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# Engaging with North Korea

## Lessons from Game Theory

A change of leadership in Washington provides an opportunity to once again reevaluate the relationship between the United States and North Korea and to figure out ways to move forward productively. In this report, we draw on intuition from game theory to better understand the situation with North Korea as it stands in early 2021. The goal is to provide insights and recommendations for the new U.S. presidential administration. These insights and recommendations are based on game theoretic analysis of how to deal with Kim Jong-un, the leader of North Korea, and the situation on the Korean peninsula; specifically, negotiations on denuclearization.

Game theory's early applications thought through strategic considerations that involved the use of nuclear weapons and how to prevent conflict and deter the Soviet Union from using its weapons or expanding its borders. Although Kim Jong-un and the North Korea of today are very different than Joseph Stalin and the Soviet Union of the early 1950s, game theoretic concepts remain useful in analyzing the situation and thinking through possible responses.

Game theory is widely used to study the interactions of actors, such as individuals, firms, and countries. Formally, a game is defined by four key elements: the players, the rules, the possible outcomes, and the payoffs (Mas-Colell, Whinston, and Green, 1995). Unlike other areas in economics in which an agent is maximizing personal benefits given outside constraints, game theory is characterized by strategic interdependence—each player's best action depends on what that individual believes the other players will do. A plan for a given player that details how to proceed through the game is called a *strategy*. A game theoretic strategy must be a “complete plan for action, covering all contingencies” (Snidal, 1985, p. 37). This means that a complete strategy must tell a player what to do at any potential point in the game, even in situations that are not likely to happen. A strategy that is expected to lead to the player's best potential outcome given what all other players are likely to do and in which no player has an incentive to unilaterally deviate from their course of action is called a *Nash equilibrium*. It was named after Nobel Prize winner John Nash, who first articulated the concept.

We can characterize the situation with North Korea in a game theoretic context to help us to better understand some of the potential issues that are involved. In this framework, the players in the game would include some subset (possibly all) of the countries that participated in the six-party talks—which occurred from 2003 to April 2009—and would discuss North Korea's withdrawal from the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). These countries—North Korea, South Korea, the United States, China, Japan, and Russia—all have intense interests in what happens on the Korean peninsula, as well as various goals and strategic objectives, many of which will likely

remain undisclosed. A complete and full characterization of the rules, possible outcomes, and payoffs of the game could allow us to solve for the Nash equilibrium outcome. However, as will be explored in the following sections, there is a high degree of uncertainty not only about the structure and payoffs of the game but even about the number of players and potential strategies involved. Because of this inherent uncertainty and the many unknowable variables, we are not able to provide an explicit “solution” to this game. Instead, we characterize game theoretic issues that can inform courses of action even without providing a complete strategy.

It should be remembered that, as with any analysis of the real world, game theoretic models are a simplification of reality and it is not possible to fully incorporate the subtle nuances and complexities of real-world environments into simplified models.<sup>1</sup> The analysis provided in this report consists of five general areas.

First, we examine some of the uncertainties inherent in any interaction with North Korea. In game theory, *asymmetric information*—when one party has access to information that another party does not—leads to two classic problems: problems of *hidden type* (where the character and motivations of one of the players are not known to the other players) and problems of *hidden action* (where a player can take an action that is not observed by other players). This “incomplete information” makes the game more complex and makes it more important for the United States to both force North Korea to reveal its ultimate objectives and use powerful incentives to enforce any agreements (Ghosh and Masson, 1994). In this context, we will examine some models that have been proposed by economists, which analyze incentives and signaling to better understand these issues.

Second, we discuss whether either side can credibly commit to an agreement that is reached. Negotiations are pointless if the players do not believe that the other side will hold up its end of the deal.

Third, we discuss issues arising from another area of uncertainty—the effective number of players in the game. In well-specified economic models, the number of players in the game is assumed from the beginning and is usually fixed throughout the game. However, in deterring North Korea, it is unclear what roles China, Russia, Japan, and South Korea will

play. The perceived payoffs, strategies, and levels of involvement of these players could also change over time, depending on how the situation evolves.

Fourth, we look at the dimension of time and deadlines. Time is important because the best strategic responses can be very different if one or more of the players is playing a *dynamic game*—which lasts over many time periods—versus a one-shot *static game*, which is a one-time event. Relatedly, optimal actions and strategies could change if there is an explicit deadline for action.

Finally, we consider the framing of the game and the objectives of the players involved. An agreement might be more difficult to achieve if winning means that the other side must lose, or if the personal egos of leaders are valued more than the lives of the citizens in their countries.

We conclude by reviewing different implications and insights from the analyses that we believe should inform the United States and its allies as they seek to deal with Kim and the situation on the Korean peninsula.

## Asymmetric information—What Does Kim Jong-Un Want?

### Hidden Type

Imagine two separate universes, each with its own North Korea and Kim Jong-un.<sup>2</sup> In the first universe, Kim’s highest goal is to preserve his position and prevent regime change. Let us call him Kim 1. As long as Kim 1 can stay the leader of North Korea and not feel threatened by his neighbors (for example, by having U.S. troops in South Korea), he will be content. He believes that he needs nuclear weapons to deter other countries from trying to remove him from power, and he knows that he must maintain the loyalty of the North Korean elites to prevent internal challenges to his authority.

In the second universe, Kim’s highest goal is to rule the North and reunify North and South Korea under his regime. Let us call him Kim 2. Kim 2 not only wants what Kim 1 wants (survival and to rule over the North), but he also wants to expand his power and influence, increase the territory that he controls, prevent others from stopping his expansion-

ist ambitions, and have North Korea recognized as a permanent nuclear state. He believes that he needs nuclear weapons to defend himself, project his power, and destroy the alliance between the United States and South Korea, which would eventually allow the North Korean military to move into South Korean territory. He must maintain the loyalty of the elites and make sure that they and the army will follow him in his ambitions. He believes that control of the South will give him greater loyalty in the North.

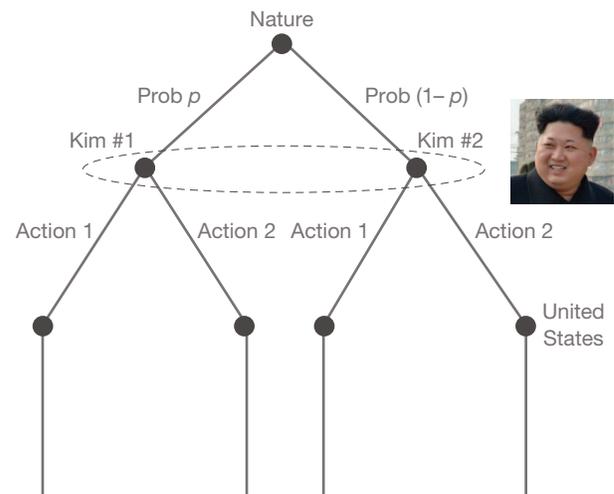
If the United States and its allies cannot tell which universe they are in and which Kim they are facing, then this is a classic problem of hidden type. Kim 1 and Kim 2 might take similar actions initially, although for different reasons, making it difficult for others to determine which Kim they are facing.

In game theory, we model this situation of hidden type by introducing an additional player, Nature, who makes an initial decision at the start of the game about which universe we are in; this decision is based on some probability that we will call  $p$  (see Figure 1). The next nodes of the game—the first move by Kim—are encircled by a dotted line.<sup>3</sup> This is meant to represent the idea that the other players in the game do not know which of the two branches they are on, and they cannot know which of the two Kims they are facing. When the United States makes its first move on the third level of nodes, it does not know whether it is on the left branch or the right branch of the game, and it must try to infer which of the two Kims it is facing to optimize its actions and reach its goals.

Games of hidden type are often characterized by the importance of signaling. It may lead to better outcomes for one or more players if the “hidden type” player can signal which type they are to the other players. When this is possible and the signaling occurs, the other players are able to separate the two types based on their actions and determine which universe they are in. This is called a *separating equilibrium* because it is possible to separate the two types.

However, Kim 2 might have an incentive to act like Kim 1, especially if he believes that his desired outcomes are more likely to be achieved if the other players believe that he is Kim 1.<sup>4</sup> For instance, Kim 2 might say that he is interested in denuclearization

FIGURE 1  
Two Potential Kim Types



of the peninsula when his real goal is to delay any potential U.S. military action or to get the United States out of South Korea because talking about denuclearization is something that Kim 1 might do. Similarly, Kim 2 might be friendly with South Korean President Moon Jae-In and former U.S. President Donald Trump to impersonate Kim 1. He could be aided in this if others want to believe that he is Kim 1 when he is really Kim 2. This situation is called a *pooling equilibrium* because the two types of players would “pool” together and do many of the same actions, regardless of their type. If this is the case, the other players cannot tell which universe they are in or which Kim they are facing because the Kims cannot be distinguished from each other based on their superficial actions.

