Nuclear Disarmament Negotiation in Unequal Nuclear Force Situation

Game Theoretic Analyses of Denuclearization of North Korea[*]

Kiyohisa SHIBAI

ROIS-DS/The Institute of Statistical Mathematics

kshibai@ism.ac.jp

Introduction

This study depicts a necessary condition to promote nuclear disarmament in unequal nuclear rivalries. The first offer of peace by the stronger side inevitably leads to a peaceful resolution *without* denuclearization. Establishing a second-mover advantage is a key factor for denuclearization.

Nuclear disarmament has been one of the most important international tasks since WWII, but has not developed in the 2010s. North Korea never relinquished nuclear weapons, and is now developing launch missiles. The basic causes of North Korea's nuclear development are national security and regime survival. Assuming that North Korea is a soft security type that regards its own security as important, the soft security type does not hope for armed conflicts and will not choose a strategy that results in war. However, such a preference does not mean that the soft security type does not select an armament strategy.

In a situation of the prisoner's dilemma, it is not always true that disarmament decreases the possibility of armed conflicts and armament increase such a possibility.

Nuclear armament strengthens nuclear deterrence but changing the nuclear balance could lead to nuclear war. More importantly, even disarmament could be militarily dangerous, since a country that gains even a small lead in rearmament would have a powerful military advantage (Glaser 1998, 115). If it is expected that military buildup is better for national security rather than disarmament, even the soft security type has an incentive to armament. The type of state does not determine its choice of armament or disarmament because this depends on relations with a rival for whether disarmament has a positive effect on national security. Nuclear disarmament alone does not contribute to decreasing the likelihood of nuclear wars.

A new condition for nuclear disarmament after the Cold War was "denuclearization," so that a new or potential nuclear power can give up possession of nuclear weapons. This is always done by the stronger country and/or international organizations, rather than the new nuclear power based on a violation of the Nuclear Non-Proliferation Treaty (NPT) or international norms. For example, the case of the North Korean nuclear development and confrontation with the U.S. differs from the Cold War scenario. North Korea violated the NPT and disrupted the international order. The goal of this case was to make North Korea comply with the nuclear nonproliferation norm, unlike the case of nuclear rivalry between the U.S. and the Soviet Union.

However, North Korea has nuclear weapons, and the disarmament negotiations are stagnant. It is almost impossible that coercion based on the international norm alone creates denuclearization. To achieve denuclearization, it is necessary to fix conditions for promoting North Korea's disarmament: the U.S. should not offer a peace treaty at first.

As mentioned above, this article's objective is to study theoretical conditions to achieve North Korea's nuclear disarmament, which leads to denuclearization.

1 Summary of Nuclear Disarmament Negotiations

This study analyzes the nuclear disarmament negotiations between unequal rivalries and shows the theoretical conditions to achieve peaceful denuclearization. This case is distinguished from equal rivalries and non-nuclear disarmament negotiations. There are some situations of nuclear disarmament between equal powers, but those are archived only by the U.S. and Soviet Union: Partial Test Ban Treaty (PTBT), Nuclear Non-Proliferation Treaty (NPT), Strategic Arms Reduction Treaty (START), and Intermediate-Range Nuclear Forces Treaty (INF). The other disarmament is a unilateral one and is by South Africa, not mutual disarmament. However, such mutual disarmaments are not completely the same as the North Korean nuclear problem because the U.S. and Soviet Union were equal nuclear powers and their goal was stability of nuclear deterrence, but the North Korean nuclear problem is their denuclearization and the end of the state of war in the Korean peninsula. Nuclear disarmament, while maintaining nuclear stability, is a sole example of the success of mutual nuclear disarmament. Denuclearization is more difficult than mutual nuclear disarmament because it causes the weaker side to lose its nuclear deterrence and makes it more vulnerable. It is not acceptable as a matter of national security policy, even though denuclearization is justifiable under international law. It is important to set a bargaining situation in which the weaker side can choose nuclear disarmament with the assurance of no deception and nuclear armament invites a heavy military sanction.

In general disarmament and peace negotiations, a stronger side must make the first move and offer conditions that makes the weaker side trust the stronger side. A typical example of this is peace negotiations, including disarmament of rebel groups in civil war.

However, in nuclear disarmament, the stronger side should not offer the peaceful condition before the weaker side offers nuclear disarmament. The cause of the difference is, of course, nuclear deterrence. Even the weaker side could maintain its national security if it has nuclear deterrence. If a peace treaty and end of conflict is provided before denuclearization, maintaining nuclear deterrence is the best security strategy. Signing of a non-war treaty and keeping nuclear weapons is referred to as "peaceful resolution" in this article, and distinguished from "peaceful denuclearization," which means signing of a non-war treaty with the weaker side's nuclear abolition.

For North Korea, signing of a non-war treaty and keeping its nuclear deterrence capability is the best result because keeping nuclear power while achieving a peace treaty is useful to contend against future threats, which include the future conflict with the U.S. There are successful previous cases of achieving the peaceful resolution: India–United States Civil Nuclear Agreement and normalization of diplomatic relations between the U.S. and Mainland China. India developed nuclear weapons without ratifying its NPT, but did not have hostile relations with the U.S., and the U.S. actually confirmed India as a nuclear power. India achieved the agreement that puts it under international safeguards, including the International Atomic Energy Agency (IAEA) Additional Protocol, *without* abandoning its nuclear weapons. Although agreeing on IAEA's safeguard means accepting IAEA's principle of nuclear nonproliferation and management of nuclear materials, India receives a stable supply of nuclear fuel and technology that is used to manage nuclear weapons. However, India does not promise future denuclearization. They can indefinitely be a nuclear power.

Therefore, making a peace treaty before denuclearization allows North Korea to continue existing as a nuclear power, although some media argue that a peace treaty

follows denuclearization.[1]

India's nuclearization is not a larger nuclear issue than North Korea's nuclearization because India has never had hostile relations with the U.S. However, even China's nuclear possession in 1964 was confirmed after normalization talks in 1970s. The Beijing government had been a threat to the U.S. and its allies in Northeast Asia, and even the Soviet Union stopped nuclear technological assistance and held hostile relations with the Beijing government after the Sino-Soviet split. The U.S. had tried to stop Chinese nuclear development through international treaties and sanctions; however, the Beijing government did not accept PTBT and NPT, never yielding to intimidation by the U.S. and Soviet Union, and hence succeeded in developing nuclear weapons. Chinese nuclearization had a huge effect on security policies of Japan, Taiwan, and South Korea, and made them rethink their nuclearization. The U.S. had to respond to their fears and security policies (Albright and Gay 1998; Burr 1999, 2007; Kim 2001; Mitchell 2004; Pollack and Reiss 2004).[2]

Although Chinese nuclearization had such a huge impact to the U.S. and its allies, the U.S. normalized diplomatic relations with the Beijing government without demanding denuclearization because cooperation with China was important to conflict with the Soviet Union. These cases show that the U.S. approves of a country's nuclear armament if the country is not or does not become an enemy after they develop their nuclear

---

[1] "Peace treaty with N. Korea possible following denuclearization," *The Korean Times*, April 18, 2020. https://www2.koreatimes.co.kr/www/nation/2022/04/103_247463.html (Retrieved August 29, 2022); "With North Korea, Peace Can Precede Denuclearization: Washington should realize peace is possible with a nuclear North Korea," *The Diplomat*, June 2, 2020. https://thediplomat.com/2020/06/with-north-korea-peace-can-precede-denuclearization/ (Retrieved August 29, 2022)

[2] The Japanese government had studied nuclear development in secret because of Chinese nuclearization and U.S. defeat in the Vietnam War. There are unofficial reports written in Japanese (「日本の核政策に関する基礎的研究（その一）」(1968 年 9 月);「日本の核政策に関する基礎的研究（その二）」(1970 年 1 月);「民主主義研究会報告書」). Kase (2001) is available as a partial summary, written in English.

weapons. Therefore, the best response for North Korea is to keep nuclear weapons if the peace treaty is realized before denuclearization.

