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The Gas Game: Simulating Decision-Making in the European Union's External Natural Gas Policy

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Introduction

The article introduces a simulation model to analyze the external natural gas policy of Germany, Italy, France, Spain, the United Kingdom, the Netherlands, Hungary, Poland, the Czech Republic and the EU Commission. The model is constructed to meet the accuracy of the game-theoretic model *predictioneer's game* (hereinafter called "PG") by Bruce Bueno de Mesquita, but it relies on real world data, simple heuristics, and numerical optimization. The article addresses three research questions: Are simulations an adequate instrument for the analysis of the EU's external natural gas policy? Which standards and trade-offs concerning accuracy and transparency have to be considered? How can possible future scenarios of the EU's external natural gas policy be simulated? It is demonstrated that the developed model is suitable for analyzing this policy field and thus fulfills necessary conditions of being an instrument to simulate possible future scenarios.

In studies about decision-making processes in the European Union the application of formal models to test general assumptions of decision-making in the EU is already well established – especially compared to other subfields of political science. Remarkable studies, in which the predictive accuracy of different models has been compared, have provided well-founded insights in general patterns of decision-making in the EU such as the importance of informal bargaining for the decision-making process, the distribution of power between different actors, etc.[1]

Though many advances have been made, there is still room left for optimization concerning the predictive accuracy of the models tested (Achen 2006; Schneider 2014; Schneider et al. 2011). In the literature on formal modelling in EU studies, this deficiency triggered research in two areas with the aim of improving the predictive accuracy in the construction of future scenarios: First of all, questions were raised regarding the adequacy of the respective models to simulate decision-making processes in the EU. Further tests have to be made to figure out which model is most suitable for which setting. Besides that, a second problem has been identified, which also limits the predictive accuracy of formal models, namely the validity of the input data. As Gerald Schneider et al. (2011: 8) put it, "prediction crucially depends on the reliability of the information used for the forecast". Data – not only regarding policy positions, but also other input variables such as influence and salience, which are incorporated in many formal models on decision-making – is often subjective: It depends on the expert opinion of the model builder and therefore might lead to wrong or less accurate predictions. In recent years various methods have been applied

[1] The most important landmarks are Bueno de Mesquita and Stokman 1994, Thomson et al. 2006 and Thomson 2011.

to generate data more objectively. Most frequently implemented are expert interviews and quantitative content analyses, especially since the EU publishes increasingly more documents with regard to the decision-making process (e.g. Eur-Lex and Council Minutes). However, these methods still have disadvantages – the most obvious ones being financial and timely costs of expert interviews on the European level.

This article tries to overcome these challenges. First, a model is constructed that takes the PG by Bruce Bueno de Mesquita as "gold-standard". This simulation has already proven a high predictive accuracy in certain areas of EU politics as well as in other political contexts. However, its successful application still depends on the environmental setting – it performs better in non-cooperative settings. Since the EU is characterized by rather cooperative forms of decision-making, it still can be assumed that this simulation is nevertheless an adequate instrument to simulate decision-making in specific policy fields, in which conflict and coercion are still central features of the EU's bargaining process. However, the main problem with the PG is that it is a black-box. The codes are not available to the public. Therefore, it is nearly impossible to analyze the process that lies behind the model. In addition, at least some of the assumptions of the decision-making process that are framing the outcomes are not really realistic: The model relies on a simulation of face-to-face negotiations of each and every actor. Therefore, the number of decisive decision-making processes that are simulated is rising exponentially with the number of players.

Nevertheless, the accuracy of the PG is widely recognized (see e.g. Feder 1995; Ray and Russett 1996; Schneider 2014: 217; Wayman et al. 2014: xiii).

In this article, we create a new model, that is independent from the theoretical assumptions of the PG but which reaches the same accuracy. To achieve this goal, we create 200 datasets including values for position, influence, salience, and resolve for ten actors. All values are assigned by a random-number-generator. These initial datasets are then fed into the PG to generate the respective outcomes. In a second step, we design a new model that is derived from simple heuristics about the decision-making process. This model is then tuned to fit the output data of the PG using numerical optimization algorithms. The whole procedure can be described as "fuzzing". "Black box testing works because you can apply some external stimulus to a program and observe how the program reacts to that stimulus. [...] All that is left is to provide interesting inputs to the program being tested." (Harper et al. 2011: 484) We end up with a model that produces nearly the same results as the PG but relies on much simpler assumptions about the decision-making process. In addition, our code is public and can be enhanced and modified by other researchers. The method of fuzzing also provides some useful insights into the PG: We can demonstrate that a simple weighted mean is very close to the results of the PG in most of the cases. Finally, our model – beating the weighted mean slightly – produces its results without the resolve variable. As a sparser model it is therefore theoretical superior to the PG.

In a second step we collect the input data for the model's variables. Since methodological approaches used in earlier studies have revealed problems concerning validity and reliability of the data (Selck et al. 2009: 466f.; Veen 2011a; Veen 2011b), we choose a methodological approach which has been largely disregarded until now: The values for the influence, salience and resolve variables derive from indirect quantitative data and theoretical considerations based on findings of previous studies. Using quantitative data, such as gas imports of the countries reduces the subjective character of the model enormously. To apply the model as an instrument for analyzing European external gas policy, it has to be demonstrated that the rules of the simulation and the rules of the compared system – the real world – are akin, so that both systems should behave similarly if certain variables change. This demonstration requires a series of tests. Firstly, a "post-diction" of the status quo of European external gas policy before the beginning of the Ukraine crisis in November 2013 is developed, based on the combination of the policy positions of selected member states and further input variables implied in the model. By simulating this status quo an initial indication is provided that the virtual world system and the real world system behave similarly and the causal assumptions – the rules – of the model are suitable for analyzing the policy field. Building on this, probable future scenarios of European external gas policy are taken into account and it is shown that the simulation is also able to mirror these variations of the original case. Hence, we demonstrate that our model serves as an analogy to the real world and can be used for analyzing European external gas policy and evaluating the effects of current and potential future developments in this policy field.

The following section describes shortly the EU's relationship to Russia as the central conflict of the EU's external gas policy to introduce the case of this study. Next, the state of the art of the rational choice institutionalist approach in the research of EU decision-making is outlined. Building on these theoretical explanations we describe our methods to build and test new models and present a new methodology to determine the values for the input variables of our models. The results section starts with the evaluation of the newly built models. Then the performance of the models in the case of the EU's external natural gas policy is evaluated. For this purpose, the simulation results of the post-dictions are compared to the status of the EU's external natural gas policy before the Ukraine crisis. In addition to that, three hypothetical but probable future "real world" developments are compared to three respective simulation scenarios to verify the validity of the models so that they can be used for further analysis in this policy field. Finally, the results are discussed and we conclude with remarks on the advantages of simulations for policy analysis.

European External Natural Gas Policy – Central Lines of Conflict

For the European Gas Policy the position of the member states towards Russia as gas supplier is extremely important. While some states see the *dependency* on Russia as a threat, others are willing to deepen the *inter*dependency to enhance their supply security. This conflict has shaped the debates on the pipeline projects Nord Stream, South Stream and Nabucco and in this way indirectly affects the supply security of the member states.

With regard to the external dimension of the European gas policy, the most important challenge for the EU consists in its rising import dependency.[2] Thus, the relationship with export and transit states is a subject of intense discussion between the EU member states and can be identified as the central line of conflict of European external gas policy

[2] According to the International Energy Agency's New Policies Scenario, natural gas demand in the EU is expected to increase 0.6% on average per year until 2035 (IEA 2012a: 130). The reasons for this are among other things the increasing use of natural gas for electricity generation as well as the commitment of many governments to reduce greenhouse gas emissions to 20% below 1990 levels by 2020: "Natural gas potentially has two roles to play in reducing carbon emissions in OECD Europe's electric power sector: as a replacement fuel for more carbon-intensive coal-fired generation and as a backup for intermittent generation from renewable energy sources." (EIA 2013: 44) While demand keeps on growing, domestic production in the EU is expected to decrease 3.0% on average per year until 2035 (IEA 2012a: 138). The EU's import dependency is thus supposed to increase.

(Mitchell et al. 2012: 76f.; Proedrou 2012: 3, 58; Stern 2010: 58, 81). The EU imports most of its natural gas from Russia (Europäische Kommission 2014: 2; Eurostat 2012).[3] This fact is evaluated differently by the individual EU member states: On the one hand, there are member states who criticize the high dependency on Russian gas, because they fear that Russia uses Europe's dependence as an instrument of pressure to achieve its foreign policy aims (Checchi et al. 2009: 18; Herranz-Surrallés and Natorski 2012: 135; Proedrou 2012: 99; Stern 2010: 60).[4] This argument was strengthened by the Russian-Ukrainian gas crisis in 2006, 2009 and 2014. In this context, it is not only warned against a one-sided dependency on Russian gas, but also against supply shortages as a consequence of tensions between Russia and its transit states (cf. Stern 2010: 81). This position – the criticism of trade with Russia as one-sided dependency – is mainly taken by Eastern European countries, whose dependency on Russian gas is particularly high because of the pipeline infrastructure built in the former Soviet Union (Hirschhausen et al. 2010: 11; Proedrou 2012: 77-78). On the other hand, certain member states – especially from Western Europe – relativize the dependency on Russia, since Russia also depends considerably on gas exports to the EU. That is why these states consider the relationship between Russia and the EU not as one-sided dependency but rather as interdependency. In this sense, Russia is not regarded as a threat to supply security but as an indispensable partner (Checchi/Behrens/Egenhofer 2009: 19; Proedrou 2012: 92). These divergent positions are reflected in the respective policies towards Russia: While the Eastern European states opt for stronger independency on Russian gas imports (Proedrou 2012: 91; Valášek 2005: 24), most of the Western European states seek to maintain good relations with Russia, to stabilize or even expand the existing cooperation and thus avoid Russia searching for alternative sales markets:

> A number of European Member States, Germany and Italy being the most prominent among them, opt for strong cooperation with Russia as a means to facilitate their energy security. The rationale behind this policy is that the more Russia becomes embedded in the EU market, the more EU security is enhanced, not endangered. In an era of fierce competition for energy resources, such agreements bind EU Member States and Russia in a network of mutual benefits and fight back Russia's plans for diversification towards other markets (Proedrou 2012: 93; see also Geden et al. 2006: 16f.).

