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A GAME-THEORETIC APPROACH TO THE RELATIONSHIP BETWEEN NORTH KOREA AND USA

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ACADEMIC YEAR

2017/2018

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Introduction

The following discussion focuses on a topic that, as of today, affects the situation worldwide, namely, the mainly verbal conflict between North Korea and USA. In particular, it is analyzed according to the principles of game theory, in order to simplify the discussion and better understand the motives of the two individuals involved and the consequences of the actions each undertook.

The reasons for the choice of such an issue are several: first, its importance and impact on the geopolitical and economic dynamics on the entire world and second, a personal interest in the field of game theory as an instrument of analysis, which has been enhanced by the study of Schelling's works of the past century. Such works have constructed the basis upon which I developed my research.

My purpose is to shed light on the strategic interactions between US President Donald Trump and North Korea's leader Kim Jong-un during their long-lasting diplomatic conflict, also showing similarities and differences with respect to the years of the Cold War. By doing so, one can be able to understand why this conflict arised and the reason why it lasted so long.

This objective is finally achieved by the use of the instruments offered by the field of game theory, which give the possibility to replicate the conflict scenario as a sequential game, where the players are the two nations' leaders. By analyzing the game, the players' moves and their motives, one is able to look at the broader picture and make several inferences about it.

The thesis is structured around three chapters: the first one presents the concept of Mutually Assured Destruction, coined by Schelling, and how it applies to both the Cold War and the North Korea-USA conflict in different ways. The second chapter, the core of this work, after having described the facts and explained the special role of China, offers an analysis of the conflict itself in game-theoretic terms, comparing the ideal scenario with the real course of events, putting special attention to the role that threats play. Finally, the third chapter explains how the conflict came to an end, namely at the summit meeting in Singapore held in June 2018, and the potential consequences of such a peace.

Through this chronological analysis, it is possible to draw some conclusions, which are presented in the last section of the discussion.

1
Mutually Assured Destruction

1.1 MAD – The concept

The doctrine of mutually assured destruction (MAD), strongly based on game theory, refers to a particular type of **Nash equilibrium** (Nash, 1951; von Neumann and Morgenstern, 1944) in which the two players, once armed, have no incentive to either attack the other, nor withdraw from the conflict itself. In such a game, both players must assume the other to be concerned only with their own self-interest, so they must limit risk and adopt a dominant strategy. One of the most well-known strategic games, in which the players face incentives very similar to the MAD ones, is the *Prisoner's Dilemma.*

1.1.2 The Prisoner's Dilemma

The *Prisoner's Dilemma* is a particularly important game, thanks to its numerous applications, which was first formalized by Merrill Flood and Melvin Dresher in 1950, and was then made more accessible to the public by Albert Tucker, who gave the game its name and changed the payoffs associated with each outcome.

The name of this game comes from a story involving two suspects in a crime: they are held in separate cells and there is enough evidence to convict both of a minor offense, but not enough evidence to convict them of a major crime unless one of them finks, meaning he/she acts as an informer against the other. If they both say nothing, they will be convicted for the minor offense and spend one year in prison. If only one of them finks, he/she will be freed and the other will be convicted for the major crime, having to spend four years in prison. If, instead, both players fink, each will spend three years in prison, that means being convicted on the principal charge with a little prison discount for having helped the investigation.

Thus, we are in a situation in which there are two players, the two suspects, who can take two actions, quiet or fink. Each player's utility is associated with a higher value the less the years of prison he/she gets. The game can therefore be

represented by a payoff matrix, where the payoffs are given by the numbers of years of prison associated with each outcome with a minus sign, to describe the negative correlation between the players' utilities and the weight of the sentence they get.

1 \ 2	Quiet	Fink
Quiet	-1, -1	-4, 0
Fink	0, -4	-3, -3

By examining the four pairs of actions in the *Prisoner's Dilemma*, one can assess that the unique Nash equilibrium is associated with the outcome (Fink, Fink) because, given the other player's action, it is always optimal to choose "Fink". This might seem counter-intuitive, as the outcome associated with the highest payoff for both players is (Quiet, Quiet), implying that the resulting Nash equilibrium for this game is Pareto-inferior compared to the latter outcome, but the incentive to freeride eliminates the possibility that such outcome occurs. Thus, each player, in order to limit the potential loss he/she would incur, must adopt a risk-dominant strategy.

When using MAD as a doctrine of national security and military strategy, it involves the potential use of weapons of mass destruction by at least two opposing sides/players. The actual use would cause the annihilation of both the defender and the attacker. This leads to a situation of equilibrium in which none of the players attacks, meaning that MAD is based on the **deterrence theory** where the threat by any player of using mass-destructive weapons is made to prevent the other player from using the same weapons.

However, according to Max Lerner in his work *The age of the Overkill* (1962), the deterrence principle, especially when preventing war, is based on an almost flawless rationality on both sides involved.

This concept can be illustrated by use of a simple game represented in a payoff matrix. Assume there are two players, who may take two actions: "strike" or "back off". If any of the two strikes, he/she would cause the opponent to engage in a retaliatory strike, leading to large negative payoffs for both. Instead backing off, although also causing negative payoffs (as, for example, a reputation loss), is associated with a better outcome for the two players, when compared with the one associated with striking, if both engage in this action.

1 \ 2	Back off	Strike
Back off	-1, -1	-∞, -∞
Strike	-∞, -∞	-∞, -∞

This game has a unique Nash equilibrium at (Back off, Back off), implying that each player, to limit the damage he/she would incur, must limit the damage to inflict onto his/her opponent. This result is closely linked to the above *Prisoner's Dilemma*, since also in this game it is desirable to adopt a risk-dominant strategy.

Furthermore, MAD is not only concerned with national security, but also with *international security*, whose concept, according to Helga Haftendorn, a political sciences professor in the FU Berlin, is strongly based on the mutual interest, between two or more countries, to survive under the conditions dictated by mutual deterrence.

1.2 MAD - The Cold War (SYMMETRY)

The first scenario in which the military strategy doctrine of Mutually Assured Destruction actually emerged is the Cold War between communist USSR and democratic USA.

In the years following World War II, the economic and ideological differences between the two superpowers caused sustained tensions for what concerns both

political and military issues, and this prolonged conflict led to what is known today as the Cold War, in which the two opponents never confronted directly but mainly competed on the development of a larger and more powerful arsenal, mainly including nuclear weapons. When the two had reached a nuclear parity, i.e. a state of equally destructive capabilities, the MAD military strategy stepped in for the first time.

Its doctrine was based on two main factors: first, **the symmetry** in the two countries' nuclear capabilities, meaning that each had the power to completely destroy the other, and the certainty of each that the other had the nerve to strike a nuclear attack, that is, a **convergence in expectations**. Thus, none of the two opponents had the incentive to strike first and destroy the other, as the defender, even if seriously damaged, would still have had the power to retaliate and strike back, leading to a situation in which both countries would be destroyed, given the durability of nuclear weapons which is a key part of the strategy of Mutually Assured Destruction.

