

Ukraine's crisis in 2022 through the lens of game theory

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## **Abstract**

### **Ukraine's crisis in 2022 through the lens of game theory**

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In this paper, I study Russia's 2022 invasion of Ukraine using game theory. I analyze different scenarios of the war based on three different realistic strategies that can be chosen by Russia, and three different realistic strategies that can be chosen by the West, leading to a simultaneous-move 3x3 non-cooperative game between these two players. In addition, I model both players with two different potential types: the West can be either approachable or aggressive, and Russia can be militant or insecure. While the available strategies of the players do not change, the type of a player determines the preferences over the available fixed strategies. Therefore, I model this situation as four different non-cooperative games depending on the players' types, and solve all four games by finding their Nash equilibria. In the second part of the paper, I include Ukraine as a third player who can affect the result of the war. The goal is to predict the possible future outcome of the ongoing war and to gain a better insight into the world's future economic and political status.

## Table of Contents

<b>1. List of Tables .....</b>	<b>v</b>
<b>2. Introduction .....</b>	<b>1</b>
<b>3. Literature Review .....</b>	<b>6</b>
<b>4. Ukraine’s History of Crisis .....</b>	<b>7</b>
<b>5. Model .....</b>	<b>8</b>
<b>6. Preferences .....</b>	<b>9</b>
<b>7. Payoffs.....</b>	<b>11</b>
<b>7.1 Description of Assigning Rankings to Each State.....</b>	<b>11</b>
<b>8. The Approachable West vs. Militant Russia (Scenario 1).....</b>	<b>12</b>
<b>8.1 The Approachable West’s Payoffs.....</b>	<b>12</b>
<b>8.2 Militant Russia’s Payoffs.....</b>	<b>14</b>
<b>9. The Aggressive West (Scenario 2).....</b>	<b>16</b>
<b>10. What If Russia Backs Down?.....</b>	<b>17</b>
<b>10.1 Insecure Russia vs. The Approachable West (Scenario 3).....</b>	<b>17</b>
<b>10.2 Insecure Russia vs. The Aggressive West (Scenario 4).....</b>	<b>18</b>
<b>11. Ukraine’s Role .....</b>	<b>19</b>
<b>12. Conclusion .....</b>	<b>21</b>
<b>References.....</b>	<b>23</b>

## List of Tables

1. Table 1 .....	4
2. Table 2 - Russia's Strategies .....	5
3. Table 3 - The West's Strategies .....	5
4. Table 4 .....	11
5. Table 5 - Scenario 1: The approachable West vs. Militant Russia .....	15
6. Table 6 - Scenario 2: The Aggressive West vs. Militant Russia .....	16
7. Table 7 - Scenario 3: The Approachable West vs. Insecure Russia .....	18
8. Table 8 - Scenario 4: The Aggressive West vs. Insecure Russia .....	19
9. Table 9 - Militant Russia vs. Ukraine .....	21
10. Table 10 .....	22

## **1. Introduction**

The modern history of conflict between Ukraine and Russia goes back to at least a few decades. At that time, Ukraine was part of the Soviet Union and was always economically and politically under Russia's control. After the dissolution of the Soviet Union, which happened during the period of 1988 to 1991, Ukraine gained independence gradually. However, the conflict did not go away since Russia still thinks of Ukraine as part of its own territory.

The conflict in 2014 is known as the annexation of Crimea, where Russia took control of Crimea, a peninsula in the south of Ukraine that also has a boundary with Russia from the East. This invasion by Russia happened following the chain of events that led to the dismissal of the incumbent Ukrainian president and the holding of a new presidential election on May 25, 2014. The United States and the European Union instantly recognized this as a fundamental shift in Ukrainian politics. Russian leaders indicated that they would not stand by and do nothing while their strategically important neighbor joins the West, so they reacted by taking Crimea. After the annexation of Crimea, people voted to overthrow their current president, Viktor Yanukovich, and in 2019 Vladimir Zelensky won the presidency. In 2022, when Ukraine finally decided to cut its ties with Russia and join NATO, Russia revealed its true nature and vehemently started invading Ukraine and killing many people. Following these events, President Biden is trying to block Russia's move by imposing sanctions against this former communist country, while avoiding sending a military force to Ukraine. On the other hand, Russia did not stand by and counter-sanctioned almost all the countries that are members of NATO. The ongoing war brought havoc not only to Ukraine, but also affected almost all the countries in the world by causing

widespread inflation, including oil price increases and gas as well as food price hikes, and scarcity of some goods in some parts of the world. Therefore, predicting the future situation of this ongoing crisis is crucial due to the fact that it determines the world's future welfare.

