

APPLICATION OF RISK DOMINANCE CONCEPT AND BAYESIAN NASH EQUILIBRIUM FOR ANALYSIS OF RECENT GEOPOLITICAL TENSION BETWEEN NORTH AND SOUTH KOREA

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ABSTRACT

Recent threats of hydrogen bomb test from North Korea were unexpected, as the relationship between South and North Korea was known to be improving. Here, Nash equilibrium and the concept of risk dominance will be used to describe the general diplomatic strategy between North Korea and South Korea and to account for North Korea's constant provocations. Then Bayesian Nash equilibrium will be applied to suggest policy lines specifically after the current hydrogen bomb test conducted by North Korea. Here, how rational thinking will lead both Koreas to continue on with the Hard-line measure towards each other will clearly be shown. At conclusive remarks, other possible diplomatic approaches to the volatile geopolitical landscape of East Asia will be suggested.

KEY WORDS

Game theory, risk dominance, Nash equilibrium, Bayesian Nash equilibrium, diplomatic approaches

1. Introduction

Attempts to apply game theory in analyzing terrorism and political issues have frequently been made. Todd Sandler, for one, argues that Game theory “captures the complex strategic interactions between terrorist and the target government.”[1] For example, popular concepts of game theory like the prisoner’s dilemma is a frequently used tool in analyzing motives of guerilla groups and designing suitable negotiations. Furthermore, scholars like Putnam [2] devised useful techniques like “Two-level game” to analyze diplomatic policies in believing that Game theory can succeed in conveying the complexity in diplomatic decisions. Precedents shown above suggest that North Korea and South Korea’s complex political relationships can be analyzed by using similar methodologies. As a matter of fact, some scholars modified two-level game theory quantitatively to apply to North Eastern Asian countries[3]. Their appropriate usage of win-set size and two-level analysis succeeded in providing a general outlook to geopolitical landscape of East Asia, and how complex interests between groups are entangled. However, the conclusion of this work, which suggested that the choice of moderate strategies over hard-line policies for nations would be more suitable for all nations involved, looks fallacious and misleading especially after recent North Korean hydrogen bomb provocation. Not only that, but despite continuous efforts for peaceful conversation, military provocations committed by North Korea are occurring often. This course of action is hard to be comprehended locally with two-level approach conducted by scholars previously mentioned. Therefore, in order to provide a tool that will help understand currently heightened tension and seemingly irrational yet consistent hard-line policies of North Korea, returning to traditional game theory analysis and using Bayesian Nash equilibrium to explain course of actions after recent hydrogen bomb test will prove to be useful in explaining this phenomenon.

As previously mentioned, the attempt for such analysis will be particularly more valuable after the recently aroused tension between the two nations. South Korea recently shut down the “Gaesung Industrial district” in spite of many economic complexities surrounding the issue. Furthermore, the international community started to slowly pressure North Korea in economical and political ways. North Korea responded to such sanctions by declaring to stop investigation on kidnapped Japanese. Two countries are maintaining hostile attitudes against each other, and understanding how such hostility was engendered and sustained became an especially more crucial task.

In this light, a rational judgement algorithm, which can validly predict rational reactions and interactions between the involved nations, is to be searched and sought. However, important acknowledgement must be made here. The final goal of this approach is not to make a reliable prediction. Rather, with what had already happened, this analysis can provide the rational justification for certain courses of actions that already occurred in the past, and suggest possible viewpoints to eye the problem. Geopolitical landscape of East Asia is typically volatile and capricious, and claims that contend that they may predict possible courses of actions are rather abstract and unlikely to be proved useful. Therefore, in this paper, the primary purpose is to understand the underlying motives behind hard-line measures conducted by both nations. Stressed again is the fact that the approach attempted below will focus on giving a general brief overview of tensioned situation that diplomatic policy makers can apply to understand the opposing nation, and devise appropriate policies to improve situations for the peninsula, rather than a definitive forecast of a yet unknown move.