An important characteristic of this strategic situation is that the USA and the USSR were not playing either a "pure coordination game", in which the players win or lose together and have identical preferences, nor a "pure conflict game" or "zero-sum game", in which winning means making the other player lose. In fact, the two players found themselves in a situation where conflict was mixed with mutual dependence, implying that, although the conflict yields a dramatic interest to the situation itself, there was an essential need for some kind of collaboration or mutual accommodation, either tacit or explicit, at least to avoid a mutual disaster. These are games in which secrecy does play a strategic role, but there is also need for the signaling of intentions to the other player.

The presence of these two apparently opposing characteristics gives rise to what Thomas C. Schelling, one of the most important economists involved with game theory, and an actual contributor to the US strategy during Cold War, called "**bargaining game**" or "**mixed-motive game**" (Schelling, 1960).

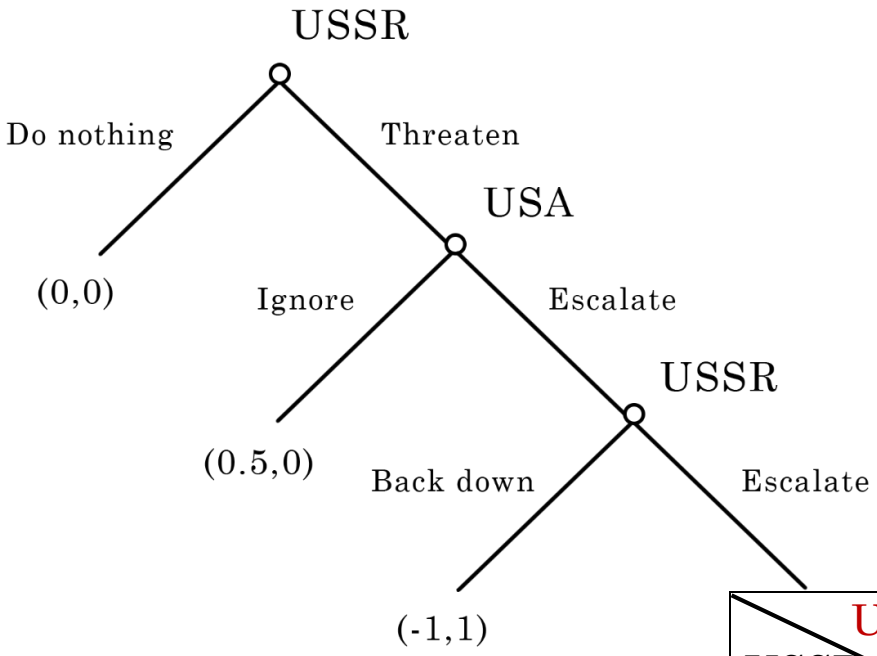
In bargaining games, elements such as commitment, threats and negotiations are of a particular importance. In the Cold War scenario, both the USA and the USSR committed, at first implicitly due to fear of MAD then explicitly with the SALT (Strategic Arms Limitation Talks) towards the end of the Cold War, to avoid the use of nuclear arms against each other. This commitment, or more precisely the lack to maintain it, was actually used as an implicit threat with the purpose of creating fear in the opponent, but, given the symmetry in the power held in the hands of the two players, its only outcome was to receive another threat, in turn, from the other player. The continuing threats increased tensions worldwide: in the

USA and USSR, in the wars that the two players were indirectly fighting, but one of their most famous and important consequences is the escalation of threats, that had never been so concrete before, which led to the Cuban missile crisis.

The game can be represented as a sequential one, and, as the game itself has been repeated several times during Cold War years, it does not really matter which player moves first, so we assume USSR does. At the start of the game, the USSR can choose between two actions: "do nothing" and "threaten", with the first yielding a payoff of zero for both players, and the second gives the choice to the USA to either ignore the threat, getting a payoff of zero but giving the opponent a positive payoff, even if small, due to reputation gains, or to escalate the threat. The escalation would, in turn, give player 1 (USSR) the choice to back down, associated with a payoff of (-1,1), as the USSR would incur in a reputation loss due to the lost credibility of its threats and the USA would gain for the opposite reason having firmly escalated, or to escalate again, whose consequences are described by the payoff matrix at the end of the sequential game, as we are assuming that, at this stage, a destructive conflict would be inevitable (in reality, it may take a lot more stages before the situation escalates to such a point).

The payoff matrix perfectly represents the concepts of symmetry between the two superpowers and of Mutually Assured Destruction, which is a consequence of the first. In fact, in any of the cases in which at least one of the two players attacks, both countries' payoffs are infinitely negative since, if one attacks and annihilates the other, the defender will engage in a retaliatory attack himself, so the payoff represents both the costs of incurring in a major human loss and the cost of engaging in such a heavy and powerful military attack. Thus, once the first player poses a threat and the second escalates it (as it happened in the case of the Cuban missile crisis) in order to, for example, prevent a reputation gain for the opposer, we are left with the unique solution in which both the USA and USSR have to back down.

It is important to note that also the payoff associated with the outcome (Back down, Back down) is negative, since both countries would incur in a loss caused by a reduced credibility in their threats, meaning a loss in their respective reputations, against each other and the rest of the world.



USSR \ USA	Attack	Back down
Attack	-∞, -∞	-∞, -∞
Back down	-∞, -∞	-1, -1

1.3 MAD – USA and North Korea (ASYMMETRY)

One of the most famous and remarkable events that occurred during the Cold War is the Korean war, which started in June 1950, when North Koreans started to invade the South. The Korean peninsula was initially divided between North and South towards the end of World War II, when the Soviet Union occupied the northern part of it, and Japan surrendered to the Allied forces, giving the power to administer the southern part of the peninsula to the USA, which, at the time, was allied with the USSR too. With the actual end of WWII, and the raising tension between these two superpowers, USA and USSR started to engage in other locally-fought battles to ensure their influence on their respective "parts" of the world. The Korean war was, in fact, one of the peripheral wars in which USA and USSR fought against each other, through the support of some other military force.

In this case, the Soviet Union was supporting North Korea through the supply of military aid, together with communist China (which was asked to intervene by USSR when the Chinese civil war would have ended). The USA, instead, were supporting South Korea the same way USSR did with the North.

This division gave rise to a significant difference, both cultural and economic, between the two Korean nations: North Korea, strongly influenced by the communist regimes of the Soviet Union and China, established a communist government with hereditary succession of leadership, and South Korea moved to become a market-oriented democracy supported by the USA. While the latter experienced a rapid growth and became a developed economy by the beginning of the new millennium, greatly due to its capitalistic influence by the most advanced economies, the former's economy went through a steep decline in value after the dissolution of the Soviet Union in the 1990s and is still strongly dependent on China for what concerns its patterns of trade.