The practical consequences of this debate about dependency and interdependency are persistent conflicts concerning the diversification and gas infrastructure policy in the EU, especially the selection of pipeline routes, which are most relevant for the EU's supply security given its high import dependency and can – depending on the routes chosen – be beneficial for the supply security of some member states and at the same time be disadvantageous to that of others (Müller-Kraenner 2008: 22ff.; Proedrou 2012: 14). In the last decade, the most important and most virulent discussions between EU member states in this field have focused basically on three pipelines: Nord Stream, South Stream and

[3] In 2002, 45% of the EU's natural gas imports came from Russia. In 2010 the share of Russian imports was reduced to 31.8%. The second most important exporter for the EU is Norway, which increased its share from 26.2% in 2002 to 28.2% in 2010 (Eurostat 2012). However, Norway's gas production is expected to decline by the end of the next decade (Honoré 2010: 125).

[4] This fear is among other things based on statements from Putin regarding the relationship with Europe as trading partner: "This mutual dependency creates consistency, predictability and stability. But if we are constantly confronted with the notion of overlarge dependency, we ask ourselves: Should we constrain our exports? We can also just search for new markets." (süddeutsche.de 17 May 2010; own translation)

Nabucco (see also Schmidt-Felzmann 2011: 585). These projects are outlined in the following:

- *Nord Stream*: The Nord Stream pipeline directly connects Russia (Vyborg) and Germany (Lubmin) and was subject of intense discussions between Germany and Eastern European member states, especially Poland. Germany initiated the project to ensure supplies for decades from Russia through a new route that eliminates transit-related risks, especially by avoiding transit through Ukraine and Belarus (Proedrou 2012: 93f.; Rulska 2006), and promote the interdependent relationship with Russia:

  Investments on the network infrastructure and expansive trade are crucial for enforcing interdependence. Starting with the former, pipelines are crucial for gas trade since they create stable relations and the anticipation of enduring trade. Agreements on infrastructure schemes signal commitment from contracting parties to engage in long-term cooperation and hence embed them in an interdependent relationship. (Proedrou 2012: 45; see also Lesser et al. 2001: 88ff.). The project implies a higher share of Russian gas in Germany and other potential customer states and is an important component of Germany's objective to create an energy partnership with Russia (Götz 2006: 3; Proedrou 2012: 81). Poland, by contrast, "has censured the Russo-German plan to build the Nord Stream as a new Molotov-Ribbentrop Pact, since it undermines its position as a transit country and exposes itself to Russian potential offensive energy policies" (Proedrou 2012: 124). Thus, Poland and several other Eastern European states vehemently criticized the pipeline project, since – in their view – it increased the dependency of the EU and especially Eastern European member states on Russia decisively (Götz 2005: 4; Yafimava 2011: 95). The discussions about the Nord Stream pipeline therefore reflect the two opposing poles of future gas trade with Russia.

- *Nabucco*: The Nabucco project was first proposed by the European Commission in 2002 and originally designed to start from Turkey via Bulgaria, Romania, Hungary and Austria (Afifi et al. 2013: 20; Proedrou 2012: 95). In opposition to Nord Stream, the Nabucco project aimed at diversifying supply sources by connecting the EU to gas sources in the Caspian Sea and Middle East regions to receive "non-Russian gas coming through non-Russian-controlled pipelines" (Proedrou 2012: 96). The advocates of its implementation stressed the pipeline's importance for a common EU energy policy and a reduction of the EU's dependence on Russian gas (Finon 2011: 47-48), while critics doubt that it is economically profitable since there might be not enough gas to use the pipeline to capacity (Afifi et al. 2013: 24; Götz 2006: 2). The Nabucco project thus represents the strategy of exploiting supply sources in the Caspian region to reduce dependency from Russia.
- *South Stream*: South Stream is a Russo-Italian project. The planned route starts in Russia and runs via Turkey, Bulgaria, Serbia, Hungary, Slovenia and Italy with branches to Croatia and Bosnia-Herzegovina. Its objective is to ensure supplies from Gazprom for the southern corridor of the EU, while circumventing transit through the Ukraine and Belarus (Papadopoulos 2008: 20f.; Proedrou 2012: 94). It is seen as Russian reaction and competing project to Nabucco (Götz 2007: 8, 29; Finon 2011: 51f., 54), because both pipelines aim at the same market: "Gazprom aspires to build South Stream before Nabucco in order to make the alternative project more unlikely to materialize" (Proedrou 2012: 84). Therefore, South Stream represents efforts of EU member states to intensify gas trade with Russia and support its position as major gas supplier for the EU while at the same time accepting the hindrance of diversification

efforts of other member states in form of the Nabucco project (Finon 2011: 52; Schuller and Triebe 2013).

As can be seen, the position taken towards Russia by EU member states decisively influences the debates and decisions concerning gas infrastructure policy in the EU and as a consequence of this the supply security of the member states. In the following section, the decision-making process of the EU's natural gas policy towards Russia is analyzed by applying several formal models to this policy field.

Theory and Methods

The Rational Choice Institutionalist Approach in the Analysis of European Union Decision-Making – an Overview

The rational choice institutionalist approach is fully established in the field of decision analysis of the EU. Different models have already been tested in comparative studies (see e.g. Bueno de Mesquita and Stokman 1994; Thomson 2011; Thomson et al. 2006). However, in recent years less attention has been paid on bargaining models in non-cooperative settings since decision-making processes in the EU are mainly characterized by cooperation and compromise. This paper tries to fill this gap by applying a model derived from the PG (Bueno de Mesquita 2011) – a non-cooperative bargaining model – to EU decision-making in the field of natural gas policy. In the following, a short overview on the application of the rational choice institutionalist approach in the analysis of EU decision-making is given.

In EU studies, much insight has been gained in recent decades by examining policy processes based on rational choice models. The most important landmarks in this research branch are the extensive studies *The European Union Decides* (Thomson et al. 2006) and *Resolving Controversy in the European Union* (Thomson 2011), in which the predictive accuracy of various models of decision-making regarding everyday decisions in the European Union has been tested.[5] An important result of the studies is that procedural models[6] do not perform well on average, while bargaining models – especially cooperative ones – predict best as a class, which serves as clear indicator that informal negotiations and compromises are important for the outcome of EU decision-making processes (Achen 2006: 295, 297; Schneider et al. 2006: 303-304; Stokman and Thomson 2004: 19). However, there is still an extensive debate in the literature about certain aspects and variables of modeling and the main question which model fits best to explain EU

[5] In line with this approach and partly building on the DEU dataset, further research on various aspects of decision-making processes in the EU has been conducted, such as questions regarding factors influencing bargaining success and the distribution of power in the EU (Bailer 2004, 2010; Cross 2013; Schalk et al. 2007; Selck and Steunenberg 2004; Selck and Kuipers 2005; Thomson 2008; Warntjen 2008) as well as methodological debates concerning the generation of input data – more specifically the extraction of policy positions (Hagemann 2007; Hix and Crombez 2005; Klüver 2009; König et al. 2005; Mattila 2012; Selck et al. 2009; Sullivan and Selck 2007; Sullivan and Veen 2009; Veen and Sullivan 2009), the determination of power (Schneider et al. 2006; Schneider et al. 2010) and salience (Veen 2011a, b; Warntjen 2012) – and measurements to test and compare the performances of different models systematically (Bueno de Mesquita 2004; König 2005).

[6] Procedural models emphasize the importance of formal rules and procedures for the outcome of the decision-making process. Bargaining models assume that the informal bargaining preceding the formal adoption of legislative acts is most important for decision-making outcomes (Thomson and Hosli 2006: 6; Schneider et al. 2006: 300f.).

decision-making. Therefore, further research including the application of different models on decision-making processes in the EU is necessary.

A bargaining model which has not been part of the studies described above, but has been applied to the DEU data set in a subsequent investigation is the PG designed by Bueno de Mesquita.[7] The author demonstrates that his model outperforms the models presented in Thomson et al. (2006), but predicts slightly worse than one of the adaptations of the Nash Bargaining Solution introduced by Schneider, Finke and Bailer (2010; Bueno de Mesquita 2011; Schneider et al. 2011: 11f.). However, the correctness of its predictions still depends on the environmental conditions; it performs better in non-cooperative settings. For these reasons, it can be assumed that the PG is particularly suitable to emulate the decision-making process of the EU's external natural gas policy, which is characterized by a high level of conflict. Thus, in the following section the main features of the PG are outlined.