2. Application of risk dominance concept and Nash equilibrium to general diplomatic interaction between North and South Korea

2.1. Major hypotheses in Nash equilibrium analysis of general diplomatic interaction between North and South Korea

0. Each player represents the two nations: North Korea and South Korea.
1. Diplomatic strategies of two nations will each be categorized by “hard line” and “appeasement”.
2. 3 additional “pride points” for either nation which selects “hard line”.
3. 3 additional “pacification and solidarity points” for both nations if and only if they both select “appeasement”.
4. 1 point subtracted for the resources spent from both nations if and only if they both select “hard line” policy for the resources spent.
5. 0.5 point is subtracted for resources spent from the nation with “hard line” policy, if and only if the other nation selects “appeasement”.
6. 1 point added for either nation which selects “hard line” for strengthened alliance with other supportive nations (In case of North Korea this would be China, and in case of South Korea, this would be United States).
7. 1 point added for both nations if they both select “appeasement” for enhanced economic cooperation.
8. In payoff function represented as (A, B) , A and B refer to utility function of North Korea and South Korea, respectively.

	Hard-line	Appeasement
Hard-line	(3,3)	(3,5,0)
Appeasement	(0,3,5)	(4,4)

Figure 1. Matrix for general diplomatic interaction

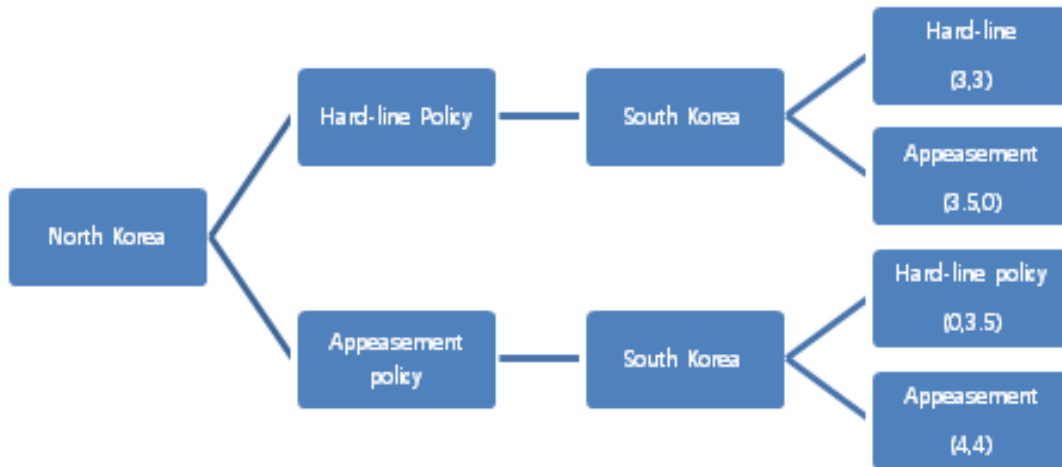


Figure 2. Outcomes of the combination of each decision plan by the nations

2.2 Analysis Of Resultant Payoff Matrix

Figure 2.1 demonstrates that two Nash equilibriums occur in (Hard-line, Hard-line) and (Appeasement, Appeasement). In both points, each nation has no incentive to move on to other strategy if the other nation is expected to persist on the same strategy. Consequently people may assume that as two nations gain higher pay off in (Appeasement, Appeasement) equilibrium than in (Hard-line, Hard-line) equilibrium, it is more likely that both nations will select appeasement policy. However, such prediction turns out simply not to be the case. North Korea, even after numerous requests for conversation and peace from South Korea, constantly provoked South Korea with terror in Rangoon, threat to withdraw in NPT, and other military actions.

The concept of risk dominance and payoff dominance, created by Harsanyi and Selten, can be used to analyze this peculiar phenomenon[4]. This tool is applied when multiple Nash equilibriums occur in a single game. When there are two Nash equilibriums in a game, for example, the equilibrium point which brings both players higher payoffs is said to have payoff dominance. The risk dominance, however, may not necessarily belong to the equilibrium point with payoff dominance. Previously, believing that the equilibrium would occur in (Appeasement, Appeasement) was largely based on the assumption that the two players would focus only on maximizing their own profit. However, in this complex diplomatic situation, “rational” decision cannot be made, as one cannot be sure how the other will act. Hard-line policy selection provides at least a payoff as big as 3. Selection of appeasement policy, though it may eventually bring a

larger payoff of 4, is too much of a gamble for the player, as if the other player selects hard-line policy, player with appeasement policy will get a zero payoff. In order to explain this disparity between rationality and reality, game theory expert Young Sei Kim provide the following formula to determine the equilibrium with risk dominance:

“In a two men cooperative game of figure 2.3, posit that equilibrium occurs in both (A,A) and (B,B) and that (A,A) is the equilibrium with payoff dominance. Then, if $(a-c)(X-Y) > (d-b)(W-Z)$, (A,A) also has the risk dominance, and if $(a-c)(X-Y) < (d-b)(W-Z)$, (B,B) has the risk dominance.” [5]

	Strategy A	Strategy B
Strategy A	(a,x)	(b,y)
Strategy B	(c,z)	(d,w)

Figure 3. Explanatory Matrix for the risk dominance concept

Application of this formula into the case stated above gives conclusion that though (Appeasement, Appeasement) equilibrium has payoff dominance, (Hardline, Hardline) equilibrium possesses risk dominance. Volatile and dependent political structure of North Korea would have made them especially less likely to take the risky decision, and the pattern of constant attack and provocation can be explained as an attempt to hold less risky position of hard-line.