As of today, due to cultural and economic differences, similar to those between USSR and USA during the Cold War, there is an ongoing conflict between North and South Korea associated to local motives, giving rise to threats and consequences between the two. However, because of the presence of US military troops in South Korea, and its historical governmental influence on the latter, the conflict between North and South Korea actually translates in one between North Korea and the USA.

The present conflict on which the world's eyes are on may look, at first glance, like the one that characterized the Cold War: a series of threats between the two nations' leaders, Donald J. Trump and Kim Jong-un, which creates a scenario of increasing tension worldwide, the absence of an actual attack from any of the two and an apparent impossibility to put an end to it. As one may argue, in fact, North Korea and the USA are actually playing a **bargaining** or **mixed motive game**, but with some features that appear quite different from those present in the game played during the long-lasting conflict between USA and USSR.

A major difference arises when analyzing the doctrine of Mutually Assured Destruction in this context, in fact, during Cold War it was the one thing keeping the two opposing sides from taking the conflict to another level, namely through the use of nuclear weapons. The idea behind the MAD is based on the theory of **deterrence**, according to which the threat of mutual annihilation would impede any opponent to attack the other(s). This concept could hold during the Cold War, given the symmetry in destructive potential of the two players, meaning that any of the two could completely destroy its opponent if he wished to. Moreover, the MAD doctrine depends on the **rationality**, as stated in section 1.1, of the players

so that they do not engage in actions that would be, in the end, self-destructive, given the consequences that would arise, and also on the condition concerning the ability to retaliate to survive after the initial attack. The rationality condition can be assumed to hold in the USA-USSR conflict, or, more precisely, there was no reason to believe otherwise as none of the players undertook actions that led to destructive consequences.

In the North Korea-USA conflict, the symmetry in the two countries' destructive power falls, since the USA can destroy North Korea, but not the other way around. This means that, in this scenario, the MAD doctrine cannot fully apply, meaning that the hypothetical destruction could never be "mutual". Another implication of the underlying **asymmetry** concerns the deterrence theory, since the only one of the two players to be deterred from engaging in the first attack is North Korea. This means that, if North Korea attacks first, it will not be able to annihilate its opponent, but it can be certain that it will be hit by a retaliatory attack by the USA, which would be able to destroy the former. If instead, the USA attacks first (even if this may not appear to be a reasonable or useful strategy), it would only destroy its opponent without any consequences, besides, of course, the material costs associated with such a move. Therefore, both the MAD doctrine and the deterrence theory appear to be unilateral in this conflict scenario, differently from that of the Cold War.

For what regards, instead, the question about the rationality of the two players engaged in this mixed-motive game, the answer may not be so obvious. As stated above, under the MAD doctrine, each player must assume the other to be concerned only with their own self-interest, which can be translated as being rational, so that the threat of a potential attack itself becomes a deterrent. When analyzing the behavior of the two current nations' leaders, President Trump and Kim Jong-un, one might wonder whether they are rational, irrational or using the so-called "madman theory", a term coined by the former USA President Richard M. Nixon that refers to a strategy in which the country's leader wishes to appear irrational to make his/her opponents fear a hypothetical destructive or, more generally, irrational response when he/she is subject to any threats.

North Korea's leader may appear irrational, given that he has killed many people using violent means, among which his half-brother and uncle. Nevertheless, these are by no means characteristics to be associated with an analysis of a man's rationality, especially when considering historical precedents, in which it was common for kings or dictators to engage in such actions to consolidate their power (see Augustus, Cleopatra and Henry VIII King of England). Moreover, these facts only suggest that Kim Jong-un is far from an ideology of sacrifice, which might justify an almost suicidal attack to the USA, and confirm his interest in self-

preservation. Given these conclusion, in the following game-theoretic analysis of the conflict, North Korea will be assumed to be a **rational** player, implying that the underlying deterrence works in this context.

While USA's current leader, President Trump, needs a more complicated analysis: he may appear to be using the madman strategy, but in an unusual way compared to its predecessors, as he wishes to be considered "mad" by both his enemies and his allies (such a choice may also be argued to be self-defeating). But the use of such a strategy does not undermine a man's rationality, it confirms it. What may be important to note about President Trump is that, in his *modus operandi* and choices made so far, he can be defined as a **risk-seeking** person, given his moves in both his foreign policy (i.e. his interactions with North Korea) and trade policy (i.e. the recent imposition of an import tariff on steel and aluminum). However, once again, one cannot infer that he is an irrational man, so the USA too will be assumed to be a **rational** player when analyzing its strategic interactions with North Korea.

2
Analysis of the conflict

2.1 Scenario

Over the last year (but on a smaller scale for much longer), precisely beginning on July 4th, 2017, when North Korea launched its first intercontinental ballistic missile, the entire world has been experiencing a situation of increasing tension, mainly caused by the engagement of the USA, having historically been the guarantee of arms-control agreements, in a diplomatic conflict with the former.

The conflict begun with economic and trade sanctions imposed on North Korea by the UN, mostly proposed by the USA. What has been surprising about these resolutions is that China, the closest ally to the sanctioned country, together with several other Nations, voted in favor of them, before even declaring itself neutral in the possibility of an armed conflict, if started by North Korea.

These happenings led to the beginning of a long series of threats, by both USA and North Korea, as the former wished to control and limit the nuclear power of the latter, with the latter unwilling to give up its sovereignty on its own military capacity, thus continuing its nuclear tests and ignoring the ongoing sanctions coming from the UN. Thus, the inability, or unwillingness, to communicate between the two main parties involved and reach an agreement led to increasing political tensions worldwide, having the effect to resuscitate the fear of a nuclear war that, differently from the Cold War in which it would have destroyed only the two opposing nations, would have had the potential to cease the existence of humanity.

It is, of course, a simplification to consider only the USA and North Korea as the players in this game, since one should also consider the diplomatic value of internationally recognized authorities, such as the UN and the NATO, and some other Nations that can be assumed to have a strategic role in such a situation, like Japan, Russia and China. The latter, in particular, is considered to have a special role, which will be discussed in more detail in the next section.

2.1.2 The role of China

People's Republic of China (PRC), a country governed by communist parties for most of its recent history, is growing to become one of the most developed and influential economies in the world. Its role in this context is of crucial importance: if, on one hand, it is the most important ally for North Korea, on the other it is becoming the most potent enemy for the United States (particularly for what concerns its economy and trade). Nevertheless, China appears to be quite impartial in this situation, almost acting like a mediator between the two parties explicitly involved in this conflict.

