

Quantification of Two Level Game Theory: Focusing on Its Practicability in the Analysis on International Diplomacy

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Abstract

Recently, the importance of Northeast Asia continues to be strengthened majorly due to inconstant international circumstances influenced by its geopolitical location to be surrounded by world powers. This tendency calls for the detailed analysis of present circumstances. Thus, the study analyzed the strength and weakness of previous two-level game theory. It presented the quantitatively modified two-level game theory, which includes the quantitative analysis tools by adding analytic tool to the existing hypothesis of two-level game theory. Analysis of recent international conflicts using this theory was included to prove its practicability.

Keywords: Quantitatively modified two-level game theory, Application to diplomatic strategy, International politics analysis

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1 Introduction

The status of Northeast Asian countries, whose geopolitical importance is becoming more significant, is rising rapidly and international conflicts between such countries are occurring frequently. There has been a series of trials to explain these conflicts via the application of game theory. However, those trials used the separate approach to explain the international diplomacy among Northeast Asian countries, which is unclear and lacks regularity. Accordingly, this study added the concept of quantifying analytic standard to the existing hypothesis of Two-Level Game Theory, and changed some hypotheses in order to suit the diplomatic status quo of Northeast Asia. This theory demonstrated its usefulness by taking part in analyzing the war threats of North Korea since 2013.

2 Quantitatively Modified Two-Level Game Theory

2.1 Major Hypotheses of Quantitatively Modified Two-Level Game Theory

Thus, this thesis suggests the quantitatively modified two-level game theory based on the application of quantification method to previous qualitative two-level game theory. This theory consists of eight major hypotheses suggested below.

H1. Diplomatic strategy of every state participating in the negotiation can be numerically assessed by ‘Firmness Index (F)’ whose range is between -1 and 1. If F exceeds that range, the maximum or minimum value is used instead.

H2. When a state participating in the negotiation is governed under the essential democracy, 0.2 points is subtracted from its F . On the other hand, when a state participating in the negotiation is governed under the one-man dictatorship, 0.4 points is added to its F , while 0.1 points is added to its F when it is governed by one-party dictatorship.

H3. When one country’s consensus is biased toward the extremism, 0.3 points is added to its F . Moreover, when there was military conflicts within 5 years from the time of negotiation, 0.2 points is added to F of the country that got preemptive strike.

H4. 0.3 points is added to F of the country with superior military power.

H5. 0.3 points is added to F of the relatively isolated participating state, while 0.5 points is deducted from F of both countries in relation of close alliance.

H6. There is one-to-one correspondence relationship between F calculated based on hypotheses H1~H6 and win-sets size in international negotiation, which could be quantitatively assessed by “Win-sets Size Index (W).” Specific relationship is illustrated in Figure 1.

H7. W calculated based on H6 is deducted (or magnified) by 10 percent when one country chooses hardline (moderate) diplomatic strategy.

H8. Every strategy of participating countries in negotiation can be categorized into either hardline or moderate strategy.

2.2 Relationship between Firmness Index(F) and Win-Sets Size Index(W)

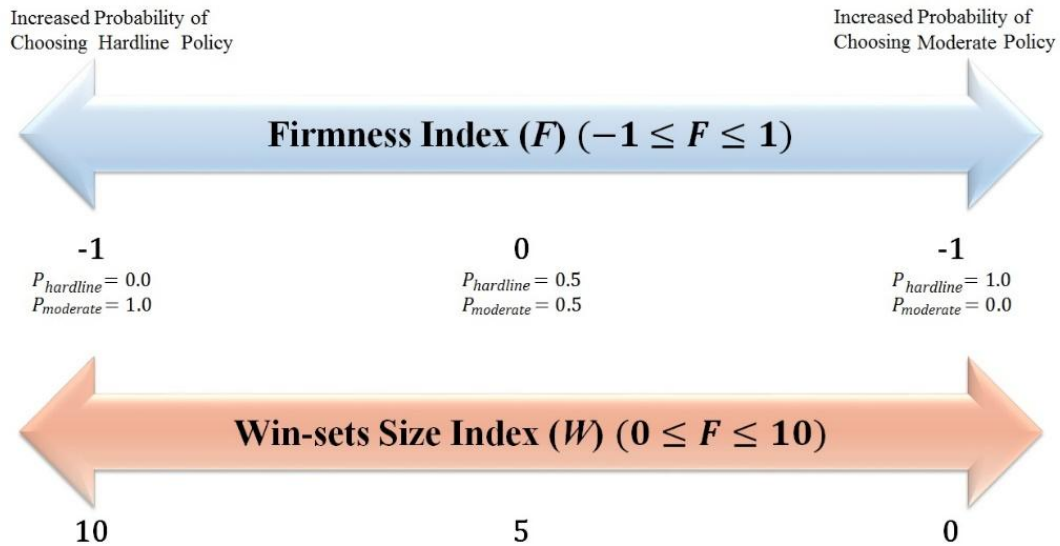


Fig. 1 Relationship between Firmness Index (F) and Win-Sets Size Index (W)

To illustrate the relationship between Firmness Index(F) and Win-Sets Size Index (W) with an example, if F of hypothetical country X is 0.7, its W is allocated to 1.5. This means that country X could willingly give up fifteen percent of original negotiation goals to reach an agreement. This method ensures one-to-one correspondence relationship between F and W suggested in **H6**.