In this situation, it is likely that Kim 2 would want to act like Kim 1, leading to a pooling equilibrium. Based on the history of the six-party talks, the United States and its allies would be likely to accommodate Kim 1 but to vigorously resist Kim 2. Knowing this, Kim 2 would pretend to be Kim 1 because this would make him more likely to achieve his goals. Other countries might think that they are playing against Kim 1 when really it is Kim 2 acting as though he were Kim 1.

In these situations, it is often better for the other players to create a *signal*—some way to distinguish between Kim 1 and Kim 2. To be effective, the

signal must be relatively more costly for Kim 2 than it would be for Kim 1. It must be a concrete action that is difficult and requires a substantial amount of effort; as economists often note, “talk is cheap.” Thus, Kim 1 would likely do the action, but Kim 2 would not and, depending on what is observed, the United States and other players could have a better idea of which Kim they were playing with.<sup>5</sup>

Thus, the United States must find some action that Kim 2 would find very difficult to undertake but that Kim 1 would not. Whether Kim takes this action will help to determine with which Kim the players are dealing. One example of such a signal (among many) could be giving up five nuclear weapons as a precondition for further talks. Because Kim 1 needs only a few nuclear weapons to ensure regime survival, giving up excess weapons would be less costly for him than it would be for Kim 2, who needs more nuclear weapons to expand his borders and prevent allies of South Korea from stopping a potential North-controlled reunification. Which Kim the United States is dealing with can be further revealed during negotiations by mandating that North Korea never have more than ten nuclear weapons at one time (subject to strict international verification) and requiring Kim to stop anti-U.S. indoctrination (perhaps in exchange for humanitarian aid from the U.S.–South Korean alliance). Kim 2 would be less likely to agree to these terms, but Kim 1, interested only in regime security, would find them easier to accept.

On April 27, 2018, Kim became the first North Korean leader to visit South Korea since the end of the Korean War in 1953; he met with President Moon. According to several media articles, during their meeting, Kim and Moon called for “complete denuclearization” of the peninsula and Kim pledged to shut down his main nuclear weapons test site at Punggye-ri by the end of May. On June 12, 2018, Kim became the first North Korean leader to meet with a sitting U.S. President when he met with then-President Donald Trump in Singapore. The agreement signed by the two leaders reiterated their commitment to “work toward complete denuclearization of the Korean peninsula.”<sup>6</sup>

So which Kim is the United States dealing with? Although relations between North and South Korea

and between North Korea and the United States have cooled since 2018, none of Kim’s actions helped to disentangle whether the United States is facing Kim 1 or Kim 2 even during the relative easing of tensions over the past few years. Because denuclearization was never defined in any of the declarations signed by Kim and Moon or by Kim and Trump, the two sides might have been interpreting it differently all along; South Korea and the United States might have believed that it meant the destruction of North Korea’s existing nuclear weapons, and North Korea might have believed that it meant the end of U.S. guarantees to protect South Korea and the removal of U.S. troops from the country. The pledge to shut down Punggye-ri would not affect Kim’s existing nuclear and ballistic missile programs, and reports suggest that portions of the site collapsed after a nuclear test carried out in September 2017, potentially making the site unusable and vulnerable to radiation leaks (Bishop, 2018; “Koreas Summit: North Korean Media Kail ‘Historic’ Meeting,” 2018; McCurry, 2018). On April 21, 2018, Kim said in a statement to the state-run Korean Central News Agency, “We no longer need any nuclear tests, mid-range and inter-continental ballistic rocket tests, and . . . the nuclear test site in the northern area has also completed its mission” (Bishop, 2018; “Koreas Summit: North Korean Media Kail ‘Historic’ Meeting,” 2018). Thus, actions taken so far do not appear to be any more costly to a Kim 2 with ambitions of expansion than to a Kim 1 who wants security for North Korea, and these actions do not help to distinguish which Kim is in charge of North Korea.

Perhaps the “maximum pressure” U.S. sanction campaign, together with a failure in Kim’s ability to test nuclear weapons, changed the game and pushed a desperate Kim 1 to go on a diplomatic offensive in 2018 to save himself and his regime (Beauchamp, 2018). Or maybe Kim 2 is playing world leaders to his advantage to decouple the United States from South Korea and Japan and pave the way for unification of the peninsula under his rule. To separate out which Kim it is facing, the United States continually must request actions that Kim 2 would find more costly than Kim 1, such as surrendering nuclear weapons as a precondition for talks, limiting the number of

weapons (subject to strict verification), and ending anti-U.S. indoctrination by state-owned media.

## Hidden Action

A second potential problem that comes from asymmetric information is hidden action. If actions are not completely observable to all players in the game, then there might be an incentive for one or more players to take actions that are beneficial to themselves but harmful to the other players.

The canonical model of hidden action is what economists call the *principal-agent problem*. (Grossman and Hart, 1983). In this setup, the principal is trying to accomplish a project and hires an agent to help complete the project. How well the project is completed depends on the effort level of the agent and factors that are outside the control of the players in the game.<sup>7</sup> If the principal can observe the effort of the agent, then the principal can ensure that the agent puts in the optimal amount of effort to produce a high-quality project. However, if the effort is not observable, then the principal cannot determine how much of the quality level of the final project came from the effort of the agent and how much it was affected by factors outside the control of either player. Because effort is costly, the agent might have an incentive to put in less effort than they otherwise would and to blame the low-quality outcome on outside factors because the principal cannot distinguish the impact of their effort from the external shocks.

In the context of North Korea, even if a deal is signed to reduce nuclear activities on the peninsula, it might be difficult for the United States and its allies to ensure that the deal is respected; Kim could take hidden actions contrary to the deal he has signed. As detailed in the following paragraphs, previous deals have foundered for precisely this reason (Kube, Dilanian, and Lee, 2018). Perhaps more concerning, in the months following the Kim-Trump summit in Singapore, several in the media, citing anonymous intelligence sources, reported that North Korea was actually increasing nuclear production at secret sites and was taking efforts to conceal the number of facilities and the number of weapons that it had (see, e.g., Joyce, 2018; Kube, Dilanian, and Lee, 2018; and Vaynman and Narang, 2018). Lindsey Graham, a

Republican senator from South Carolina, reportedly even warned Trump that he was being “played” by North Korea (“Lindsey Graham Warns Trump He’s Being ‘Played’ by North Korea,” 2018).<sup>8</sup> According to journalists, many countries had taken Trump’s tweet that, “There is no longer a Nuclear Threat from North Korea” (Sullivan, 2018) as permission to ease off on the enforcement of sanctions, potentially giving North Korea a large boost to its economy before it had taken any concrete steps toward denuclearization (Boot, 2018). An easing of sanctions by China alone or by China, Russia, and South Korea already could be economically significant for North Korea.

From a game theory perspective, there are two ways to ameliorate the principal-agent problem. The first is strict monitoring and verification to ensure that the agent is putting in the maximum effort.<sup>9</sup> In general, monitoring and verification are very costly, and in the context of North Korea, complete monitoring and verification might or might not be possible.<sup>10</sup> For example, in the past, North Korea has hidden key facilities, and as its missiles become more mobile, they could be harder to detect and track (Berger and Cotton, 2018; Harrison, 2005; McLaughlin, 2018; O’Carroll 2013; Treverton, 2018). Some also believe that the country has developed a network of tunnels that would make it difficult to

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determine where weapons of mass destruction are hidden (Mollman, 2018). Experts believe that the total number of nuclear sites in North Korea could be as high as 100 facilities.<sup>11</sup> Complete monitoring and verification of all of these facilities would be a huge task for the International Atomic Energy Agency, which currently has about 300 inspectors to assess the nuclear facilities of 200 countries (Sanger and Broad, 2018).

A second way to get a higher level of effort in the presence of hidden actions is to incentivize the agent so that their payoff depends on the success of the overall project.<sup>12</sup>

One potential strategy would be to give Kim, North Korean elites, or both a large stake in a South Korean firm whose fortune is tied to peace, stability, and development in North Korea. Because the North Korean economy is very small with significant potential to grow, the value of Kim's stake in such a firm easily could be larger than the entire North Korean gross domestic product over time.<sup>13</sup> Kim's personal fortune would then rise and fall with the prospects for peace and development in his country. Any cheating on his nuclear commitments would cause him to forfeit a given percentage of his equity and claims to future growth of the company. Although there might be unintended consequences and negative incentive effects to such a mechanism, aligning incentives of the players that are involved is the best way to deal with hidden action when strict monitoring is not possible.

