumptions of his model has a unique subgame-perfect equilibrium, which is reached immediately. From an economical perspective, one can state that when negotiation ends in the first period this implies that the equilibrium is efficient because no resources are lost in delay. Secondly, Rubinstein's model (1982) predicts that when a player becomes more patient (i.e. when he values the future more) relative to the opponent, his bargaining power increases, and therefore he ends up with a higher share of profit. Thus, in this basic formulation, bargaining power in Rubinstein's model (1982) depends on players' relative cost of waiting.

2.1 Application of game theory on the Russia-Ukraine conflict

Here follows a selection of papers written on conflicts between gas supplying countries and gas transition countries. Many of them use the latest developments in the political situation to assign pay-offs to possible outcomes in games. This is in line with my approach.

In the literature on the gas market it is typically assumed that gas producers enjoy a first mover advantage[1] vis-a-vis transit countries or importers, but face severe restrictions in their action space. Producers such as Russia may determine the price, while importers react by choosing quantities, or they may commit to sales, while transit countries respond by setting transit fee (see Hirschhausen et al, 2005).

However, Hubert, one of the most involved authors on the topic of gas-conflict between Russia and its gas-transition countries, disagrees with this approach. He states that real world gas contracts are rather sophisticated and able to avoid most of the inefficiencies assumed in this literature. Second, the results on power and distribution of profits are driven by ad hoc assumptions on the sequencing of decisions. Hubert & Ikonnikova (2003) use a cooperative game theoretical approach that assumes, in contrast, that players negotiate efficiently and that allows players to derive their power endogenously from their role in gas production and transport.

In their paper, Hubert & Ikonnikova (2003) have modeled the pipeline construction in the Eurasian gas market as a bargaining process between one producer (Russia) and several potential transit countries (Ukraine, Poland, Slovakia). In a multilateral, cooperative setting, they assumed equal bargaining power between producer and transit country[2], and applied a Shapley-value analysis to compare the returns to each of the players from different possible coalitions. They found that the option to construct the commercially unviable North Transgas pipeline can strengthen the negotiating power of Russia in negotiations with Ukraine. Hubert & Ikonnikova (2003) concluded that, given the low credibility of Ukraine in committing to long-term transit contracts, (foreign) investment in the Ukrainian pipeline system appears not to be likely in the near future, as "expanding facilities in Ukraine would strengthen this country too much in ex-post negotiations to make the project interesting for other players."

[1] The first-mover advantage states that a player who can become a leader is not worse off than in the original game where the players act simultaneously. In other words, if one of the players has the power to commit, he or she should do so (Turocy & Von Stengel, 2001).

[2] This is in line with the assumption made by Nash (1950) that players involved in the game have an equal bargaining skill.

Unlike Hubert or Nash assumed in his formal model (1950), Hirschhausen et al (2005) assigned unequal bargaining power to the different players in their game theoretical model. They argued that the transporting country (i.e. Ukraine) holds more power because it owns the essential facility, a common situation in international pipeline gas trade. They found that Ukraine would show non-cooperative behavior as long as it was the exclusive transit country. 'However, when Russian efforts to diversify transit routes succeeded, Ukraine changed its strategy and entered into a cooperative agreement with Russia. They showed that Russia wins from more cooperative behavior by the transit countries because it can raise sales and profits' (Hirschhausen et al, 2005). Furthermore, the paper suggested some political explanations for the uncooperative behavior Ukraine showed initially.

Grais & Zheng (1996) used a different approach. They analyzed the quantity, price and transit fee of gas contracts between Russia and Europe, in a hierarchical three-stage Stackelberg game in which Russia is the leader, followed by the transit country, which in turn is followed by the response of European demand (taking into account a potential alternative gas supplier). They studied the impact of exogenous shocks, e.g. an exogenous change in the preference for Russian gas over other gas. Therefore, the paper argues for establishing stable contracts in order to create an environment more conducive to trade and investments. They state that 'if the transiter and supplier increase their competitiveness through cost reductions this would improve the payoffs of all players in the game' (Grais & Zheng, 1996). Furthermore, 'the perception of increased reliability of gas supply from Russia shifts the demand for Russian gas outward and leads to an expansion of gas trade. The supplier and the transiter have some scope to raise their respective charges with expanded volumes, and thus can harvest improved payoffs. The importer's welfare deteriorates as the cost of importing gas rises' (Grais & Zheng, 1996).