This attitude can be easily observed when looking at the facts: first, as stated above, China has, almost in every specific situation, voted in favor of US-proposed UN sanctions inflicted onto North Korea, after the latter had started to engage in unethical and internationally unaccepted tests on its military capacity, for what regards both nuclear and non-nuclear weapons. These sanctions also forced China to limit oil exports to, and ban textile imports from, North Korea. Furthermore, confirming its strategic role as mediator and "cushion" between USA and North Korea, China declared its neutrality in case of an armed conflict, if the one who started it was its historical ally.

Of course, this could not have happened without the pressure coming from the US government, which, during this diplomatic and mainly verbal conflict, started to act against China too as, for example, the US Senate Banking Committee did, in November 2017, by unanimously backing new sanctions targeting Chinese banks that were in business with North Korea. This probably happened because of the belief, by US President Trump, that China should have played a bigger role in stopping Kim Jong-un from keeping on with his weapons programs.

But, given its lack of participation in the actual conflict, one cannot consider China as one of the players, when analyzing this situation in a game-theoretic analysis, but more as a third party who has a partial ability to influence the two players' moves.

2.2 Strategic Analysis: what should have happened

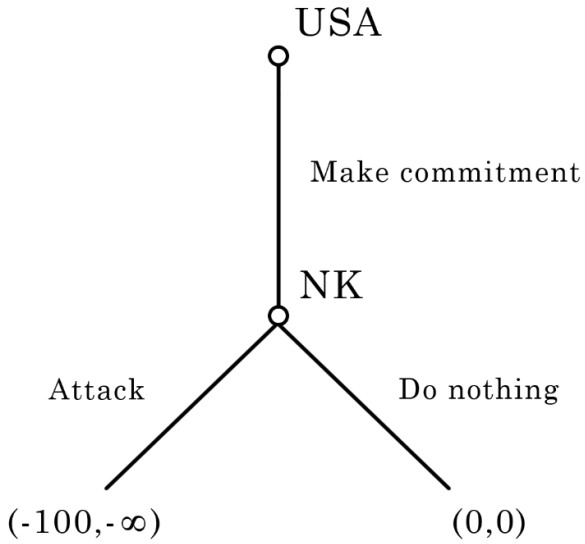
Considering Mutually Assured Destruction and its implication described in chapter 1, and having assumed that both players, North Korea and USA, behave rationally, it is clear that, its working as a deterrent, would only prevent an attack from North Korea, since the two countries' military powers are vastly different, meaning that the latter could not annihilate its opponent. This implies that the US are not facing a real problem, given that it does have the power to destroy its opponent.

In a brief analysis made by Thomas C. Schelling, the economist suggested that a reasonable strategy for the USA to undertake is to make a simple commitment against North Korea: "if you attack, I will annihilate you". This statement would work as a deterrent from an attack just as the MAD doctrine did in the Cold War era and would solve all the US's diplomatic issues.

Let us consider a scenario in which the US follow Schelling's advice. The underlying game involves the two players, USA and North Korea. Assume the US make the above statement as its first move, this means that it will ignore its opponent while it improves its military and nuclear capabilities. At some point, North Korea will have developed such powerful weapons that enable it to reach the US territory, but, given its opponent's commitment and the assumption of self-preservation and thus rationality made in chapter 1, it will be deterred from engaging in an attack.

Such a situation can be described by an extensive game, given its sequential structure, in which the USA make the first move, which is the commitment itself, and North Korea (referred to as NK in the game), given the other player's move, can choose between two courses of action: "Attack" and "Do nothing". Each country prefers to incur in the least costs (economic, human and reputational) possible. Assume that, if the second player chooses to attack, given the first player's commitment to retaliate, it will incur in an infinite loss, as it would be destroyed. While the first player will incur in a loss including the human losses caused by the other's player attack, and in an economic loss due to the cost of retaliating. However, the first player will not be destroyed, implying a much lower cost compared to that of the second. For numerical simplicity, assume that the USA, i.e. the first player, if attacked, would receive a payoff of -100.

Given these assumptions, the game works as follows:



Thus, in order not to incur in an infinitely negative payoff given its rationality, North Korea will prefer the action "Do nothing". This implies that, in this scenario, the commitment made by the USA would work as a deterrent against an attack from the opposing player.

The unique Nash equilibrium resulting from this sequential game is (Make commitment, Do nothing), associated with a payoff of (0,0).

2.3 Strategic Analysis: what really happened

Instead of adopting the above illustrated strategy, the US and North Korea entered in a loop of mutual threats back and forth, whose only consequence has been to destabilize the underlying asymmetric deterrence and create an environment of tension for both parties and the rest of the world.

This can be easily explained through a general discussion. In fact, as long as the USA do not engage in a direct attack against its opponent, the use of a threat as a strategic move and intimidation causes, as its main effect, the uncertainty of whether an attack might actually happen. The continuing threats that two opponents made against one another, thus, have contributed to create such an uncertain situation.

Let us first consider the effects of the threats from the US, which went from the imposition of new UN sanctions against North Korea, of which some were

implemented but ignored by the receiver, to the actual annihilation of the former. One may argue that some of them can be considered as childish, not so much for their content but for the way the US President expressed them.

As stated above, the main consequence coming from the ongoing threats from the USA was to create uncertainty in North Korea about an attack, meaning the perception of not being safe. This led the threat-receiver to create the force to be able to survive and deter such hypothetical and, at the same time, impending attack. Thus, it is quite easy to argue that the US threats are what caused the acceleration in North Korea's test and development of nuclear weapons.

The main question that arises at this point is why North Korea does not just accept the US-posed conditions so that there would be no need for an attack. A possible answer lies in the US popular press and government statements, according to which it is the *existence* of a dictatorship that is repugnant to them. Thus, it is reasonable to believe that an attack to North Korea will occur regardless of whether the former builds military and nuclear capability. This implies that it would be useless to accept the terms and sanctions dictated from the USA, as, according to these statements, it would not reduce the risk of an attack.

Instead, the role of the threats coming from North Korea is somewhat different. Besides, of course, having the effect of increasing tension, as the threats from the US do, their main scope is to make its opponents fear, and maybe overestimate, its military capacity, and are thus used as a deterrent from any attack. Moreover, another important strategic move that Kim Jong-un uses for the same scope is the **secrecy**, about both his own location and that of his nation's weapons.

These actions cause uncertainty also on the US side, destabilizing the underlying asymmetric deterrence described in chapter 1 for this scenario, and, thus, cause worldwide tensions to keep on increasing.

From this brief analysis, one can infer that, first, it is the threats coming from the US press and/or President that drove incentives for North Korea to develop nuclear weapons, as stated above, thus threats lead to undesired actions and make things worse, in opposition to what one may believe. This implies that threats themselves are moves, i.e. actions, with consequences.

Thomas C. Schelling gave an important insight with respect to this scenario and the effects of threats; he believed that instead of non-threatening, what is needed is to be clear about whether one is going, or not, to attack, especially given press commentaries.

