

APPLYING GAME THEORY TO NORTH KOREA-CHINA RELATIONS

ABSTRACT

Relations between North Korea and China are not improving on political matters since 2006, when North Korea started to do regular nuclear attempts. In order to explain the nature of relations between these both countries, I propose to apply the framework of Game theory. These concepts and the notion of risk dominance will be used to describe the general diplomatic strategy between North Korea and China and to account for North Korea's constant provocations. A situation of the Game theory called the Nash Equilibrium will be applied to suggest policy lines specifically after the stronger provocations of the North Korean state. At conclusive remarks, some limitations toward Game theory on its application on relations between China and North Korea will be suggested.

STRESZCZENIE

Stosunki polityczne między Koreą Północną a Chinami nie poprawiają się od 2006 r., kiedy północnokoreańskie władze rozpoczęły regularne próby jądrowe. Aby wyjaśnić naturę stosunków między tymi dwoma państwami, proponuję zastosować ramy teorii gier. Te pojęcia, w tym dominacja i ryzyko, będą używane do opisanego ogólnej strategii dyplomatycznej obu państw we wzajemnych stosunkach. Będziemy również uwzględniać skale prowokacji Korei Północnej. Równowaga Nasha, czyli profil strategii teorii gier, zakłada optymalną strategię każdego gracza i będzie opisana w poniższym artykule, biorąc pod uwagę stosunki między oboma państwami. Zakończenie artykułu będzie dotyczyć ograniczenia teorii gier dotyczącej jej stosowania w relacjach między Chinami a Koreą Północną.

KEYWORDS: *institutional limitations, Nash Equilibrium, international relations, game theory, theoretical approach*

SŁOWA KLUCZOWE: ograniczenia instytucjonalne, równowaga Nasha, stosunki międzynarodowe, teoria gier, ujęcie teoretyczne

AIM OF THE ARTICLE

The aim of the article is to apply the Game theory to the relations between North Korea and China. First, the article will define the Game theory. Secondly, we will see the Games theory application to international relations. The third part of the article is a brief summary of diplomatic relations between North Korea and China. The last part is dedicated to the implication of the Game theory in the development of the nuclear policy of North Korea, and the behavior of China in such situation. Finally, the author aims also at providing limitations regarding the framework of Game theory as an understanding of relations between North Korea and China.

GAME THEORY

The Game theory is the analysis of the behavior of decision makers in situations of strategic interdependence. Oskar Morgenstern and John Von Neumann founded the mathematical field of Games theory in the XX century. Applying it to economics, they published some texts in a series of papers in the 1930's. They summarized and published it again under a new version in 1944 in a book entitled *Theory of Games and Economic Behavior*.

The structure of game theory is considered as one of the frameworks for understanding global social and economic situations. For this purpose, the Game theory is employing various conceptual models and aim to explain some kind of real phenomena using theory which would operate through related models. The Game theory is a kind of 'toolbox', from which the right tools must be selected. In the Game theory, there will be a distinction between *modelling* and *analysing* a game (Smith, 1982, p. 169). Modelling means the construction of a game model that corresponds to an imaginary or a real world situation. Analysing means choosing and applying a solution concept to a game model, and deriving a prediction of or a prescription for the players' choices (Grüne-Yanoff, Till, Lehtinen, 2010, p. 38). These economists are distinguishing three main components of game theory. First, the *theory proper* indicates the concept of a game and provides the mathematical elements that

are needed for the construction of a game. Secondly, the *game structure* is a description of a particular game that is constructed using elements of the first point. Thirdly, the *model narrative* provides an account of a real or a hypothetical economic situation.

GAME THEORY APPLICATIONS TO INTERNATIONAL RELATIONS

International relations have long been a subject of study, but international relations, as a scientific discipline, started after the First World War. The subject of international theories has been divided in different fields and schools of studies such as realism, liberalism, and constructivism which aims were to find policies avoiding wars. The personalization of states was introduced by the German philosopher Hegel, who considered that states are the key-actors of International Relations, as they are the only one who can decide upon the starting of a conflict. Henry Kissinger, an American diplomat and a National Security adviser focused on the role of strategic alliances in order to preserve its national interest.