Finally, in their paper Holz et al (2008) provide an outlook for European gas supply until 2025. In this paper, several scenarios are examined such as 'higher demand growth' and 'Russian exports constrained'. Holz et al (2008) state that current worries about energy supply security issues may be overrated. 'More specifically, they predict that Russia will continue to play an important role as a supplier to Europe (~ 1/3 of imports), but it will not play the dominant role that many studies (and politicians) suggest it might play. Also, the diversification of natural gas supplies, already observed in this decade, should continue and contribute to supply security' (Holz et al, 2008).

3. THE MODEL

The infinite horizon model (Rubinstein, 1982), which in turn is based on the classic example of the ultimatum game on how to divide a pie, is often used as point of departure for bargaining problems as such. Just like Rubinstein (1982), I will adopt the strategic approach for my bargaining situation. However, in reality there is almost always a fixed, finite limit to the amount of time that can be spent bargaining and this often has a decisive influence on bargaining strategies (Sjöström, 1991). Therefore, I prefer the original finite horizon model designed by Stahl (1972) as starting point for my problem.

The basic bargaining situation is then defined as follows: two players, Russia and Ukraine, have to reach an agreement on the partition of a pie. The pie *P* stands for the total amount of gas profit and for simplicity this is reduced to the size of 1. In turn, each player has to make a proposal as to how the pie should be divided. In period 1 Player 1 (Russia) may make an offer (x_1, x_2), where $x_1 + x_2 = 1$ and $0 \leq x_i \leq 1$ for $i = 1, 2$. After player 1 has made an offer, player 2 (Ukraine) has the options to either accept the division of the pie or to reject it and continue with bargaining. When player 2 decides to reject the offer, the game then moves to period 2 and he may make a counter offer (y_1, y_2), where $y_1 + y_2 = 1$ and $0 \leq y_i \leq 1$ for $i = 1, 2$. Player i prefers $x = (x_1, x_2)$ to $y = (y_1, y_2)$ if $x_i \geq y_i$. If players fail to reach an agreement before the end of period 2 the game is finished and default pay offs are realized.
In all the scenarios and the extensions in this paper I will make the following assumptions:

(A-1) 'pie' is desirable, and therefore there is a conflict of interest over the set of possible agreements,
(A-2) continuity,
(A-3) every player can individually reject any proposal,
(A-4) there is complete and perfect information,
(A-5) whenever players are indifferent, they choose to participate.

I will refer to this model as the ‘standard model’ throughout the rest of the paper.

3.1 Scenario 1: How would the pipeline project influence the bargaining power of Russia and Ukraine?

The first version of the model examines how the prospect of an additional pipeline (i.e. the *Nord Stream* project) that will directly connect Russia to Western Europe, and thus surpassing Ukraine as a transit country for gas, will affect the equilibrium outcome of the game.

I will now determine the default pay offs, which are realized at the end of period 2 if Russia and Ukraine fail to reach an agreement. Based on the real world situation, the additional pipeline that will surpass Ukraine is already under construction. When the construction of the pipeline is finished, Russia's default pay off changes in R (for $R>0$). This increase in the pay off is due to the fact that Russia will have direct access to the European market now and hence will be able to negotiate a more efficient price. The pay off of Ukraine, in contrast, will deteriorate. I assume that Ukraine's profit for facilitating the gas transit to Europe will suffer. Therefore Ukraine's will change in U, for $U<0$.
In the first case, I regard the timing of completion of the pipelines as a fixed factor and therefore I assume the project will be completed in period 2 of the game. The timing of the game is then as follows:

1. Player 1 (Russia) makes an offer in period 1,
2. Player 2 (Ukraine) makes a counteroffer in period 2,
3. Game ends, if no agreement is made default pay offs (as determined in the 2nd period) are realized.

3.2 Scenario 2: How does uncertainty about the date of completion of the pipeline affect the bargaining power of Russia and Ukraine?

This scenario is based on the one above, except with the difference that the exact timing of the completion of the pipeline is uncertain. There is a chance that complications during construction could arise, political turmoil in the region could break out, or a natural disaster could happen. Any of these factors would cause a significant delay in the process of completing the pipeline project and as a consequence it is uncertain whether the project will be completed on time in period 2.

Therefore, in period 2 there is an exogenous probability p (for $0<p<1$) that the project is finished. The default pay offs and preferences of each player remain similar to scenario 1. The timing of the game is now as follows:

1. Player 1 (Russia) makes an offer in period 1,
2. Player 2 (Ukraine) makes a counteroffer in period 2 (with probability p that the pipeline is finished at the end of the period),
3. When p occurs, the default pay offs change in the values as described in scenario 1,
4. Game ends, if no agreement is made default pay offs (dependent on p) are realized.