In this paper, I analyze first Russia's invasion of Ukraine through the lens of game theory. I set up a simultaneous move game with a 3x3 payoff matrix between Russia and the West. Using the Nash Equilibrium (NE) concept, there is no player in equilibrium who can do better by unilaterally changing their strategy (Nash, 1950). In the second part of the paper, I include Ukraine as a third player who can affect the result of the war through an equilibrium path.

The main goal of this paper is to predict the future outcome of the ongoing war and to gain a better insight into the world's future economic and political status.

My paper is going to answer the following questions:

- What is Ukraine's crisis?
- How can it be analyzed using game theory?
- What is the prediction for the future outcome of the war?

Many papers tried to analyze Ukraine's crisis in 2014, which is known as the annexation of Crimea. Russia took control of part of Ukraine named Crimea due to its people's rebellion against not signing the EU contract and desire to join NATO. Amongst these papers, Ericson and Zeager (2015) used the revised theory of moves introduced by Brams (1993) to analyze their conflict in 2014. Based on Brams (1993):

*“The Theory of Moves (ToM) focuses on interdependent strategic situations in which the outcome depends on the choice that all players make”.*

Also, Van Eck (2016) studied the annexation of Crimea through the game of chicken and compared it with the ToM model. Another paper by Dong and Li (2018) studied the economic sanction game among the US, EU, and Russia to explore its economic impact on the world.

Among all the papers that studied the conflict between Russia and Ukraine in 2014, none had the opportunity to analyze the ongoing war which started in February 2022. Additionally, none have included Ukraine in their game as the third player who could impact the result of the conflict.

In this paper, I analyze different scenarios of the war by modeling them according to the actual situation that is happening right now in the world. I consider different scenarios with different types of Russia and the West. The West can be either approachable or aggressive, and Russia can be militant or insecure. This leads to four different games. Table 1 displays the four possible scenarios of the game, based on each player's type. Each type of player is given by the different payoffs that this player type receives in the 9 outcomes of the game, where the outcomes are determined by the strategy profile. It turns out that the specified type-specific payoffs lead to a dominant strategy for both types of Russia, and the best response of both types of the West to this dominant strategy is the same strategy, although this best response depends on the West's type. This is meant to be a realistic depiction of the preferences of the different types of the two players, and as a result, the NE strategy is determined by the type of each player and it turns out that it is independent of the other player's type and strategy choice. This then results in the same strategy being used in the Nash Equilibrium by the same type of player, regardless of the other player's type or strategy as shown by Table 10.



As the analysis will show, 4 scenarios are defined for this model. Table 1 defines the 4 possible scenarios of the game based on each player's type.

**Table 1**

	<b>Militant Russia</b>	<b>Insecure Russia</b>
<b>The approachable West</b>	Scenario 1	Scenario 3
<b>The aggressive West</b>	Scenario 2	Scenario 4

Scenario 1 is the game between the approachable West and militant Russia. Scenario 2 is between the aggressive West and militant Russia. Moreover, scenarios 3 and 4 are between insecure Russia versus the approachable and aggressive West respectively. Depending on the level of aggressiveness of both players, the Nash-Equilibrium might differ. In the model, 9 possible outcomes are defined. In scenario 1, with the approachable West vs. militant Russia the equilibrium is SN-IN. When both players are aggressive (scenario 2), they both wouldn't let go of Ukraine; accordingly, the equilibrium ends in MA-IN. Moreover, I examine the situations where the West's sanctions force Russia to back down and bring its military forces out of Ukraine's soil (scenarios 3 and 4). In this case, insecure Russia vs. the approachable West and the aggressive West's Nash Equilibrium ends in SN-DS and MA-DS respectively. Tables 2 and 3 list Russia and the West's strategies.