Another factor that accounts for the frequency of (Hard-line, Hard-line) is that it is relatively easy to adapt strategies in this particular game. Previous example of how North Korea arbitrarily decided to ignore NPT demonstrates how easy it is to switch to hard-line while previously exhibiting appeasing behavior. If the two nations both lie in (Hard-line, Hard-line) equilibrium, and if one of the nation decides to turn to appeasement policy, there is no huge incentive for the other to also move on to appeasement policy. However, if they are both currently in (Appeasement, Appeasement) equilibrium, and if one abruptly turns to hard-line policy, the other almost necessarily also has to move on to hard-line policy to avoid great loss.

In other words, even when with great conversation efforts (Appeasement, Appeasement) equilibrium was maintained, it is a very fragile maintenance as either nation’s sudden capriciousness will shift the equilibrium to (Hard-line, Hard-line), whereas vice versa is highly unlikely to take place.

3. Bayesian Nash equilibrium sought in current North Korean Hydrogen Bomb test

Unfortunately, the analysis stated above is not sufficient to draw valid insight into recent situation regarding the North Korean Hydrogen bomb test. There is an imbalance of information in this case. South Korea does not know whether North Korea actually possesses a hydrogen bomb. In other words, it is a Bayesian game with imperfect information.

Simply put, North Korea’s “type” is unknown to South Korea. They can actually have a hydrogen bomb whose destructive capacity surpasses that of any extant weapons, or they might not. Major

Hypotheses from the analysis of general diplomatic strategies will be kept, but with minor additions.

3.1 Major Hypotheses for Bayesian analysis of diplomatic strategies of nations regarding North Korean hydrogen bomb test

0. Each player represents the two nations: North Korea and South Korea
1. Diplomatic strategies of two nations will each be categorized by “hard line” and “appeasement”
2. 3 additional “pride points” for either nation which selects “hard line” policy
3. 3 additional “pacification and solidarity points” for both nations if and only if they both select “appeasement” policy
4. 1 point subtracted for the resources spent from both nations if and only if they both select “hard line” policy for the resources spent.
5. 0.5 point is subtracted for resources spent from the nation with “hard line” policy, if and only if the other nation selects “appeasement policy”
6. 1 point added for either nation which selects “hard line “ policy for strengthened alliance with other supportive nations(In case of North Korea this would be China, and in case of South Korea it would be United States)
7. 1 pointed added for both nations if they both select “appeasement policy” for enhanced economic cooperation.
8. In payoff function represented as (A,B), A and B refer to utility function of North Korea and South Korea, respectively.
9. With an actual hydrogen bomb, North Korea’s expected payoff when they choose hard-line policy will be added two extra points, each point awarded for increased pride and stronger alliance with other supportive nations

3.2 Analysis of resultant payoff matrix

With the common player South Korea, the two payoff functions will be created on basis of whether North Korea has a hydrogen bomb or not.

	Hard-line	Appeasement
Hard-line	(3,3)	(3.5,0)
Appeasement	(0,3.5)	(4,4)

Figure 3. Case of North Korea not owning a hydrogen bomb

	Hard-line	Appeasement
Hard-line	(5,3)	(5.5,0)
Appeasement	(0,3.5)	(4,4)

Figure 4. Case of North Korea actually owning a hydrogen bomb

Let us contend that the probability that North Korea has a hydrogen bomb is p , and that the probability that North Korea does not have a hydrogen bomb is $(1-p)$. If North Korea indeed has a hydrogen bomb, the optimal strategy for North Korea is to go with Hard-line policy regardless of what policy line South Korea would choose. And with the case in which North Korea did not

succeed in creating a hydrogen bomb, we already figured that the Nash equilibrium with a higher payoff (without applying the risk dominance concept) occurs when both nations choose appeasement policy. From this point, the major task be on how to calculate that appropriate payoff given the set probability of p and the magnitude of utilities suggested by two matrixes. By so weighting the probability and thereby figuring the range of p , one can get a glimpse of idea on the more likely course of action.