2.3.2 A game-theoretic analysis

As in most political tension/conflict cases, North Korea and USA are playing a **bargaining**, or **mixed-motive**, **game**, given the mixture of mutual dependence and conflict in this scenario.

The ideal course of events described in section 2.2 only involved a two-action game, and it maybe did not occur because of its simplistic view. In fact, it is important to consider the different motives of the two players, which are hard to include in the simple assumption of rationality. For what concerns the USA, its actions may be driven, besides by rationality, also by the willingness of President Trump to maintain its role as the world's most important leader, being the head of the most influential and powerful economy. This is what may have led the USA to show such a strong position in this conflict, especially given the gaining economic importance of China (this might also explain the numerous declarations about the latter, which are unrelated to our present analysis and will not be discussed).

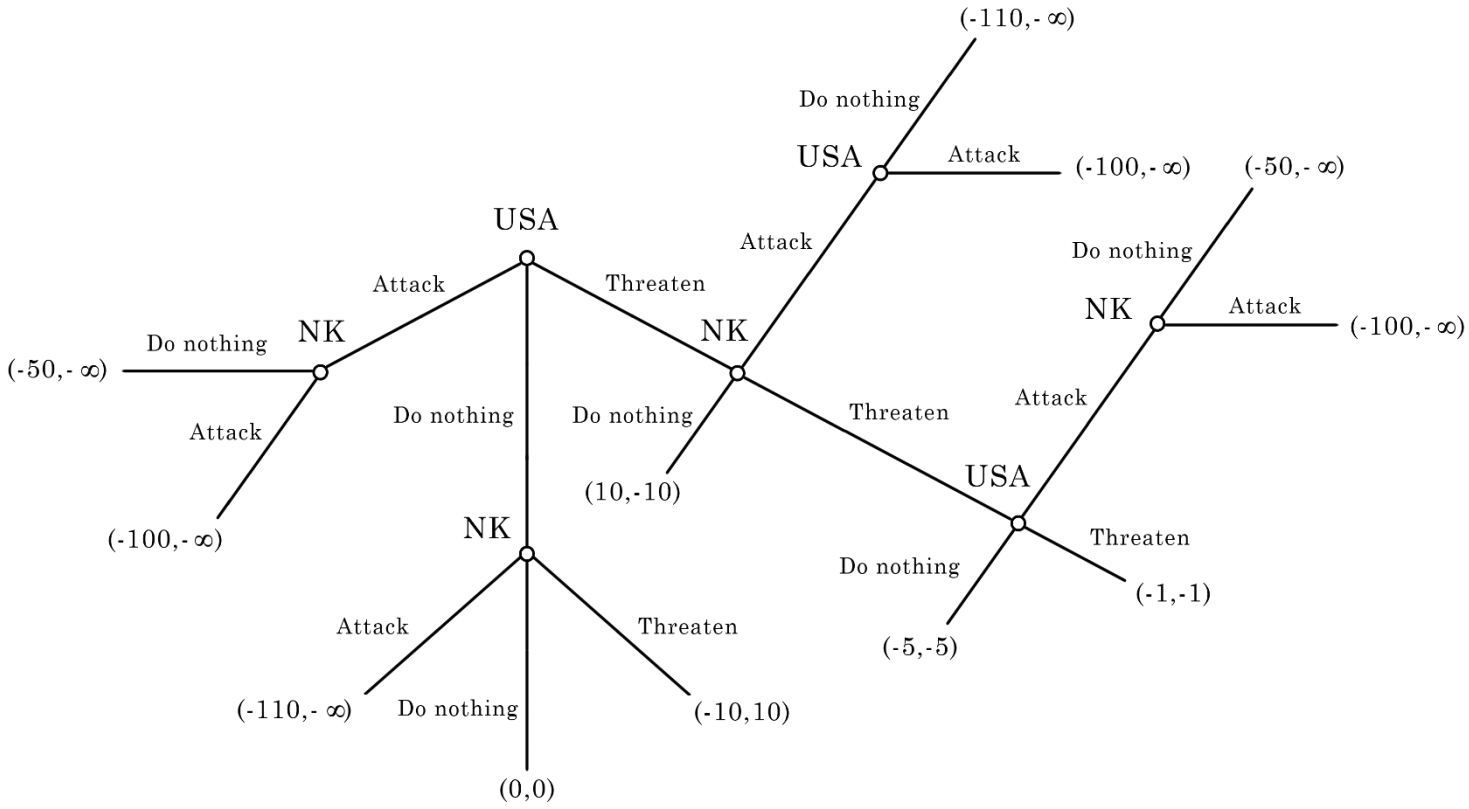
On the other hand, North Korea's leader, Kim Jong-un, may have followed the same incentives for distinct reasons. It is, in fact, common for a dictator to show himself as powerful on the outside, meaning with respect to other nations, to keep his reputation and influence on the inside.

Given these considerations, the actual course of events becomes understandable, if not justifiable.

It now follows a game-theoretic analysis of what happened. The game can be represented through an extensive one, given that each player's action is an answer of the previous one made by the opponent. Its structure is similar to that described in section 1.2, but in this case, mainly because of the difference in the means of communication, the threats were so numerous and frequent that one might assume a decrease in their value along the time path (also considering that, *ex post*, no attack ever occurred).

In the analysis, consider **threats** to be of any kind, from threats to sanction to threats to annihilate, in order to simplify the discussion. Thus, both players have three possible moves overall: "do nothing", "threaten" and "attack".

Assume also that the game starts *after* North Korea started building nuclear capacity, so the US moves first and has the three options listed above. It now follows a graphical representation of the extensive game.



Note that the only action that does not lead to an end of the game, if it is continuously used by both players, is "Threaten". In fact, every time a player chooses such move, the other has the possibility to choose among all three options and so on. This implies that the game potentially has an **infinite horizon**. It can thus be assumed that the use of such a strategy leads the players to a *status quo*, whose payoff is represented, for graphical simplicity, after the third time the move "Threaten" is chosen.

Here follows an explanation of every outcome (recall that the values expressed as payoffs are just symbolic and are meant to describe ordinal preferences):

- **(Attack, Do nothing):** this outcome is associated with a sequence of events in which the USA attacks North Korea and the latter does nothing, and is associated with a payoff of (-50,-∞), as the attacker incurs in the material cost of engaging in such an action and the defender is destroyed.
- **(Attack, Attack):** represents the situation in which the USA attacks and North Korea retaliates. Here the payoff is (-100,-∞) because North Korea would still be annihilated as before, but the US would incur in costs

involving both those associated with attacking and the human loss due to attack received without, however, being completely destroyed.