*Table 2 - Russia's Strategies*

<b>LG</b>	<b>Let Go</b>
<b>DS</b>	<b>Destabilize</b>
<b>IN</b>	<b>Invade</b>

*Table 3 - The West's Strategies*

<b>BU</b>	<b>Business as Usual</b>
<b>SN</b>	<b>Sanctions</b>
<b>MA</b>	<b>Military Aid</b>

I organize the paper as follows: firstly, I discuss existing papers which have studied the crisis related to this paper. Secondly, I briefly explain Ukraine's history of conflict with Russia in order to elucidate the significance of such an analysis. Following this, the model defines the ongoing crisis in the framework of game theory: first of all, the ordinal payoffs attributed to each player will be unraveled; after that, I indicate the Nash-Equilibrium in each scenario of the game. The last section concludes.

## 2. Literature review

The existing literature on the conflict between Ukraine and Russia is limited to the annexation of Crimea. Since the present war is an ongoing crisis, not many had the opportunity to analyze it in the framework of game theory, except for a few. Ericson and Zeager (2015) studied the annexation of Crimea which happened in 2014 through the lens of the Theory of Moves (ToM). Their analysis is a revised version of ToM which was first introduced by Brams (1993). They conclude that the game will end in SN-DS (SN: imposing sanctions against Russia, DS: destabilizing Ukraine), where both the West and Russia will impose sanctions against each other to neutralize each other's moves.

Van Eck (2016) shows how the game of chicken can be used to analyze the Ukraine crisis and then compare their version of the game with what Ericson and Zeager (2015) presented through the theory of moves. The game of chicken is a model, like the Prisoner's Dilemma or Stag Hunt, that is helpful in explaining political phenomena. He concludes that the game of chicken is enough to explain this crisis.

Velado (2017) also explained this conflict through the game of chicken. His analysis predicts what variables may shift the actual "equilibrium" of this frozen conflict to a new scenario in which the problem of the ownership of Crimea could be solved. His result shows that there is a high possibility that Russia may cooperate. Additionally, the author concludes that further research is needed to fully predict the ramifications of the conflict.

On the other hand, some papers show the effect of sanctions of this war on each country's economy. For instance, Dong and Li (2018) used numerical general equilibrium model calibration and simulation methodology to compute payoffs and then study the impact of sanctions on each selected country. By studying the level of effect of sanctions on countries

that are involved in the conflict one may be able to predict the outcome of the war. Dong and Li (2018) conclude that the US and EU may continue to use sanction measures to pressure Russia. Russia's best choice is to retaliate when confronting the sanctions, however, Putin is the one who gets hurt more in the end compared to other involved countries.

### **3. Ukraine's History of Crisis**

On the 21<sup>st</sup> of December 1991, the strongest communist country in history collapsed. After the resignation of Gorbachev, the Union of Soviet Socialist Republics (USSR) dissolved into 15 independent states, ending the 44-year Cold War between east and west. After the dissolution of the Soviet Union, it was a suitable moment for Ukraine to fight for its independence from Russia. On 1 December 1991, a referendum took place for people to vote for the independence of their country. Since the USSR acknowledged Ukraine's independence in 1991, the majority of the peninsula's ethnic Russian population has backed calls for secession from Ukraine and reunification with Russia (Ingelevic-Citak, 2015).

In November 2013, President Yanukovich did not sign the European Union association agreement, which was a legally binding agreement between Europe and Ukraine to establish a close relationship between them. This triggered an anti-government demonstration of Ukrainian people who wanted to have closer ties with the EU instead of going under Russia's thumb again. In addition to drawing attention from around the world, the late 2013 demonstration in Ukraine over its government's refusal to sign a new agreement with the EU sparked serious challenges to its statehood and increased domestic unrest (Dragneva-Lewers, 2016). Thereafter, the government adopted a resolution demanding the dismissal of the incumbent president and holding a new presidential

election on May 25, 2014. The United States and the European Union instantly recognized this as a fundamental shift in Ukrainian politics. Of course, Russia argued that the procedure was illegal and refused to put up with accepting the new government (Velado, 2017). Russian leaders indicated that they would not stand by and do nothing while their strategically important neighbor joins the West, so they reacted by taking Crimea (Mearsheimer, 2014).