Whether an incentive scheme can be set up that would encourage North Korea to buy into the project of nuclear disarmament and peace on the Korean peninsula without too many negative consequences is still an open question. What is clear is that policymakers should begin thinking now about ways to enforce any potential agreement on nuclear disarmament. It is likely that both heavy monitoring and powerful incentives will be necessary to prevent Kim from hidden action after any agreement is signed. Good deterrence involves threats and incentives (Myerson, 2017).

## Can Either Side Credibly Commit?

Even if neither side cheats, one or more players could decide to walk away from the agreement at a future point in time. In games in which both players do not act at the same time (sequential games), game theorists distinguish between a Nash equilibrium and a subgame perfect Nash equilibrium. The difference is that, in a *Nash equilibrium*, each player must be playing a strategy that is their best response to the strategy that each other player is playing, but in a *subgame perfect Nash equilibrium*, the strategies must also be credible.<sup>14</sup> For a stable agreement, both sides must be able to credibly commit to upholding any promises made in the future. This could be difficult for both the United States and North Korea; many analysts argue that it is contrary to North Korean negotiating culture. According to North Korean refugees, North Korean elites believe that an agreement is just the midpoint of negotiations. They believe that a smart player will cheat as much as possible after the agreement is signed to improve the negotiated outcomes for itself and provide leverage for future negotiations.

North Korea has made three previous agreements on nuclear weapons and has not abided by any of them. *The Joint Declaration of the Denuclearization of the Korean Peninsula* was agreed to by South and North Korea in 1992. A commission was created and held several meetings in 1992 and 1993. However, this commission made no concrete progress. North Korea then announced that it would withdraw from the NPT in 1994. Soon after, the *Agreed Framework* was negotiated, in which the United States promised humanitarian aid and North Korea agreed to freeze its illicit plutonium weapons program and remain part of the NPT. However, North Korea began uranium enrichment and nuclear weapon production—in violation of the agreement—not long after it was signed. It officially withdrew from the NPT—for a second time—in January 2003, and then it began again to openly pursue nuclear weapons.

In August 2003, the six-party talks were initiated among China, Japan, North Korea, Russia, South Korea, and the United States. In 2005, North Korea agreed to abandon “all nuclear weapons and existing nuclear programs.” In 2007, the parties agreed

on implementation of the 2005 agreement. However, the agreement broke down in 2009, when North Korea launched a modified Taepo Dong-2 three-stage rocket, which it claimed was part of its civilian space program (Davenport, 2018a). North Korea then insisted that it was no longer bound by its previous agreements and that it would not return to talks (Davenport, 2020).

At the same time, North Korea, China, and other players might also have a hard time believing that the United States will abide by its agreements. With the United States pulling out of the 2015 Paris Climate Agreement in June 2017 and then pulling out of the Iran nuclear agreement in May 2018 (which the United States had supported and helped to get ratified by a unanimous United Nations Security Council Resolution only three years prior), world leaders might find it increasingly difficult to trust the United States to live up to its agreements, especially agreements made when the opposite political party was in power.<sup>15</sup> As the relationship between the United States and North Korea cooled in mid-2020, North Korea accused the United States of making “empty promises,” claiming that the United States had not lived up to commitments that it had made during the recent summits. “Nothing is more hypocritical than an empty promise,” said North Korean Foreign Minister Ri Son Gwon (Lee, 2020).<sup>16</sup>

Any agreement between the United States and North Korea, the United States and China, or all parties involved must stipulate specific incentives and punishments to prevent countries from later walking away from their commitments. The countries must then be prepared to implement these incentives and punishments if the conditions of the agreement are not met.

## How Many Effective Players Are in the Game?

The effective number of players in a game can affect the structure of the game and the potential strategies and payoffs. The best courses of action might be very different depending on whether North Korea and the United States are the only two players negotiating nuclear disarmament or the effective set of interested

parties also includes many other countries, such as China, South Korea, Russia, and Japan. Either the United States or North Korea might try to strategically alter the number of effective players in the game to tilt the situation toward their preferred outcomes.

As North Korea’s biggest ally, support from China will be critical to any successful deal on nuclear disarmament on the Korean peninsula. Some analysts have argued that China’s failure to enforce sanctions rigorously has allowed Kim to increase his nuclear ambitions and that tougher enforcement by China in 2017 forced Kim to the negotiating table, where he offered to denuclearize.

Kim’s meeting with top South Korean diplomats in March 2018, a surprise trip to Beijing to meet with Chinese President Xi Jinping later that month, a meeting with South Korean President Moon Jae-in in April of that year, and a visit with Vladimir Putin in Russia in April 2019 might have indicated that Kim would like to expand the relevant players beyond just North Korea and the United States. Kim’s first meeting with Xi was the first time that he had left his country since becoming leader in 2011 (Lee Myers and Perlez, 2018). It is unclear exactly what was discussed, although both leaders were positive about the outcomes of the meeting (Lee Myers and Perlez, 2018).

Some worried that Kim was working behind the scenes to undermine U.S. interests or to play allies off one another. At this time, Trump was deeply unpopular outside the United States. A Pew Research Center survey in June 2017, which included 37 countries, found that a median of just 22 percent of those surveyed outside the United States had confidence in Trump to do the right thing when it came to international affairs and that some of the steepest declines in the United States’ image were found among its allies (Wike et al., 2017). Through his meetings with South Korean and Chinese leaders, Kim might have been trying to lay the groundwork to blame the United States and Trump for any lack of meaningful progress on denuclearization over the coming years. These high-level personal visits could have been intended to help to increase sympathy for North Korea and increase its profile relative to the United States.

These efforts might be part of the North Korean leader’s larger strategy to play all sides to his advan-

tage to achieve his ultimate aims. By creating nuclear weapons capable of hitting the continental United States, Kim put pressure on the United States–South Korea alliance that could lead to a “decoupling” of the two countries’ strategic interests. Just as France wondered if the United States would sacrifice New York to protect Paris when the Soviet Union developed weapons capable of directly threatening the United States (in the 1950s, France decided that it would not and developed its own nuclear weapon), South Korea might be asking if the United States would sacrifice Seattle to save Seoul. With some concerns about its ally, a clear desire to maintain peace, and worries about the motives and ability of the United States—whose rhetoric under Trump was viewed as questionable—South Korea might be less likely to follow the United States’ lead in dealing with its northern neighbor. Potentially further exacerbating the divide, Trump’s announcement after his Singapore summit with Kim that the United States and South Korea would suspend joint military exercises designed to prepare for a North Korean invasion seemed to come as a surprise to South Korea and other U.S. allies in the region (Borger, 2018). Many were critical of the move because it seemed to give North Korea and China something that they had long sought, with Trump even using North Korea’s own language to criticize the military activities without the United States getting anything in return (Friedman, 2018).

Some also feared that Trump was willing to risk long-time alliances for positive news headlines. Before taking office, he campaigned on a slogan of “America First” and criticized U.S. allies Japan and South Korea as *free riders*, suggesting that they should start paying their fair share for multilateral defense. A nuclear deal—in which the United States agrees to stay out of the region in return for Kim giving up his intercontinental ballistic missiles (ICBMs)—that leaves North Korea with a regional nuclear strike capability would cause a decoupling of the United States and South Korea or Japan because North Korea still could strike U.S. allies (but not the United States) (Jackson, 2018). Fears that Trump or one of his successors might pursue such an “America First” strategy intensified in early May 2018, when it was reported that Trump had ordered the Pentagon

to prepare options for reducing the number of U.S. troops in South Korea in advance of his first summit with Kim (Sang-Hun and Rich, 2018). Kim’s actions to cause cracks in the U.S.–South Korean alliance and the America First mindset of a large swath of U.S. voters might have weakened the alliance, having potential repercussions in any subsequent negotiations (Beauchamp, 2018; Dreazen, 2018; Jackson, 2018; Ward, 2018).

Coalitions are important for multiplayer games; thus, the United States should focus on getting buy-in from South Korea, China, Japan, and Russia to present a united front to North Korea. This is beneficial no matter what North Korea does; in game theory, this is called a *dominant strategy*. Because China is key to the success of any trade sanctions, negotiators should make sure that U.S. and Chinese interests are aligned to the largest extent possible before any further negotiations with Kim. Support from China is crucial for reaching an agreement with North Korea, and compliance with the deal will be more likely with Chinese pressure. Unfortunately, an escalating trade war between the United States and China and anti-China rhetoric around the coronavirus disease 2019 (COVID-19) pandemic could undermine U.S. influence in the region and weaken the United States’ ability to influence North Korea.