- **(Do nothing, Attack):** this outcome describes a scenario in which the US commit to do nothing about North Korea building its nuclear capacity, and the latter attacks. It is associated with a payoff of (-110,-50) as, the first player incurs in human and reputational losses (for not having retaliated) and the second faces the material costs associated with engaging in an attack.
- **(Do nothing, Do nothing):** represents a situation in which the USA ignore the fact that North Korea is building and testing nuclear weapons, and then the latter does not engage in any action against the former. This can be thought to be equivalent to the scenario described in section 2.2, where the first "Do nothing" could imply a commitment by the US as the one previously considered. The payoff associated with such outcome is, in fact, (0,0).
- **(Do nothing, Threaten):** in this scenario, first the USA commit to do nothing, then North Korea makes a threat against the former. Due to reputational reasons, it leads to an outcome where the first player "loses" and the second "wins". For this reason it is associated with a payoff of (-10,10).
- **(Threaten, Do nothing):** in this scenario, the US threatens North Korea and the latter does not respond. Here the payoff (10,-10) represents the respective reputation gains/losses of the two players, as the USA gains from standing firm, and North Korea loses by not doing so.
- **(Threaten, Threaten, Do nothing):** as in the previous case, here the USA makes a threat, North Korea responds and then the first player does nothing. The payoff associated with this outcome is less incisive with respect to the former, as it represents the decrease in the value (i.e. credibility) of threats as they keep coming and is, in fact, (-5,5) as in this case it is the first player that, in the end, gives up and does nothing.
- **(Threaten, Threaten, Threaten):** as stated above, this outcome represents the scenario in which both players continuously choose the action "Threaten" and it thus leads to a *status quo*. Given the assumption of the decreasing value of threats, due to credibility-related motives, the payoff associated with such outcome is (-1,-1). This value is negative as to represent the loss given by the receiving of a threat, but small since, after several times a threat is received, it loses its fear-causing effect.
- **(Threaten, Threaten, Attack, Attack):** this outcome is equivalent to the (Attack, Attack) one, since it would involve the same consequences, only with the addition of two moves.

- **(Threaten, Threaten, Attack, Do nothing):** again, the outcome associated with this sequence is equivalent to that associated with (Attack, Do nothing) for the same reasons as the previous course of action considered.
- **(Threaten, Attack, Attack):** once again, this sequence of actions yields an outcome equivalent to that of (Attack, Attack) but, differently from the former, the two players attack in the opposite order, meaning that North Korea, after receiving a threat from its opponent, attacks and causes, in turn, an attack from the USA.
- **(Threaten, Attack, Do nothing):** this outcome, although highly unlikely as any one in which only one player attacks, yields a negative payoff for both players, namely (-110,-50). The outcome is equivalent to that occurring when the course of action is (Do nothing, Attack), since it has the same consequences on the two players.

Having considered all the achievable outcomes in this game, it is now possible to discuss which strategies are preferred for each player. It is evident that every outcome for which the last action(s) is (Attack), (Attack, Do nothing) or (Do nothing, Attack) yields large negative payoffs for both countries, explaining why such course of action never occurred. Actually, there are only two outcomes in which the players do not incur in great losses.

The first is (Do nothing, Do nothing), associated with a payoff of (0,0). However, such outcome can never occur because, if the USA choose as its first move "Do nothing", North Korea will have an incentive to deviate and choose the action "Threaten", which is associated with a higher payoff for the latter. Nevertheless, since the outcome (Do nothing, Threaten) is associated with a negative payoff for the first player, the US will never choose the move "Do nothing" in the first place, so this outcome is not an equilibrium.

The second is the infinite use of the action "Threaten" by both players, represented in the game as (Threaten, Threaten, Threaten) and associated with a payoff of (-1,-1). Having considered that the only other strategy for which the players do not incur in large losses is not an equilibrium, one can infer that this outcome is, although it is **Pareto-inferior** (Pareto, 1902) with respect to the former. The reason for this is that it is the only outcome in which none of the players have an incentive to deviate, since the player who does so causes a greater loss for himself when choosing "Do nothing" and a greater loss for both when choosing "Attack".

In the end, the latter strategy is the one that the two players decided to adopt, confirming the assumption of rationality of the two players made above.

In reality, this strategy can be considered as fruitful when (i) either it is enforced for long enough that no negative outcome ever occurs, but this scenario is quite unrealistic since the game can never actually have an infinite horizon; (ii) or when the two players, at some point in time, decide to open up communication and try to draft an agreement in order to finish the game, which is exactly what happened in this case and will be discussed later on.

Although adopting a continuing "Threaten" strategy, when considering its short-run consequences, may look like the uncomplicated way to embrace such conflict, it actually happens to require an in-deep analysis to capture the value of the threat itself. A threat is, in fact, a strategic move and, as such, it can alter the game's course of action in a way instead of another.

Here follows a digression to better understand the role of threats in game theory.

2.3.3 The strategic role of threats

Threats are one of the most crucial elements involved in bargaining games, both in military wars or international conflicts and in industry competition. Thomas C. Schelling, in his book *The Strategy of Conflict* (1960), in which for one of the first times threats are considered as actual moves in a strategic game, defines threats as simple communications of one's own incentives, whose scope is to impress on the other player the consequences of his acts. At the same time, if the threat succeeds in deterring, it can benefit both parties. However, besides communication, threats often are about an action that the threatening party would have no incentive to perform, meaning that it would hurt the latter, implying a deterrence based of the fear of mutual harm. The threatener only has the incentive to bind himself to fulfill the threat, and if it succeeds, he will never have to engage in that action. Thus, threat success means **not** having to fulfill what was threatened. However, its efficacy depends on the ability to convince the other party, and it is ineffective unless the threatening party can present his own incentives in a way to demonstrate that, *ex post*, he would have the incentive to carry out his threat. Making a threat credible is often difficult, especially when it is a "big" one, meaning a threat with enormous consequences. One way to make a threat credible is to allow the threatened party to control his destiny. According to professors Avinash Dixit and Barry Nalebuff, this sort of strategy can be compared to an automatic trigger, which may work since it gives the idea of a conscious suicide, implying that the risk lies in the hands of the threatened party.

As a general rule, one must threaten that he **will** act, not that he **may** act, if the deterrence purpose of the threat fails. Saying that one may act is equivalent to saying that one may not, implying that the threatener has kept the power of decision, i.e. that he is not committed.

Thus, threats are strongly related to commitments and there are several ways to commit in advance to an action that one would prefer not to carry out, in order to make his commitment a deterrent for a specified action of the opposing party. One is, of course, bluffing about the costs that the threatening party would incur by engaging in the threatened action, i.e. convincing the other party that his own costs are minor with respect to the actual ones. Another way to commit may be to pretend such a strong revenge motivation that overcomes the self-damage associated with the threatened action. Alternatively, one can try to stake his reputation on fulfillment in order to impress his opponent.

It can be argued that the last two ways cited above, about how to commit to threats, were the ones used in the conflict scenario described in the previous section by Donald Trump and Kim Jong-un, although made in a much more implicit way.