3.3 Scenario 3: How can the EU influence the bargaining game when she decides to construct its own pipeline which surpasses both Ukraine and Russia?

In the third possibility the EU is no longer a passive spectator of the bargaining outcome between Russia and Ukraine, but she might decide to construct her own pipeline. This proposed *Nabucco* gas pipeline will lead through the Balkan and connect the EU with Turkey, an independent gas supplier. For simplicity, I assume that the amount of gas channeled through the *Nabucco* project will be sufficient to fully supply the EU. This implies that the EU, the main customer of both Ukraine and Russia, would abandon the old contract completely. This would lead to financial distress for both Ukraine and Russia. However, political decision making on the EU level is traditionally a lengthy process[3], financial resources for the initial investment have to be gathered first and negotiations with Turkey and other parties involved might cause another hold up in construction. Therefore, it is uncertain if the EU would start the project.

This scenario is modeled similar to the ones above. Ukraine and Russia are again the active players involved in the bargaining process and will alternate offers to come to an agreement how to split the gas profits. They may differ in preferences. At the end of the 2nd period there is a chance q (for $0<q<1$) that the EU will start the *Nabucco* gas pipeline and this has two implications:

[3]E.g.The Baltic states and Poland mustered their influence in the EU to lobby against the *Nord Stream* project and became one of the major obstacles for the development of a common EU energy policy (Hubert, 2009).

- The default pay offs for Ukraine and Russia change into $U = R = -1$ as *Nabucco* will replace all potential gas profits that could be made.
- The game ends and the new default pay offs are realized.

The timing of the game is as follows:

1. Player 1 (Russia) makes an offer in period 1,
2. Player 2 (Ukraine) makes a counteroffer in period 2 (with probability *q* that the EU will construct her own pipeline at the end of the period),
3. When *q* occurs, the default pay offs change in the values as described above,
4. Game ends, if no agreement is made default pay offs (dependent on *q*) are realized.

3.4 Scenario 4: Integrated model of all options: 'A race against pipes'

In the final version of the model, I will include both possibilities of the *Nord Stream* and *Nabucco* projects in the framework. This version combines all of the earlier scenarios and will be a two player finite horizon bargaining game with complete and perfect information and two uncertain factors. However, it is not possible that the two uncertainties in the game happen simultaneously. I make the assumption that both the *Nord Stream* pipeline as well as the *Nabucco* pipeline completely offsets the current amount of gas channeled through Ukraine. Both pipelines can be viewed as perfect substitutes and therefore if one project is finished, it will not pay off for the other party to construct the other pipeline. Therefore, if *p (q)* occurs, subsequent pay offs are realized and the game is finished. I will investigate both cases of which pipeline will be completed first. The timing of the game is as follows:

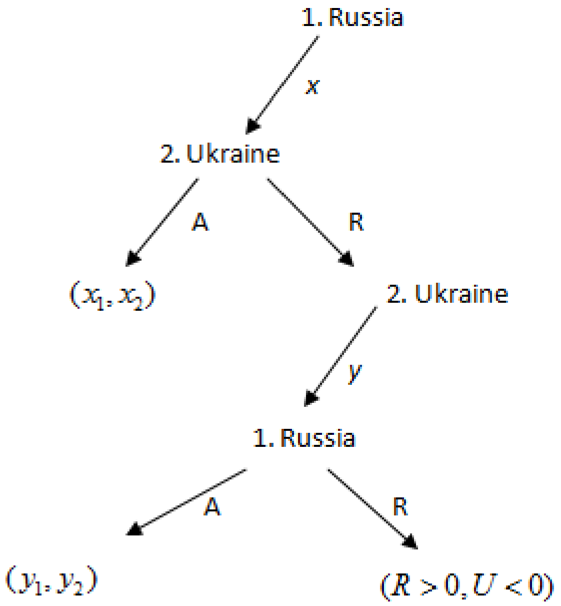
1. Player 1 (Russia) makes an offer in period 1,
2. Player 2 (Ukraine) makes a counteroffer in period 2 (with probability *p (q)* that Russia (EU) will complete its own pipeline at the end of the period),
3. When *p (q)* occurs, the default pay offs change in the values as described in earlier scenarios,
4. When *p (q)* does not occur, there is probability *q (p)* that the other project will be finished, in which case those pay offs will be the relevant ones,
5. Game ends, default pay offs (dependent on *p* or *q*) are realized.