Game theory is the analysis of how decision makers interact in decision making to take into account reactions and choices of the other decision makers. International conflict and other phenomena in international relations occur as a result of decisions made by dignitaries. Therefore, Game-theory applications to international relations take the form of models (Snidal, 1985, p. 5; Sułek, 2012, p. 40), that are describing states' interactions within three models: extensive, strategic, and coalitional. The two first games are non-cooperative games. The third one is a cooperative game.

In an extensive-form model, the analyst thinks in terms of states presented as players, actions available to players, taking in account a certain level of information conditions (also taking in account lacks of information) and thus for outcomes of interactions. Therefore, players are at the center of the considered game (Serdar, 2012).

In a strategic level, there are nothing but players, players' strategies and preferences over outcomes. They also consider opponent's choices. It's a basic approach in comparison to the extensive-form model. Both games are more global than the third one.

In a coalitional form, the game is based not only on coalitions of players but also on the impact of these coalitions. This game is opposed to the two previous one, as there are possibilities to collaborate and therefore, to forge alliances. It is a critical model to describe what occurs in the international relations. The third one is obviously important as there are supreme authorities over sovereign states, such as the European Union, the United Nations or the Associations of South and East Asian Nations. This game implies also that international relations may impact the relations between its members. The notion of self-interest is getting at least jeopardized in such configuration. This is most naturally applied to situations arising in political science or international relations, where concepts like power are most important (Turocy, Stengel, 2001, p. 6). For the purpose of the article, cooperative game is assumed, regarding the model used the strategical one was selected.

In order to analyze the outcome of the strategic interaction of several decision makers, theorists used the concept of Nash Equilibrium. The Nash Equilibrium was named after the American mathematician John Nash. However, a first version of the Nash Equilibrium concept was developed by the French mathematician Antoine Augustin Cournot in his book entitled *Researches on the Mathematical Principles of the Theory of Wealth* (1838). The Nash Equilibrium provides a way of predicting what will happen if several people or several institutions are making decisions at the same time, and if the outcome depends on the decisions of the others. In a nutshell, a Nash Equilibrium is a state in which no participant can gain by a unilateral change of strategy if the strategies of the others remain unchanged.

NORTH KOREA'S NUCLEAR WEAPONS PROGRAM

In spite of the establishment of bilateral relations between North Korea and China on 6 October 1949, and taking in account that 2009 was declared as the “year of China–North Korea friendship” (중국-조선 민주주의 인민 공화국 우정의 해)¹, relations between both countries are worsening. Chinese State organizations are openly criticizing moves of the North Korean leadership toward an uncontrolled development of its nuclear arsenal (Lendon, 2017). Critics of the Chinese side are punished by the North Korean authorities through kidnapping of Chinese citizens. As an example, on the 5th May 2013,

North Korea took over a Chinese fishing boat, demanding around 100,000 USD for its safe return (Reuters, 2014). After each North Korean nuclear test, Chinese authorities are criticizing the North Korean political behavior by urging them to remain committed to its denuclearization commitment, and stop taking any actions that would make the situation worse.

The Americans and the Japanese are also urging China to cooperate with them to coordinate a potential solution to the North Korean issue. The problem lies on the fact that there is no long-term cooperation between the United States and China. Both states are nevertheless cooperating on some kind of sanctions (hacking the IT system of some North Korean structures, hacking North Korea's missiles). The problem is also dealing with the Chinese basic stand which has not changed in a few years, unlike the United States which is trying a set of different policies concerning North Korea. We can, however, hope that Beijing may change its position – especially with a generational shift within Chinese elites. Until now, Beijing has been quasi-neutral as far as it has served the best interests of China in Northeast Asia. This is due to a fear of domestic instability in North Korea and in the entire region of North-Eastern Asia.

Globally speaking, North Korea has a nuclear technology program. Western powers believe it is a front for a nuclear weapons program. Since the 2000's, western powers have offered North Korea concessions (such as the KEDO program) in exchange for dropping the program, but North Korean authorities has not followed through. Therefore, North Korea is worried that the United States cannot credibly commit to concessions in the future. Once American war exhaustion from Iraq and Afghanistan wears off, the U.S. can use the threat of preventive war to induce North Korea not to develop weapons and stop offering concessions. In contrast, the U.S. would have to continue offering concessions if North Korea had a fully functioning nuclear weapons. Thus, North Korea will continue to proliferate.