Nuclear disarmament and nonproliferation policies do not necessarily lead to denuclearization (Shibai 2012, 2015, 2019). To accomplish nuclear disarmament, trust building, security assurance, and coercion of denuclearization must be achieved simultaneously.

2   First Mover Advantage in Nuclear Negotiations

There are many analyses of nuclear disarmament and arms control negotiations, mainly during the Cold War period. However, there is one factor that has not received much attention: the order of proposals. The player that moves first affects the result of a negotiation.

In a general negotiation, the first mover has an advantage and the agreement favors them (Ausubel and Deneckere 2002; Benton, Liebling, and Kelley 1972; Binmore, Osborne, and Rubinstein 1992; Chertkoff and Conley 1967; Fudenberg, Levine, and Tirole 1985; Galinsky and Mussweiler 2001; Lieberman and Montgomery 1988; Liebert, Smith, and Hill 1968; Kennan and Wilson 1993; Muthoo 1999; Osborne and Rubinstein 1990; Rubinstein 1982, 1985; Sobel and Takahashi 1983; Yukl 1974). Rubinstein (1982: 98-100, 1985: 52-53, 92-95) depicts models where the first move gives a relative advantage to the first player when each player alternates their offers and certain conditions are fulfilled because the alternate offer is based on the first offer. In summary, the first proposal serves as an anchor and gives the first mover an advantage (Loschelder, et al. 2016); the first mover's first offer restricts the second-mover's scope of the strategy for as long as the negotiation is continued.

6

When the initiative is taken by a rival, another player cannot reclaim the initiative. They have no choice but to reject it and end the negotiation if they complain. For example, the first offer of a nuclear test ban treaty was made by the Soviet Union on March 1958, but the U.S. did not take up the offer because the treaty contributed to fixing the Soviet Union's military superiority by the Sputnik shock and affected NATO member's nuclear and security policies. If the U.S. continued the negotiation, they had to receive at least one of the two undesirable results. The U.S. started new bargaining and offered the draft of the PTBT to the Soviet Union in August 1962 because they were concerned about China's nuclear development. The Soviet Union accepted cooperation with the U.S. on China's nuclear issue and demanded dealing with the West German nuclear issue. The U.S. accepted this and made West Germany ratify the PTBT, even though West Germany strongly desired to keep the option of nuclear weapons for their national security policy, and complained about the ratification (Bur and Richelson 2000/01; Chang 1990; Gavin 2004/05; Seaborg 1981; Wenger and Gerber 1999). In the nuclear nonproliferation negotiations, the U.S. took first advantage for mainly preventing Chinese nuclearization. Unsurprisingly, the Soviet Union offered amendments and demanded solving the West German nuclear issue. However, the first move anchored this nuclear nonproliferation negotiation on the Chinese nuclear issue and succeeded in gaining cooperation with the Soviet Union on the Chinese nuclear issue.

There is a limit to the number of times you can reject an offer. It is difficult to maintain the status quo on nuclear issues because nuclear powers always develop nuclear technologies and increase nuclear weapons for their own and ally's securities. If a nuclear power in an inferior position develops nuclear weapons and equalizes forces, conditions for nuclear stability are changed and conflicts are more likely to occur. To prevent the

nuclear power balance from changing to an undesirable situation, a player must continue the negotiation or become a first mover at some point.

The objective of nuclear disarmament is to decrease the possibility of nuclear wars (including stabilizing nuclear deterrence), not to win a nuclear war. Therefore, the first mover's advantage is especially useful for nuclear issues because the first move can make an offer to gain or keep its superiority and nuclear stability. The second-mover must think about amendments that do not destabilize nuclear deterrence. However, it is more difficult for the second-mover to make an offer that gives them superiority than the first mover because the necessity of nuclear stability restricts the second-mover's scope of the strategy, not only the first offer.

3   Second-Mover Advantage in Unequal Nuclear Rivalry

The first offer is advantageous in a negotiation and this is also true in arms control and disarmament negotiations for nuclear stability, as with the U.S.–USSR negotiations. They negotiated about keeping nuclear deterrence and that any result should never disable their nuclear deterrence. Nuclear deterrence assures their security, and their power balance remains unchanged: no country can win in a nuclear attack.

However, negotiations for denuclearization are to deprive one side's nuclear deterrence capability. If the result is denuclearization, the denuclearized country loses nuclear deterrence and its national security is under nuclear threat. The country has a strong motivation to keep nuclear deterrence and avoid such a result. Therefore, the negotiation in an unequal nuclear rivalry for denuclearization is a different situation from the negotiations of equal rivalry.

In the negotiations of unequal rivalry, the first offer cannot be advantageous because

of incentives for keeping nuclear deterrence. This section analyzes the first mover's disadvantage in the denuclearization bargaining and constructs the game models.

3-1   General Peace Talks in Unequal Rivalry

In unequal nuclear rivalry, especially in a disarmament negotiation, the issue is about how a weaker state's security is assured. The issue in the denuclearization negotiation is the order of the negotiation. The meaning of "unequal rivalry" is that the disparity in forces, especially nuclear weapons, is obvious and the weaker side cannot win a war against the stronger side, even with nuclear weapons. All the weaker side can aggressively do is to deter attacks with nuclear threats. The weaker side is skeptical and strongly anxious for its survival. Therefore, if the stronger side hopes for peaceful conflict resolution, they must use the first mover advantage for achieving it.

General peace talks show that a stronger side should move first and assure no deception to the weaker side for peaceful agreement. The stronger side is easily defeated after the weaker side disarms for a peaceful agreement, and the weaker side does not choose disarmament without assurance of no deception. However, the non-disarmament action of the weaker side leads to the stronger side's distrust and the security dilemma becomes more serious (Glaser 1992; Kydd 1997, 2005, Ch. 3). To avoid the spiral of fear in the non-nuclear disarmament negotiation, the stronger side must take initiative.

For example, the model case shows peace talks of civil wars and ethnic conflicts, which includes disarming rebel groups. To end the armed conflict and recover the social order, the government must demand disarmament to the insurgent group, even if the cause of the civil war was the government. The insurgent group cannot easily choose disarmament because of the fear of the government's deception after disarming. When the weaker side

chooses armament at first, the stronger side decides on war to prevent a disadvantageous war in the future. The weaker side has no incentive to move first, even if there is a high risk that the stronger side will attack because, in this situation, the weaker side always chooses an aggressive option at its turn, armament, or rebellion. Therefore, the first offer is the role of the stronger side if the purpose is disarmament and end of war. There is also the first mover advantage in the peace talks, including disarmament.

3-2　The Disadvantage of the First Move in Unequal Nuclear Rivalry

In the nuclear disarmament issue of unequal rivalry, gaining peace treaty while keeping nuclear weapons is the best result for the weaker side. The role of the stronger side is more important for achieving peaceful denuclearization. However, unlike conventional disarmament, denuclearization requires the weaker side to move first because the first mover advantage is lost in the negotiation. To achieve denuclearization peacefully, the stronger side must encourage the weaker side to clearly depict their intention to disarm before the stronger side's move. A typical example of this is the North Korean denuclearization issue.

North Korea can be regarded as a soft security type in the weaker side in the nuclear issue; the optimal strategy of North Korea is peaceful resolution in many situations. There are two key factors in this disarmament game. The first is an imbalance of military forces. North Korea is quite concerned about its regime being collapsed, so the imbalance makes North Korea untrustworthy of the U.S. The U.S. can win a war against North Korea, but the expected cost and damage by nuclear attacks makes the U.S. hesitant to conduct military actions.