4. SOLVING THE MODEL

4.1 Scenario 1: How would the pipeline project influence the bargaining power of Russia and Ukraine?

In the first scenario I will solve there is certainty that the Russian pipeline will be finished in period 2. Find below the structure of the game: 'A' denotes an agreement between both players, 'R' denotes a rejection by Player *i*.

fig.1



First, I will derive the potential pay offs for each player at each stage of the game:

Period 1	**Agreement:**	**Reject:**
Russia:	x_1	game continues to period 2
Ukraine:	x_2	game continues to period 2

Period 2	**Agreement:**	**Reject:**
Russia:	y_1	$R > 0$
Ukraine:	y_2	$U < 0$

I will solve this game by using backward induction. This implies I will first analyze the subgame in the second period and derive the best possible strategy for Player 1 given the previously chosen action of Player 2. In this period Player 2 (Ukraine) makes a counteroffer to Player 1 (Russia):

- Russia will accept Ukraine's offer provided $y_1 \geq R$.
- Ukraine does not want a breakdown of negotiations as $U < 0$, which is always lower than the lowest possible agreement with Russia.
- Ukraine offers therefore $(y_1 = R, y_2 = 1 - R)$ which Russia will accept.
- The Nash Equilibrium of this subgame is: (accept if $R \leq y_1 \leq 1$; $y_2 = 1 - R$).

Given this information, I will move to the first period. Now, Russia may make an offer to Ukraine:

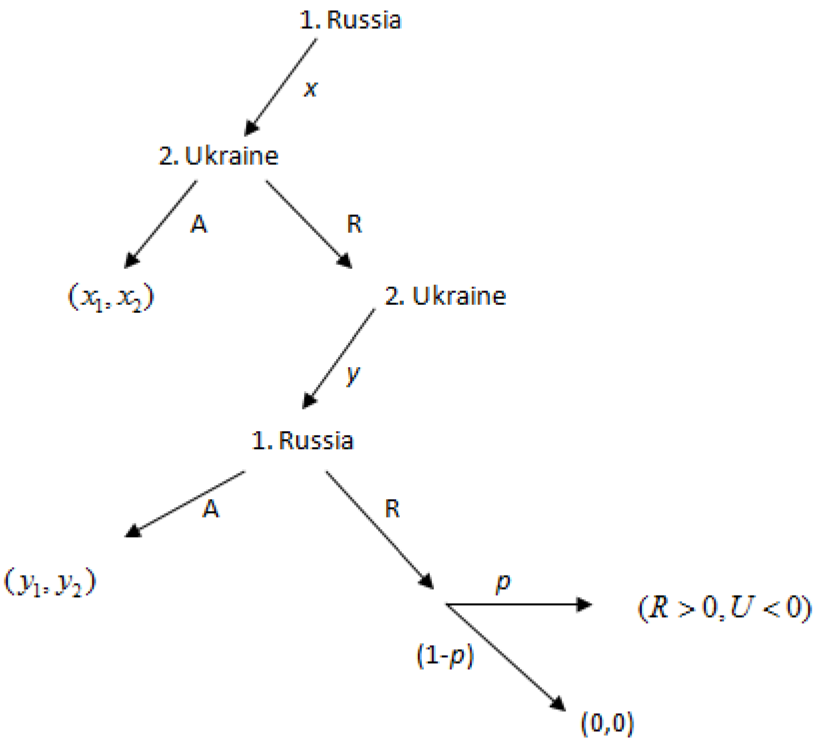
- Ukraine will accept if $x_2 \geq y_2$ * $y_2 = 1 - R$

  $x_2 \geq (1 - R)$
- As $x_1 + x_2 = 1$, Russia will offer $x_1 = R$ which Ukraine will accept. The Subgame Perfect Nash Equilibrium outcome is thus for Russia to offer $x_1 = R$ in the first period. Ukraine will accept this offer, as Ukraine knows that, were the game to move to period 2, Ukraine would offer $y_2 = 1 - R$ which yields exactly the same pay off. Given assumption (A-5) 'whenever players are indifferent, they choose to participate', Ukraine will accept Russia's offer in period 1.
- The associated pay offs are $x_1 = R$ for Russia and $x_2 = 1 - R$ for Ukraine.

4.2 *Scenario 2: How does uncertainty about the date of completion of the pipeline affect the bargaining power of Russia and Ukraine?*

This scenario has basically the same structure as the one above, except for the difference with respect to the timing of completion of the Russia pipeline, which is now uncertain.

fig.2



Again, I will start with the analysis of the 2nd period, by using backward induction.

- Now, Russia will accept Ukraine's offer provided $y_1 \geq pR + (1-p)0$.
- Ukraine still does not want a breakdown of negotiations as $U < 0$, which is always lower than the lowest possible agreement with Russia.
- Ukraine offers therefore $(y_1 = pR, y_2 = 1-pR)$ which Russia will accept.
- The Nash Equilibrium of this subgame is: (accept if $pR \leq y_1 \leq 1$; $y_2 = 1-pR$).