China’s two biggest fears in relation to North Korea are chaos in the country that spills over into its territory and the potential for the United States to station troops on its border if North Korea were to fall.<sup>17</sup> The United States should address these fears explicitly and provide guarantees to China in exchange for support in forcing denuclearization in North Korea. For instance, the United States could publicly state that if there is regime change in North Korea, U.S. troops will never be based north of the 38th parallel (with some obvious conditions, such as no loose nuclear weapons).<sup>18</sup>

## Is This a Repeated Game?

Whether this is a one-time static game or a repeated dynamic game also matters for the structure and outcome of the situation in North Korea. In game theory, a *static, simultaneous-move game* is a game

that is played only once with both players acting at the same time. A *sequential game* is a game in which one player makes a move that is observed by other players, who then make their own moves. A *repeated game* is a one-shot game that is played multiple times. Repeated games could mandate a different set of strategies than if the static one-shot game is played only once. For example, threatening to reward or punish the other players in future rounds based on what they do in the current round often allows cooperation to be sustained in repeated games even if it is not possible in one-shot games.

Although the exact set of circumstances in any current negotiations will not be repeated, the international community has negotiated disarmament with North Korea before, in 1992, 1994, and 2003 through 2007. In that sense, the existing negotiations between the United States and North Korea simply might be the latest stage in a complex repeated game between the two countries. Strategies and tactics that are used could set precedents for future interactions, and negotiators must keep this in mind. As noted, North Korea's failure to live up to its previous agreements and evidence that it was being deceitful after the 2018 Singapore negotiations should be taken into account in assessing the viability of solutions.

Along with the potential that nuclear disarmament will be negotiated with North Korea again in the future, the international community must also remain cognizant that it might be playing a repeated game with other states with nuclear aspirations, even though those states will not be present formally in any negotiations with North Korea. If North Korea achieves its goals and has positive outcomes from its nuclear strategy, then other countries—such as Iran, Saudi Arabia, Turkey, or Vietnam—might be encouraged to more-aggressively pursue nuclear weapons. For instance, some analysts have suggested that the terms of agreement should include the endowment of an annual \$30 billion economic development fund from South Korea to North Korea for a period of at least ten years, as well as \$20–30 billion in war reparations from Japan and international loans from other members of the six-party talks (Bang, 2018). Some money to modernize the economy and improve infrastructure and trade in the region might make sense, and it would be far less costly to pay off North

Korea than to finance a war and the potential economic and human consequences thereof, as noted in unpublished 2020 RAND Corporation research from Marco Hafner, Bruce W. Bennett, Troy D. Smith, Erez Yerushalmi, Eugeniu Han, Jirka Taylor, and Clement Fays.

However, this strategy likely is not politically feasible in the current environment. Efforts by the South Korean government to set up such a fund in the past were rejected by the South Korean people. It would also be difficult to guarantee that North Korea would not divert these funds to producing more nuclear weapons or other military capabilities. Furthermore, this money would effectively double the North Korean gross domestic product, and it is unclear that North Korea could absorb this level of investment in the short term.

Depending on his desire for power, least expensive of all might be to buy off Kim Jong-un and his elites directly and guarantee that they would not be tried for war crimes if they give up power and relocate outside North Korea, leaving the country to be integrated into South Korea. However, such a strategy might encourage other leaders to try to develop nuclear weapons to receive large payoffs for themselves or their countries, and it is unclear whether Kim and other elites would take the deal (Cowen, 2018). Some observers were critical of Trump for meeting with Kim in the first place. As one reporter noted, “The U.S. president’s message to unsavory regimes could not be more dangerous: if you want to be safe against America, build a bomb” (Stephens, 2018). Others disagreed with this sentiment, arguing that, as in the past, the only way to productively move forward with North Korea was to engage in dialogue (King, 2017; Buckley, 2009).

Thus, any action taken or not taken by the United States or the international community regarding North Korea will not only set expectations for future North Korean negotiations but will provide an example of how the international community might react if other countries abandon the NPT and pursue nuclear weapons. The fact that the United States and other international powers mostly accommodated other countries that have developed nuclear weapons (e.g., China, India, Pakistan) likely encouraged North Korea to pursue its current path.

If the United States is playing a repeated game with other potential nuclear powers, then deterrence becomes much more important than if it is playing a single-shot game with North Korea. Actions taken now could encourage other countries to also develop nuclear weapons, so, in addition to ensuring the best possible outcome from the current negotiations with North Korea, the United States needs to adopt a strategy to discourage other countries from threatening to develop nuclear weapons to achieve their national goals. Seeking to punish North Korea and demonstrate to Kim that nuclear weapons are a threat to regime survival would better dissuade other potential nuclear aspirants but could make the current negotiations more precarious.

Similarly, previous U.S. actions can dynamically affect the situation. Within North Korea, Kim Jong-un often cites the example of Muammar Gadhafi of Libya, who renounced chemical and nuclear weapons in 2003 to improve his country's relations with the United States, United Kingdom, the European Union, and other countries. Less than a decade later, in 2011, he was deposed and killed with U.S. help. Such previous moves make Kim more skeptical of U.S. promises to ensure his survival and the survival of his regime, should he give up weapons (Stephens, 2018). Demonstrating the salience of this precedent, the North Korean Vice Minister of Foreign Affairs, Choe Son Hui, said that the country could make the "U.S. taste an appalling tragedy it has neither experienced nor even imagined up to now"<sup>19</sup> in response to both former Vice President Mike Pence and former national security adviser John Bolton suggesting that talks with North Korea should follow the so-called Libya model.

By the two-year anniversary of the Trump-Kim Singapore summit, relations between the two countries had significantly cooled. Some in North Korea believed that Trump had used Kim for a photo opportunity to help his domestic political agenda and that he never had any intention of engaging seriously with the country. North Korean Foreign Minister Ri Son Gwon said, "Never again will we provide the U.S. chief executive with another package to be used for achievements without receiving any returns" (Suliman, 2020). At around the same time, Kim Yo Jong, Kim Jong-un's sister, threatened military action

against and then caused the destruction of the South Korean liaison office (Aitken, 2020). A feeling of having been betrayed by Trump could make negotiations between U.S. leaders and those in North Korea more difficult in the future.

## Is There a Timeline for Resolution?

In bargaining games, there is often a *disagreement point*, a deadline or point by which negotiations have to be concluded. If no deal is struck by this point, then a default scenario kicks in. For instance, the United Kingdom voted to leave the European Union in June 2016 and former Prime Minister Theresa May invoked a provision in the European Union treaty, Article 50, to start a formal withdrawal process in March 2017. According to Article 50, there was a two-year period of negotiation on terms of the U.K. exit after which the United Kingdom was to leave the European Union regardless of whether any agreement had been made (the deadline was later extended). However, in the current situation with North Korea, there is no deadline. In fact, one can view the current events as a 65-year continuation of the Korean War because a peace treaty between the two parties was never signed.

Different deadlines might be important for each of the two sides. The United States wants a deadline by when denuclearization will be achieved. North Korea wants a deadline by when sanctions will be lifted.

Since the Singapore Summit, Kim has been more interested in pushing negotiations forward than have U.S. negotiators. In fact, the North Korean regime initially established a December 2019 deadline for negotiations ("Kim Open to Another Summit with Trump, with Conditions," 2019). Although the regime has not explained the source of the pressure it seems to be facing, Kim's elites appear to be exerting serious pressure on him to find an end to the economic sanctions against the North.<sup>20</sup> The sanctions are hurting North Korean entrepreneurs economically (Dong Hui, 2019; Sang-Hun, 2019), many of whom are from the North Korean elite class. Kim has promised to secure sanctions relief each of the four times he has met with China's leader, when

he has met with the South Korean and Russian leaders, and in the two summit meetings he held with former President Trump. Across these meetings, Kim has reportedly achieved very little sanctions relief. Moreover, at the Hanoi summit, Kim demonstrated that he was clearly not a god, having failed to know former President Trump's breaking point and being unable to force a deal. There is evidence of food shortages in North Korea and concerns about fuel shortages—problems that have likely been exacerbated by the COVID-19 pandemic. It could also be that the North Korean regime is running short of hard currency to pay for its military developments and outside goods for its elites (Kang, 2019; Shim, 2018). All of these factors are likely putting pressure on Kim, forcing him to set a negotiation deadline.