The second is the order of the game. It is better for the U.S. that North Korea

denuclearize before concluding the signing of a non-war treaty in the Korean peninsula, but it is impossible for North Korea to do this without robust assurance of its own security. Nevertheless, the U.S.'s moving first and selecting the peace treaty does not always lead to a favorable result because such an offer does not assure North Korea's denuclearization. The more North Korea demands robust security, the more North Korea needs nuclear weapons.

In a nuclear disarmament negotiation, the substantial disadvantage of possessing nuclear weapons is only sanctions. Deterioration of relations or escalation of conflicts with countries rarely manifests itself as direct damage if sanctions are not imposed. Therefore, the cost of keeping nuclear weapons is expressed by the amount of sanctions s^t in this game model.

WS ——————————————— s^t
c^t
continuation of
conflict

armament   disarmament

SS

1-p - - - - - - - - - - - - - - - - - - - p

war   peace   war   peace

WS   -2   3   -4   1
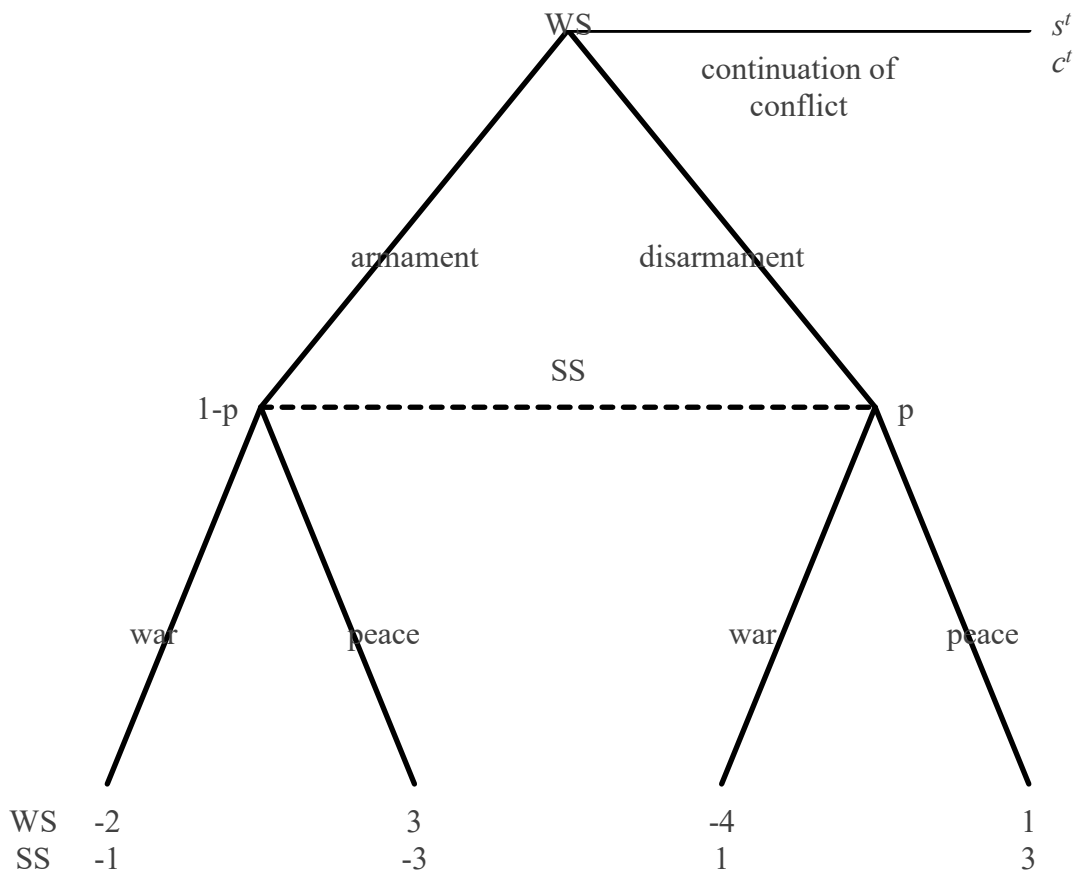SS   -1   -3   1   3

Figure 1. Nuclear disarmament games in unequal rivalry: Weaker side (WS) moves first

In these games, "continuation of conflict" means that the stronger side continues non-military sanctions and the weaker side continues provocations and escalating tensions with nuclear development. The stronger side's profit c^t includes the weaker side's continuous provocations, such as nuclear and missile launch tests by the weaker side[3]. If the amount of c^t is unacceptable, the stronger side unconditionally chooses peace. "Armament" means that the weaker side formally declares the possession of an important nuclear capability because the completion of development unambiguously changes the

---

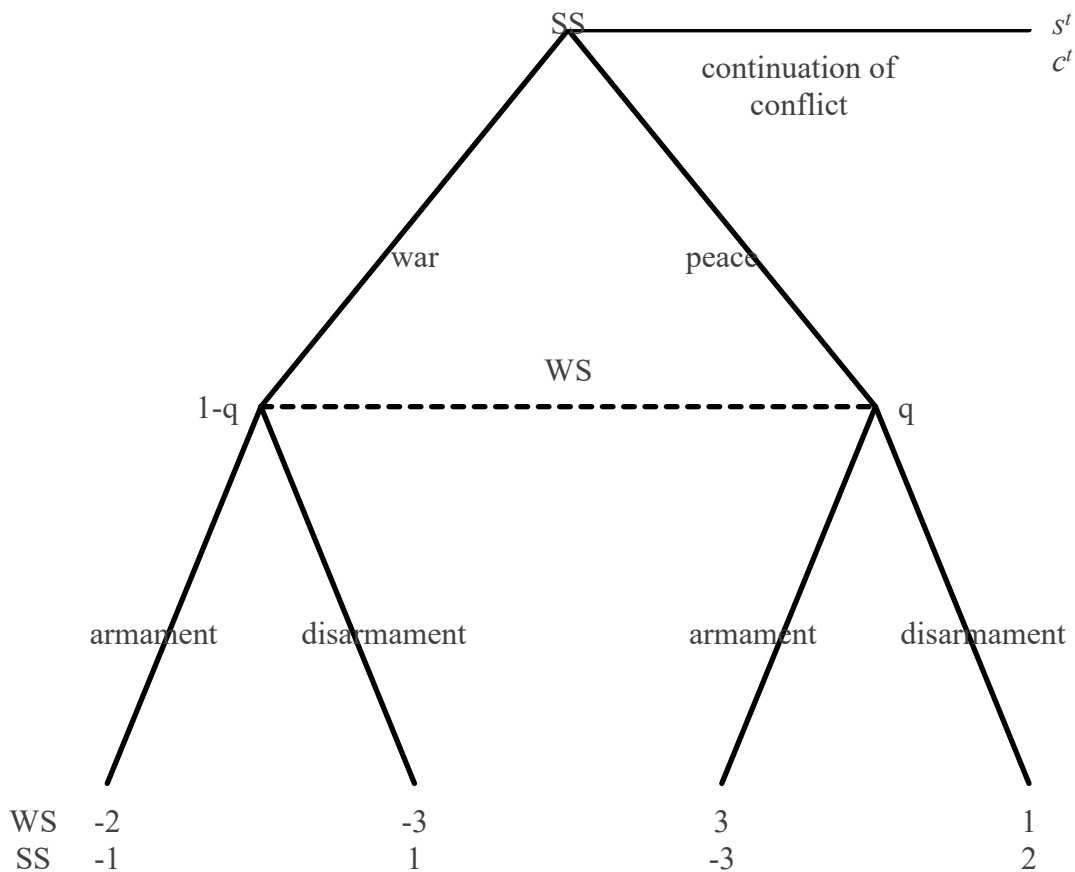[3] c^t is cost of the stronger side's sanction at the continuation of conflict at turn t.

situation of nuclear rivalry and the stronger side must take some action. If no response is given, it is taken as tacit approval: it is a kind of "peace" in the game. In the current North Korean nuclear issue, stipulating nuclear possession in the Constitution in 2012 is the armament of North Korea. Conducting nuclear and missile tests are a continuation of conflict, not armament. "Disarmament" means formally giving up important military development. If North Korea formally declared completion of long-range missiles to strike the mainland of the U.S., that is a form of armament. "War" means a military sanction to stop the weaker side's important military development coercively, and "peace" means accepting its possession of the nuclear capability and completing the state of hostility. North Korean's demanding a non-aggression pact with the U.S. is a typical example of this. Signing of a non-war treaty while keeping nuclear deterrence capability is the best result for North Korea. If the U.S. wants to solve the conflict with military power, they must move first and before North Korea chooses armament.