Of course, gaining Crimea by force was a major threat to NATO membership for Ukraine. Based on Mearsheimer (2014) the war on Ukraine's soil is mostly the West's fault as they knew Putin would not stay idle and let NATO expand its territory all the way to Russia's backyard.

After the annexation of Crimea, people voted to overthrow their current president, Viktor Yanukovich, and in 2019 Vladimir Zelensky won the presidency. In 2021, President Zelensky requested to join NATO by their people's will and later faced Russia's aggressive response, and finally, on February 24, 2022, Russia declared war against Ukraine. Heavy financial penalties against Russia were imposed by Ukraine's Western allies in response to this most recent strike, including limitations on the Russian central bank and the expulsion of important banks from the primary global payments system (Aloisi and Daniel, 2022).

#### **4. Model**

I am going to analyze Ukraine's crisis by using a non-cooperative 3 x 3 simultaneous move game. To represent this crisis, some assumptions are necessary.

- Russia and the West are both rational actors; therefore, they intend to maximize their payoffs.

- Payoffs are shown on an ordinal scale. Payoff numbers only rank the ordering of outcomes from best to worst for each player and not the degree to which a player prefers one outcome over another.
- No ties are allowed for this game.
- We have two players in this game: Russia and the West. In general, the West consists of all the countries that are members of NATO, whose interests are somewhat aligned with the well-being of Ukraine.
- Each player has 3 strategies, as shown by Tables 2 and 3.

I analyze 4 possible scenarios of this game between Russia and the West in the following. Scenario 1 is a game between the approachable West and Militant Russia. Scenario 2 is between the aggressive West and Militant Russia. Scenarios 3 and 4 consider the situations in which Russia backs down (insecure Russia) and prefers to destabilize Ukraine by imposing sanctions over invasion versus the approachable West and the aggressive West respectively. Table 1 displays the 4 possible scenarios of the game based on each player's type. (Note that Table 1 is a type table, not a strategic game.)

In order to keep the analysis simpler and tractable, we will analyze the four scenarios separately and leave the Bayesian analysis for future work. That is, we assume for now that both players know the opponent's type.

## **5. Preferences**

Russia and the West are the two major players in this game and their strategies define the future economy of the world. In addition, based on the history of Ukraine, we assume that Ukraine is willing to join NATO at any cost regardless of each player's actions; therefore,

Russia and the West adjust their strategies accordingly. This assumption, to some extent, is a simplification of the model to make our analysis more comprehensible.

Three actions can be defined for each player of this game, following Zeager and Ericson (2015):

Russia's actions are as follows:

**LG- Let go:** Completely give up invading Ukraine and let it join NATO without any interference.

**DS- Destabilize:** Impose sanctions on Ukraine and the West to paralyze their economy with the intention of not letting Ukraine join NATO.

**IN- Invade:** Send military troops to Ukraine and declare war to end its desire to join NATO forever.

The West's actions are as follows:

**BU- Business as usual:** Leave Ukraine alone and do nothing against Russia's invasion. In other words, give up Ukraine as one of its potential allies and leave it for Russia's insatiable thirst for power.

**SN- Sanctions:** Impose sanctions against Russia to hinder their progress in Ukraine, yet not directly interfere in the war.

**MA- Military aid:** Declare war against Russia in Ukraine and send its military troops to aid the Ukrainian people.

## 6. Payoffs

In this section, I will rank the payoffs based on each player's point of view separately. As it has been mentioned before, the payoffs are going to be ordinal. Unlike cardinal payoffs, ordinal payoffs don't have any meaning on their own and show only the ranking of preferences. Table 4 shows the matrix of the game. Based on each player's actions there are 9 possible states in this game.

