# Studying Economic Sanctions using the Graph Model for Conflict Resolution

by

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# AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

# Abstract

The methodology of the Graph Model for Conflict Resolution (GMCR) is improved to show how a Graph Model can account for strength of sanctions, to introduce a trigger option to simplify a model, and to connect a Graph Model with the concept of BATNA (Best Alternative to Negotiated Agreement). Two real life applications are provided to illustrate these advances: the OPEC (Organization of Petroleum Exporting Countries)/US Shale oil producers conflict, and the North-South Sudan oil pipeline dispute.

Sometimes disputants attempt to manipulate behavior by threatening sanctions. Clearly, the success of this threat depends on the strength of the sanctions. This type of conflict is represented in this thesis by two identical graphs with different preferences reflecting the strength of the sanction. Both of the real world conflicts examples are analyzed in this way.

The concept of a Conflict Trigger (CT) is introduced to simplify a Graph Model. If the CT is selected, the number of states in the model can be significantly reduced, thereby, simplifying the analysis. The North/South Sudan conflict illustrates the employment of a CT for reducing the complexity of the analysis.

BATNA is a widely utilized principle used in the analysis of negotiations. Because many negotiations can be captured in a Graph Model, it is reasonable to ask how BATNA is connected. The four steps of BATNA are compared to a typical Graph Model of a negotiation to identify similarities and differences. The use of BATNA's reservation value in combination with a Graph Model of a negotiation gives insight into when a negotiator would accept an offer. The application of BATNA in the North/South Sudan conflict demonstrates its value.

# Acknowledgements

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# Acronyms

| | |
|---|---|
| BATNA | Best Alternative to Negotiation Agreement |
| CPA | Comprehensive Peace Agreement |
| CSR | Corporate Social Responsibility |
| CT | Conflict Trigger" |
| DMs | Decision-Makers |
| DPRK | Democratic People's Republic of Korea |
| EU | European Union |
| GMCR | Graph Model for Conflict Resolution |
| GMR | General Metarational |
| IEA | International Energy Agency |
| IOCs | international oil companies |
| JEM | Justice and Equality Movement |
| NCP | National Congress Party |
| NPT | Non-Proliferation Treaty |
| OFID | OPEC Fund for International Development |
| OPEC | Organization of Petroleum Exporting Countries |
| R | Nash Stability |
| RV | Reservation Value |
| SAF | Sudanese Armed Forces |
| SEQ | Sequential Stability |
| SLM | Sudan Liberation Movement |
| SMR | Symmetric Metarational |

| | |
|---|---|
| SPLA | Sudan People's Liberation Army |
| SPLM/A | Sudan People's Liberation Movement/Army |
| SPLM-N | Sudan People's Liberation Movement-North |
| SS | South Sudan |
| SSDM/A | South Sudan Democratic Movement/Army |
| UNISFA | United Nations Interim Security Force for Abyei |
| US | United States |
| WMDs | weapons of mass destruction |

# Chapter 1
# Introduction

The main objective of this thesis is to study economic sanctions using GMCR. The strength of sanctions is a significant factor that can impact the outcome of a dispute. It is also a major component of a decision maker's preference ranking when a dispute or a negotiation is modeled within the Graph Model for Conflict Resolution (GMCR) (Kilgour et al., 1987; Fang et al., 1993; Fang et al., 2003a, 2003b; Kilgour and Hipel, 2005; Kilgour and Hipel, 2010; Kinsara, et al., 2015; Xu et al., 2018). It is hypothesized that a decision maker's preference ranking of states or scenarios which could occur in a dispute will change based on whether the financial sanction is tolerable or intolerable. To illustrate this, the model will have two identical graphs but with different preferences based on the strength of the financial sanction.

The preference ranking in GMCR requires a significant amount of research to accurately identify it. A decision maker may not have the time or the resources to identify the preferences in the model. The "conflict trigger" (CT) principle is introduced to aid in such a situation, as it can simplify the model by reducing its size. The CT model will break down the Graph Model into two areas: one in which the conflict is triggered, and another in which the conflict is expected to have little to no impact on the focal decision maker.

GMCR allows the user to predict a conflict outcome and understand what needs to be done in order to achieve a desired resolution. For example, inverse GMCR, a function within GMCR, allows a user to identify the preferences required for a dispute to be resolved in a particular state. However, it does not guide the user on how to obtain the required preferences. For this reason, the Best Alternative to Negotiated Agreement (BATNA) is introduced to aid the user in achieving the required preferences. BATNA's methodology overlaps with some of the steps of GMCR. One of the steps in BATNA is to identify a "reservation value," which can be used as a reference by a negotiator to know whether to

accept or reject an offer. This step can be used to identify an opponent's reservation value and alter the preference rankings to reach a desired equilibrium.