Although North Korea wants a deadline for sanctions relief, it likely does not want a deadline for denuclearization. In the past, the lack of a clear deadline for denuclearization has meant that time has been on North Korea's side. As the years have passed since the first failed agreement and the world has been slow to act, the country's nuclear capabilities have increased. As economist Tyler Cowen notes, "it is the U.S. and South Korea that need something from a summit, and that strengthens the bargaining hand of Kim" (Cowen, 2018). Kim's offer to denuclearize was likely an attempt by Kim to delay any U.S. action and stall for more time to build his nuclear arsenal and ICBMs. Under the guise of good-faith negotiations, if he is able to buy the resources (because of a significant ease in sanctions early in the negotiation process) and time, he might be able to create additional weapons and further enhance his ICBM technology. By the time it is clear to the international community that negotiations will not lead to any meaningful denuclearization despite the ease in sanctions, North Korea will be much more dangerous, with the United States and South Korea in more-precarious positions. If North Korea completes 50 to 100 nuclear weapons, the range of uses broadens substantially, to include North Korean early use in a conflict. For example, recognizing its vulnerability to U.S. and South Korean fighter aircraft, North Korea could plan, at the start of a conflict, to use nuclear weapons to target the South Korean airfields with the best fighter aircraft. If North Korea

fields 20 ICBMs with nuclear warheads, it might be able to inflict damage on U.S. cities despite the best counterforce and missile defense efforts of the United States. Indeed, with 200 nuclear weapons and perhaps 30 ICBMs, capabilities that North Korea might achieve in the next ten to 20 years, North Korea would pose a substantial threat. It might turn to South Korea and demand that the South surrender immediately. It might also turn to the United States and demand that it stay out of the conflict. In unpublished RAND Corporation research, Hafner, Bennett, Smith, Yerushalmi, Han, Taylor, and Fays find that fighting a war with North Korea when it has advanced to such potential nuclear capabilities could cost millions—or even tens of millions—of lives, with huge economic costs.

Thus, if he is able to obtain sanctions relief in the beginning of the negotiation process as a gesture of good faith, Kim could revert to dragging out the negotiations of a final deal as North Korea did from 2003 through 2009. Having gained his goal of sanctions relief and, potentially, promises of economic development and increased trade for his willingness to engage in talks, Kim could then pursue a strategy of stalling on the details of a final deal or the exact date for verified denuclearization to further increase his stock of nuclear weapons and ICBMs. For the United States, a deadline at the beginning of the process for when a final deal will be reached and a strict timetable for denuclearization as part of the final deal will be important to ensure that North Korea does not get to 200 nuclear weapons or 30 ICBMs as it continues to "negotiate" over minutiae.

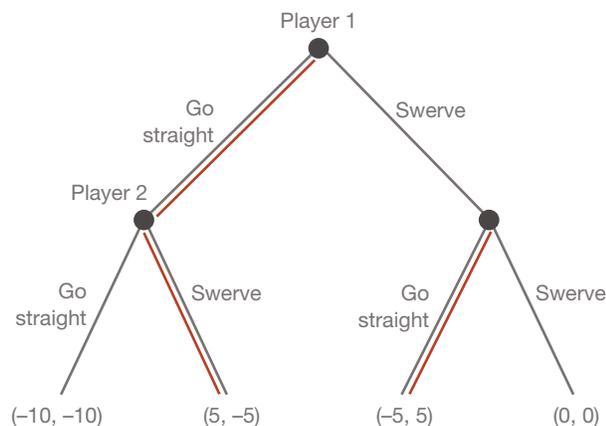
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Although North Korea wants a deadline for sanctions relief, it likely does not want a deadline for denuclearization.

Although it is counterintuitive, in game theory, players often increase their potential payoffs by limiting their future choices. This is called precommitment and can best be illustrated with the classic game of *chicken*. In this game, two motorists are speeding toward one another on a one-lane road. If one player swerves and the other goes straight, then a crash is avoided. The player that swerves loses respect and is viewed as a coward (has a lower payoff). The player who goes straight is seen as courageous and gains respect (has a higher payoff). If both players swerve, both get lower payoffs for “being chicken.” If neither player swerves, then both players crash into each other and their payoffs are even worse than if they had swerved. The game has two natural outcomes (Nash equilibria): either player 1 swerves and player 2 goes straight, or player 1 goes straight and player 2 swerves.

Now imagine that player 2 has quicker reflexes and can observe what player 1 does before making their own choice. This is called *sequential chicken* because player 2 moves after player 1. In this game, player 1 knows that if they go straight, player 2 will be forced to swerve and player 1 will get a better payoff than if they swerve. Player 2 would like to bluff and say that they will go straight, but when it really comes down to it, if player 1 goes straight, player 2 will swerve to avoid the crash. Figure 2 illustrates this game and the likely strategies of each player in red. Player 1’s payoffs are listed first and player 2’s payoffs

FIGURE 2  
Sequential Chicken



NOTE: Depicted payoffs in brackets are for illustrative purposes only and do not represent a real-world example.

are listed second. In the equilibrium outcome of this game, player 1 gets a payoff of 5 and player 2 gets a payoff of -5.

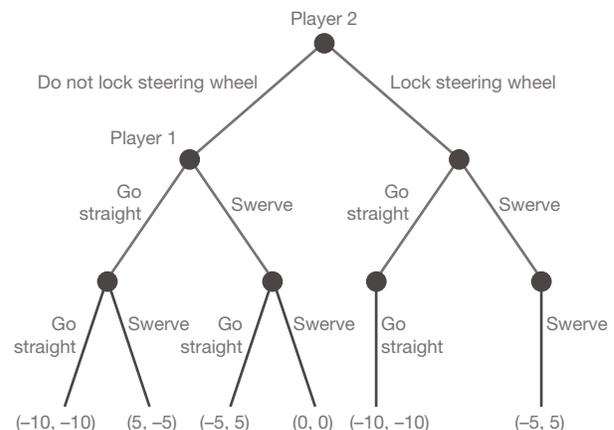
However, if player 2 can precommit to a device that will force them to go straight, then player 1 will be forced to swerve and player 2 will get the higher payoff. For instance, if player 2 can lock their steering wheel at the beginning of the game (and if player 1 knows this) then player 1 will know that player 2 must go straight (having no choice) and player 1 will swerve. By reducing their future choice set, player 2 ensured themselves a higher payoff. Figure 3 illustrates the game of sequential chicken with precommitment. Now, the likely outcome of the game is for player 2 to lock her steering wheel and for player 1 to swerve, knowing that player 2 must go straight. Under this scenario, the payoff for player 1 is -5 and for player 2 is 5.

Counterintuitively, because economists in general think more choice is usually better, Player 2 does better under precommitment by limiting their future choices than if they did not commit.

Similarly, the United States could precommit to a timeline for a final deal to be in place and for complete, verified denuclearization, and could set up some predetermined punishment for North Korea if the timeline is not met.<sup>21</sup>

One example of a potential punishment is a negative information campaign aimed at Kim. The North

FIGURE 3  
Sequential Chicken with Precommitment



NOTE: Depicted payoffs in brackets are for illustrative purposes only and do not represent a real-world example.

Korean leader cares a lot about his reputation, and North Korean elites love to consume Western media (especially South Korean soap operas). The United States and its allies could set a date for successful, verified denuclearization. If this deadline is not met, the United States could begin an information campaign within North Korea to educate the people of North Korea about the atrocities of the current regime and life in other parts of the world (along with imposing tough economic sanctions).

Experts note that North Korean propaganda, which glorifies and aggrandizes the “Supreme Leader,” is important in maintaining the legitimacy of the regime. According to some reports, propaganda about Kim’s father, Kim Jong-il, included crediting him with having invented the hamburger, curing dwarfism, and shooting eleven holes-in-one the first time he played golf. When he was born, the sky was brightened by a star and a double rainbow, and he was reported to have never had a bowel movement (Maass, 2003; Feinberg, 2014). A U.S.-led information campaign could include a South Korean style soap opera about the life and times of Kim Jong-un, which would decrease the leader’s prestige among elites.<sup>22</sup> A film depicting Kim’s killing of senior North Korean officials since he has taken power (perhaps 300 or more)—including his uncle, Jang Song-thaek, and his half-brother—could call into question his legitimacy.<sup>23</sup>

There is some evidence that Kim is very attuned to how he is perceived and that the threat of such an undertaking might be an effective inducement. For example, when a U.S. comedy film about killing Kim, *The Interview*, was set to release in the United States in 2014, the regime called it an “act of war” and promised “merciless” retaliation. At the time, a North Korean government spokesman said that “making and releasing a movie on a plot to hurt our top-level leadership is the most blatant act of terrorism and war and will absolutely not be tolerated” (“North Korea Threatens War on U.S. over Kim Jong-Un Movie,” 2014). In November of that year, the studio making the movie, Sony Pictures, suffered a cyber-attack that was believed to have come from North Korea, and hackers threatened terrorist attacks on cinemas that showed the film. Although many theaters decided not to show the film in response to the

North Korean threats, the film was released digitally and later picked up by foreign distributors, Netflix, and Sony’s Crackle (Cieply, 2017; Feinberg, 2014). As further evidence of the importance of information and media, the cessation of South Korean news and pop music being broadcast across the demilitarized zone was discussed when Kim and Moon met in late April 2018 and was one of the most concrete actions to come out of the summit (“Koreas Summit: North Korean Media Hail ‘Historic’ Meeting,” 2018; “South, North Korea Remove Propaganda Loudspeakers as Ties Thaw,” 2018).