*Russia*

*Table 4*

		<i>Russia</i>		
		LG	DS	IN
<i>West</i>	BU	BU-LG	BU-DS	BU-IN
	SN	SN-LG	SN-DS	SN-IN
	MA	MA-LG	MA-DS	MA-IN

### 6.1 Description of assigning rankings to each state

To make our model more realistic and more interesting, it is good to consider different scenarios based on the players' ranking of outcomes. Each player's payoff will be assigned according to the preference rankings, from 9 to 1. In this paper, I am going to consider the different characteristics of both players and analyze them in separate games. Whether the West is aggressive or approachable differs in terms of its priorities. An aggressive West



prefers military aid in response to the invasion of Russia; yet an approachable West tries to avoid direct military action against Russia, as it may lead to disastrous ramifications, like World War III. On the other hand, a militant Russia may prioritize invasion with destabilization, and otherwise is the insecure type.

## **7. The Approachable West vs. Militant Russia (Scenario 1)**

In scenario 1, we assume the West is approachable and Russia is Militant. The approachable West chooses imposing sanctions (SN) over both military aid (MA) and business as usual (BU) when Russia's strategy is either DS or IN. Additionally, militant Russia prioritizes IN over DS.

### **7.1 The Approachable West's Payoffs**

For the approachable West, preference rankings are as follows:

**BU-LG > SN-DS > BU-DS > SN-IN > SN-LG > BU-IN > MA-IN > MA-DS > MA-LG**

By looking at the West's preferences, when Russia's action is fixed on LG, business as usual is its top priority since Ukraine can join NATO freely without any cost. Imposing sanctions (SN), and military aid (MA) are the second and third options for the West respectively. For the approachable West confronting Putin with military force in Ukraine brings chaos in the world and may lead to World War III, therefore, President Biden would want to avoid MA at any cost, that's why even if Russia invades Ukraine the approachable West still prefers to do nothing in return instead of choosing MA. Accordingly, when Russia tries to force Ukraine to give up its independence by invasion or destabilization, the West's preferences are **SN > BU > MA**.

By fixing the West's action on **BU**, if Russia chooses **LG**, it is preferred by the West against **DS** and **IN** respectively. That's because business as usual brings no cost for the West, and destabilization is also less expensive compared to sending military forces to Ukraine. On the contrary, when the West's action is fixed on **SN**, **DS** is preferred to **IN** since again it is the less aggressive state. It is clear that **LG** has the lowest value for the West. The reason is that, by imposing sanctions against Russia, while Putin agreed to back down and let go of Ukraine completely, the West is practically declaring an aggressive manner against Russia and provoking it to change its move to **DS** or possibly **IN**. In other words, by choosing to impose sanctions against Russia, the West is putting Ukraine in more danger than before. The same scenario is true for the next ranking when the West's action is fixed on **MA**. That is to say; if the West is supposed to bring its troops to Ukraine's soil, it is logical to do it for the better cause which is in response to Russia's direct assault. The same reasoning also goes for **LG** here as well.

For the approachable West, it seems that **BU-LG** is the best possible outcome that could happen since Ukraine can easily join NATO without Russia's hostile response. The second-best possible outcome for the West is **SN-DS**. As **MA** is the last preferred action for the West, **MA-LG**, **MA-DS**, and **MA-IN** are the worst outcomes respectively. In scenario 1 for the approachable West, we assume:

**BU-DS > SN-IN**

**SN-LG > BU-IN**

**SN-LG > BU-DS**

In these assumptions, **IN** is the least preferred action for the approachable West. Also, it is better for Ukrainian as well since Russia's direct assault has lower payoffs. It is good to mention that in this paper the West's payoffs are correlated to Ukraine's avail.