The effectiveness of economic sanctions is explored in the context of the conflict between OPEC and US Shale oil producers in 2014. The outcome was not what OPEC anticipated, perhaps because OPEC miscalculated the strength of its sanctions.

The North-South Sudan conflict over the pipeline fees resulted in an impasse. North Sudan demanded a fee of $32 per barrel, South Sudan refused and countered with 1$ per barrel. BATNA is used in this conflict to determine whether South Sudan should have accepted or rejected the offer.

Chapter 2 explains the methodologies used, including GMCR, inverse GMCR, BATNA, and CT. Chapter 3 investigates the OPEC-SHALE conflict over the oil market that led to the crash of oil prices in 2014. Specifically, it examines the impact of the strength of financial sanctions on the preference rankings of the decision makers. Chapter 4 studies the Sudan conflict and investigates whether the use of BATNA would have helped the decision makers (DM) reach a more desired equilibrium. Moreover, the CT principle can be used to simplify the model, and the results of the CT model are compared with the original non-simplified model to verify whether results in the CT model remain the same after simplification. Figure 1.1 shows the Thesis outline.

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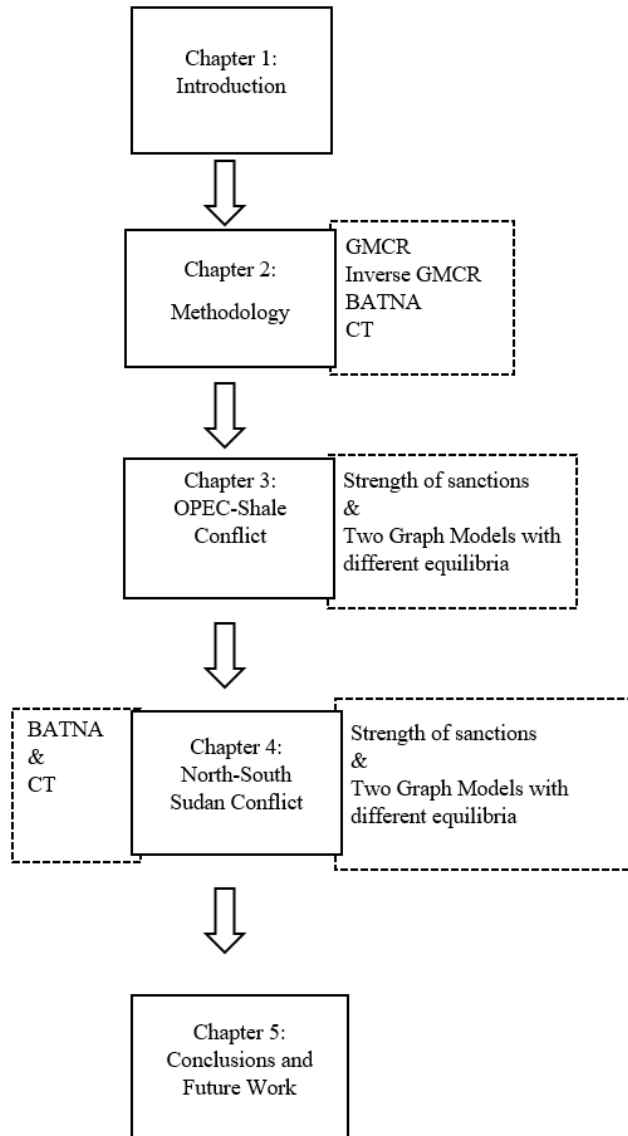
**Figure 1.1: Thesis outline**

# Chapter 2
# Methodology

In this chapter, the Graph Model for Conflict Resolution is explained, followed by Inverse GMCR, BATNA, and the concept of a Conflict Trigger (CT).

## 2.1 Graph Model for Conflict Resolution

Major disputes often arise as a result of conflicts of interest over economic relationships, distribution of resources, and/or political affiliations. Resolving conflicts requires stakeholders to compromise. Using the Graph Model for Conflict Resolution (GMCR), each of the options or actions provided by the Decision-Makers (DMs) is factored into the model. This entails using the strategic resolution modeling and analysis integrated within GMCR to envision the conflict and hopefully aid in resolving a real-world conflict.