A true precommitment device would set a firm date by which negotiations must be concluded and denuclearization must be achieved and would not allow the United States to change this date at a later point in time, although the exact mechanisms of this would need to be worked out.<sup>24</sup> By sacrificing its future flexibility, other players in the game might believe that the United States and its allies were credible in their threats.

## Is This a Zero-Sum Game?

In a zero-sum game, one party must lose for the other party to win. In coordination games, it is possible that an equilibrium is reached that is better for all parties involved. How the parties view the structure of the game and their potential payoffs can sometimes determine whether the game is zero-sum or positive-sum.

The payoffs for the current game with North Korea might extend beyond economic gain and loss and even beyond the potential loss of life. Over the last several years, both Kim and Trump have spoken in terms of “winning” and competition when addressing the current conflict. Both leaders were thought to care a lot about their images and to take slights both very personally and as indications of personal disrespect. If *winning* in this context means that the other party must be seen to lose, then both parties might view any potential negotiations as zero-sum—if North Korea obtains what is perceived as a favorable outcome, then the United States loses, and vice versa. A much more productive strategy would be to view the negotiations in a potential win-

win framework—all parties should work together to minimize the possibility of loss of human life.<sup>25</sup> Whether this is the ultimate goal of the United States or North Korea remains to be seen. Disturbingly, years ago Kim Jong-un’s father told his grandfather that if North Korea lost a war with the United States, “I will be sure to destroy the Earth! What good is the Earth without North Korea?” (Kim, 2009) How much personal ego and nationalist pride overshadow the concern for human life (both the lives of North Koreans and others) and which view of the potential payoffs prevails both could determine how acrimonious negotiations become. The United States should try to convince North Korea that their preferences are not diametrically opposed and that they share interests in mutually beneficial outcomes. Kim might be open to such positioning if he is trying to increase his influence and status in the international community. Although Kim might not be able to change his tone because of internal pressures and North Korean cultural values, pushing him toward rhetoric that values the lives of his citizens and describes the United States as an ally could help both sides to claim victory in any negotiations.

## Conclusions

With the ability to destroy most of Seoul and to allegedly reach the continental United States with a nuclear weapon (now or in the near future), the stakes of negotiations for nuclear disarmament on the Korean peninsula are very high. Although the motivations and objectives of the various parties involved might never be fully known, concepts from game theory can help to focus our thinking on some critical aspects of future negotiations. Recent media articles have claimed that, so far “everyone is playing Kim’s game” and that “failing to recognize that generates huge unnecessary risks to the U.S.-South Korea alliance and U.S. interests in the region” (Jackson, 2018). Several insights can be gained from analyzing the situation using some common ideas from game theory.

First, the United States and the international community should try to force Kim to reveal which “type” he is quickly by requiring an action that would be costly for him to undertake if his ultimate goal is

reunification of the Korean peninsula under North Korea, but less costly if his goal is regime survival. Giving up five nuclear weapons now might be a way to determine which type of Kim the world is dealing with. How leaders should approach future negotiations with Kim and which policies and strategies should be pursued by the United States, South Korea, China, and Japan depend on what Kim’s ultimate motivations and goals are. For example, if Kim is primarily interested in regime survival, then a partial withdrawal of U.S. troops could promote peace in the region. However, if he intends to rule all of the Korean peninsula, then any backing away of the United States from South Korea could be appeasement, encouraging further bold, unwanted moves from Kim.

Second, from the beginning of the negotiations, the United States and the international community should consider robust mechanisms to enforce any potential agreement. This should include both robust monitoring and verification and incentive mechanisms that align the interests of Kim and the international community, such as a stake in a South Korean company that will benefit from peace and development in the North. Robust enforcement is especially important because of North Korea’s history of cheating on previous agreements and the fact that current diplomatic activity could be a stalling tactic to buy more time to develop more weapons.

Third, mechanisms to ensure that all sides can credibly commit to any agreement in the long run—with meaningful penalties should they renege—should be explored. For instance, along with extensive in-country monitoring, any aid payments should be contingent on the verified destruction of a given number of weapons that North Korea already possesses. Specified payments to the other parties or punishments for deviating or withdrawing from the deal can be written into the agreement to ensure the compliance of all parties. The deal should also be set up in the United States as a treaty instead of an executive agreement because treaties are legally stronger and harder to overturn; they require a two-thirds majority in the Senate to ratify.<sup>26</sup>

Fourth, the United States must be wary of Kim’s efforts to undermine its position with the other players in the game and to weaken the alliance with

South Korea. Kim's 2018 diplomatic charm offensive, coupled with statements questioning the U.S.–South Korean relationship by the former administration, might drive a wedge between the United States and South Korea with South Korea rejecting the United States in favor of peace and a thawing of relations with the North. Similarly, a nuclear deal between U.S. leadership and Kim that protected the United States and guaranteed that it would not intervene in the region—but left Japan and South Korea vulnerable to attack—would sacrifice important strategic relationships. Either outcome would further undermine U.S. influence in the region.

Fifth, China is critical for any lasting solution in North Korea. Although difficult during a trade war and with conflict about the global COVID-19 pandemic, the United States should ensure Chinese buy-in for any strategy pursued regarding North Korea, and should work to align U.S. and Chinese interests on the peninsula.

Sixth, the United States must balance any accommodation of North Korea with dynamic realities, including the possibility of future negotiations with North Korea and incentive effects that could lead other countries to pursue nuclear weapons. If Kim or North Korea are seen to have gotten a good deal or benefited from creating nuclear weapons, such results could encourage other leaders to also seek to do so. Trying to come to a win-win agreement while minimizing positive incentives for bad behavior (either for North Korea or for other countries) will be extremely difficult.

Seventh, the United States should set a deadline for complete denuclearization and consequences if that deadline is not met. Setting up a negative information campaign against Kim by flooding the coun-

try with “The Life and Times of Kim Jong-un” if he does not live up to his commitments to denuclearize under a signed agreement might be a credible threat that could provide a concrete deadline.

Eighth, the United States should use win-win rhetoric and try to push Kim and U.S. negotiating officials toward an objective of valuing all human life above nationalistic or personal ambitions. Pushing both U.S. and North Korean leaders to publicly make such statements could help to frame negotiations if they are each seeking to improve their country's images on the world stage. Whether the leaders believe such statements, stating these goals publicly could help to influence negotiators and the perceptions of citizens' in the two countries.

Finally, although game theory assumes that players maximize their perceived payoffs given their constraints, actors in the real world do not necessarily behave as economists would predict. Because of the volatile personalities involved, there is a distinct possibility that leaders might not make decisions that match the best possible outcome for themselves and their countries (Snidal, 1985). As economist Tyler Cowen observed before the first meeting between Kim and Trump, “There is the risk that Trump or Kim could feel humiliated by a summit that yielded nothing, again raising the chance of war or miscalculation leading to disaster” (Cowen, 2018). Given North Korea's rhetoric on the two-year anniversary of the Singapore summit, this warning seemed especially prescient. Policymakers and people in positions of power should try everything possible to minimize opportunities in future negotiations for impulsivity and rash actions that could lead to irreversible mistakes, a bad or untenable deal, or armed conflict.

## Notes

<sup>1</sup> According to Snidal (1985, p. 26), “game theory often seems to demand more information than can feasibly be obtained” and “it cannot always adequately incorporate other important available information – including relevant historical details about the context of interaction, insights into the personalities and behavior of decision makers, and understandings of the diplomatic or foreign policy process.” To the extent that historical events or outside influences that could affect North Korean strategies can be identified, they can often be incorporated into the structure of the game or the strategies and pay-offs of the various players.

<sup>2</sup> Note that the types that we present are illustrative only. In reality, there may be other “types” of Kim. The point is that it is important to figure out ways to distinguish ultimate motives and goals. See, also, Davis et al., 2021, for strategies to develop different adversary models.

<sup>3</sup> In game theory, we say that they are in the same information set.

<sup>4</sup> There is a long literature dealing with deception. See, for example, Whaley, 2016.

<sup>5</sup> The classic example of this model is a potential worker searching for a job. The worker could be of low ability or high ability and the employer would like to distinguish which of the two types he is dealing with. If it is much costlier for the low-ability type to attend college than it would be for the high-ability type, then the employer can infer which type she is dealing with by observing whether the worker went to college or not. See Spence, 1973.

<sup>6</sup> Kim, Bierman, and Stiles, 2018; Bender, Gordon, and Cheng, 2018; and McCarthy, Weaver, and Lyons, 2018. As noted in the following paragraph, it is unclear whether the meaning of *denuclearization* is the same for all parties involved. Moon is quoted as saying that “I don’t think denuclearization has different meanings for South and North Korea. The North is expressing a will for a complete denuclearization” (Reuters, 2018). Others in the media claimed that the word could have different meanings for Trump and Kim (Gladstone, 2018).