The games of Figure 1 and 2 are built on the assumption that the weaker side is the soft security type: (disarmament, peace) > (armament, war).

In the game of Figure 1, "the first mover" weaker side chooses continuation of conflict if the expected utility of armament, a, is less than s^t and the expected utility of disarmament, d. It carries out armament if $a > s^t$ and $a > d$. It chooses disarmament if $d > s^t$ and $d > a$. To lead to peaceful denuclearization, not only $d > s^t$ and $d > a$ but also $a > s^t$ are needed because the weaker side can choose continuation of conflict if $a < s^t$. This shows that the stronger side must not only exhaust the weaker side with sanctions, but also convince the weaker side that offering nuclear disarmament voluntarily will spare

them from the worst. The (disarmament, peace)[4] is an equilibrium point if $p > 1/2$ and s^t < a < d in Figure 1.

In summary, the condition to make (disarmament, peace) the Nash equilibrium point in the game of Figure 1 is as follows: $d > a > s^t$. Only when the damage from sanctions in turn t is significant enough to make an armament or disarmament decision, and the subjective probability distribution is such that the weaker side can trust the stronger side, is peaceful denuclearization achieved.

SS ——————————————————— s^t
continuation of c^t
conflict

war   peace

WS

1-q ·- - - - - - - - - - - - - - - - · q

armament   disarmament   armament   disarmament

WS   -2   -3   3   1
SS   -1   1   -3   2

---

[4] The notation of (x, y) means that x is the first mover's strategy and y, the second mover's one. If $u_{SS}(x, y)$ is noted, the stronger side's expected utility of (x, y). If $u_{WS}(x, y)$ is noted, the weaker side's expected utility of (x, y).

14

Figure 2. Nuclear disarmament games in unequal rivalry: Stronger side (SS) moves first

It is impossible to draw the path of (peace, disarmament) in Figure 2, in which the stronger side is the first mover, because the optimal strategy of the weaker side remains the same at armament, irrespective of the value of q. Figure 2 shows that the peaceful denuclearization is never realized by the first move of the stronger side, because it has no incentive to denuclearize a non-enemy nuclear power with paying sanction costs.

3-3   Effect of Nuclear Deterrence

The discussion has proceeded on the assumption that the weaker side has a hard secure desire. However, the weaker side can have a more moderate preference order, as follows: peaceful denuclearization > peaceful resolution > war > stronger side's win. This is the preference order of the soft security type. The former pursues nuclear possession for the military advantage in every conflict, but the latter hopes for security and survival, so it is necessarily obsessed with nuclear weapons. Supposing the weaker side is the soft security type, (disarmament, peace) is an equilibrium point if $p > 1/2$ and $s^t < a < d$ in Figure 3 and (peace, disarmament) is an equilibrium point if $q > 1/2$ and $c^t < w < pe$ in Figure 4.[5]

---

[5] w is the expected utility of choosing war. pe is the expected utility of choosing peace.
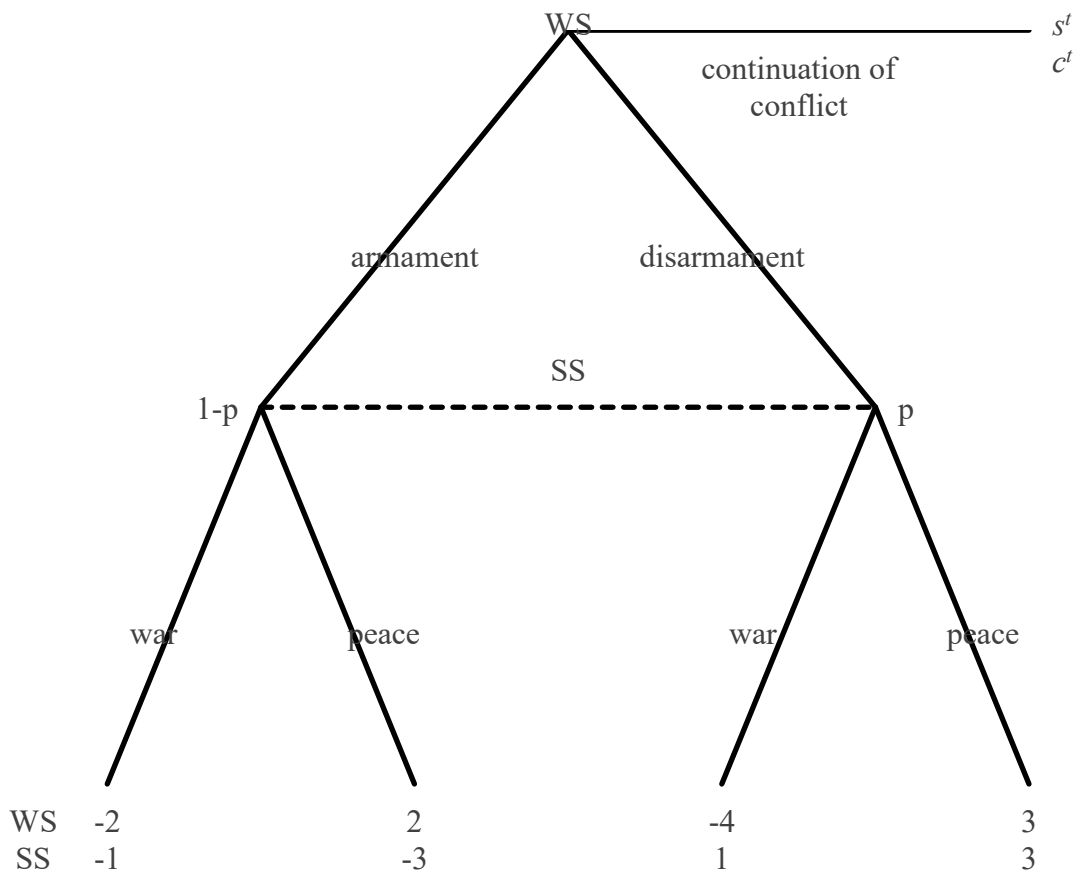
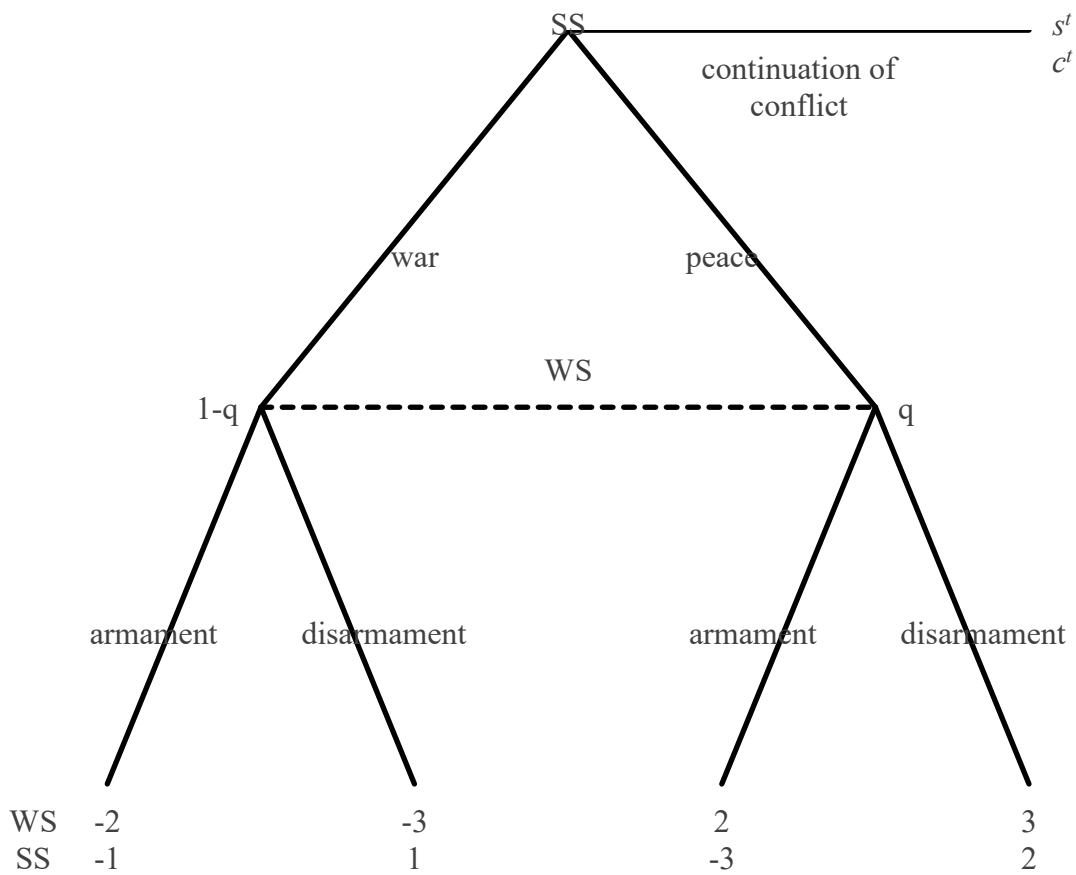Figure 3. Nuclear disarmament games with soft security type: Weaker side moves first