2.3 Expectancy Function $f(x)$

The below expectancy function $f(x)$ shall be used in analyzing the current diplomatic policy of each participating country.

$$f(x) = W_{\text{hardline}} \times x + W_{\text{moderate}} \times (1 - x)$$

x	The probability of choosing hardline strategy ($-1 \leq x \leq 1$)		
W_{Hardline}	W when choosing hardline strategy	W_{moderate}	W when choosing moderate strategy

3Application to International Diplomacy

3.1North Korea throwing war threats toward South Korea since 2013

3.1.1Abstract of Negotiation Conditions

Table 2Firmness Index (F), and basic Win-sets Size Index of involved countries

	South Korea – North Korea		United States – North Korea		China – North Korea	
	South Korea	North Korea	United States	North Korea	China	North Korea
F	0 ^[2]	1 ^[3]	0.5 ^[4]	1 ^[5]	-0.1 ^[6]	0.5 ^[7]
W	5.0	0	2.5	0.0	6.0	2.5

Table 3Negotiation goals of each involved country based on their priority

Priority	South Korea	North Korea	United States	China
1	Control of North Korean assaults	Stabilization of Kim Jung-un regime	Recovery of support toward the current administration	Protection of Chinese corporates in North Korea
2	Realization of “Dresden Initiative” for reunification	Improvement in relationship between Two Koreas	Deterrence of nuclear proliferation	Non-admittance of North Korea being a state with nuclear weapon

^[2] $F = 0(\text{Initial Value}) - 0.2(\text{H2-Application of Democracy}) + 0.2(\text{H3-ROKS Cheonan sinking and Bombardment of Yeonpyeong of 2010}) = 0$

^[3] $F = 0(\text{Initial Value}) + 0.4(\text{H2-One-man Dictatorship}) + 0.3(\text{H3-Jucheism}) + 0.3(\text{H4-Asymmetric Power}) + 0.3(\text{H5-International Alliance}) = 1.3$. Since this value surpasses the maximum range of F , the maximum value of 1 is given.

^[4] $F = 0(\text{Initial Value}) - 0.2(\text{H2-Application of Democracy}) + 0.3(\text{H4-Military Superiority}) = 0.1$

^[5] $F = 0(\text{Initial Value}) + 0.4(\text{H2-One-man Dictatorship}) + 0.3(\text{H3-Jucheism}) + 0.3(\text{H5-International Isolation}) = 1.0$

^[6] $F = 0(\text{Initial Value}) + 0.1(\text{H2-One-party Dictatorship}) + 0.3(\text{H4-Military superiority}) - 0.5(\text{H6-Traditional Alliance}) = -0.1$

^[7] $F = 0(\text{Initial Value}) + 0.4(\text{H2-One-man dictatorship}) + 0.3(\text{H3-Jucheism}) + 0.3(\text{H5-International Isolation}) - 0.5(\text{H6-Traditional Alliance}) = 0.5$

3	Improvement in North Korean human rights issue	Withdrawal of economic sanctions	Reinforcement of alliance among U.S. – South Korea – Japan	Dissolution of alliance among U.S. – South Korea – Japan
4	Improvement in relationship between two Koreas	International Admittance of North Korea being a state with nuclear weapon	Non-admittance of North Korea being a state with nuclear weapon	Maintenance of North Korean regime
5		Discontinuance of Key Resolve Training		

Negotiation complexion which quantified circumstances of negotiation based on above hypotheses and W of each country are below **Table 4**, **Table 5**, and **Table 6**.

Table 4 Negotiation complexion between South Korea and North Korea

$(W_{South\ Korea}, W_{North\ Korea})$		Negotiation Strategy - North Korea	
		Hardline Policy	Moderate Policy
Negotiation Strategy - South Korea	Hardline Policy	(4.5, 0.0)	(4.5, 1.0)
	Moderate Policy	(5.5, 0.0)	(5.5, 1.0)

Table 5 Negotiation complexion between United State and North Korea

$(W_{United\ States}, W_{North\ Korea})$		Negotiation Strategy - North Korea	
		Hardline Policy	Moderate Policy
Negotiation Strategy - United States	Hardline Policy	(2.25, 0)	(2.25, 1.0)
	Moderate Policy	(2.75, 0)	(2.75, 1.0)

Table 6 Negotiation complexion between China and North Korea

$(W_{China}, W_{North\ Korea})$		Negotiation Strategy - North Korea	
		Hardline Policy	Moderate Policy
Negotiation Strategy - China	Hardline Policy	(5.40, 2.25)	(5.40, 2.75)
	Moderate Policy	(6.60, 2.25)	(6.60, 2.75)

Diplomatic strategies of four major countries in negotiation could be quantified like the below **Table 7**, considering a number of symptoms reported in mass media and other aspects.