However, in threat situations, as in bargaining, commitments are not completely clear, as each player cannot precisely predict the other player's costs and values associated with the two actions involved in the threat and, furthermore, the process of commitment may be a progressive one, as it is in the North Korea-USA conflict. **Communication** may also be an issue, since it is often neither completely impossible nor entirely reliable, and, while communicating the commitment can be done directly between the two parties, some other evidence can only travel though medias.

The communication between Donald Trump and Kim Jong-un during the conflict may be of particular interest, since it has been quite intense especially given the ease with which one can communicate throughout the world. But this intensity does not imply, of course, clarity between the two parties, it, instead, gives them a greater incentive over- or understate their commitments, leading, paradoxically, to an even more unclear communication. Furthermore, the media's attention on the issue caused the situation to be perceived as even more tense.

When communication is imperfect, there are the conditions in which arises the unhappy possibility of the two parties simultaneously making a commitment: one committing to the threat, and the other to the action against which the threat is made. In these cases, both actions may occur at the same time, and the recognition of this scenario becomes itself a deterrent to the making of commitments. However, when such a situation occurs, meaning that the threat is made and fails

to deter, there is a stage prior to the threat fulfillment in which **both** parties have an incentive in undoing their commitments, but cannot do so because of reputation motives. This is because the purpose of the threat itself is gone, its deterrence value is now inexistent, and the commitment to fulfill it is the only thing left which would cause, as stated above, harm in both the threatener and the threatened.

In order to reduce the risk of misunderstanding resulting from imperfect communication, it is important to put care and precision in defining the threat, both in the action that is threatened against and in the counter-action that is threatened. After the threat is made, its credibility depends on the threatened party's belief that its opponent will indeed carry out its commitment even when it has no incentive to do so, i.e. when the former engages in the action that is threatened against. Defining the threat in a precise way, meaning that its terms are visible both to the two players involved and to third parties, often involves the introduction of some arbitrary elements, implying that it needs to be attached to something that is visible: actions rather than intentions.

In the case studied earlier in this chapter, most of the threats the two players made against each other were not so explicit nor concrete as to be defined as "precise". This could possibly be an indicator of the unwillingness to actually carry out the threat itself, or of an underlying overconfidence, meaning that each player could have believed that the threat statement would have been enough to put an end to the whole situation.

Analyzing more in detail the relationship between threats and commitments, it is quite straightforward to state that the former, just as the latter, is a **renunciation of alternatives** that makes one worse off than needed in the event that such a tactic fails. But the main difference between these two strategic moves arises from the fact that threats are conditional on the other player's moves. While the commitment fixes a course of *action*, the threat fixes a course of *reaction*. This implies that the commitment is a means of gaining the first move in a bargaining game, while the threat is a commitment to a stated second move, given the other player's previous one.

Thus, threats can completely alter the structure and the preferred course of actions in a game and this is why they can be so crucial in better understanding bargaining games. However, their functioning can drastically change based on which degree of rationality the players are assumed to possess. The working of such strategic move is also particularly interesting when the players involved are not considered to be symmetrical (in their options among which to choose an action, in their value system etc.).

Given the analysis in section 2.3.2 and the chosen strategy by USA and North Korea, which involved almost exclusively the use of threats, it results that the two engaged in such actions for their own different motives, but the latter analysis of threats demonstrates that some mistakes were made by both players in their use of such moves.

3

The end of the tensions and its implications

3.1 The meeting between Donald Trump and Kim Jong-un

As anticipated in the previous chapter, the bargaining game involving the USA and North Korea ended in a quite peaceful way. The two countries' leaders, in fact, met on June 12th of the current year in their first summit meeting, which was held in Singapore. The importance of such happening, which made it the most eagerly awaited geopolitical summit, is mainly due to the fact that it has been the first time that a US President met with the leader of North Korea, which can be argued to be one of the most repressive nations, as of today.

This event led, before it actually occurred, to the analysis of the hypothetical scenarios that it might present and their consequences, and, after it occurred, to a study of the meeting itself and the consequences it might bring on North Korea, the USA and the rest of the world. When looking at the consequences, a particular discussion must be devoted to China, given its special role with both the two opposing nations in the conflict.

The one thing that was certain even before June 12th is that this date would have changed the world's equilibrium, particularly in the East-Asian region.

The following sections of the chapter will thus be devoted to an *ex ante* and *ex post* analysis of the summit meeting.

3.2 *Ex ante* Analysis: Best and Worst-case scenarios

The potential consequences of the summit meeting between Donald Trump and Kim Jong-un involved a wide range of happenings, from the implausible complete disarmament of North Korea to a breakdown of the meeting. However, the fact that the two leaders decided to meet, seemed to have decreased the tensions worldwide, no matter the results coming from it.

In order to understand the consequences of what really happened, it is important to analyze those of the two extreme cases that could have happened.

1. Best-case scenario:

According to Trump and his team, and for most of the world, the perfect scenario involved the "complete, verifiable and irreversible dismantlement" of North Korea's nuclear program. This was the main goal of the US administration, often stated in the days that led to the summit, but usually referred to using the acronym CVID.

However, it is quite straightforward to see why this could have never happened. North Korea's acceptance of the CVID would have implied the shipment of all its nuclear weapons, and other military crucial elements, to the US or some third country. The problem that makes such a scenario impossible, as stated in section 2.3, is that, given that the issue for the US is the simple existence of a dictatorship such as the one governed by Kim Jong-un, North Korea sees its nuclear weapons as the only deterrent against its opponent invading and putting an end to the Kim dynasty. This simple reasoning lies behind all of North Korea's refusals to the sanctions received and the terms dictated by other countries during these years.

According to this analysis, the US could not expect to receive much from the meeting with its opponent.

2. Worst-case scenario:

The possibility of this scenario is what makes the summit particularly relevant, meaning that the price of a potential failure is enormously high. In fact, not only could the two leaders fail to make progress, their meeting may cause a deterioration in their relationship, potentially leading to a dangerous escalation of threats against one another and the start of a war.

Unfortunately, this situation may not be so improbable as it sounds, especially given some of the declarations that both Donald Trump and Kim Jong-un made against each other in the past year, some of which looked like personal insults. In particular, there were worries about the unpredictability of putting the two leaders to negotiate, Trump being a man who is not afraid to speak his mind in every situation, and Kim being a young, cold-blooded dictator who has killed many people to secure power for himself.

Thus, the specific behavioral characteristics of the two players are the reason why such a hypothetical devastating scenario may have arised.

3.3 *Ex post* Analysis: The consequences of the meeting

In the end, what happened was not close to any of the two extreme scenarios, but somewhere in between. However, there has been some criticism on Trump's choices.