Figure 4. Nuclear disarmament games with soft security type: Stronger side moves first

In addition, $q = 1$ makes the weaker side choose disarmament, even if the values of peaceful denuclearization and resolution are the same (Figure 5).

SS ——————————————— s^t
continuation of c^t
conflict

war   peace

WS

1-q ----------------------------------- q

armament   disarmament   armament   disarmament

WS -2   -3   2   2
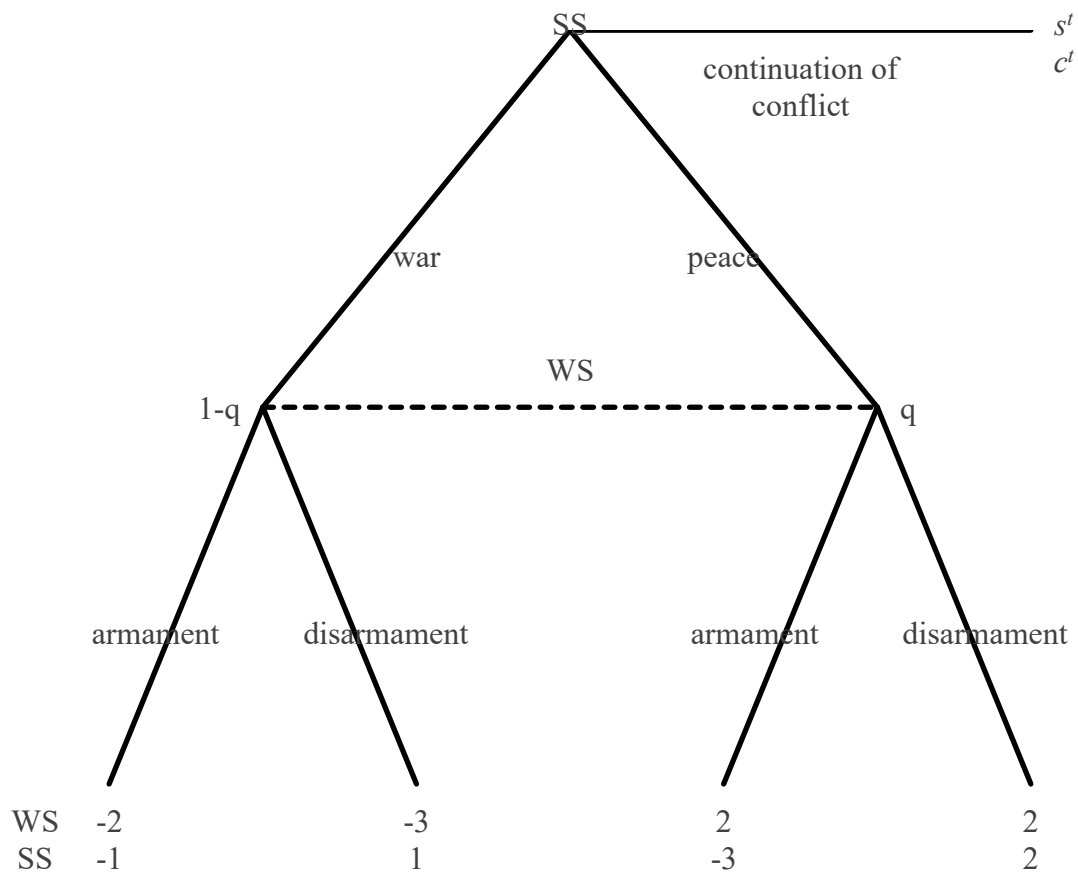SS -1   1   -3   2

Figure 5. Game of $a = d$

However, in nuclear disarmament negotiations, $a = d$ is impossible if nuclear deterrence has a security advantage and peaceful resolution is always more profitable than peaceful denuclearization for the weaker side. The greater the effectiveness of nuclear deterrence, the less benefit there is for the weaker side to denuclearize. The expected utilities of the weaker side is never $u_{WS}(pe, d) > u_{WS}(pe, a)$ in Figure 6 and 7 because the utility of nuclear deterrence, nd, is more than 0 and another profit, signing of a non-war treaty, is the same. The aforementioned cases, when considering the U.S. to China and the U.S. to India, show that the stronger side can accept a peaceful resolution if their nuclear weapons cease to be an immediate military threat at that time.
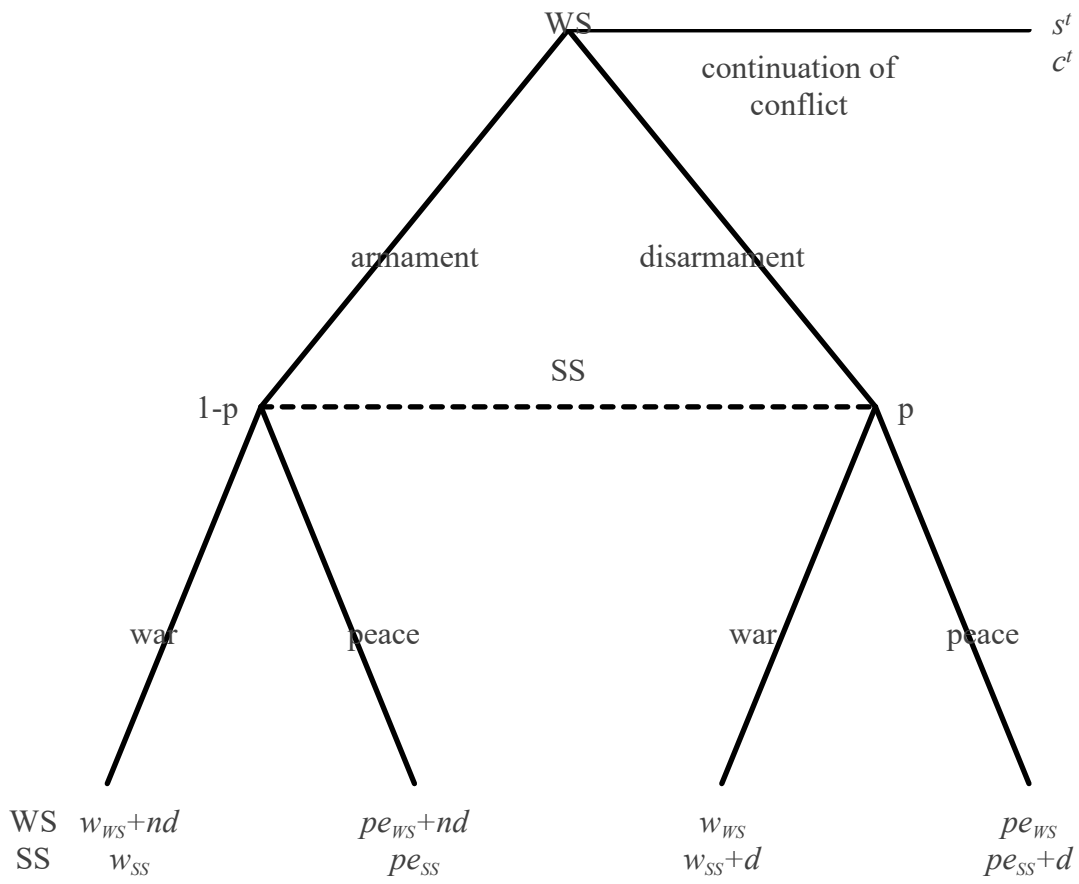
Figure 6. Effect of nuclear deterrence: Weaker side moves first

SS s^t

continuation of
conflict c^t

war peace

WS

1-q $\cdots\cdots\cdots$ q

armament disarmament armament disarmament

WS $w_{WS}+nd$ w_{WS} $pe_{WS}+nd$ pe_{WS}
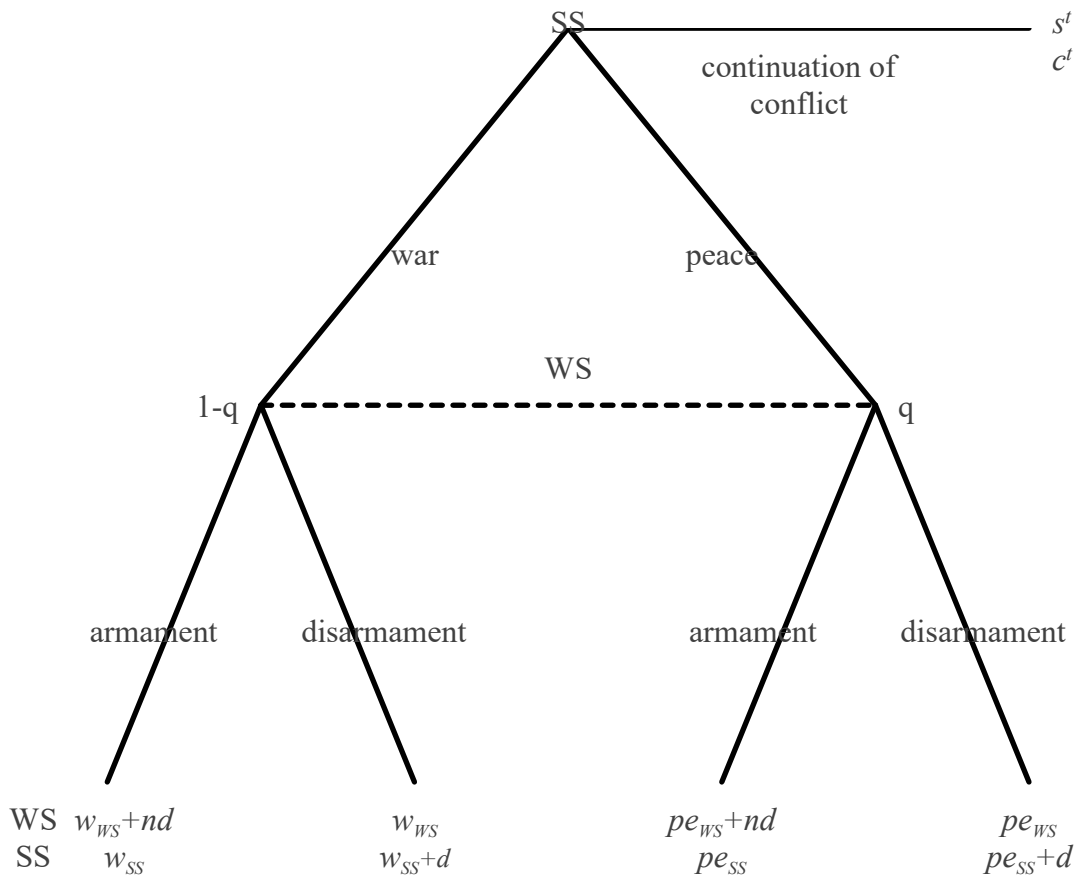SS w_{SS} $w_{SS}+d$ pe_{SS} $pe_{SS}+d$