The Predictioneer's Game

The PG by Bueno de Mesquita is a bargaining model developed for a rather competitive, non-cooperative setting. It assumes that informal bargaining processes take place before the formal legislative process starts and that this bargaining determines the policy outcome decisively (Bueno de Mesquita 1994: 74). In the model, the players are characterized by the policy position they are advocating at the beginning of the negotiations as well as their degree of influence, the importance they attach to the issue (salience) and their flexibility regarding the policy outcome (resolve) (Bueno de Mesquita 2010). To set the values of these variables, Bueno de Mesquita uses detailed information from area experts as empirical basis (Bueno de Mesquita 2010; Schneider et al. 2011: 7). The game is iterated. In every round each player enters a direct negotiation with each of the other players, in which they might attempt to strengthen the coalition surrounding their policy position (Arregui et al. 2006: 127; Bueno de Mesquita 2010: 243). Given these dynamics, the input variables as well as the payoffs can change in the course of the game (Bueno de Mesquita 2011: 74). The players take their decisions under uncertainty; beliefs are updated according to Bayes' Rule (Bueno de Mesquita 2010: 243). The game ends "when the sum of player payoffs in an iteration is greater than the projected sum of those payoffs in the next iteration" (Bueno de Mesquita 2010: 243).

Model-building Methods

Since the codes of the PG are not available to the public, in this section we construct a model, which is able to meet the accuracy of the PG, but relies on real world data, simple heuristics and numerical optimization. More precisely, we used "fuzzing" (Harper et al. 2011) to test several models against the performance of the PG. We constructed a simple

[7] Bueno de Mesquita's original forecasting model, the „expected utility model" (in Thomson et al.'s study it is called "challenge model"), was part of the study by Thomson et al. (2006). While this model generated the most accurate predictions in Bueno de Mesquita's and Stokman's study (1994), it performed less well in the following study (2006) compared to the alternative bargaining models applied (Schneider et al. 2006: 305f.). However, Bueno de Mesquita has revised it significantly and has created a much more complex structure for his new model, the PG. That is why the results of the "expected utility model" cannot be transferred onto the new model (Bueno de Mesquita 2011).

linear regression model, a weighted mean model and two different models based on heuristics and optimization methods that are described below.

As explained in the previous section, in the PG each actor is characterized by four input variables: policy position, influence, salience and resolve (Bueno de Mesquita 2010).[8] All values are on a scale between 1 and 100. To analyze the PG, we created 200 datasets containing the four input variables for 10 actors. All values were randomly assigned. Feeding these test sets into the PG gave us the corresponding outcomes. The output has the form of a spreadsheet with different tables showing the changing of the values for every round of the simulation. The relevant value is the smoothed mean of the round in which the stopping rule is reached (Bueno de Mesquita 2010). We extracted this information from the 200 spreadsheets automatically and created a new table with 41 columns (four variables for each actor and the final smoothed mean) and 200 rows (one for every run of the simulation). This master sheet could then be used to test new models against it. The approach is similar to data-mining methods that are becoming more prominent in political science (Hegelich et al.). The difference is that we are not fitting our models against some real world data but against the output of a data generating process: the PG. We started with a plain linear regression model with all variables. As a second model, we took the mean of the positions weighted by the product of salience and influence. This weighted mean is known to be very reliable (Achen 2006: 277, 295). In the next step, we constructed a new model based on simple heuristics simulating negotiation processes. The basic idea is that actors with similar goals will reach an agreement fast that represents their combined positions, form a coalition and then confront the other actors. This process is repeated until all actors are combined and a final position is reached. This principle of coalition-forming can be modeled by hierarchical clustering, more precisely agglomerative clustering. "Agglomerative clustering algorithms begin with every observation representing a singleton cluster. At each of the *N – 1* steps the closest two [. . .] clusters are merged into a single cluster, producing one less cluster at the next higher level. Therefore, a measure of dissimilarity between two clusters (groups of observations) must be defined." (Hastie et al. 2009: 523) We experimented with different dissimilarity measures and decided to construct a range of *position* and *resolve* for each player: We took the position as starting point and then subtracted the logged resolve to find the lower range. The upper range was found by adding the logged resolve. The result is a matrix with two entries for each player. We then calculated the Euclidean distance and ran the hierarchical clustering on it. We have chosen the *complete linkage* hierarchical clustering algorithms, because it creates clusters where the differences between the individual members of the groups are biggest. (James et al. 2013: 395) This seems to fit to the idea that players with different positions (and low resolve) will have major problems finding a common position and therefore should be merged later in the simulation. In accordance to the hierarchical clustering we than take the mean of the positions of the players that are merged, weighted by the power of each player which is defined as the product of their influence and salience. This result is then fixed as the new position of the coalition. The simple heuristic behind this is that the position of the most powerful player has the strongest influence on the position of the coalition. After merging the players' positions the mean of their power is taken as the power of the coalition. Here, the underlying simple heuristic is that the power of a coalition is not necessarily growing with the number of players. Weak players might be forced in negotiations to work against the shared position

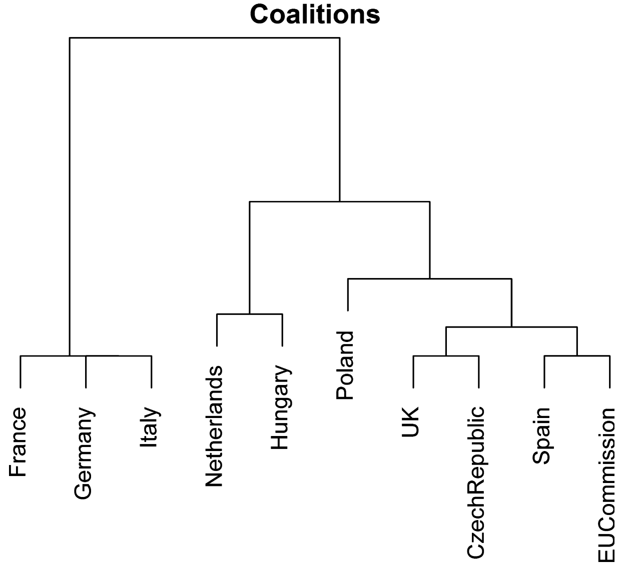
[8] There are more advanced versions of the PG with a *group* variable, possible *vetos* and *external shocks*.

of the coalition. This procedure is repeated until all players are merged and the weighted mean of all adjusted positions is then taken as the final result. Besides the numerical result the hierarchical clustering allows to visualize the coalition forming in a so called dendogram, where the height of the connections between the clusters shows the dissimilarity (see Figure 1).

One advantage of this approach is that the model can be tuned to predict the original values of the PG more accurately. We introduced additional variables in different places of the equations, e.g. a constant to give more weight to resolve or a variable considering the order of the clustering. These new equations were then numerically optimized by using the Brent algorithm (Brent 2013) to find a local minimum. Based on this optimization the performance of the model is enhanced. In addition, by analyzing the optimization results we found out that the resolve variable has hardly any effect. Therefore we could come up with a second model that relies only on three variables for each player (position, influence and salience) without losing much in accuracy.

Measuring the performance of the different models is a crucial point. The basic principle is to measure the difference between the original results from the PG and the predicted values of the different models. But there are different ways to do this. One possible solution is to calculate a correlation between the PG values and the predictions (sometimes called "pseudo R^2 approach"). More common is the calculation of the mean squared error (MSE). Here, the mean of the squared deviance (to get rid of negative signs) of each prediction from the original values is taken. This measure has the difficulty that it is not in the same scale as the original values (because it is squared). Therefore, another measure is commonly used: the mean absolute error (MAE). The MAE is the mean of the absolute values of the deviance so it has the same scale as the original data. A MAE of 5 therefore would mean that our model is on average 5 points away from the position the PG has predicted.

Figure 1: Coalition tree



Our approach deviates from the original theoretical approach of the PG in two essential points: First, we do not simulate face-to-face simulations of all involved players. Instead – relying on the hierarchical clustering – we only have to calculate N – 1 negotiations (9 in our case). We think that this is closer to the real negotiation process than the 3.628.800 (10!) negotiations the PG is simulating. The number is reduced so drastically because in our model the coalitions that emerge are assumed to be stable and therefore additional negotiations only take place between these coalitions. Second, our model falls in a way short behind the strict theoretical assumptions of game theory: A strong player who builds a coalition with a weaker player might lose influence in the game as a whole. Therefore, one could argue that it is not rational to form a coalition. But there are three arguments against this critique: First, we simply defined the rules of the game in a way that every player has to form a coalition and every coalition has to come to an agreement with the other coalitions. Not forming any coalition therefore is simply no alternative in our simulation. It is important to note that a coalition in our model does not involve a mutual agreement but it is only a metaphor for the negotiation process. In our simulation even the worst enemies form a "coalition" in the end. Second, we introduced a variable that gives more weight to the coalitions that are formed first. Therefore, it can be rational to join a weak partner with a similar position early in the game. Third, the strict assumptions of rational choice have been questioned in policy analysis for decades (Jones 2003; Lindblom 1959; Simon 1976). Thus, one could argue therefore that our model is gaining a "sense of reality" instead of losing theoretical strictness.

Finally, as can be seen in the following section, our model comes up with more or less the same outcomes than the PG. The differences in theory therefore seem to be marginal in practice. Before presenting the results, we describe the determination of the input variables of our models and the PG when applied to the EU's external natural gas policy.