## 2.1.1 Motivation for Using GMCR:

GMCR (Fang et al., 1993; Xu et al., 2018) is a method to model and analyze strategic conflicts. It enables the analyst to have a clear macro view of problems with multiple participants and multiple objectives. This results in a better understanding of a conflict's outcome, and more informed decision-making. GMCR is flexible enough to be applied in most disputes, and it does not demand as much information as other methods, making it more practical. GMCR also allows the DM or mediator to think outside of the box and explore all possible solutions. The user, with minimal input, can see all possible outcomes and can make slight changes to the model and track their possible effects on the dispute.

**2.1.2 The Model**

In GMCR, the DMs control the movement of a dispute from one state to another in order to improve their situation. A state is formed by a combination of the DMs' actions. GMCR consists of two main stages: modeling, and analysis, as shown in Figure 2.1.
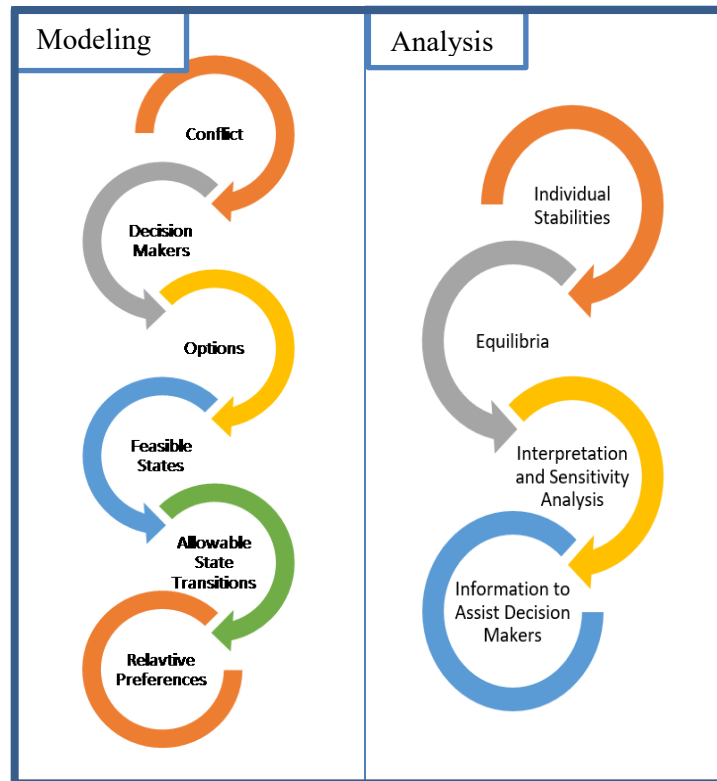


**Figure 2.1: Modeling and analysis phases**

Stage 1) Modeling: In this stage, the user will identify the conflict's parameters. The first step in the modeling stage, after choosing a conflict to be modeled, is identifying the decision-makers (DMs) who control the actions of each side in a dispute. A DM, in GMCR, has options or actions they can use in the dispute. The combinations of these options form a state or an outcome. For example, if DM1 has an option to escalate, and DM2 has an option to withdraw, one possible state will be DM1 using the option to escalate and DM2 choosing not to withdraw. Moreover, another possible state is if DM1 does not escalate and DM2 withdraws. The DMs' options and preferences will be displayed in table form,

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as shown in Table 2.1. The DMs are on the left side of the table, followed by the actions they are going to use in a dispute. A Y for "yes" indicates that the DM has exercised that option, while an N for "no" means that the DM did not use the option. A state is formed by combining the actions of each DM. For example, the first column to the right of the column "options" is a state. The bottom row in Table 2.1 shows the state number. For example, state number 2 is that state in which DM1 will Escalate (Y) and DM2 will not Withdraw (N), and so (YN) is a representation of State 2. Another example is State 3, in which DM1 will not Escalate (N), and DM2 will Withdraw (Y), and (NY) is a representation of State 3. In this example, there are 4 possible outcomes or states. The number of possible states in a conflict is equal to $2^x$, where x is the total number of options within the conflict. For example, a conflict with two DMs, with each DM having 2 options to execute, will result in a total of 4 options. As a result, the number of states or outcomes will be $2^4 = 16$ states. The next step is to remove the infeasible states, which are states that are logically not possible. For example, if a DM has an option to sign a peace treaty and another option to use military action, the state in which the DM uses both of these options is logically not possible because they cannot sign a treaty and attack at the same time. After removing the infeasible state, the user will study the transitions of the DMs between states. In some cases, the DM has irreversible options, meaning that once they use an option, they no longer can move back. Finally, in the modeling stage, the feasible states are identified and sorted from "most preferred" to "least preferred" for each DM.