Figure 7. Effect of nuclear deterrence: Stronger side moves first

Peaceful denuclearization will more easily be achieved if the effect of nuclear deterrence was decreased and extinguished; however, it is impossible to expect this. To achieve a peaceful denuclearization in a situation where nuclear deterrence works, making the weaker side move first and offer nuclear disarmament voluntarily is a necessary condition. Therefore, the following methods should be analyzed.

4   Methods to Reduce Uncertainty

To summarize the analyses, the conditions for peaceful denuclearization are as follows:

(1) It does not create the expectation that the stronger side will make the first move

and compromise on a nuclear issue.

(2) The stronger side implements sanctions to force the weaker side into a decision of armament or disarmament, rather than maintaining the status quo.

(3) It is necessary to maintain confidence that the stronger side is willing to respond to "disarmament" with "peace" when the weaker side is pushed to the brink by sanctions.

It is difficult to reconcile conditions (2) and (3) because it means achieving an increase in the likelihood that strengthening sanctions will provoke radical behavior, while simultaneously maintaining trust.

Figure 1 shows that the weaker side's moving first is necessary to reach peaceful denuclearization and (disarmament, peace) is an equilibrium point. When the game is repeated, the more complex model is needed to construct the same sequential equilibrium at the final stage. This section analyzes strategies where the stronger side induces the weaker side to make the first move.