Now moving to the first period when Russia may make an offer gives:

- Ukraine will accept if $x_2 \geq y_2$ * $y_2 = 1-pR$

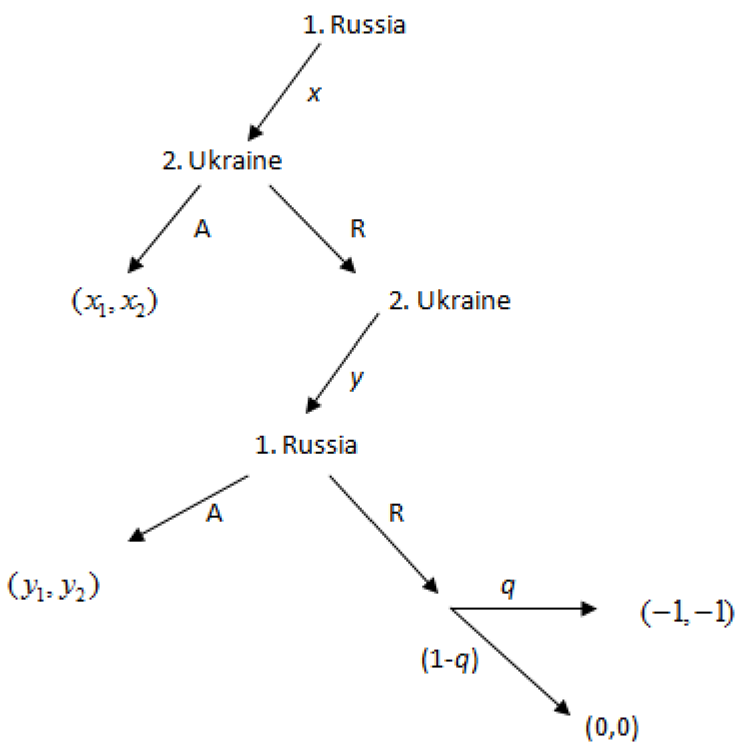
  $x_2 \geq (1-pR)$

- As $x_1 + x_2 = 1$, Russia will offer $x_1 = pR$ which Ukraine will accept. The Subgame Perfect Nash Equilibrium outcome is thus for Russia to offer $x_1 = pR$ in the first period. Ukraine will accept this offer, as Ukraine knows that, were the game to move to period 2, Ukraine would offer $y_2 = 1 - pR$ which yields exactly the same pay off. Given assumption (A-5), Ukraine will accept Russia's offer in period 1.
- The associated pay offs are $x_1 = pR$ for Russia and $x_2 = 1 - pR$ for Ukraine.

4.3 Scenario 3: How can the EU influence the bargaining game when she decides to construct its own pipeline which surpasses both Ukraine and Russia?

In my third scenario the EU has some influence and threatens both Russia and Ukraine to build her own pipeline and thus surpass both countries. This is modeled with probability q which will yield a negative pay off for Russia as well as Ukraine.

fig.3



I stick to the backward induction approach used in my previous scenarios.

- Russia will accept Ukraine's offer provided $y_1 \geq -1q + (1-q)0$.
- This time both players do not desire a breakdown of negotiations as their pay offs associated with a breakdown are always lower than any possible agreement (provided $q > 0$).
- Ukraine offers therefore $(y_1 = -q, y_2 = 1)$ which is similar to $y_1 = 0$ as $(0 \leq y_i \leq 1)$. Russia will accept this offer.
- The Nash Equilibrium of this subgame is: (accept if $y_1 \leq 1$; $y_2 = 1$).

In the first period I find:

- Ukraine will accept if $x_2 \geq y_2$ $\quad\quad * y_2 = 1$

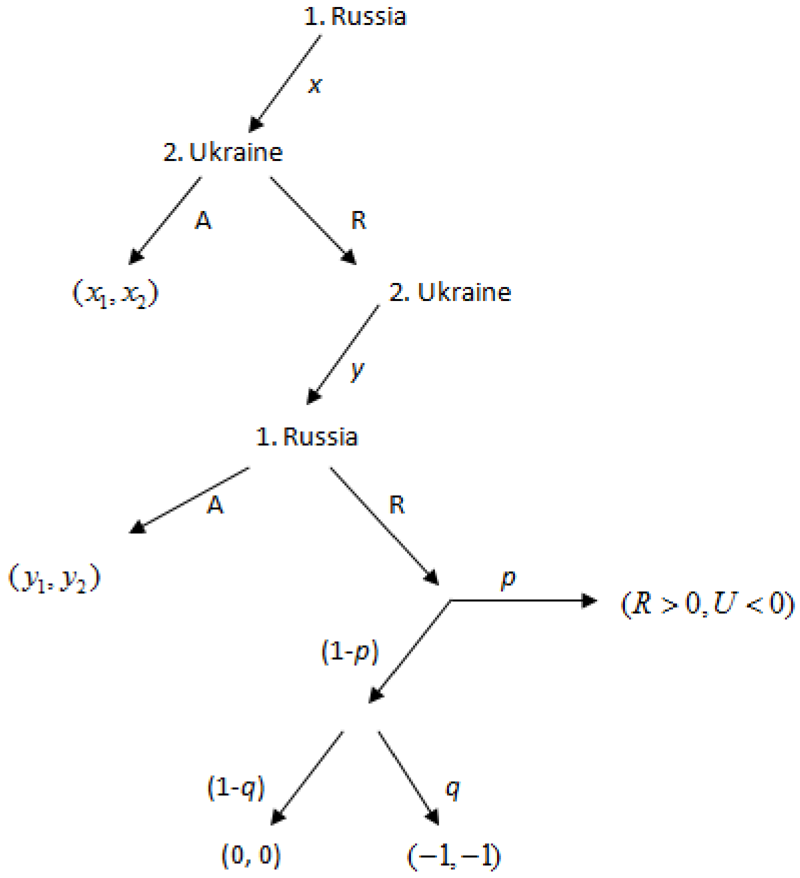
  $x_2 \geq 1$
- The Subgame Perfect Nash Equilibrium outcome is thus for Russia to offer $x_1 = 0$ in the first period. Ukraine will accept this, as it knows that in period 2 Ukraine would offer $y_2 = 1$. Given assumption (A-5), Ukraine will accept Russia's offer in period 1.
- The associated pay offs are $x_1 = 0$ for Russia and $x_2 = 1$ for Ukraine.

Hence, in the case that the EU holds a credible threat to construct her own pipeline, Ukraine takes all the gas profit through bargaining.

4.4 Scenario 4: Integrated model of all options: 'A race against pipes'

The most complicated yet interesting scenario is that in which both projects are possible: I.e. now both Russia as well as the EU can make a threat they will construct their own pipeline. However, when one of these projects is put into action, I assume that the other project will be abandoned. Therefore, it is essential which threat will me made first. I will investigate both cases, of which the option in which Russia's project comes first is illustrated below.

fig.4



Using backward induction, I derive:

- Russia will accept Ukraine's offer provided $y_1 \geq pR + (1-p)(-1q) + (1-q)0$
- As Ukraine's all 3 possible pay offs when Russia rejects are all lower or equal to successful agreement of the bargaining, Ukraine wants to avoid a breakdown.
- Ukraine offers therefore $(y_1 = p(R+q) - q, y_2 = 1 - p(R+q) + q)$ which Russia will accept.
- The Nash Equilibrium of this subgame is: (accept if $p(R+q) - q \leq y_1 \leq 1$; $y_2 = 1 - p(R+q) + q$).

Finally, in the first period I conclude:

- Ukraine will accept if $x_2 \geq y_2$ * $y_2 = 1 - p(R+q) + q$

$$x_2 \geq 1 - p(R+q) + q$$

- The Subgame Perfect Nash Equilibrium outcome is thus for Russia to offer $x_1 = p(R+q)-q$ in the first period. Ukraine will accept this offer, since Ukraine knows that when the game moves to period 2, Ukraine would offer $y_2 = 1-p(R+q)+q$ which yields the same pay off. Again, given assumption (A-5), Ukraine will accept Russia's offer in period 1.
- The associated pay offs are $x_1 = p(R+q)-q$ for Russia and $x_2 = 1-p(R+q)+q$ for Ukraine.

In this setting the Nash Equilibrium is dependent on both the parameters *p* and *q*. It is important to note that the order in which those probabilities occur in the last stage of the game is influential. If I derive a similar analysis as above with the only difference that *q* occurs before *p*, I obtain $(x_1 = pR(1-q)-q$; accept if $x_2 \geq 1-pR(1-q)-q)$ as outcome. From this I conclude that whichever probability *p* or *q* comes first in the game, has relatively more influence on the outcome.