First of all, it is important to note that almost any talk between the US and North Korea significantly reduces the risk of an attack from any of the two. The simple undertaking of this summit, therefore, changes the public's behavior and perceptions as to reducing the tension that characterized such relationship for a long time.

In the summit, Donald Trump and Kim Jong-un signed a joint statement, which contained polite and diplomatic clichés, but is really considered to be quite empty. This type of statement is not uncommon among conflicting players, as it is a way to keep talks going, meaning that it does not resolve any problems but keeps the countries engaged in a peaceful discussion.

Later, Donald Trump made an important concession to North Korea, promising the latter that the US will stop its joint military exercises with South Korea. The US president was trying to adopt what is known as a "**freeze for freeze**" strategy, meaning that he freezes the military exercises with South Korea, hoping that North Korea, in turn, will freeze its nuclear weapons tests. However, given that South Korea officials expressed surprise with respect to this statement, it appears that Trump has made such a promise without first acknowledging them nor obtaining their consent. It is highly unlikely that the South Korean leadership will put up a struggle to this choice, given its position as US ally and its tense relationship with North Korea, but Trump's breach of his alliance with the former will probably deliver South Korea the message that the USA cannot always be trusted.

Another notable element in this meeting is the staging of the summit itself, in fact, the USA organized it in a way to give Kim Jong-un some symbolic, but still important, concessions. At the latter's request, the two countries and their leaders were presented as equals, thus raising Kim Jong-un to a superpower's level such as that of the US, the most powerful economy in the world. Besides this detail, the entire theatre of the meeting was given a degree of ceremony and almost of royalty.

These apparently insignificant facts were instead a big concession to North Korea's leader, given his issues with legitimacy, both at home and abroad.

It therefore appears that the US made a lot of concessions to its opponent, although it did not cost them much to do so. However, such concessions can only be given once, and the USA actually did not ask a lot in return.

The lack of specific requests from the USA is considered to be a **lost opportunity** to receive more valuable concession from North Korea, such as partial disarmament or some intrusive inspections on their nuclear weapons.

Furthermore, the summit may have an important meaning for other US opponents. In fact, it seems like Kim Jong-un almost forced Trump to engage in a negotiation because of having developed nuclear weapons that could have reached the US territory. However, contrary to most US statements about the refusal for any kind of dictatorship, President Trump did not present Kim's human rights record (which are considered among the history's worst) as an issue in the meeting, he instead stated that North Korea could become a major touristic destination. The latter statement was made, sadly and ironically, almost one year after an American tourist was tortured and killed while he was in North Korean custody.

In conclusion, after having considered all these elements, one might infer that, if the purpose of the meeting was to bring the world substantially closer to resolving the North Korea crisis, it did not do so, at least when talking about long-term implications. In fact, as said above, North Korea took no steps, not even rhetorical, in the direction leading to its nuclear disarmament. Neither the USA made any serious, long-run commitment, since the promised freeze of the joint military exercises with South Korea can be easily reversed at any time. Thus, given what happened, or actually what did not, the suspicion that the US cannot be trusted anymore for what concerns arms-control agreement arised, especially since the US President, in the past, has made numerous declarations and statements promising the complete dismantlement of North Korea's nuclear weapons (CVID) and, when it was time to try and deliver those promises, nothing happened.

However, it is worth restating the first point brought in the discussion: **any** talk between Donald Trump and Kim Jong-un, even if it elevates the latter in a questionable way and grants him big concessions without asking much in return, significantly reduces the risk of war, both actual and perceived. However, since the meeting did not bring any long-term insurance against it, this risk-reducing effect will live only as long as the talk between the two leaders continue, and it is, thus, very likely to be temporary. Nonetheless, Donald Trump has made some declarations suggesting that he is willing to continue to engage in talks with Kim

Jong-un, if this means saving millions of lives, so the world can, at least for now, be optimistic for what regards this long-lasting conflict.

3.3.2 The "unintended" consequences on China

The peace between Donald Trump and Kim Jong-un, at least apparently, is likely to bring benefits across the entire Asian region involved, including China. This belief mainly lies on the fact that the latter would see the threat of a war in a confining country almost disappear and on the possibility of trade sanctions previously imposed on North Korea, which directly affected China being its main trading partner, being lifted. However, the possible scenario that China might face is not quite simple nor positive.

In fact, the achieved stability in the Korean Peninsula might lead the US to engage in a strategic competition with China, which has become the most powerful economy in the world after the USA and is still growing, in a more intense way with respect to how it has been already doing. A confirm to this hypothesis first came from a statement made by the US defense secretary, which said that the US troops, no matter the conflict with North Korea, are meant to stay in the Indo-Pacific region. Thus, if the tensions with the latter come to an end, some of the tens of thousands of troops that are currently employed in South Korea would be freed. The US troops will not just go home and, being the responsibility for protecting South Korea enormously reduced, will probably be placed in other strategic positions across the region, thus putting a renewed focus on contrasting the Chinese influence in the Asian-Pacific area.

Furthermore, the rapprochement of the countries formerly engaged in the conflict could seriously harm China's trading patterns if Kim Jong-un prioritizes the US over China in order to maintain a good relationship. In fact, North Korea may be able to find better trade deals with the USA than it currently receives from China.

Thus, considering Trump's position with respect to China, which has been stated in direct and indirect ways during his mandate so far, the consequences that the latter might face after the summit that brought peace, even if potentially temporary, between North Korea and USA may be argued to be more *strategic* than *unintended*.

Conclusions

This study has highlighted, when trying to analyze the North Korea-USA conflict, two important facts about it. First of all, the game-theoretic analysis of the conflict, presented in chapter 2, has shown that the two players' choices, although strongly criticized at the time, have made up the course of action that led to the unique equilibrium of the game, meaning the best one among which they could have chosen, proving to be more rational than they were expected to be.

However, when analyzing more in detail the specific set of actions they undertook, i.e. threats, it has been proven that, in the way threats have been made, the two nations' leaders were not so rigorous.

Nevertheless, it was demonstrated that the Mutually Assured Destruction doctrine, as it did during the years of the Cold War, and although the two situations cannot be treated as equals as explained in chapter 1, is able to keep dynamics of geopolitical tensions at a sustainable level, almost like an equilibrium, preventing them to escalate into dangerous situations.

Secondly, the subsequent analysis of the Singapore summit, which brought peace between North Korea and USA, and its consequences, made in chapter 3, has shown that US President Trump's choices, although, once again, heavily criticized, may be more strategic that they appear. In fact, such choices, i.e. promising to remove his troops from South Korea and not asking for anything from Kim Jong-un, are likely to bring about major repercussions on China's economy and patterns of trade. Such consequences, whether they were intended or not, could thus cause a dramatic change in the dynamics of geopolitical relationships worldwide, the same way the end of the Cold War did.

This implies that, whenever a situation of equilibrium, a geopolitical one in this context, is changed, it affects and changes every other equilibria.

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