Suppose that nuclear deterrence does not lose its positive security effect: then, it is difficult or impossible to change the payoffs of the weaker side's armament in Figures 1 and 2. The payoff (including the nuclear deterrence effect) is never less than the payoff of disarmament because $uws(pe, a) > uws(pe, d)$ and $uws(w, a) > uws(w, d)$ is fixed in the game, and the relationships of expected utilities also do not depend on the subjective probabilities p and q. In the game of Figure 1, $uws(a, w) > uws(d, w)$ is fixed because of the effect of nuclear deterrence and nuclear retaliation. The nuclear threat of the weaker side is effective because it has strong motivation to use nuclear weapons in a war against the stronger side for its survival when the former is backed into a corner by the strong side. The $uws(a, w) > uws(d, w)$ and incentive to choose armament is the same, even if the

21

weaker side's type is soft secure, which prefers peaceful denuclearization to peaceful resolution. Therefore, there is no method to decrease the payoff of armament unless the nuclear deterrence is useless. Changing the payoff of the stronger side's payoffs in the case of disarmament in Figure 1 is a method to increase the likelihood of peaceful denuclearization.
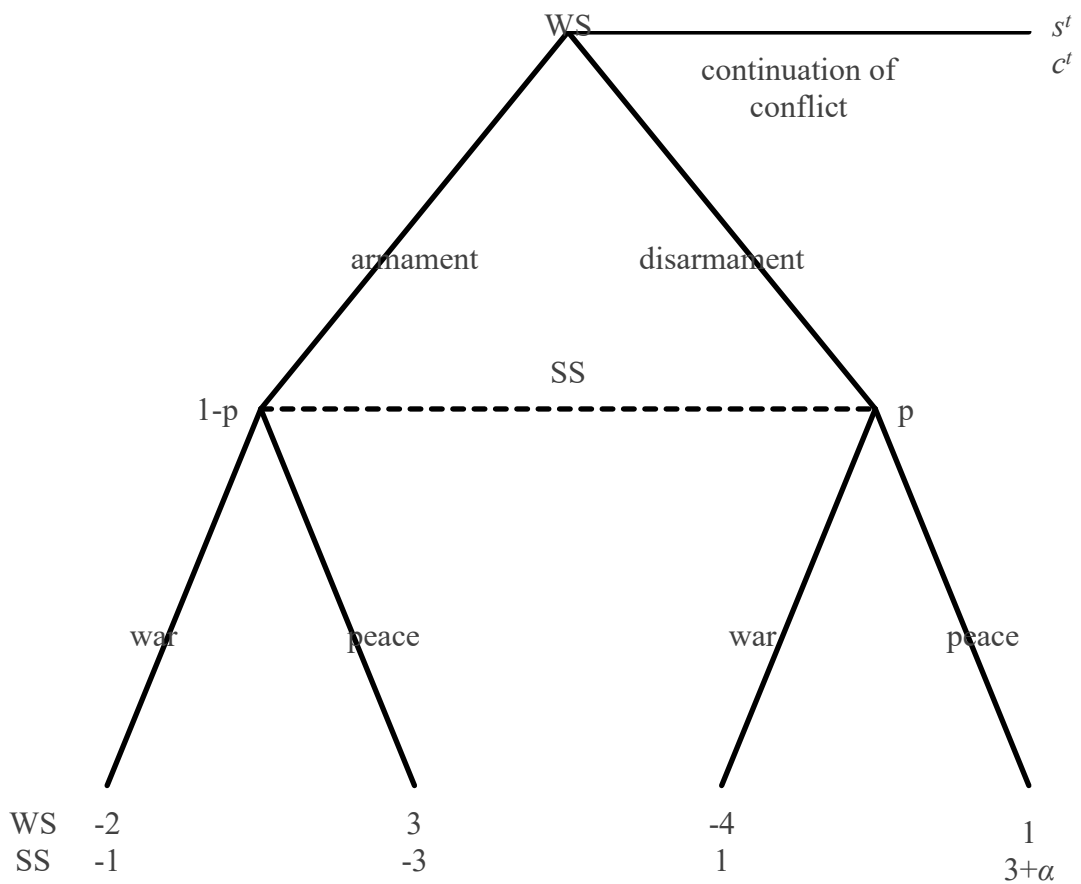

Figure 8. Effect of changing the stronger side's payoff

As shown in Figure 8, a corrected game, decreasing the payoff of $u_{SS}(d, w)$ and/or increasing $u_{SS}(d, pe)$ increases the likelihood of peaceful denuclearization and makes it easier for the weaker side to opt for disarmament.

Variables to increase α should have an immediate effect on negotiations and must be something that the weaker side can trust to be feasible. What changes the payoffs of the stronger side and reduces uncertainty of the weaker side in the real world? Of course, there are variables that not only decrease the uncertainty, but also increase it. The causal variables are allies of the stronger side, public opinion of the stronger side, and International Organization.

Even if the values of some exogenous variables are 0, the weaker side can choose disarmament if the total value is more than $u_{ss}(d, w)$. They thus reduce the uncertainty of the negotiation. What the disarmament game needs is exogenous variables that elevate the gains of peace without elevating the gains of war. Such variables are by no means numerous and the effect of each one is never large. It is, therefore, important to collect as many as possible.

5   Conclusions

This study presented theoretical conditions to promote North Korean nuclear disarmament without armed conflict. The methods for the peaceful denuclearization are discussed on the assumption that the weaker side is soft secure and makes rational decisions.

The unequal nuclear rivalry makes it more difficult to solve nuclear disarmament and stabilize nuclear deterrence than equal rivalry. A weak nuclear power who is in conflict with a strong nuclear power has much stronger incentive to keep nuclear deterrence than a non-nuclear power protected by the nuclear umbrella. Many states tried to develop nuclear weapons; the main reason for this was nuclear and/or military threat (Campbell, et al. 2004). The weak nuclear power or potential nuclear power never loses the incentive

as long as the threat exists because nuclear deterrence prevents any military attack from the stronger side. In addition, keeping nuclear deterrence is useful in preparing for future threats and this is an incentive for denying denuclearization, even if the conflict with the stronger nuclear power is resolved.[6] If other methods to achieve peaceful denuclearization are to be created, nuclear deterrence must be nullified. Such a task is considerably more difficult than stabilizing mutual nuclear deterrence. This study is based solely on the premise of nuclear deterrence; research beyond this framework will be the subject of a future work. Extinction of nuclear deterrence is a necessary condition to completely free the world from the nuclear threat.

Both the assurance not to be attacked after denuclearization and the coercive power to give up nuclear weapons are necessary in the denuclearization negotiation. The stronger side's military power and sanctions are useful in making the weaker side giving up nuclear weapons. However, the stronger side must be left with the hope that it can resolve the issue peacefully if it compromises first. The stronger side must make the game situation but must never move first. The most difficult task of the stronger side is trust building and not to defect in the second move after denuclearization of the weaker side.

Interactions among allies, public opinions, and international organizations are also important for trust building. IAEA specifically has a unique role in the unequal nuclear rivalry. However, their activities do not necessarily match the stronger side's policy. For example, according to the surveys on nuclear issues, only 7.4% of Japanese think that the U.S. contributes to nuclear disarmament and 10% of Americans think Japan contributes to nuclear disarmament. However, 21.6% of Japanese think that Japan contributes and

---

[6] In surveys on nuclear issues in 2022, 25.5% of Americans agreed that "To prepare for future threats" is an appropriate reason to possess nuclear weapons, but only 11% of Japanese agreed (Shibai 2022).

48.4% of Americans think the U.S. contributes (Shibai 2022).

The public opinions of the two countries think positively about their own government and negatively about another government in nuclear disarmament issues. This antagonism can make it difficult for Japan to cooperate with the U.S. Two of most important states in North Korean nuclear issues implemented various policies for peace of Northeast Asia, but the nations are critical of each other. It is difficult for the Japanese government to cooperate with the U.S. denuclearization in the Korean peninsula if the public opinion agrees on the U.S. policy. This study shows that there is no first mover advantage in the unequal rivalry. Japanese cooperation is one of the necessary conditions to make North Korea move first. The more that exogenous variables cooperate with the U.S., the greater the likelihood of getting North Korea to make the first move.

As long as a nuclear power has no incentive to demand denuclearization to a non-hostile nuclear power, the first offer of peace inevitably leads to a peaceful resolution without denuclearization. Establishing the second-mover advantage is a key factor for denuclearization.

References

Albright, David and Corey Gay. 1998. "Taiwan: Nuclear Nightmare Averted." *Bulletin of the Atomic Scientists* 54:1: 54-60.