Determination of the Input Variables

In this section, the selection of the players and the values of the input variables, derived from a combination of qualitative and quantitative data, are explained for the issue analyzed in this paper. While the selection of the players and their salience scores are determined by data on the countries' import volumes, the influence score is derived from the number of seats of the member states in the European Parliament. The policy positions result from a qualitative content analysis based on two nationwide German newspapers (*Frankfurter Allgemeine Zeitung* and *Süddeutsche Zeitung*), the British newspaper *Financial Times* as well as secondary literature regarding the three pipeline projects Nord Stream, South Stream and Nabucco.

Selection of the Players

To select the players of the game, the individuals or groups who are interested in trying to influence the outcome of the issue being analyzed have to be identified (Bueno de Mesquita 2010: 50). Recent studies regarding decision-making in the EU have proven that energy policy and especially the sensitive area of supply security are still dominated by the member states: "Member States intend to retain their sovereignty with regard to determining their energy mix, as well as choosing their suppliers. [...] [They] retain a pivotal role in designing, implementing and monitoring energy security" (Proedrou 2012:

49, 52; see also Ciambra 2012; Morata and Solorio Sandoval 2012: 210). Thus, the focus is on the member states as unitary actors. However, further restrictions make sense, because it can be assumed that member states which import large quantities of natural gas have the highest interest in influencing European external gas policy. Besides that, studies of external gas policy have shown that the dependency on Russia in the context of gas trade is of special importance to Eastern European states (Larsson 2006, 2007; Proedrou 2012: 91f.; Valášek 2005: 24). Therefore, in selecting the players, the quantities of natural gas imports as well as the difference between Eastern and Western Europe have to be considered. The ranking in Table 1 shows the major importers in the period from 2000-2010[9] in Eastern and Western Europe:

As relevant decision-making actors, we choose the top three of Eastern European states, i.e. Hungary, Poland and the Czech Republic, because in the ranking there is a significant margin regarding the import volumes of the states following the selected players. Therefore, it can be assumed that those states are less interested in the energy relationship with Russia and thus not taken into account in the analysis. With regard to the Western European states we choose the top six. Although it is true that there is also a significant margin after the top three, i.e. Germany, Italy and France, the Netherlands and the

Table 1: Selection of the players

Western European Countries	Imports on average per year (in million cubic metres)	Eastern European Countries	Imports on average per year (in million cubic metres)
Germany	87128.91	Hungary	10694.09
Italy	68045.00	Poland	9800.36
France	44699.55	Czech Republic	9305.73
Spain	29565.36	Slovakia	6653.18
Netherlands	23817.36	Romania	4121.36
United Kingdom	21029.91	Bulgaria	3115.82
Belgium	17759.3	Lithuania	2977.36
Austria	9033.09	Croatia	1102.27
Finland	4605.73	Latvia	1605.55
Ireland	3958.18	Slovenia	1069.09
Portugal	3868.27	Estonia	867.00
Greece	3000.00		
Luxemburg	1200.36		
Sweden	1042.64		
Denmark	13.82		
Cyprus	0		
Malta	0		

Source: International Energy Agency (2004; 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012b)

[9] In this period the debates about the three pipeline projects Nord Stream, South Stream and Nabucco took place. As was explained in section 3, the positions of the EU member states towards Russia can be derived from these debates. The analysis of these projects thus constitutes the central empirical basis to derive the player's policy positions which are supposed to "postdict" contemporary natural gas policy in the context of the simulation. Therefore, the selection of the players, which is based on the import volumes from Russia, also comprises this period.

Table 2: Issue continuum

Numerical value	Policy Position
100	full confidence in Russia as gas supplier; natural gas should exclusively be imported from Russia
90	full confidence in Russia as gas supplier; only very little diversification projects are pursued
80	Russia is the most important contracting partner for pipeline projects; further diversification efforts – especially in LNG – are necessary, but Russia is given priority as source of natural gas supply
70	striving for a long-term cooperation with Russia as the most important contracting partner for natural gas imports; alternative pipeline projects with the purpose of diversification are supported, but not promoted as strong as pipeline projects with Russia
60	balanced share of imports from Russia and other supply sources; if the latter only have little chance of implementation, pipeline projects with Russia are prioritized
50	balanced share of imports from Russia and other supply sources
40	balanced share of imports with a slight preference for other supply sources
30	notable share of Russian imports relative to the total amount of imports, but other supply sources have priority
20	the share of Russian imports relative to the total amount of imports should be small, other supply sources have priority.
10	the dependence on Russian imports has to be minimized, other supply sources have to be explored.
0	Russia has to be excluded from gas supply for the European Union

United Kingdom should not be disregarded, because they have always been very important actors in the European gas sector due to their domestic resources and their recently growing import volumes. However, since the model is supposed to be used as an instrument to create future scenarios of the EU's external natural gas policy, we also add the European Commission. The reason for this addition is the power the European Commission gained with the implementation of the Third Energy Package in 2011. Although the European Commission might not be a relevant actor for the post-diction of the EU's external natural gas policy, the role of the European Commission in the conflict with Russia concerning the South Stream project during the Ukraine crisis has demonstrated that it can become relevant in the future and should thus not be disregarded in advance (Stern et al. 2015).

Policy Positions

The position variable refers to the bargaining position of each actor at the moment the analysis begins (Bueno de Mesquita 2011: 75). It is not an ideal point, but the position the actor advocates within the context of the situation, taking constraints into account (http://www.predictioneersgame.com/game).[10] To determine the score of the actors' policy

[10] In contrast to the expected utility model the PG can take either ideal points or current bargaining positions as basis for the position variable (Bueno de Mesquita 2011: 75f.). In this study the actual bargaining positions, which are derived from the qualitative content analysis serve as empirical basis for the position variable.

positions, as a first step the issue continuum has to be defined (see Table 2). In the present case, defining the issue continuum implies considering the possible positions the players could take towards Russia as gas supplier and reflecting "the relative degree of difference across policy stances that are not inherently quantitative" (http://www.predictioneersgame.com/game).

These policy positions express the relationship with Russia in rather technical and strategic terms: The extreme values 0 and 100 reflect the polarized policy positions of excluding Russia completely as gas supplier for the EU and relying on Russia as the only gas supplier. They set the boundaries of the issue continuum. Embedded in the wider context of the dependence-interdependence-concept, the policy positions between 100 and 70 are attributed to states which advocate the concept of interdependence, the policy positions between 69 and 30 are in between, evaluating gas trade with Russia not exclusively as a threat to their supply security, but not simply relying on the dependence of Russia on the European market either, while the policy positions between 29 and 0 are attributed to states which criticize high volumes of Russian imports as one-sided dependency and direct nearly all of their efforts towards diversification of supply sources.

Although the actors' positions are finally transformed into numeric values, the continuum does not provide a natural numeric interpretation, since the member states' policy positions towards Russia do not necessarily correlate with their import volumes or other similar data. Thus, the question arises how to gain information about them. As already explained, the policy positions of the players taken towards Russia are best reflected in debates about diversification and infrastructure policy in Europe, especially in debates about the pipeline projects Nord Stream, South Stream and Nabucco, so that these debates constitute appropriate units of analysis. Nevertheless, questions concerning the methodological proceeding remain.

In EU studies on decision-making there is still an extensive debate about which data sources to use for generating information about the actors' policy positions. When applying his simulation, Bueno de Mesquita uses information from expert interviews as empirical basis for the values of the four input variables "policy position", "influence", "salience" and "resolve". The same accounts for the DEU dataset. Though advantages and disadvantages of the interviewing approach in EU studies have already been discussed extensively in the literature (see e.g. Bueno de Mesquita 2004, 2010; Schneider et al. 2011; Selck 2005; Sullivan and Selck 2007; Sullivan and Veen 2009; Thomson 2011; Veen 2011b; Warntjen 2012), it is indisputable that the DEU data set constitutes an extremely valuable contribution to the consolidation of empirical knowledge about decision-making in the EU. Still, problems of this way of proceeding which arise beyond merely scientific aspects cannot be ignored: Namely that it is a very costly, time-consuming approach, especially when it comes to studies on the European level. Within the context of the debate about the input data of the models, some authors therefore propose the quantitative analyses of primary documents made available from the EU, such as the Eur-Lex and PreLex databases and Council Minutes[11] (Hagemann 2007; Häge 2011; Sullivan and Veen 2009: 19), or data generation based on European party manifestos (Veen 2011b). However, using the EU's databases is not possible in the

[11] Though these data sources offer substantial information about the legislative process in EU decision-making, their appropriateness for examining policy positions has nevertheless been doubted by some scholars (see e.g. Selck et al. 2009: 466f.).

present case, since decisions regarding pipeline projects are not taken within the framework of the formal decision-making setting in the EU. Therefore, a qualitative content analysis[12] based on two German nationwide newspapers (*Süddeutsche Zeitung* and *Frankfurter Allgemeine Zeitung*) as well as the British newspaper *Financial Times* has been carried out for these three cases, covering the period between 2000 and 2010. Two remarks concerning the period under examination and the sources are necessary: Though the initial policy positions of the actors had to be explored, we did not limit the period under examination to the beginning of the decision making process of the pipeline project, but extended it to the year 2010. This was necessary, because some member states did not comment on the projects immediately in the media. The period chosen was long enough for collecting statements from all actors and deduce their initial bargaining position from these statements.[13] With regard to the newspapers chosen it has to be mentioned that the three pipeline projects received very much attention in the German media. Therefore, the two German newspapers already provided enough information to examine the actor's policy positions. Nevertheless, we added the British newspaper *Financial Times* and the review of the secondary literature as a control for national bias. In total, 339 newspaper articles, in which the players' positions towards the pipeline projects are reported, have been extracted according to the three categories: "approval/ rejection", "dependency/interdependency" and "significance of the project in relation to the whole supply portfolio".[14] The advantage of the qualitative content analysis is that the relevant data from the text material is extracted systematically, so that the information is gradually summarized in view of the research question without passing over components of the original data (Gläser and Laudel 2010: 204f.). This rule-based procedure reduces the risk of post-dictive bias[15] and serves as an appropriate tool to scale the qualitative data: The result of the content analysis is a compact description of the member states' policy positions which can then be compared to the positions of the issue continuum with the purpose of transforming the policy positions of the players in numerical values. The results are presented in Table 3. To sum up, the allocation of the member states on the issue continuum reflects huge differences in their initial policy positions towards Russia as gas supplier.