Table 7 Quantified Diplomatic Strategy of Major participating countries

	x	Reasons
South Korea	0.4	♦ RyooGiljae, the minister of Unification announced that the South Korean government always welcomes the re-continuance of tourism in Geumgang Mountain, and it will do its best to prevent South Korean NGOs from scattering propaganda targeting North Korea for better mood suited to negotiation.^[8] ♦ Ministry of Reunification announced that the South Korean government will continue to do its best to construct trust and improve relationship between two Koreas in February, 2015.^[9]
North Korea	1.0	♦ National Defense Commission of the DPRK announced that there would be determined “punishment” if the “puppet government of traitors in South Korea” keeps challenging the authority of NDC of the DPRK in 25th January, 2015.^[10]
United States	1.0	♦ Power of balance in the legislative moved toward the Republicans after the election of 2014, which increased the need for Obama administration to break the deadlock by launching successful diplomatic policies.^[11]
China	0.6	♦ After the purge of Jang Sung-taek in North Korea, trade between North Korea and China seriously diminished, which significantly lowered the possibility of recovery of a blood pledge.^[12]

Negotiation circumstances of **Table 4**, **Table 5**, and **Table 6** can be visualized by the below graphs (**Graph 1**, **Graph 2**, and **Graph 3**). In addition, the current status of four major countries in each negotiation table quantified in **Table 7** can be found in those graphs. This is summarized in **Table 8**.

[8] 서울경제 “북미관계냉기류속남측에강경성명...고민깊어가는정부”, January 25th, 2015

[9] YTN “정부, ‘북미관계와별개로남북대화추진’”, February 4th, 2015

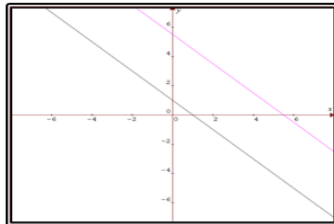
[10] 서울경제 “북미관계냉기류속남측에강경성명...고민깊어가는정부”, January 25th, 2015

[11] 통일뉴스 “2015 남북관계전망: 북미관계를중심으로”(안태형 LA통일전략 연구협의회사석연구위원), January 31st, 2015

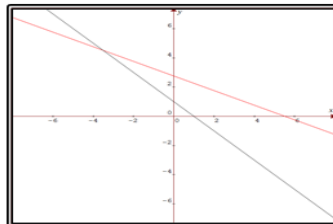
[12] 한겨레 “중국외교학원쑤하오교수 ‘북중관계, 상당히냉담’”, December 14th, 2014

Graph 1 Graph regarding negotiation between South and North Korea

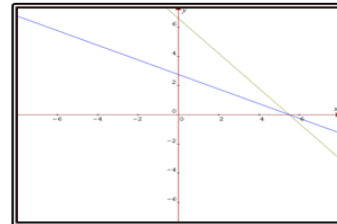
Pink	Expectancy function of South Korea ($f(x) = 5.5 - x$)
Black	Expectancy function of North Korea ($g(x) = 1 - x$)

**Graph 2** Graph regarding negotiation between U.S. and North Korea

Red	Expectancy function of United States ($f(x) = 2.75 - 0.5x$)
Black	Expectancy function of North Korea ($g(x) = 1 - x$)

**Graph 3** Graph regarding negotiation between China and North Korea

Yellow	Expectancy function of China ($f(x) = 6.6 - 1.2x$)
Blue	Expectancy function of North Korea ($g(x) = 2.75 - 0.5x$)

**Table 8** Quantified diplomatic strategies based on Graph 1 ~ Graph 3^[13]

Graph 1			Graph 2			Graph 3		
	x	$f(x)$ $g(x)$		x	$f(x)$ $g(x)$		x	$f(x)$ $g(x)$
South Korea	0.4	5.10	United States	1.0	2.25	China	0.6	5.88
North Korea	1.0	0.00	North Korea	1.0	0.00	North Korea	1.0	2.25
Subtraction	.	5.10	Subtraction	.	2.25	Subtraction	.	3.63

4Conclusion

Considering the cases above, these conclusions can be deduced.

1. Continuous firm attitude of a nation becomes a strong factor that hinders the establishment of negotiation between countries.
2. The breakdown of negotiation leads to a result in which both countries are not able to accomplish any objective. Thus each nation is likely to set an establishment of negotiation, which requires the expansion of W , as its first priority goal.
3. There can be cases in which the expansion of W size of one country does not lead to another's W expansion. In this case, the country will select hardline strategy as an alternative to reduce the W difference and spare oneself not to be in adverse condition in the upcoming negotiation.
4. When the negotiation is established, success or failure depends on W difference between two nations and the range of W that can be shared, but the influence of the latter is more important.

^[13]The probability of choosing hardline policy 'x' of each participating country is the result of calculation based on analysis on media reports of February, 2015.

However, there are some aspects to be improved in the expectancy function used in the analytic process based on this theory. Profits of each country in negotiation process were calculated based on the W size reflecting present circumstances, and the adjusting proportion in hardline and moderate policy was set equally in all countries. This led to almost identical appearances in analyzing all negotiation cases. In this thesis, this was not an influential factor, but in other analytic processes, there is a possibility that this will become a serious factor that affects the accuracy of analysis.

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