Therefore, if South Korea chooses to play Hard-line, their expected payoff would be $3.5(1-p)+3p$, and if South Korea chooses to play appeasement policy, their expected payoff would be $4(1-p)+p*0$. [6] Simple calculation would provide with result that unless $p < 0.1428$, performing hard-line policy would bring higher payoff to South Korea. Without much value judgement, it is easy to figure out how depending an entire nation's security on the probability of seventh. Bayesian analysis thus concludes that South Korea would be more rational to cling to Hard-line policy on North Korea. After all, greatest concern of nation lies on security of its citizen, Hasty appeasement policy would not be favorable in that manner after all.

The relationship between the result of risk dominance analysis and bayesian analysis may seem unclear at first, but two identical results from completely different sets of tool stress a crucial point. Though the two analyses entail different kinds of mathematical justification while explaining its theory, the nature of rational reasoning behind the two are remarkably similar. Risk dominance analysis takes into account the "risk" in confiding in the other nation to act in an optimal mode possible for both sides. Bayesian analysis, likewise, takes into account the likeliness of an occurrence of certain type (possessing a working hydrogen bomb), which can increase the risk of persisting with appeasement policy in a dramatic degree. In other words, the nature by which the two methodologies attempt to consider the possibly involved risks is very similar if not identical.

Furthermore, as the two research methods insinuates similar equilibrium points, it is also valid to predict that in the short-term, strained tension would be kept. For in short term not enough time is provided to make a change in payoff function, two nations have but to cling to hard-line policy for the sake of their own citizen's security. Naturally, the conclusion of this research requires a different perspective than that was previously used in approaching the geopolitical complexity in diplomatic interaction between the two Koreas.

4. Conclusive Remarks

Rational analysis of the diplomatic complexities involving the situation between South Korea and North Korea explains the unfortunate necessity of the maintenance of (Hard-line, Hard-line) equilibrium. However, this situation can be viewed in different perspective. Continued Hard-line policies between two groups are actually rational judgments for their own safety. Such judgments are sagacious, because a nation's top priority lies on ensuring the safety of citizens. Here while neither can actually lower its military security level. For North Korea, abandoning their nuclear weapons mean complete vulnerability in face of powerful nations, and for South Korea, strong military alliance with U.S.A is something one cannot afford to lose.

This mathematical rationality is not so widely acknowledged among politicians and media from both nations [7]. Some even suggest that South Korea must build their own nuclear weapons. Such arguments show how there are difficulties involved in seeing through the real problem in this whole brouhaha. South Korea's having nuclear bomb will not make any difference. If either side possesses a nuclear weapon, then whether the other also has or has not does not make huge difference, because having nuclear weapon in that case simply can serve for nothing but a

revenge after the damage is already done. Significant point to be made is that North Korea will get severely damaged both militarily and economically if they do indeed use a nuclear weapon on the peninsula, regardless of whether South Korea has a nuclear weapon or not. It all once again comes down to the matter of trust, on whether each side can confide on the other for the “risk“. Nothing substantial can be accomplished before this tension is mollified.

Consequently, attempts for cultural interaction can be a way that will be practical and useful. The approach at first glance can look banal and redundant, but is still worth taking an additional look. Success case of reunification between Western and Eastern Germany[8] is well known. Slow but continuous cultural interaction created mutual trust and cultural awareness, and slowly the two nations became closer to one. In other words, as cultural disparity became eased, a more stable relationship between two nations was established. Governmental tension is still extant, and it is hard to expect a substantial change at the current moment. Slow cultural conversations must be attempted by small cultural organizations[9]. The possibility is open in all areas. Whether it starts with music, drama, media, or sports, there must be more frequent attempts to penetrate the steadfast wall that remains high between North Korea and South Korea[10].

Possible game theory approach can occur on several new aspects of this cultural approach towards the diplomatic problem. Researches on how cultural interactions can positively affect the payoff matrix are available, and traditional game theory analysis of the case of Eastern and Western Germany’s cultural interaction, a possible example of traditional two men cooperative game, may also be conducted. As a matter of fact general belief here would be that diplomacy and game theory will continue to be closely related and frequently associated [11], as understanding the rationale behind certain seemingly irrational actions can always provide valuable political insights to the researchers.

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