Influence

The value of the variable "influence" reflects the relative potential ability of each player in persuading others to change their position on the issue. The values usually vary between 0 and 100, although they are not restricted to this range. As a useful approach Bueno de Mesquita recommends crediting the player who is most persuasive with a score of 100 and

[12] For a detailed description of the methodological approach see Gläser and Laudel 2010.

[13] Since we conceptualized the member states and the European Commission as unitary actors, changes of government during this period did not matter for the research on the respective policy positions.

[14] The categories have been developed on the basis of preliminary theoretical considerations. The advantage of applying these categories when extracting the data from newspaper articles is that the huge amount of text material is reduced to only the relevant information and systematically structured with regard to the research question. Though the categories are determined in advance, they are still open for change during the extraction process and can be expanded if necessary (Gläser and Laudel 2010: 200).

[15] Referring to Bueno de Mesquita (2004) and Schneider et al. (2006), Veen describes the problem of post-dictive bias as "the issue of estimates of policy positions being tainted by knowledge of policy outcome" (Veen 2011b: 25).

Table 3: Input Variables

Player	Policy Position	Influence	Salience	Resolve
Germany	100	100	42.0	30
Italy	100	76.8	31.3	30
France	100	76.8	20.1	30
Spain	50	53.2	0.1	30
Netherlands	70	26.6	6.1	30
United Kingdom	40	76.8	0.1	30
Hungary	60	23.5	81.5	30
Poland	10	53.2	78.1	3ß
Czech Republic	40	23.5	76.2	30
European Commission	50	10	37.8	50

rate all of the other players relative to that score (Bueno de Mesquita 2010: 50, 53f.; http://www.predictioneersgame.com/game).

In EU studies lots of research on the measurement of power has been done. With regard to formal modelling of decision-making processes it can be summarized that the different models tested performed best when the influence of the member states was either measured with voting power indices reflecting a regressive distribution of power[16] or when the influence was determined as an equal distribution between the member states (Bueno de Mesquita 2011: 77; Schneider et al. 2010: 98f.; Thomson 2011: 224).[17] In the present case, the application of voting power indices is problematic since they are developed to measure the voting power of members of institutions with specific voting rules (Veen 2011b: 45), but the EU's external natural gas policy is not embedded in the formal voting procedures of the EU. However, there are still many reasons for arguing that large member states dispose of more capabilities to influence the decision-making process than smaller states (e.g. larger bureaucracies for lobbying activities, economic resources to offer side payments, etc.), though the bargaining power of small member states might be disproportionately great (Cross 2013: 78; Thomson 2011: 225, 237). Against this background, we consider it to be reasonable to differentiate between large and small member states, but to assume a regressive distribution of power. We therefore determine the influence values corresponding to the average number of seats of the member states in the European Parliament from 2000 to 2010, starting with a score of 100 for the country with the most seats and calculating the remaining scores in relation to it, since the concept of degressive proportionality in the European Parliament implies that the larger states are under-represented while the smaller member states are overrepresented (Corbett et al. 2011: 28f.). The European Commission is characterized with a relatively low value of influence, because between 2000 and 2010 she was engaged in the internal dimension of

[16] The regressive distribution computed in Thomson 2011 is based on the distribution of voting weights among member states according to the qualified majority voting (QMV) rules employed in the Council (Thomson 2011: 213f.).

[17] In spite of the relatively good predictive performances of models implying voting power indices, some scholars doubt that the mere consideration of votes is enough to reflect bargaining power, but that other – partly informal – factors are relevant, e.g. negotiation skills, the actors' policy positions, etc. A very good overview of various aspects influencing bargaining power and the respective state of the art offer e.g. Bailer 2010 and Veen 2011b.

natural gas policy, but hardly had any power in the external natural gas policy of the EU. The values resulting from these considerations are summarized in Table 3.

Salience

Salience assesses how important an issue is for all players and to what extent they are willing to exert their influence in the negotiation process. These values also range from 0 to 100 (Bueno de Mesquita 2010: 50, 53). The question of how to determine the actors' salience values reveals further boundaries of the media approach: Though the newspaper articles offer a broad range of information on the policy positions of the member states, the relevant actors hardly clarify in their statements the importance they attach to the issue. A quantitative analysis of the issue's media coverage might indicate the importance of the issue as a whole, but will not provide the researcher with information about the actor-specific salience (Warntjen 2012: 181). However, in our view it is possible to derive the actor-specific values from quantitative data if we consider the starting point of the conflict between the member states: The research question asks for the position of EU member states towards Russia as gas supplier including their political strategy towards Russia to ensure reliable supply. As was pointed out earlier, the main dispute arises from the question of how to evaluate the large import volumes from Russia; namely whether volumes should remain equal or even be increased to establish an independent relationship between the EU and Russia or whether the dependency on Russia is perceived as a threat to supply security which is why the EU's import portfolio should be diversified. Thus, it can be assumed that the political strategy towards Russia is most relevant for those states which have a high share of Russian gas imports. The value of salience is therefore calculated as the share of Russian gas imports relative to the total amount of gas imports of each player in percent.[18] The data used for this formula includes the average value of the gas imports between 2000 and 2010 (source: Natural Gas Information). The values are summarized in Table 3.

Resolve

This variable, an indicator of resolve, reflects "the relative weight each stakeholder gives to resolving an issue compared to holding firm to its position" (Bueno de Mesquita 2011: 75) even if the latter results in failing to reach any agreement. The values of this variable vary between 0 and 100; higher values indicate a greater willingness to form compromises, while lower values indicate an intense commitment to a position so that the players are rather unwilling to compromise (Bueno de Mesquita 2011: 75; http://www.predictioneersgame.com/game).

Deriving the resolve of the negotiating parties from newspaper articles entails risks of being misled by the already known policy outcome and confusing the factors which actually lead to position shifts: Actors who shift their positions significantly during the negotiation process might be attributed with a high willingness to compromise although they may simply lack the power to influence the negotiation process and vice versa. When applying his simulation to the DEU dataset, Bueno de Mesquita does not dispose of expert estimates of the resolve variable and thus sets every actor's initial value at 50, in the

[18] For the European Commission we used data from the EU-28.

middle of the resolve scale (Bueno de Mesquita 2011: 76). We follow his approach in attaching the same score to all actors – except for the European Commission – since we lack an empirical basis for profound variation in this variable, but modify it slightly on the basis of previous findings regarding decision-making in the EU as well as earlier applications of the PG.

In applications of the simulation in other contexts, players normally fell between 0 and 35.[19] In this game, all of the players are assigned with a score of 30. As can be seen, this is on the one hand a relatively high score, compared to other applications of the game, but on the other hand still quite modest if one takes into consideration that the players are all member states of the EU and therefore cooperate in many ways. In the following, the derivation of this score is explained: The study by Thomson et al. has shown that "the best predictions are given by models based on cooperative solutions that include the positions of *all* EU decision-makers. *Unanimity, wherever possible*, is a very strong norm in the EU, [. . .]" (Stokman and Thomson 2004: 19). Furthermore, all of the players import high volumes of natural gas and therefore depend on common decisions with other states to build the infrastructure necessary to provide gas imports. Thirdly, EU member states know that they have to negotiate in numerous other cases in the future, in which they might need to cooperate with other member states to achieve their goals. They are constantly engaged in common policy making. Having this in mind might stimulate the member states' willingness to compromise (Arregui et al. 2006: 151f.; Bueno de Mesquita 2004: 132; Schneider et al. 2006: 305). These three arguments speak in favour of a very high resolve score of the players. However, the score also has to take into account the fact that the member states' interests still remarkably determine EU energy policy in general and external gas policy in particular. The score of 30 therefore reflects these poles given that it is relatively high in comparison to players in other contexts, but not exceeding them either just because the players are member states of the EU. Because of its supranational character, the European Commission is equipped with the score 50. Table 3 summarizes the input values for the selected players.

Results

Results of the model-building

As described above, we created four models that try to predict the same results as the PG in a random simulation of 200 cases: a simple linear regression (linear model; hereinafter called "LM") with 40 predictors (four for each of the ten players), the weighted mean (hereinafter called "WM"), a model based on the described heuristics and optimized numerically (heuristic model; hereinafter called "HM") and a model that does not take into account the *resolve* values (reduced heuristic model; hereinafter called "RHM") but is more or less as accurate as the HM.