5. EXTENSIONS

5.1 Discount factors

One factor that has not been taken into account in the model is the time preference of each player. Often, it is assumed that with each delay in a bargaining process, players become more impatient and this adversely affects their bargaining skill. I can model this through the introduction of a fixed discount factor for each player, which results in a lower pay off for each delay in the bargaining deal. Russia and Ukraine have different time preferences and hence different discount factors. This is known as asymmetric impatience. The discount factors are denoted as δ_i for $0 < \delta_i < 1$. When an offer is accepted, all players get the (discounted) share they agreed on. To the assumptions I have made in the model section of this paper I will add:

(A-6) 'time' is valuable.

Implementing and solving this for the fully integrated model through backward induction gives $[x_1 = \delta_2(p(R+q)-q)$; accept if $x_2 \geq 1-\delta_2(p(R+q)+q)]$ as outcome.

Implementing discount factors to the model could be a value addition to the model since in the Ukraine-Russia situation time preferences do play a role. Ukraine in particularly, faces a time constraint by the threat of two alternative pipelines and therefore has a strong incentive to push for agreement before the realization of these projects. In the model I would assign Ukraine therefore a lower discount value than Russia, which would favor Russia's pay off in equilibrium.

5.2 Switch order of the game

Another variation could be to switch the order of the game, i.e. Ukraine may make the first offer and Russia may make the counteroffer in period 2. This would provide Russia with the last mover advantage[4] and would result in the outcome of ($x_1 = 1, x_2 = 0$) in all of the

[4] The last-mover advantage exists when a player is able to dictate the final terms of a negotiated agreement (Webster, 2009).

scenarios. This seems not realistic and in the discussion section I will further outline why I believe Russia should make the first offer and Ukraine should have the last mover advantage.

5.3 EU does not solely depend on Nabucco

One could argue that, due to the EU's growing energy consumption, the *Nabucco* pipeline would be insufficient to completely replace gas that is consumed from the pipelines through Russia and Ukraine. In this scenario it is likely that the EU remains customer of Russia and Ukraine even after the completion of the *Nabucco* pipeline. For the model this implies that the negative default pay offs of the original game, would be altered in some positive pay offs such that $0 \leq (R = U) < 1$. This, however, does not affect the relative bargaining positions of the players as the pay offs will be symmetrical in all cases.

6. DISCUSSION

In all of the scenarios above, I let Russia make the first offer. This has a significant influence on the partition of the pie, as Ukraine now has the last mover advantage. There are a number of reasons why I have modeled this. First of all, it seems natural to give Russia the first opportunity to bargain since Russia is the actual producer of the gas, and therefore should be able to be the first to approach potential partners. Secondly, Ukraine owns the current pipelines that lead the gas through its territory. Ukraine controls and facilitates the final step of the gas supply chain before it reaches its European customers. Therefore, Ukraine should make the final offer in the bargaining process. Finally, in the literature Hirschhausen et al (2005) argue that the transporting country (i.e. Ukraine) holds more power because it owns the essential facility, a common situation in international pipeline gas trade.

In my model I have examined how the power balance between Russia, the gas producer, and Ukraine, the main gas transporter, is affected by the potential construction of new pipelines. In scenario 1 I find that the construction of the *Nord Stream* Pipeline, strongly improves Russia's bargaining position. This is similar to the result Hubert & Ikonnikova (2003) have found. From a situation in which Ukraine has all the bargaining power due to the last movers advantage, Russia can now make a credible threat to Ukraine if it does not make at least a similar offer to the future profits arising from the *Nord Stream* project. Since this pipeline is still under construction the exact amount of profit it will generate is unsure.

In addition, I extend this scenario by introducing uncertainty regarding the completion of the *Nord Stream* Pipeline. I find that this uncertainty has a negative impact on Russia's bargaining power.

In the third scenario I conclude that when the EU holds a credible threat by constructing its own *Nabucco* pipeline, Ukraine will be able to use its last movers advantage to the fullest, since either player has an incentive to avoid a breakdown of the negotiations at all cost. As a consequence, Ukraine will claim the whole pie. Note that the assumption that the EU completely abandons both Ukraine and Russia after having finished its own pipeline is crucial here.

It becomes more interesting when both probabilities are modeled. The Subgame Perfect Nash Equilibrium outcome becomes more complex, but the essence remains similar to the other scenarios. The more realistic the probability Russia will construct its pipeline; the more

Russia's bargaining position is strengthened. However, the larger the possibility of construction of the EU pipeline; the more this will affect the equilibrium outcome for Russia in a negative way. When the probabilities are set equal (e.g. $p=q=0,5$) then default pay offs will cancel out and the final equilibrium will be similar to that in scenario 2. Furthermore, it matters which prospect seems to be realized earlier. The order in which p or q can occur does affect the relative weight the parameter holds in the outcome. Based on the real world situation, in which the Russian *Nord Stream* pipeline is already being constructed and the EU *Nabucco* pipeline is still in a negotiation stage, I prefer the version of the game in which p occurs before q.