Ausubel, Lawrence M., Peter Cramton, and Raymond J. Deneckere. 2002. "Bargaining with Incomplete Information." In *Handbook of Game Theory*, Vol. 3, edited by Robert J. Aumann and Sergiu Hart. Amsterdam: Elsevier, 1-53.

Baum, Matthew and Tim J. Groeling. 2010. *War Stories: The Causes and Consequences of Public Views of War*. Princeton: Princeton University Press.

Benton, Alan A., Harold H. Kelley, Barry Liebling. 1972. "Effects of Extremity of Offers and Concession Rate on Outcomes of Bargaining." *Journal of Personality and Social Psychology* 24:1 (October): 73-83.

Binmore, Ken, Martin J. Osborne, and Ariel Rubinstein. 1992. "Noncooperative Models of Bargaining. "In *Handbook of Game Theory with Economic Applications*, Vol. 3, edited by Robert J. Aumann and Sergiu Hart. Amsterdam: Elsevier, 181-225.

Burr, William, ed. 1999. "New Evidence on Taiwanese 'Nuclear Intentions', 1966-1976." *National Security Archive Electronic Briefing Book* (19). Retrieved August 28, 2022 http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB20/

Burr, William, ed. 2007. U.S. "Opposed Taiwanese Bomb during 1970s: Declassified Documents Show Persistent U.S. Intervention to Discourage Suspicious Nuclear Research." *National Security Archive Electronic Briefing Book* (221). Retrieved August 28, 2022 http://www.gwu.edu/~nsarchiv/nukevault/ebb221/index.htm

Burr, William and Jeffrey T. Richelon. 2000/01. "Whether to 'Strangle the Baby in the Cradle': The United States and the Chinese Nuclear Program, 1960-64."

International Security 25:3 (Winter): 54-99.

Campbell, Kurt M., Robert J. Einhorn, and Mitchell B. Reiss. 2004. *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*. Washington, D.C.: Brookings Institution Press.

Chang, Gordon H. 1990. *Friends and Enemies: The United States, China, and the Soviet Union, 1948-1972*. Stanford: Stanford University Press.

Chertkoff, Jerome M. and Melinda Conley. 1967. "Opening Offer and Frequency of Concession as Bargaining Strategies." *Journal of Personality and Social Psychology* 7:2 (October): 181-185.

Dancy, Geoff. 2018. "Deals with the Devils?: Conflict Amnesties, Civil War, and Sustainable Peace." *International Organization* 72:2 (Spring): 387-421.

Foyle, Douglas. 1999. *Counting the Public in: Presidents, Public Opinion, and Foreign Policy*. New York: Columbia University Press.

Fudenberg, Drew, David K. Levine, and Jean Tirole. 1985. "Infinite-Horizon Models of Bargaining with One-Sided Incomplete Information." In *Game-Theoretic Models of Bargaining*, edited by Alvin E. Roth. Cambridge: UK and New York: Cambridge University Press, 73-98.

Galinsky, Adam D. and Thomas Mussweiler. 2001. "First Offers as Anchors: The Role of Perspective-Taking and Negotiator Focus." *Journal of Personality and Social Psychology* 81:4: (October): 657-669.

Galinsky, Adam D., Gillian Ku, and Thomas Mussweiler. 2009. "To Start Low or To Start High?: The Case of Auctions Versus Negotiations." *Current Directions in Psychological Science* 18:6 (December): 357-361.

Glaser, Charles. 1998. "The Flawed Case for Disarmament." *Survival* 40:1 (Spring): 112-

128.

Kase, Yuri. 2001. "The Costs and Benefits of Japan's Nuclearization: An Insight into the 1968/70 Internal Report." *The Nonproliferation Review* 8:2 (Summer): 55-68.

Kennan, John and Robert Wilson. 1993. "Bargaining with Private Information." *Journal of Economic Literature* 31:1 (March): 45-104.

Kim, Seung-Young. 2001. "Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles: The South Korea Case, 1970-82." *Diplomacy & Statecraft* 12:4 (December): 53-80.

Lieberman, Marvin B. and David B. Montgomery. 1988. "First-Mover Advantages." *Strategic Management Journal* 9 (Special Issue): 41-58.

Liebert, Robert M. William P. Smith, J. H. Hill, and Miriam Keiffer. 1968. "Effects of Information and Magnitude of Initial Offer on Interpersonal Negotiation." *Journal of Experimental Social Psychology* 4:4 (October): 431-441.

Loschelder, David D., Roman Trötschel, Roderick I. Swaab, and Malte Friese. 2016. "The Information-Anchoring Model of First Offers: When Moving First Helps Versus Hurts Negotiators." *The Journal of Applied Psychology*: 101:7 (July): 995-1012.

McDonald, Patrick J. 2009. *The Invisible Hand of Peace: Capitalism, the War Machine, and International Relations Theory*. Cambridge: Cambridge University Press.

Mitchell, Derek J. 2004. "Taiwan's Hsin Chu Program: Deterrence, Abandonment, and Honor." In *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, edited by Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss. Washington, D.C.: Brookings Institution Press, 293-313.

Osborne, Martin J. and Ariel Rubinstein. 1990. *Bargaining and Markets*. Cambridge:

Academic Press.

Pollack, Jonathan D. and Mitchell B. Reiss. 2004. "South Korea: The Tyranny of Geography and the Vexations of History." In *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, edited by Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss. Washington, D.C.: Brookings Institution Press, 254-292.

Rubinstein, Ariel. 1982. "Perfect Equilibrium in a Bargaining Model." *Econometrica* 50:1 (January): 97-109.

Rubinstein, Ariel. 1985. "A Bargaining Model with Incomplete Information about Time Preferences." *Econometrica* 53:5 (September): 1151–1172.

Seaborg, Glenn T. 1981. *Kennedy, Khrushchev, and the Test Ban*. Berkley and Los Angeles: University of California Press.

Shibai, Kiyohisa. 2012. "The Problem of Third Party in International Negotiations." *International Relations* 169 (June): 139-153. (Japanese)

Shibai, Kiyohisa. 2015. "Correlation between Nuclear Nonproliferation in Europe and Nuclear Proliferation in East Asia." *International Relations* 180 (March): 98-110. (Japanese)

Shibai, Kiyohisa. 2019. *Trade-off between Nuclear Proliferation in East Asia and Nuclear Nonproliferation in Europe.* Okayama: University Education Press. (Japanese)

Shibai, Kiyohisa. 2022, forthcoming. *Cross-National Survey on Nuclear Disarmament Issues: Japan, Hiroshima, Nagasaki, and the U.S. 2022 Web Survey. ISM Survey Research Report No.122*. Tokyo: The Institute of Statistical Mathematics.

Sobel, Joel and Ichiro Takahashi. 1983. "A Multistage Model of Bargaining." *The Review*

of Economic Studies 50:3 (July): 411-426.

Wenger, Andreas and Marcel Gerber. 1999. "John F. Kennedy and the Limited Test Ban Treaty: A Case Study of Presidential Leadership." *Presidential Studies Quarterly* 29:2 (June): 460-487.

Ye, Puyu and Jun Zhuang. 2019. "Denuclearization or Not? A Multiple-Player Sequential Game Model." In *Game Theory and Nuclear Stability in Northeast Asia*, edited by Lauren Ice, James Scouras, Kelly Rooker, Robert Leonhard, and David McGarvey. Baltimore: The Johns Hopkins University Applied Physics Laboratory LLC, 87-98.

Yukl, Gary A. 1974. "Effects of Situational Variables and Opponent Concessions on a Bargainer's Perception, Aspirations, and Concessions." *Journal of Personality and Social Psychology* 29:2 (February): 227-236.