We now plot the predicted values of these models against the original values of the PG (Figure 2).

It can be seen that all models predict the original values quite well: most of the points are close to the plotted regression line.

The numerical evaluation supports this impression. Table 4 shows the correlation coefficient (COR), the mean squared error (MSE), and the mean absolute error (MAE).

[19] Information based on the correspondence with Bruce Bueno de Mesquita.

Figure 2: Model plots

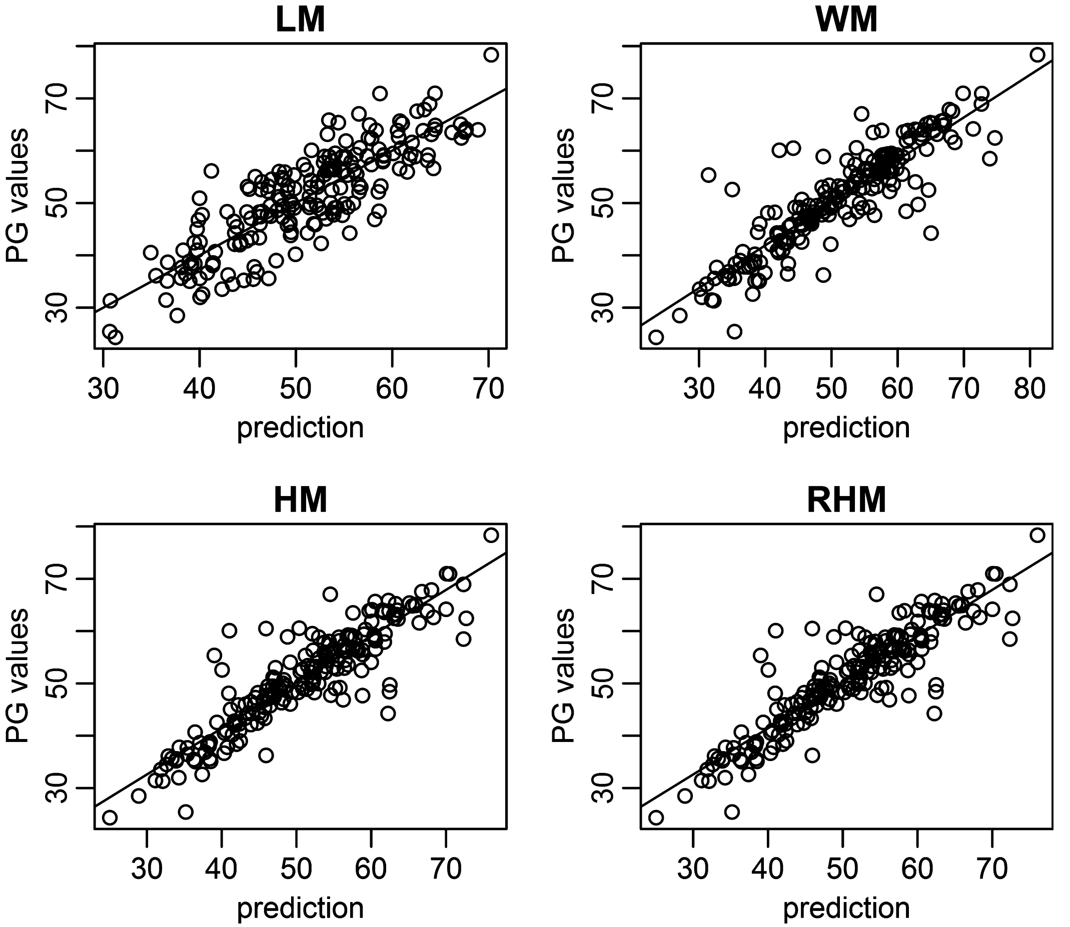


Table 4: Numerical evaluation

error measures			
	COR	*MSE*	*MAE*
LM	0.84	27.55	3.26
WM	0.88	24.93	3.09
HM	0.9	20.43	3
RHM	0.9	20.5	3.01

No matter what error measure is taken, the picture stays the same: The LM is already quite accurate but it is beaten by the WM. Our own models are more accurate than the WM and perform more or less identically. They show a correlation of 0.9 with the original values of the PG. On average, our models deviate only 3 points from the final position the

PG predicts. Because the RHM is sparser (it works without *resolve*) we choose this model for the further analysis.

When evaluating the deviation of our new model from the PG as a measurement of its overall predictive accuracy concerning EU decision-making, a further aspect has to be taken into consideration: The PG – that means our "gold-standard" itself – features a mean absolute error of 22.8 in its application to the whole DEU dataset and a mean absolute error of 16.9 when applied to 37 issues of the DEU dataset, which do not have a recursion point and are thus supposed to reflect the non-cooperative bargaining environment modelled in the PG (Bueno de Mesquita 2011: 80f.). Therefore, it is impossible to judge if our model is (slightly) weaker than the PG or if it might even outperform it. We are therefore convinced that our model is suitable to analyze the external natural gas policy in the EU. Thus, in the following section a post-diction of the EU's external natural gas policy before the beginning of the Ukraine crisis in November 2013 is generated applying the PG as well as our new models. In this way, we can compare the model results with the real world policy and evaluate their predictive accuracy.

Simulation Results

In this section, the simulation results of the post-diction are interpreted and it is analyzed whether the models can be considered an analogy to the policy decisions made in the EU's real external natural gas policy before the beginning of the Ukraine crisis in November 2013.[20]

As we can see in the following table, after inserting the input variables described in the previous section, the models all produce similar results, ranging between 61 and 68.

How can these results be interpreted? The scores express the EU's policy towards Russia as gas supplier as a result of the negotiations between the players. It is a post-diction of the EU's external natural gas policy focusing on the relationship with Russia in November 2013. If we compare these scores with the corresponding positions in Table 1, these outcomes reflect the tension between the two existing concepts regarding the evaluation of gas trade with Russia – dependence and interdependence – with a tendency towards the concept of interdependence which is a bit stronger in the PG than in the other models. However, in all models the players striving for a strategic partnership with Russia assert themselves more successfully in negotiations regarding gas infrastructure policy. Nevertheless, the simulation results consider – our own models more than the PG – that efforts to diversify still exist, but are given less priority and are – in case of conflicting interests or doubting chances of implementation – dropped for the benefit of pipeline projects with Russia.

The coalition tree (Figure 1) provides us with additional information about the coalitions formed in the HM and the RHM. According to these models, France, Germany and Italy form a coalition and have to enforce their position against all of the other players. In the group of the opponents, the coalition of the Netherlands and Hungary is the one most willing to cooperate with France, Germany and Italy, while the other players are much more skeptical. If we compare the coalition tree and the

[20] We determine November 2013 as corresponding date of our point prediction, because in the literature on the Ukraince crisis it is assumed that the conflict between the EU and Russia marks a turning point in their gas relations (Engerer et al. 2014: 479; Granholm and Malminen 2014: 9; Westphal 2014: 1f.).

simulation results of the HM and the RHM, we can infer that France, Germany and Italy form a very influential coalition, which is able to enforce its position against the other players since the simulation results clearly mark a tendency towards a strategic partnership with Russia, but obviously this coalition still has to agree to certain concessions towards the opposing group of players.

As already explained, the post-diction of European external gas policy is a necessary – though not sufficient – step to test whether the causal assumptions of the model as well as the acquired data fit to analyze this policy field. It requires a comparison of the simulation result with the European external gas policy in November 2013 – more precisely with the infrastructure projects implemented in recent years and the position towards Russia reflected in these projects. In the following, the negotiation results of the pipeline projects Nord Stream, South Stream and Nabucco, which served as empirical basis for the content analysis, as well as additional infrastructure measures in the EU are outlined and interpreted with regard to the respective policies towards Russia.

- *Nord Stream*: This pipeline project was evaluated as an effort to strengthen the energy partnership with Russia and its contribution to gas supply of the EU. The supporters of the project successfully achieved its realization: Line 1 was inaugurated in November 2011, line 2 in October 2012 (Nord Stream AG 2013). Thus, a pipeline project was implemented which reflects the striving for a strategic energy partnership with Russia and is supposed to intensify gas trade with Russia for decades.
- *Nabucco*: The Nabucco pipeline was supposed to diversify gas supply sources and to decrease dependency on Russian exports. The implementation of the project failed – amongst other problems – because of the withdrawal of the companies RWE (Germany) and MOL (Hungary). The latter finally opted for the Russo-Italian project South Stream because of decreasing chances of implementation of the Nabucco project and economic reasons (Olt 2007).
- *South Stream*: This Russo-Italian pipeline project was considered as competing project of the Nabucco pipeline. It implies the supply of Southern Europe with Russian gas. In December 2012 the construction of the South Stream pipeline was officially started (FAZ 2012).[21]

As can be seen, serious efforts to diversify gas supply sources and to reduce the dependency on Russian gas existed in the EU: The most prominent one was the Nabucco pipeline project. In addition to that, many member states invested in the construction of LNG terminals in the last decades to diversify their supply sources, especially Spain, France, Italy and the UK (Gilardoni 2008, 76ff.). Moreover, the Trans Adriatic Pipeline project, connecting the Caspian Region with Greece and Italy, was introduced in 2003 and its construction is supposed to start in 2015 (TAP AG 2012). Repugnant to this, a very strong opposing pole existed, which advocated a long-lasting energy partnership with Russia and was finally able to implement its pipeline projects Nord Stream and South Stream.