GAME THEORY AND RELATIONS BETWEEN NORTH KOREA AND CHINA

Regarding relations between China and North Korea, we will focus on the nuclear program of North Korea as being an element driving the relations between both countries. The basic issue with jeopardize the nature of relations

between North Korea and China is the nuclear program developed under the guidance of the North Korean leader Kim Jong-un. In order to present it under the form of a simple game at a strategic level, we will assume that China has two strategies. Attack North Korea in order to stop the nuclear risk over the northern Asian region and thus maintain its hegemonic position. The second strategy will be to not attack and adopting a “wait and see” attitude. We can also carefully assume also that North Korea has two strategies: stop nuclear research and continue to develop its own program. Hence, we have two players and each player has two strategies. In this case, the Nash Equilibrium is a situation where no individual player can do better by changing their strategy, so long as the other party does not change strategy (Holt, Roth, 2004, p. 4000). Therefore, as long as China does not change strategy, North Korea will continue to apply its policy. Below payoffs to the North Korea-China’s Dilemma game.

TITLE: PAYOFFS TO THE NORTH KOREA-CHINA’S DILEMMA GAME

We explain the current status quo between North Korea and China regarding North Korean nuclear research through the following assumptions: there are only two players, each has two strategies, they simultaneously interact only once, their preferences are ordered according to primary and secondary objectives, and each player strives to obtain highest possible outcome given other’s choices. The simplification does not take in account the role of other countries (The United States, Russia, and Japan) in the solving of the nuclear problem over the Korean Peninsula.

The game which is implied is dependent from primary and secondary objectives of the players (hence countries). The model asks for additional justifications or amendments; it does not represent the only possible stylization. Nevertheless, it is possible that the equilibrium does not change as a result of new assumptions. This would inform the modeler about the impact of different assumptions upon explanations.

The problem of North Korea’s nuclear research activities constituting yet another source of friction between North Korea and China. We do opt for the simplest possible model at strategic level: a 2×2 game. We assume China has

two strategies: attack and do not attack. We also consider that North Korea has two strategies: stop nuclear research and do not stop. Hence, we have two players and each player has two strategies.

The outcome matrix looks as follow:

Table 1.
Game matrix between North Korea and China

		North Korea	
		Stop	Continue
China	Attack	Outcome 1	Outcome 2
	Do not attack	Outcome 3	Outcome 4

Source: own elaboration

We consider that North Korean’s main objective is to become a nuclear power and China’s main objective is to stop the development of the North Korean nuclear program. Supposing that a Chinese attack cannot destroy all North Korean facilities, North Korea mostly prefers outcomes 2 and 4 as compared to outcomes 1 and 3. The decision “stop” prevents North Korea to reach its most important objective. Thus, for North Korea, we have $\{\text{outcome 2, outcome 4}\} > > \{\text{outcome 1, outcome 3}\}$. Suppose also that North Korea prefers outcome 4 to outcome 2 and outcome 3 to outcome 1 as it prefers no Chinese attack; its secondary objective. These assumptions generate the following preference ordering for North Korea: $\text{outcome 2} > \text{outcome 4} > \text{outcome 3} > \text{outcome 1}$.

Chinese mostly prefers outcomes 3 and 1 as compared to outcomes 4 and 2, as North Korea’s stop decision leads to the realization of China’s main objective: North Korea does not become a nuclear power. Thus, for China, we have $\{\text{outcome 3, outcome 1}\} > \{\text{outcome 4, outcome 2}\}$. Suppose also that China prefers outcome 3 to outcome 1 and outcome 4 to outcome 2 as it prefers to avoid a military failure; its secondary objective. These assumptions generate the following preference ordering for China: $\text{outcome 3} > \text{outcome 1} > \text{outcome 4} > \text{outcome 2}$. Now assume also ordinal-level preferences, with 4 indicating the best, 3 the next-best, 2 the next- worst, and 1 the worst outcome for players.

The first number in each cell denotes North Korea's preference for that outcome and the second number denotes that of China.

The game matrix therefore becomes:

Table 2.