<sup>7</sup> Note that the model assumes that *effort* is actions that people will not take without rewards (not just work hours) and that effort is aligned with the interests of the principal (i.e., not wasted).

<sup>8</sup> Some others in the media also believed this; see Boot, 2018; and Tracy, 2018.

<sup>9</sup> For example, fast food restaurants often have strict guidelines and standards, time cards, and heavy monitoring by management to make sure that employees put in a certain level of effort.

<sup>10</sup> *Monitoring* is often used to refer to checking that acknowledged sites are in compliance, and *verification* can include inspecting undeclared sites and ensuring that all sites have been acknowledged.

<sup>11</sup> “Other sources provide different estimates of the number of nuclear [weapons of mass destruction] facilities in North Korea. The [International Atomic Energy Agency] has a smaller list of [North Korean] nuclear facilities it is remotely monitoring that includes 11 declared and undeclared facilities, nearly all of which are located in Yongbyon. At the other end of the spectrum, the South Korean Ministry of Defense has asserted that there are

‘about 100 sites related’ to [North Korea’s] nuclear program” (Bonds et al., 2014, pp. 104–105).

<sup>12</sup> For example, law firms, investment banks, and consulting companies often tie a large portion of their employees’ salaries to the overall performance of the firm. Because the effort level of these types of employees is very difficult to monitor, they are given a direct incentive in the outcome of the project and thus put in more effort than they otherwise might.

<sup>13</sup> North Korea’s gross domestic product was estimated to be \$29 billion in 2016 (Bank of Korea, 2017). In 2018, Samsung had \$225 billion in sales, \$41 billion in profit, \$293 billion in assets, and a market cap of \$326 billion (Stoller, 2018).

<sup>14</sup> A Nash equilibrium is *subgame perfect* if and only if it is a Nash equilibrium in every subgame of the game. This ensures that a credible strategy (one from which the player would not be tempted to deviate) is played on each subgame and, thus, that the overall strategy is credible.

<sup>15</sup> Landler, 2018; DeThomas, 2017; Stephens, 2018. As Stephens states, “There could be no sharper incentive to North Korea to keep its arsenal than Washington disowning the Iran deal.”

<sup>16</sup> Some in North Korea might believe that the United States also failed to live up to its agreements when it suspended construction of two light-water nuclear reactors in 2003; this construction was negotiated under the 1994 Agreed Framework. According to the United States, it halted construction because of North Korea’s failure to live up to “the conditions necessary for continuing” the project. U.S. intelligence sources had recently reported that “North Korea’s centrifuge program was pursuing technology for a uranium enrichment program, which would produce material for nuclear weapons.” North Korean officials might have interpreted the events differently, however. See Davenport, 2018b; and Sanger, 2002.

<sup>17</sup> “Thinking the Unthinkable in China: Abandoning North Korea,” 2017; Mount, 2017; and Bush, 2014. Note, however, that in unpublished RAND Corporation research from Marco Hafner, Bruce W. Bennett, Troy D. Smith, Erez Yerushalmi, Eugeniu Han, Jirka Taylor, and Clement Fays (2020), the authors estimate that the economic costs to China of refugees from North Korea are relatively small.

<sup>18</sup> As Myerson (2017) points out, North Atlantic Treaty Organization forces did move east when there was regime change in Eastern Europe toward the end of the Cold War and, for the same reason, U.S. forces likely would need to move into North Korea until stabilization was achieved.

<sup>19</sup> Noack, 2018; “‘Political Dummy’ and ‘Libya Model’: The Mike Pence–North Korea Exchange That Killed the Summit,” 2018. Former President George W. Bush’s 2002 State of the Union address, in which he named North Korea (along with Iran and Iraq) as part of the “Axis of Evil,” might have had a similar chilling effect on relations between the two countries.

<sup>20</sup> This pressure on Kim is reported in numerous news stories and has been corroborated with one of the authors of this report in 2019 by North Korean refugees who still maintain contacts in North Korea.

<sup>21</sup> We note, however, as pointed out by one reviewer, that neither presidents nor U.S. Congresses like being obligated to do anything specific, preferring instead endless flexibility.

<sup>22</sup> It is widely believed that North Korean elites consume Western media, even though it is banned in the country. Kim's father, Kim Jong-il, was reported to have a collection of over 30,000 films, including every Oscar winner, and was said to be a film scholar, once writing, "The cinema occupies an important place in the overall development of art and literature. As such it is a powerful ideological weapon for the revolution and construction." The older Kim also kidnapped South Korea's most famous film director, Shin Sang-ok, and forced him and his actress wife to make propaganda movies for the North from 1978 until the filmmaker escaped in 1986. See Feinberg, 2014; and Maass, 2003.

<sup>23</sup> "It was never clear if this reign of terror was a sign of Kim's strength or insecurity" (Jackson, 2018). See also Shim, 2016.

<sup>24</sup> However, as one reviewer of this report noted, short-term denuclearization might not be a possibility because of North Korea's security concerns and worries that it would delegitimize Kim.

<sup>25</sup> It may be difficult, however, to balance this strategy with the desire to deter other countries from pursuing nuclear weapons. If North Korea is seen to benefit from its development of nuclear weapons and breaking of international norms, other countries could seek to do the same.

<sup>26</sup> Keating, 2015. This might be very difficult because some members of the Senate already have established requirements for a treaty that Kim will not accept.