## 7.2 Militant Russia's payoffs

Among the 9 possible outcomes of this game, Russia's preference rankings are as follows:

**BU-IN > SN-IN > BU-DS > MA-IN > SN-DS > MA-DS > BU-LG > SN-LG > MA-LG**

By looking at the preference rankings, Russia prefers invasion over Destabilizing and Letting Go respectively, while the West chooses Business as usual. The reason is obvious. If Russia does nothing and lets go of Ukraine, Putin will lose one of his most important allies to the West which is the last thing he wants. Additionally, because getting Ukraine back at any cost is Russia's priority, therefore, invasion is preferred over Destabilizing, even though the cost of initiating war might be higher. The same preference is true for Russia when the West chooses to impose sanctions or even bring military forces into Ukraine. Accordingly, we may conclude that no matter the West's strategy, Russia will always choose the ordering **IN > DS > LG**. In other words, **IN** is a dominant strategy.

On the contrary, when Russia's actions are fixed, Putin prefers a more passive West, which does nothing against Russia's actions. Thus, the ranking of **BU > SN > MA** is preferred by Russia for the West's actions.

Amongst the possible states, **MA-LG** is the worst outcome for Russia. Not only the West brings its troops to Ukraine's aid, but also Russia steps back and does nothing in response. The second and third-worst possible states for Russia are **SN-LG** and **BU-LG** respectively. On the other hand, **BU-IN** is the first, and **SN-IN** is the second-highest preference for

Russia. At this point, I assume  $SN-IN > BU-DS$  and  $MA-IN > SN-DS$ . The ordering of such assumptions is based on the level of aggressiveness of Russia.

Now, in Table 5 we can see the first scenario of the complete game with each player's payoffs. Underlined payoffs are the best responses for the two players. For instance, if Russia chooses **LG**, the best response for the approachable West is to choose **BU**. The same logic is true for the rest of the underlined payoffs.

*Table 5 - Scenario 1: The approachable West vs. Militant Russia*

		Russia		
		LG	DS	IN
West	BU	<u>2</u> , 3	7, 7	4, <u>2</u>
	SN	5, 2	<u>8</u> , 5	<u>6</u> *, <u>8</u> *
	MA	1, 1	2, 4	3, <u>6</u>

As it is shown in Table 5, **BU-LG** and **BU-IN** are the best outcomes that could happen for the West and Russia respectively.

For the approachable West, **MA** is strictly dominated by both **SN** and **BU**, therefore we can eliminate it. On the other hand, for Russia, **LG** and **DS** are both strictly dominated by **IN**. So, we are left with only two states in which the West is going to choose **SN** over **BU**. Therefore, **SN-IN** is the unique pure strategy Nash Equilibrium.

Since the Nash Equilibrium is unique, by switching to best responses iteratively we arrive at this unique NE starting from any strategy profile. For instance, if we assume that the

West moves first and the initial state is at **BU-LG**, the West will pass and prefers **BU**, since moving to any other rows makes the West worse off ( $9 > 5 > 1$ ). Then, Russia would move the game to **BU-IN**, where  $9 > 7 > 3$ . After that, the West would prefer SN ( $6 > 4 > 3$ ) and Russia will pass. This means that we have reached the unique NE, **SN-IN**.

By definition, an outcome is Pareto efficient if there is no other outcome that makes at least one agent better off without leaving anyone worse off. In scenario 1 it is easy to see that the unique Nash Equilibrium is also Pareto efficient, since there are no other states in which Russia or the West could be better off without making the other player worse off.

### 8. The aggressive West (Scenario 2)

In scenario 2, we assume the West is aggressive compared to the last case. The aggressive West chooses military aid (**MA**) over imposing sanctions (**SN**) when Russia's strategy is either **DS** or **IN**.

The aggressive West's preferences are as follows:

$$\mathbf{BU-LG > SN-LG > MA-LG > MA-DS > MA-IN > SN-DS > SN-IN > BU-DS > BU-IN}$$

*Table 6 - Scenario 2: The Aggressive West vs. Militant Russia*

	<b>Russia</b>			
		<b>LG</b>	<b>DS</b>	<b>IN</b>
<b>West</b>	<b>BU</b>	<u>9</u> , 3	2, 7	1, <u>9</u>
	<b>SN</b>	8, 2	4, 5	3, <u>8</u>
	<b>MA</b>	7, 1	<u>6</u> , 4	<u>5*</u> , <u>6*</u>

Letting go of Ukraine by Russia is the best situation for the West. After that, **DS** and **IN** are preferred respectively ( $LG > DS > IN$ ).