Game matrix between North Korea and China

		North Korea	
		Stop	Continue
China	Attack	(3,1)	(1,3)
	Do not attack	(4,2)	(2,4)

Source: own elaboration

We notice that North Korea gets better outcome, if the country keeps continuing the development its nuclear program ($3 + 4 > 1 + 2$). Similarly, China obtains better outcomes by choosing “do not attack” ($4 + 2 > 3 + 1$) regardless North Korean choices. Therefore, the Nash Equilibrium is do not attack and continue and offer the best utilities to the two players (ie. North Korea and China) as North Korea may continue to pursue its main objective and China will have less military expenditures. The combination (Do not attack, Stop) is not a Nash Equilibrium, as the North Korean outcome is unsatisfying for North Korea. There may be some simplifications in this analysis as we consider that there are only two players and only two strategies.

LIMITATIONS OF THE GAME THEORY AND NASH EQUILIBRIUM APPROACHES

We can apply some limitations to the behaviors of China and North Korea using a Game theory framework. There may be some simplifications in this analysis as we consider that there are only two players and only two strategies. According to neoclassical analysis, we do assume that North Korea does indeed wish to “maximize” its payoff (known as profit) by developing nuclear weapons. This may well be the case, but evidences we possess are not based on harsh documentation. I would like to underline the high capabilities of the Asian to hide the development of their projects. Therefore, the Nash Equilibrium is

based on conditions and assumptions which are difficult to verify in the case of North Korea, mainly due to the irrationality of its leadership.

Therefore, we can conclude that attempts to analyze the present situation on the Korean Peninsula and with regard to North Korea using Nash Equilibrium, are approximate. We may assume, that players are “irrational”: their behavior cannot be forecasted. Aggressive behaviors and instincts from both sides prevent on a long-term the establishment of Nash Equilibrium. Observing relations between China and North Korea, we can easily remark a major balance on a short-term approach, however on a long-term approach, there are too much variables (such as changes in the North Korean leadership) which prevent from getting the Nash Equilibrium. Nash Equilibrium, is an equilibrium, and as its names implies, however absence of balance is more common than equilibria in nature, and this includes mankind (Loye, 1987; Riane, 1987, p. 63). The Nash Equilibrium mentioned in the previous part seems to be rather an equilibrium based on the following definition: It would be an equilibrium interpreted as a potential stable point of a dynamic adjustment process in which individuals adjust their behavior to that of the other players in the game, searching for strategy choices that will give them better results (Holt, Roth, 2004, p. 4000). Furthermore, the Israeli-American Nobel prize winner Daniel Kahneman consider that humans cannot make the rational calculations required by conventional economics. They rather tend to take mental shortcuts that may lead to erroneous predictions, i.e., they are biased. There are several categories of biases such as the illusion of control, the ability to know the reaction of other decision-makers, etc. Basically it's due to the fact, that both countries have different dominant pure strategy.

CONCLUSION

We may conclude that the Nash Equilibrium is not the best way of presenting North Korean-Chinese relations due to different biases and the nature of the dominance of non-equilibrium over equilibrium conditions in international relations. On a short-term approach, this kind of approach is suitable, meanwhile on a long-term we can recognize its limitations due to limited information and to further irrationality of political actors which long-term behavior remains hard to predict. Hence, because of these

limitations, establishments of the Nash Equilibrium are difficult to foresee in international conflicts. It seems also risky to base decisions on peace or war, economic sanctions using game theory. That's why, it sounds more appropriate to extend the theory by including non-equilibrium phenomena. However, Consequently, game theory, as a deductive method, is obtaining new explanations for international interactions by changing game rules and assumptions.