Based on data from the European Commission, the EU's gas demand will rise from 487.9 billion cubic meters (bcm) now up to 600 bcm in 2030. Hence, it is desirable to put the projects that I use in my model, *Nord Stream* and *Nabucco* with a capacity of 55 bcm and 35 bcm respectively, in perspective and compare them with the existing pipeline network. However, this is a complex matter and outside the scope of the model I use in this paper, but a good topic to conduct further research on. One could argue that due to the substantial increase in demand from the EU, neither the *Nord Stream* nor *Nabucco* pipelines will be able to replace the current gas transport through Ukraine. This would imply that Ukraine preserves its role as a major transit country and that the bargaining process between Ukraine, Russia and the EU will continue to be of key importance. For the model this would mean that any negative default pay offs for either Ukraine or Russia as currently modeled would be obsolete.

Another important aspect of the real situation is the fact that international deals in the gas sector are all set in long term contracts. These contracts would range between 10-20 years and therefore the gas sector is characterized as a rigid and inflexible sector. So even when the new pipeline projects would be finished within a short time period, players in the game cannot adjust immediately.

A relevant question to ask is whether the *Nord Stream* and *Nabucco* options are economically efficient. Both pipelines will be (partially) constructed offshore and will require an extensive investment of parties involved. From the literature I find that alternative options such as an extension of the current pipeline network in Ukraine and Belarus would be less costly and more efficient, yet these options are not executed. An explanation for this could be the large role of geopolitics in this topic: Russia can use its position as main gas producer as a political tool to achieve goals other than those of pure economical interest, Ukraine's bargaining attitude is interrelated to the incumbent government's stand towards Russia and the West, and the EU also wants to diversify its gas suppliers to decrease dependency on Russia for diplomatic reasons. The paper of Hirschhausen et al (2005) provides some political explanations for the uncooperative behavior Ukraine showed. In practice however, economical and political arguments are entwined and difficult to measure and to capture in a model together. Therefore, this model focuses on the relative economic effects on bargaining power of Russia and Ukraine by a change of the status quo. It is usable to predict how specific projects such as the *Nord Stream* and *Nabucco* pipelines influence relative shifts of power between Russia and Ukraine. Furthermore, the model shows that neither party can afford a breakdown of negotiations thus it is not likely that events such as in January 2006 and 2009 will happen again in the near future.

7. CONCLUSION

In this paper I have analyzed the conflict of how to share gas profits between Russia and Ukraine by using a game theoretical model. I have investigated 4 different scenarios in which 2 major pipeline projects, i.e. Russia's *Nord Stream* pipeline and the EU's *Nabucco* project, play a key role.

The results in this paper are based on relative shifts in *economical* bargaining power between Russia and Ukraine. Geopolitical motives might be present or influential but those fall outside the scope of this paper. This would be a good topic for further research.

The central model I have used is based on Stahl's (1972) finite horizon bargaining model, in which two players have to reach an agreement on the partition of a pie. This is the Nash Equilibrium of the game. In turns, the players Russia (player 1) and Ukraine (player 2) have to make a proposal as to how the pie should be divided. There are two periods and the players differ in preferences on how to divide the gas profits.

In the first scenario I have found that the construction of Russia's *Nord Stream* pipeline strongly improves Russia's bargaining position compared with Ukraine's. However, when I introduced uncertainty regarding the completion of the pipeline I found that this would negatively affect Russia's bargaining power.
In another scenario I focused on the other large-scale project, the *Nabucco* pipeline, which would connect the EU directly with Turkey and thereby surpass Russia and Ukraine completely. I concluded that when such a threat that would affect both countries severely exists, Ukraine holds a relatively better bargaining position since it may make the final offer.
In the final scenario I integrated all of the above situations. In this version of the model, the Nash Equilibrium depends on the probabilities of the construction of *Nord Stream*, *Nabucco* and the profit *Nord Stream* would generate for Russia, though the essence remains the same. When the likelihood that *Nord Stream* is finished on time increases, Russia improves its bargaining position and the opposite occurs when the chance that *Nabucco* will be constructed becomes larger. Furthermore, it matters which prospect seems to be realized earlier.
Finally, I found that neither party can afford a breakdown of negotiations and thus it is not likely that events such as in January 2006 and 2009 will happen again in the near future.

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