When Russia's strategy is fixed on **DS**, the West prefers **MA** over **SN**, since military aid guarantees the freedom of Ukraine for the West compared to imposing sanctions, even though the cost of such a strategy is higher. Also, **BU** is a weaker action in this case. Finally, when Russia's action is fixed on **IN**, again **MA** is preferred to **SN** and to **BU** respectively for the same reason.

In Table 6, we can see the payoff matrix of these strategies by Russia and the West. Since neither player has the intention to let go of Ukraine completely, **BU** and **LG** are not the options when the other parties' strategy is to use Ukraine to their own benefit at any cost.

The best responses for both players to their opponent's actions have been underlined in Table 6. By removing **LG** and **DS** for Russia, as these are strictly dominated by **IN**, we are left with three outcomes only. The violent West chooses **MA** against Russia's invasion. The game ends in **MA-IN**, so it is the unique pure strategy Nash Equilibrium of this game.

## 9. What if Russia backs down?

### 9.1 Insecure Russia vs. The Approachable West (Scenario 3)

Let's assume the sanctions that the West imposes on Russia paralyze its economy to the effect that the former Soviet Union has no other choice but to back down. In this case, **DS** gains more value against **IN** ( $DS > IN > LG$ ). The new ordering of the payoffs is:

$BU-DS > SN-DS > MA-DS > BU-IN > SN-IN > MA-IN > BU-LG > SN-LG > MA-LG$

Consequently, after adjusting the payoffs based on this case, Table 7 shows scenario 3. Unlike the last scenarios, the unique pure strategy Nash Equilibrium is the **SN-DS** outcome. This state tells us that after Russia backs down, the approachable West also prefers to move its troops out of Ukraine and continue fighting with sanctions as the cost of staying on Ukraine's soil and providing military assistance is costly and not necessary anymore for the approachable West.

**Table 7 - Scenario 3: The Approachable West vs. Insecure Russia**

		Russia			
			LG	DS	IN
West					
	BU	9, 3	7, 2	4, 6	
	SN	5, 2	<u>8*</u> , <u>8*</u>	<u>6</u> , 5	
	MA	1, 1	2, <u>7</u>	3, 4	

### 9.2 Insecure Russia vs. The Aggressive West (Scenario 4)

Scenario 4 for insecure Russia vs. the aggressive West is shown in Table 8. Russia's payoffs are the same as in the last scenario, and instead the West's payoffs are adjusted based on its level of aggressiveness. In this case, the unique pure strategy Nash Equilibrium is **MA-DS**, where Russia prefers **DS** over **IN**, while the West keeps its military forces on Ukraine's soil to make sure the threat is completely gone, or at least until Ukraine becomes officially one of the members of NATO.

**Table 8 - Scenario 4: The Aggressive West vs. Insecure Russia**

		Russia		
West		LG	DS	IN
	BU	2, 3	2, 2	1, 6
	SN	8, 2	4, 8	3, 5
	MA	7, 1	6*, 7*	5, 4

### 10. Ukraine's role

The role of Ukraine in this model is somewhat controversial. In essence, Ukraine only has two choices: to resist Russia or give up joining NATO. As the actual situation in the world indicates with the new president, Zelensky, and also its determined people who showed real interest in joining NATO throughout history, it very much chooses to resist Russia, and turning back has less value. The second point is that militarily Ukraine does not have enough forces to confront Russia's troops. Therefore, it needs the aid of the West. Accordingly, the situation of the ongoing war is in the hands of two of the most powerful countries in the world. Due to this reason, considering Ukraine as the third player in this model is not important.