References

- Allan P., Schmidt, C. (1994). *Game Theory and International Relations. Preferences*, Cheltenham: Edward Elgar Publishing Ltd. ISBN 1852789255.
- Choi, D., Lee, M. (2008). *Applying game theory for strategy transboundary river: the case of the Han River in North and South Korea*, "Korean Water Resources Association" 41(4), p. 353–363. ISSN 2287-6138.
- Grüne-Yanoff, T., Lehtinen, A. (2010). *Philosophy of game theory*, "Philosophy of Economics", no. 13.
- Harsanyi, J. (1995). *Games with Incomplete Information*, "The American Economic Review" 85(3), p. 291–303. ISSN 0002-8282.
- Holt, C.A., Roth, A. (2004). *The Nash Equilibrium: A perspective*, "Proceedings of the National Academy of Sciences" 101(12), p. 3999–4002. ISSN 1091-6490.
- Kreps, D., Milgrom, P., Roberts, J., Wilson, R. (1982). *Rational cooperation in the finitely repeated prisoner's dilemma*, "Journal of Economic Theory", no. 27, p. 245–252. ISSN 0022-0531.
- Krugman, P., Obstfeld, M. (2001). *Économie internationale*, 3^e édition, Louvain-La-Neuve: Édition De Boeck Université, p. 271–285. ISBN 9782744075308.
- Kydd, A. (2005). *Trust and mistrust in international relations*, Princeton: Princeton University Press. ISBN 9780691133881.
- Loye, D., Riane, E. (1987). *Chaos and transformation: Implications of nonequilibrium theory for social science and society*, "Systems Research and Behavioral Science" 32(1), p. 53–65. ISSN 1099-1743.
- Mesjasz, C. (1997). *Założenia analizy negocjacji*, „Zeszyty Naukowe/Akademia Ekonomiczna w Krakowie”, nr 499, s. 67–80. ISSN 0208-7944.
- Myerson, R. (1991). *Game Theory: Analysis of Conflict*, Cambridge: Harvard University. ISBN 9780674341166.

- Nash, J. (1951). *Non-Cooperative Games*, "The Annals of Mathematics" 54(2), p. 286–295. ISSN 0003-486X.
- Nash, J. (1950). *The Bargaining Problem*, "Econometrica" 18(2), p. 155–162. ISSN 1468-0262.
- Nash, J. (1953). *Two-Person Cooperative Games*, "Econometrica" 21(1), p. 128–140. ISSN 1468-0262.
- Rapoport, A. (1962). *Three modes of conflict*, "Management Science" 7(3), p. 210–218. ISSN 0025-1909.
- Rasmussen, E. (1989). *Games and Information: An Introduction to Game Theory*, Cambridge: Basil Blackwell. ISBN 9781405136662.
- Rubinstein, R.J. (1982). *Perfect Equilibrium in a Bargaining Model*, "Econometrica" 50(1), p. 97–109. ISSN 1468-0262.
- Selten, R. (1975). *Re-examination of the perfectness concept for equilibrium points in extensive games*, "International Journal of Game Theory", no. 4, p. 25–55. ISSN 1432-1270.
- Smith, J. (1982). *Evolution and the Theory of Games*, Cambridge: Cambridge University Press. ISBN 139780521288842.
- Snidal, D. (1985). *The game theory of international politics*, "World Politics" 38(1), p. 25–57. ISSN 0043-8871.
- Sułek, M. (2012). *Prakseologiczna teoria stosunków międzynarodowych*, "Przegląd Strategiczny", nr 1, s. 35–49. ISSN 2084-6991.
- Turocy, T.L., Stengel, B. (2001). *Game Theory*, "CDAM Research Report LSE-CDAM-2001-09", Texas A&M University & London School of Economics, Tech. Rep.
- Von Neumann, J., Morgenstern, O. (1944). *Theory of Games and Economic Behavior*, Princeton: Princeton University Press. ISBN 9780691130613.
- Wolny, M. (2013). *Aspekt sytuacji status quo we wspomaganii wielokryterialnego wyboru bazującego na teorii gier*, „Studia Ekonomiczne”, nr 132, s. 136–147. ISSN 0239-6416.

Internet sources

- Hui, L., Rajagopalan, M. (2014). *North Korea seizes Chinese fishing boat, demands fine: media*, 23rd September 2014, <http://www.reuters.com/article/us-china-northkorea-idUSKCN0HI0QQ20140923> [access: 20.03.2017].

Lendon, B. (2017). *China criticizes North Korea, praises US on nuclear issue*, 20th April 2017, “CNN.com”, <http://edition.cnn.com/2017/04/19/asia/china-us-north-korea-statements/> [access: 25.05.2017].

Serdar, G. (2012). *A Short Note on the Use of Game Theory in Analyses of International Relations*, 21st June 2012, “E-international Relations”, <http://www.e-ir.info/2012/06/21/a-short-note-on-the-use-of-game-theory-in-analyses-of-international-relations/> [access: 25.02.2017].

Endnotes

¹ The Korean translation of North Korea referred rather to Democratic People’s Republic of Korea (조선 민주주의 인민 공화국).