To sum up, it can be stated that none of the EU member states pursued the strategy of relying exclusively on natural gas imports from Russia. They either already imported natural gas from other states, e.g. Norway or Algeria, or looked for diversification

[21] The break-up of the project, announced by Russian president Wladimir Putin in December 2014, took place after the beginning of the Ukraine crisis and therefore does not have to be considered in the comparison of post-diction and real EU gas policy in November 2013.

possibilities like LNG terminals or alternative pipeline projects circumventing Russia. However, the most important infrastructure measures in the EU are voluminous natural gas pipelines, since the EU still covers the majority of its natural gas demand with pipelines (IEA 2012b: IV.38). In this sector, the member states advocating an intense partnership with Russia prevailed. The external gas policy of the EU in November 2013 was thus characterized by the tension between the dependence and the interdependence concept and the corresponding policies towards Russia, but the final policy outcome is determined by the latter, since the most important and successful pipeline projects of the last decades imply long-lasting cooperation with Russia as exporter to the EU.[22] Therefore, the models all serve as an analogy to the real world, since they all reflect these opposing poles (our models slightly more than the PG), but indicate that the policy outcome tends towards pipeline projects with Russia if there is a lack of realistic alternative projects.

Given this real world outcome, we can also detect analogies between the coalition tree of model-1 and model-2 and the real policy process. In spite of the – in quantitative terms – strong group of states opposing an intensive energy partnership with Russia the leaders of the Nord Stream- and South Stream-project, Germany and Italy, were able to persuade coalitions of the other group, the Netherlands and Hungary as well as the UK and the Czech Republic, to support their projects, which finally forwarded the failure of the Nabucco-project.

After affirming the correspondence of post-diction and real world policy, in the next section we apply additional tests to verify the validity of the simulations.

Verifying the Validity of the Simulations with Additional Scenarios

In this section, the validity of the simulations is tested by comparing expectable future scenarios of the EU's external gas policy with policy outputs produced by modified versions of the original models in accordance with the changed conditions. This is a necessary step before using the models for predictions of the development of the EU's gas policy based on *ceteris paribus* assumptions.

As was shown in the preceding section, the simulation results serve as an analogy to the observed reality. This finding is of importance, since it is a necessary condition to be able to formulate expectations about real world politics by creating different policy scenarios based on the original simulations. Because only "to the extent the same rules apply to the simulation and to the compared system, both systems should behave similarly" (Hegelich 2016). The concordance of simulation outputs and EU gas policy in November 2013 is thus a first hint that the rules of the simulations are akin to the rules

[22] Some might argue that the TAP was implemented and therefore a pipeline, which connects the EU to the Caspian Region and is not filled with Russian gas. However, the TAP was a competing project to the Nabucco-West pipeline, the "reduced version" of the originally planned pipeline, and consequently prevented the implementation of Nabucco-West. In addition to that, it connects Greece, Albania and Italy and therefore circumvents many EU member states, which are extremely dependent on Russian gas. Thus, TAP is a diversification project in the sense that it circumvents Russia, but it does not increase the supply security of the most vulnerable member states – and (except for Italy) not of the players of this simulation either, as Energy Commissioner Guenter Oettinger explained: "We cannot forget the reason why the route from Turkey to Austria [i.e., Nabucco] is so important, because it connects the largest number of vulnerable gas markets in Central and Southeastern Europe, dependent on a single supply source [i.e., Russia]. Our concern is to reduce the dependence of the most exposed countries, as soon as possible." (Press Release, May 21 2013, quote taken from Şaban 2013)

of the real world system. Still, the comparison of simulation outcomes and policy result in the real world is not sufficient to assume that the simulations emulate the real world system adequately so that they are able to predict policy outcomes reliably, because it is only *one* case, which has proven to be an analogy to the real world outcome. This could simply be a coincidence. However, the strength of simulations is that their validity can be verified by performing additional scenarios to test whether in these scenarios the simulations also produce policy outcomes which mirror the real world policy. Although there are no further "real" cases with which the scenario outcomes can be compared, it is possible to imagine probable future developments of EU external gas policy: What is likely to happen if certain conditions of contemporary EU external gas policy change? To compare these expectations with the simulation output, one has to consider how these changed conditions in the "real world system"[23] can be emulated in the simulations by modifying the data. Finally, the expected development of the real world system can be compared to the policy outcomes produced by the simulation. This way of proceeding – considering hypothetical but very reasonable future developments of "real" EU gas policy, emulating the changed setting in the simulations and comparing the future expectations with the simulation outputs – enables the researcher to test whether the concordance of the original simulation output and the contemporary EU gas policy is simply a coincidence or whether the simulations also prove to emulate the "real world system" correctly in other cases. To conduct this plausibility test of the simulations three possible scenarios of future EU gas policy are described, emulated in the simulations and finally the hypothetical real world output and the virtual world output are compared.

- *Case 1 – Change of government in Poland:* In the debates about the three pipeline projects, Poland was the biggest opponent of expanding Russian gas imports to the EU. It was the only member state which constantly argued for preventing the Nord Stream project. Therefore, it can be assumed that if a change of government takes place in Poland and the policy towards Russia changes drastically into one that is in favor of an energy partnership with Russia the way it is proposed by Germany, Italy and France, this will have an effect on the EU's external gas policy. Since an important actor responsible for the prevention of a common EU energy partnership with Russia would turn into a pro-Russian advocate, we can in all probability expect the EU's external gas policy to tend even stronger towards the strengthening of Russia's role as gas supplier in the EU and the support of pipeline projects with Russia.
  How can this change of government be portrayed in the simulation? The salience, influence and resolve variable scores remain the same, since the import volumes from Russia and the seats in the European Parliament will not change. But the change of government has to be represented in the policy position. Since in the "real case scenario" Poland opts for a policy towards Russia, which is similar to the policies of

[23] Of course it cannot be proven that the hypothetical cases would occur in exactly the same way in the real world system, but based on the expertise acquired in the field of EU gas policy it is possible to describe what can be *expected* to happen in the real world with a *very high probability* if certain conditions change. To avoid any misunderstanding it is important to stress that we do not expect the *starting point* of the scenario, i.e. hydraulic fracturing in Germany or the radical policy changes of Germany, Italy, France or Poland, to occur with a high probability in the near future. Instead for the choice of the scenarios it is important that the *consequences* of these events can be predicted with high a probability since the evaluation of the simulation is based on whether it is able to predict *these consequences* adequately.

Table 5: Simulation results

Simulation results					
Case	*LM*	*WM*	*HM*	*RHM*	*PG*
Post-diction	61	65	62	62	68
Variation 1	71	87	85	85	87
Variation 2	57	52	53	53	54
Variation 3	36	21	23	23	21

Germany, Italy and France, the implementation in the simulation requires a transformation of the policy position score of Poland into 100, which is the policy position score of the three just mentioned players.

As has been explained above, the probable assumption of the "real case scenario" is that the EU's external gas policy tends towards promoting Russia as the most important gas supplier for the EU. To support the assertion that the simulation presented in this paper is viable, the simulation result has to mirror this real case scenario adequately. As we can see in Table 5, the simulated policy outputs of this modification are almost identical, they vary between 85 and 87.[24] The models thus predict a notable variation in the EU's external natural gas policy compared to the post-diction. According to the PG and our models, a change in Poland's policy towards Russia would influence the EU's external gas policy in a way that it strives for a long-term cooperation with Russia as the most important contracting partner for natural gas imports. In contrast to the postiction, this scenario predicts a stronger support for a long-lasting energy partnership with Russia and less efforts in diversification projects. These simulation results can thus be assessed as an analogy to the expected "real case scenario".

- *Case 2 – Germany starts hydraulic fracturing:* In Germany there is an intense debate about the use of hydraulic fracturing to extract gas from non-conventional sources. Although some political parties opt for a ban or at least tighter controls on hydraulic fracturing and a moratorium by the federal state of North Rhine-Westphalia was adopted, several companies have acquired exploration licenses and some test drilling has already taken place (Buchan 2013: 4; Fleming 2013: 31; Umbach 2013: 8). Since Germany disposes of an extensive onshore shale gas basin (Buchan 2013: 3) and has in addition to that decided to phase out nuclear power by 2022, the interest in unconventional gas resources remains quite high (Umbach 2013: 8). However, the general view among the German government has been that a decision about prohibiting or permitting hydraulic fracturing can only be taken if further scientific research about the risks of hydraulic fracturing has been conducted (Umbach: 2013: 8). Thus in 2015 the German government decided that from 2018 on an expert commission should investigate whether commercial drilling should be approved (Bundesministerium für Wirtschaft und Energie 2015). Germany is a powerful member state in the EU, which clearly advocates an energy partnership with Russia and the Nord Stream pipeline is deemed to be a Russo-German project. Thus, there cannot be any doubt that the energy relations between Russia and Germany shape the

[24] Only the simple linear regression model deviates significantly from these scores.

EU's external gas policy significantly. Given this background, it can be expected that Germany's interest in Russian imports will decrease if it extracts its domestic shale gas resources, Germany's support for an intense energy partnership with Russia will be less committed and consequently Russia counts less for the EU's gas supply while diversification projects gain importance in comparison to the EU's present gas policy.