In Table 9 we illustrate the game between Ukraine and Russia, with the ordinal payoffs based on 6 possible outcomes. Ukraine's strategies are RE (resistance) and GA (giving up). Giving up for Ukraine in the middle of the war is to declare that under no circumstances this country is going to join NATO again and possibly they might have to change their



incumbent president and go under Russia's thumb once and for all. On the other hand, resistance means fighting back for its freedom. Let's assume **RE**  $\succ$  **GA** for Ukraine (similar to Ukraine's current position in the world). The strategies and ordering of preferences for Russia are the same as militant Russia. Militant Russia's payoffs are as follows:

**LG-GA**  $\succ$  **IN-RE**  $\succ$  **DS-RE**  $\succ$  **DS-GA**  $\succ$  **IN-GA**  $\succ$  **LG-RE**

Obviously, the best situation for Russia is that Ukraine gives up joining NATO and obeys Russia once and for all. Therefore, **LG-GA** has the highest payoff for Russia. On the contrary, **LG-RE** has the lowest value for Russia, as it would let Ukraine join NATO without doing anything in return. The reason that **IN-GA** and **DA-GA** have the second and third lowest payoffs for Russia respectively is that invading or destabilizing Ukraine, while it decides to give up joining NATO and does what Russia says, exacerbates Russia's political position in the world. Additionally, there is no need for the high cost of such strategies when Ukraine voluntarily accept Russia's terms. Accordingly, since Russia is militant, it prefers IN to DS such that **IN-RE**  $\succ$  **DS-RE**.

In Table 9, we can see the complete payoff matrix of the game between militant Russia and Ukraine.

**Table 9 - Militant Russia vs. Ukraine**

		<b>Ukraine</b>	
<b>Russia</b>		<b>RE</b>	<b>GA</b>
	<b>LG</b>	<b>1, <u>6</u></b>	<b><u>6</u>, 1</b>
	<b>DS</b>	<b>4, <u>5</u></b>	<b>3,3</b>
	<b>IN</b>	<b><u>5*</u>, <u>4*</u></b>	<b>2,2</b>

The unique pure strategy Nash Equilibrium is **IN-RE**, where Ukraine fights back for its freedom, while Russia invades Ukraine by sending military forces.

## **11. Conclusion**

In this paper I examine, with the help of game theory, Russia’s invasion of Ukraine, which started on February 24<sup>th</sup>, 2022. My analysis predicts that there are 4 possible solutions for the ongoing crisis in Ukraine right now in 2022, which are summarized in Table 10. In scenario 1, since the West is cautious enough to avoid confronting Russia on Ukraine’s soil, the Nash Equilibrium is SN-IN where SN is a strategy for the West to impose sanctions on Russia and IN is the invasion of Ukraine by Russia. In scenario 2, with the aggressive West, the Nash Equilibrium is MA-IN (MA is a strategy for the West to send military aid to Ukraine and IN is a strategy for Russia to invade Ukraine), where the West’s priority is to not let Russia take control of Ukraine as it did in 2014 when President Putin usurped Crimea. Scenarios 3 and 4 are concerned with a situation where the West’s sanctions hinder Russia’s economy and President Putin has no choice but to retreat. So, the game is between

an insecure Russia vs. an aggressive or approachable West respectively. In these cases, with the approachable West, the Nash equilibrium is SN-DS (DS is a strategy for Russia to destabilize Ukraine by imposing sanctions against it), where both countries would rather fight by imposing sanctions and avoid a military conflict. Finally, with an aggressive West, the Nash Equilibrium is MA-DS, where the West prefers to stay on Ukraine’s soil until their ally joins NATO officially, while an insecure Russia avoids directly invading Ukraine and fights back with destabilization.

**Table 10**

	<b>Militant Russia</b>	<b>Insecure Russia</b>
<b>The approachable West</b>	SN-IN	SN-DS
<b>The aggressive West</b>	MA-IN	MA-DS

In the last part of the paper, the role of Ukraine in the war is shown in a 3 x 2 payoff matrix. The equilibrium outcome is IN-RE, where Ukraine chooses to resist Russia’s invasion. Ukraine’s future fate mostly depends on the West’s reaction to Russia’s invasion, therefore MA-IN in scenario 2 is preferred by Ukraine to SN-IN in scenario 1. Since Ukraine has not been able to convince the West to send military aid, the role of Ukraine as the third player is not as significant as the roles of the other two major parties.

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