## References

- Aitken, Peter, "Kim Jong Un's Sister Threatens Military Action Against South Korea, Promises 'Tragic Scene' at Liaison Office," *Fox News*, June 13, 2020.
- Bang, Chan Young, "Give Kim an Offer He Can't Refuse: Exchange Nukes for Economic Modernization," *NK News*, April 30, 2018.
- Bank of Korea, "Gross Domestic Product Estimates for North Korea in 2016," webpage, July 21, 2017. As of May 12, 2021: <https://www.bok.or.kr/eng/bbs/E0001959/view.do?nttId=230095&menuNo=400071&pageIndex=7>
- Beauchamp, Zack, "The Case for—and Against—Trump's North Korea Policy," *Vox*, March 6, 2018.
- Bender, Michael C., Michael R. Gordon, and Jonathan Cheng, "Trump Calls Four-Hour Summit 'Fantastic,'" *Wall Street Journal*, June 12, 2018.
- Berger, Andrea, and Shea Cotton, "Walls and Ladders: The Latest UN Panel of Experts Report on North Korea Sanctions," *War on the Rocks*, March 28, 2018.
- Bishop, Mac William, "North Korea's Vow to Shut Punggye-ri Nuclear Site Appears Mostly Symbolic," *NBC News*, April 30, 2018.
- Bonds, Timothy M., Eric V. Larson, Derek Eaton, and Richard E. Darilek, *Strategy-Policy Mismatch. How the U.S. Army Can Help Close Gaps in Countering Weapons of Mass Destruction*, Santa Monica, Calif.: RAND Corporation, RR-541-C, 2014. As of May 10, 2021: [https://www.rand.org/pubs/research\\_reports/RR541.html](https://www.rand.org/pubs/research_reports/RR541.html)
- Boot, Max, "Kim Jong Un Has Played Trump Like a Stradivarius," *Washington Post*, July 9, 2018.
- Borger, Julian, "U.S. to Suspend Military Exercises with South Korea, Trump Says," *The Guardian*, June 12, 2018.
- Buckley, Chris, "IAEA Says Dialogue Only Way Forward for North Korea," Reuters, April 19, 2009.
- Bush, Richard C., "China's Response to Collapse in North Korea," blog post, Brookings Institution, January 23, 2014. As of May 10, 2021: [brookings.edu/on-the-record/chinas-response-to-collapse-in-north-korea/](https://www.brookings.edu/on-the-record/chinas-response-to-collapse-in-north-korea/)
- Cieply, Michael, "As North Korea Rumbles Again, Insiders Tell How Small Players Stood Tall on Helping Sony's 'The Interview,'" *Deadline Hollywood*, April 17, 2017.
- Cowen, Tyler, "Game Theory Scowls at Trump-North Korea Talks," *Bloomberg*, March 13, 2018.
- Davenport, Kesley, "The Six-Party Talks at a Glance," fact sheet, Arms Control Association, last reviewed June 2018a. As of May 10, 2021: <https://www.armscontrol.org/factsheets/6partytalks>
- Davenport, Kesley, "The U.S.-North Korean Agreed Framework at a Glance," fact sheet, Arms Control Association, last reviewed July 2018b. As of May 10, 2021: <https://www.armscontrol.org/factsheets/agreedframework>
- Davenport, Kelsey, "Chronology of U.S.-North Korean Nuclear and Missile Diplomacy," fact sheet, Arms Control Association, last reviewed July 2020. As of May 10, 2021: <https://www.armscontrol.org/factsheets/dprkchron>
- Davis, Paul K., Angela O'Mahony, Christian Curriden, and Jonathan Lamb, *Influencing Adversary States: Quelling Perfect Storms*, Santa Monica, Calif.: RAND Corporation, RR-A161-1, 2021. As of May 10, 2021: [https://www.rand.org/pubs/research\\_reports/RR-A161-1.html](https://www.rand.org/pubs/research_reports/RR-A161-1.html)
- DeThomas, Joseph, "The Lamps Are Going Out in Asia," blog post, *38 North*, September 25, 2017. As of May 26, 2021: <https://www.38north.org/2017/09/jdethomas092517/>
- Dong Hui, Mun, "Majority of Pyongyang State-Run Factories Close After U.S.-DPRK Summit Fails to Bear Fruit," *Daily NK*, April 2, 2019.
- Dreazen, Yochi, "Here's What War with North Korea Would Look Like," *Vox*, February 8, 2018.
- Feinberg, Scott, "Sony Hack: Father of North Korean Leader Was Obsessed with Hollywood Movies," *Hollywood Reporter*, December 18, 2014.
- Friedman, Uri, "Trump Got Nearly Nothing from Kim Jong Un," *The Atlantic*, June 12, 2018.
- Ghosh, Atish R., and Paul R. Masson, *Economic Cooperation in an Uncertain World*, Hoboken, N.J.: Wiley, 1994.
- Gladstone, Rick, "Trump and Kim May Define 'Korea Denuclearization' Quite Differently," *New York Times*, June 10, 2018.
- Grossman, Sanford J., and Oliver D. Hart, "An Analysis of the Principal-Agent Problem," *Econometrica*, Vol. 51, No. 1, January 1983, pp. 7–45.
- Harrison, Selig S., "Did North Korea Cheat?" *Foreign Affairs*, Vol. 84, No. 1, January–February 2005, pp. 99–110.
- Jackson, Van, "What Kim Jong Un Wants from Trump," *Politico*, May 1, 2018.
- Joyce, Kathleen, "North Korea Believed to Be 'Deceiving' U.S., Increasing Nuclear Production: Report," *Fox News*, June 30, 2018.
- Kang, Dong Wan, "North Korean Government Responsible for Food Shortages," *DailyNK*, May 14, 2019.
- Keating, Joshua, "The Iran Deal Sets a Dangerous Precedent for Expanded Executive Power," *Slate*, September 11, 2015.
- Kim, Hyun-Sik, "The Secret History of Kim Jong-Il," *Foreign Policy*, October 6, 2009.
- "Kim Open to Another Summit with Trump, with Conditions," Associated Press, April 13, 2019.
- Kim, Victoria, Noah Bierman, and Matt Stiles, "North Korea Offers a Starkly Different View of Singapore Summit," *Los Angeles Times*, June 12, 2018.
- King, Ariana, "Dialogue Still the Way Forward on North Korea: Chinese, Russian Foreign Ministers," *Nikkei Asia*, September 22, 2017.
- "Koreas Summit: North Korean Media Hail 'Historic' Meeting," BBC News, April 28, 2018.
- Kube, Courtney, Ken Dilanian, and Carol E. Lee, "North Korea Has Increased Nuclear Production at Secret Sites, Say U.S. Officials," *NBC News*, June 30, 2018.
- Landler, Mark, "Trump Abandons Iran Nuclear Deal He Long Scorned," *New York Times*, May 8, 2018.
- Lee, Jeong-Ho, "North Korea Says Trump's 'Empty Promise' Dashes Hopes for Deal," *Bloomberg*, June 11, 2020.

- Lee Myers, Steven, and Jane Perlez, "Kim Jong-Un Met with Xi Jinping in Secret Beijing Visit," *New York Times*, March 27, 2018.
- "Lindsey Graham Warns Trump He's Being 'Played' by North Korea," *CBS News*, July 22, 2018.
- Maass, Peter, "The Last Emperor," *New York Times Magazine*, October 19, 2003.
- Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green, *Microeconomic Theory*, New York: Oxford University Press, 1995.
- McCarthy, Tom, Matthew Weaver, and Kate Lyons, "Trump-Kim Summit: World Scrambles to Decipher 'Denuclearisation' Deal—as It Happened," *The Guardian*, June 12, 2018.
- McCurry, Justin, "North Korea Nuclear Test Site Has Collapsed and May Be out of Action—China Study," *The Guardian*, April 26, 2018.
- McLaughlin, Jenna, "U.S. Doubles Down on Tracking North Korea Ahead of Trump, Kim Meeting," *CNN*, April 29, 2018.
- Mollman, Steve, "A North Korean Propaganda Film Is Coming True, Thanks to Donald Trump," *Quartz*, March 9, 2018.
- Mount, Adam, "How China Sees North Korea," *The Atlantic*, August 29, 2017.
- Myerson, Roger, "Game Theory on North Korea Needs to Look at Promises and Dangers," *CNBC*, August 28, 2017.
- Noack, Rick, "How Kim-Trump Tensions Escalated: The More the U.S. Said 'Libya,' the Angrier North Korea Got," *Washington Post*, May 24, 2018.
- "North Korea Threatens War on US over Kim Jong-Un Movie," *BBC News*, June 26, 2014.
- O'Carroll, Chad, "Why Is Tracking North Korean Aircraft So Difficult?" *NK News*, August 9, 2013.
- "Political Dummy' and 'Libya Model': The Mike Pence -North Korea Exchange That Killed the Summit," *Associated Press and Haaretz*, May 24, 2018.
- Reuters, "North Korea Willing to Accept 'Complete Denuclearization' without Conditions, Moon Says," *NBC News*, April 19, 2018.
- Sang-Hun, Choe, "North Korea's State-Run Economy Falters Under Sanctions, Testing Elite Loyalty," *New York Times*, April 18, 2019.
- Sang-Hun, Choe, and Motoko Rich, "Notion of U.S. Troop Cuts Unnerves South Korea and Japan," *New York Times*, May 4, 2018.
- Sanger, David E., "North Korea Says It Has a Program on Nuclear Arms," *New York Times*, October 17, 2002.
- Sanger, David E., and William J. Broad, "Verifying the End of a Nuclear North Korea 'Could Make Iran Look Easy,'" *New York Times*, May 6, 2018.
- Shim, Elizabeth, "Kim Jong Un Has Purged, Executed More Than 300 People, Spy Agency Says," *United Press International*, December 28, 2016.
- Shim, Elizabeth, "Report: Fuel Shortage in North Korea Forcing Station Shutdowns," *United Press International*, November 2, 2018.
- Snidal, Duncan, "The Game Theory of International Politics," *World Politics*, Vol. 38, No. 1, October 1985, pp. 25–57.
- "South, North Korea Remove Propaganda Loudspeakers as Ties Thaw," *Al-Jazeera*, May 1, 2018.
- Spence, Michael, "Job Market Signaling," *Quarterly Journal of Economics*, Vol. 87, No. 3, August 1973, pp. 355–374.
- Stephens, Philip, "Donald Trump Shatters International Trust in America," *Financial Times*, May 3, 2018.
- Stoller, Kristin, "The World's Largest Tech Companies 2018: Apple, Samsung Take Top Spots Again," *Forbes*, June 6, 2018.
- Suliman, Adela, "North Korea's Kim Backs Away from Trump Relationship Two Years After Historic Handshake," *NBC News*, June 12, 2020.
- Sullivan, Eileen, "Trump Says 'There Is No Longer a Nuclear Threat' After Kim Jong-Un Meeting," *New York Times*, June 13, 2018.
- "Thinking the Unthinkable in China: Abandoning North Korea," *Agence France Press*, October 1, 2017.
- Tracy, Abigail, "Getting Played, and Loving It: Why Trump Can't Quit His Summit Addiction," *Vanity Fair*, July 31, 2018.
- Treverton, Gregory F., "The Dangers of a Preemptive Strike," *Time*, March 2017.
- Vaynman, Jane, and Vipin Narang, "There Are Signs North Korea Is Still Working on Its Nuclear Program. Here's Why 'Denuclearization' Is So Problematic," *Washington Post*, June 30, 2018.
- Ward, Alex, "Great Opportunity or Trap? 12 Experts Weigh in on the Trump-Kim Summit," *Vox*, March 9, 2018.
- Whaley, Barton, *Practise to Deceive: Learning Curves of Military Deception Planners*, Annapolis, Md.: Naval Institute Press, 2016.
- Wike, Richard, Bruce Stokes, Jacob Poushter, and Janell Fetterolf, "U.S. Image Suffers as Publics Around World Question Trump's Leadership," *blog post*, Pew Research Center, June 26, 2017. As of May 11, 2021: <http://www.pewglobal.org/2017/06/26/u-s-image-suffers-as-publics-around-world-question-trumps-leadership/>



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