Again the question arises how this "real case scenario" can be simulated. In the simulation it is assumed that Germany's gas imports are reduced significantly since domestic production increases.[25] The volume of imports affects the salience variable, the score is now supposed to be lower. Moreover, it is assumed that Germany has less interest in an energy partnership with Russia, since its domestic production increases, Russian gas imports are hardly necessary anymore and besides, the decision to start "fracking" reflects a policy which opts for more diversification measures. Germany's policy position is thus reduced to the score of 50. These changes in the salience and the position variable generate almost similar results in the HM, the RHM and the PG with scores of 53 and 54 (see Table 5) So, according to the simulations, Russia becomes less important for the EU's external gas policy, since pipeline projects with Russia are not prioritized in comparison to other supply sources (the scores are close to 50), even if the implementation of other pipeline projects implies more challenges. Therefore, in this case the simulation results can also be assessed as an analogy to the expected "real case scenario".

- *Case 3 – Radical policy change of Germany, Italy and France towards Russia:* In the first two cases it has been tested whether the simulations are able to portray the EU's gas policy adequately if single member states change their policy towards Russia. An interesting test for the range of explanations of the models is to think of a scenario in which a group of member states changes its policy towards Russia radically. The analysis of the three pipeline projects Nord Stream, South Stream and Nabucco has shown that Germany, Italy and France are the strongest advocates of prioritizing Russia as contracting partner for pipeline projects and have at the same time huge influence in the EU's gas policy. This becomes obvious if one looks at the successful implementation of their promoted pipelines: Germany was the main actor in the development of the Nord Stream project, Italy in the South Stream project and France participated in both. Therefore, it can be expected that a radical change in the gas policies of these states towards a minimization of Russian imports would imply a significant loss of importance for Russia as gas supplier of the EU and the EU's gas policy would clearly be directed towards diversification projects.

  How can such a development be emulated in the simulation? Similar to the first case, the salience, influence and resolve variable scores would remain constant. The policy changes have to be reflected in modifications of the policy position scores. In the "real case scenario" Germany, Italy and France opt for a minimization of Russian imports and thus take the same position as Poland. The policy position scores of the three players are therefore changed into 10. The simulated policy outputs of this scenario range between 21 and 23 (see Table 5).[26] They thus deviate significantly from the

[25] Because of long-term contracts, Germany will still be obliged to import certain amounts of gas from Russia in the future. Therefore, it would be necessary to examine these contracts and to calculate the extent to which Germany would actually be able to reduce its imports to enhance the closeness to reality of this simulation. However, in this paper it is waived to perform such a calculation but to estimate a realistic value since the purpose of this scenario is simply to test the validity of the simulation and hence whether the simulation indicates the same tendency of policy development as the "real case scenario".

[26] Again the simple linear regression model deviates significantly from these scores.

simulation outputs of the post-dictions. According to our models and the PG, a drastic deterioration of the relations between Germany, Italy and France towards Russia would shape the EU's external gas policy in a way that Russian imports are only of very little significance for the EU, while other supply sources are generally prioritized. Hence, "real case scenario" and simulation results are also similar in this case.

What conclusions can be drawn from these scenarios for the validity of the models? Except for the LM, in all three cases the policy outputs of the modified models serve as analogies to the "real case scenarios". The simulations thus not only perform well in the post-diction of contemporary EU external gas policy but also in other scenarios. Hence, the simulations have passed an important test to verify their validity and they are obviously very suitable to portray the real world system.

Conclusion

According to most recent studies, the PG is the model which outperforms most other models at analyzing and predicting EU decision-making if the setting is characterized by rather non-cooperative conditions. However, the problem of the PG is that its codes are not available to the public. Hence, the decision-making process which is simulated in the model remains a black box. Therefore, in this paper we introduced a method to construct models that perform equally well but are open source and rely on – in our opinion – more realistic assumptions of the negotiation process. In addition to that, a new way of generating the input data has been presented, which provided a viable empirical basis. By conducting a post-diction as well as three test scenarios, we demonstrated that our models fit for a policy field like the European external gas policy, which on the one hand is dominated by the national interests of the EU member states. It thus has to be concluded that our models are highly suitable for analyzing European external gas policy and that it may provide additional insights when used for predictions.

We applied our new models as well as the PG to the external natural gas policy of the EU – more precisely to analyze the divergent positions of nine EU member states towards Russia as gas exporting country and the resulting policy outcome in the form of infrastructure measures. It was shown that the simulations all produce almost similar results and serve as analogies to the "real world" – the EU's external gas policy regarding Russia before the beginning of the Ukraine crisis – since they reflect the tension between the striving for more independency from Russian imports on the one hand and the long-term commitment to Russia as main supplier of the EU to guarantee its imports on the other hand, while they simulate correctly the tendency towards a close and long-lasting trade relationship with the exporter. The validity of the simulations have additionally been tested by considering hypothetical but very reasonable future developments of "real" EU gas policy, emulating the changed setting in the simulations and comparing the future expectations with the simulation outputs. The simulations have in all three cases – the change of government in Poland, hydraulic fracturing in Germany as well as the policy changes in Germany, Italy and France – produced policy outputs, which are similar to the expected "real case scenarios". The models and the empirically obtained data thus fulfill a necessary condition to be suitable to analyze the policy field of the external gas policy of the EU.

Concerning the task of modeling decision-making processes in the EU, two important conclusions can be drawn: Firstly, non-cooperative bargaining models should not be left out of consideration in search of adequate models to simulate the decision-making process in the EU. Though compromise has proven to be a central characteristic of EU decision-making, there obviously still exist policy areas in which the member states are less willing to cooperate. For these cases our preferred RHM turns out to be a useful instrument for analysis, since it reflects the competitive bargaining environment in its rules, but even so offers the possibility of attenuating the non-cooperative aspect of the model with the incorporation of coalition-building. Secondly, the successful application of the model also indicates that the combination of newspaper articles, secondary literature and quantitative data provides an easily accessible, but still reliable empirical basis for the input values. This does not mean that this way of proceeding is always the optimal method for generating the necessary data. The adequacy of a method always depends on the object of research and the research question. However, with our exemplary case we want to demonstrate that – especially in policy fields which receive much attention in the media and offer the possibility of cumulative research by building upon previous studies – this methodological approach offers various advantages and should therefore be applied more often to broaden our empirical knowledge about EU decision-making. Thus, we argue in line with Selck, Yardımcı and Kathan (2009: 470) who state that "[t]he data is out there; all we have to do is use it".

Besides that, with regard to the methodological approach the general question arises how policy analysis and game theory can benefit from each other and in what way an additional scientific value is achieved by applying the formal model. In this paper, the policy positions of nine EU member states were derived from a comparative case study, analyzing three pipeline projects: Nord Stream, South Stream and Nabucco. Case studies have long-standing tradition in EU studies (Pahre 2005: 114). Their strength lies in the detailed, comprehensive and context related analysis of certain aspects of political reality and therefore they provide deep insights into the research object (Borchardt and Göthlich 2007: 36; Muno 2009: 121; Sartori 1994: 24). However, case studies are often criticized for not being able to draw general conclusions or to falsify established theories (Achen 2006: 265; Lijphart 1971: 691; Ragin 2000: 90, quoted by Muno 2009). In contrast, formal models serve to give insight into what usually happens. This inevitably requires a reduction of complexity and focus on the essential parts of political phenomena, disregarding peculiarities and details of single cases (Achen 2006: 267; Pahre 2005: 120). Still, the performance of a model "crucially depends on the reliability of the information used for the forecast" (Schneider et al. 2011: 8) and thus on the empirical basis, which, in this paper, consists of the comparative case study. It is exactly this interface, which combines the advantages of both methodological approaches and compensates their respective disadvantages: While case studies provide necessary and elaborate sources of data – in this paper the policy positions of nine EU member states towards Russia as supplier of natural gas –, the formal model enables the researcher to generalize these findings – as was shown above by describing general patterns of decision-making in the respective policy field. In addition to that, the combination of the two methods makes it possible to develop and compare different scenarios of European external gas policy based on ceteris paribus assumptions given by the simulation. The scenarios performed in this paper served to proof the validity of the simulation, but they also gave a first impression for researchers not familiar with simulation methods of the possibilities the simulation approach provides. These scenarios are not only interesting for researchers, but especially for practitioners who are enabled to try out the effects of different policy options carried out by themselves or other actors on a scientifically valuable basis.

Against this background, our model opens a new perspective for further research concerning the EU's external natural gas policy: Since the model performed quite well in the post-diction and the "real world scenarios", we are confident that the model will also be useful for predictions. At present, the international gas market is changing rapidly. Because of the "shale gas revolution", the USA turned from the world's biggest importer to the world's biggest producer of natural gas. Other countries like Poland are also keen to participate in the boom of unconventional gas. In addition – and probably most important – the political relationship between the EU and Russia has deteriorated significantly due to the Ukraine crisis and the natural gas sector has been converted into an additional "battle field" with both sides announcing a change of strategy in their respective natural gas policies. These uncertainties make sound predictions of the EU gas policy both more necessary and more difficult. To simulate these processes in a model is thus an important but not easy to accomplish task for further research.

With regard to the modelling approach, it would be interesting to compare our model in subsequent studies with additional other models, especially with an adaptation of the Nash Bargaining Solution introduced by Schneider, Finke and Bailer, which outperformed the PG when applied to the DEU dataset (Schneider et al. 2010). In addition to that, further research should explore to what extent the fuzzying approach can also be used to emulate other game theoretic models.

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