**Table 2.1: Example of table form for DMs' options**

|  | Options | States | | | |
|---|---|---|---|---|---|
| DM1 | Escalate | Y | Y | N | N |
| DM2 | Withdraw | Y | N | Y | N |
|  | State Number | 1 | 2 | 3 | 4 |

Stage 2) Analysis: the possible resolutions to the conflict are determined. This stage includes:

1. Individual stable states for each DM

2. Overall equilibria

3. Follow-up analysis such as sensitivity analysis

**Figure 2.2: GMCR - Forward approach**

A state is said to be stable if the DM is not willing to move away from it. A state which is stable for every DM is called an equilibrium or possible resolution. To reach an equilibrium, the DMs can move from a current state to this equilibrium using unilateral moves. Usually, there is more than a single path that leads to the desired equilibrium. Stability Analysis is a comprehensive evaluation of every DM's readiness to consider a range of possibilities as solutions. GMCR is considered to be the forward approach, as seen in Figure 2.2. There are four main solution concepts to define how stability can take place in terms of moves and counter-moves:

1. Nash Stability (R): DMs have no unilateral moves to a more preferred state

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1. Nash Stability (R): DMs have no unilateral moves to a more preferred state

2. General Metarational (GMR): all of the focal DM's improvement moves can be blocked by a move from an opponent DM.

3. Sequential Stability (SEQ): all of the focal DM's improvement moves can be sanctioned by an opponent DM's unilateral improvement.

4. Symmetric Metarational (SMR): an opponent can sanction the focal DM's improvement, and the focal DM cannot escape to a more preferred state.

## 2.2 Inverse GMCR

Inverse GMCR (Kinsara et al., 2015a) can be very useful in negotiations. It allows the mediator to find the preferences that will make a particular state an equilibrium. This will enable a mediator to motivate the DMs to take specific actions within the conflict in order to reach their desired equilibrium. Inverse GMCR does not need the preference rankings to be defined for all DMs; its main requirements are as follows:

1. Decision-makers (DMs)

2. Options for each DM

3. Infeasible states

4. Allowable transitions

5. Desired equilibria for a given solution concept

Inverse GMCR makes it convenient for a mediator to envision how to influence a conflict and can be interpreted as a backward approach, as shown in Figure 2.3.
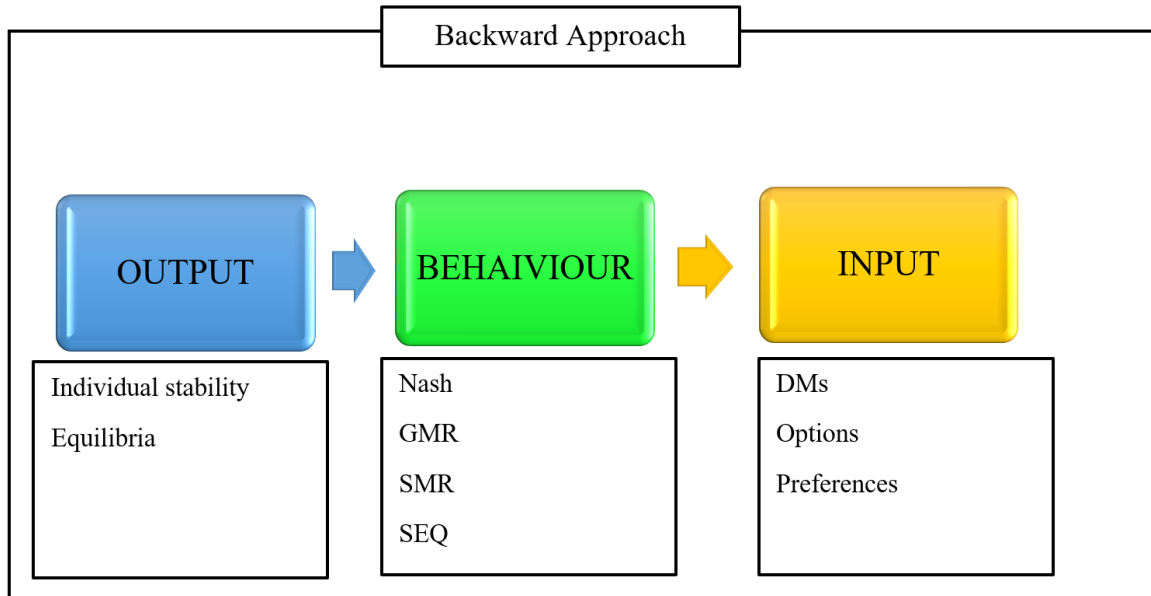
**Figure 2.3: GMCR - Backward approach**

In addition to inverse GMCR explained above, as well as the contributions given in this thesis, a range of other extensions to the GMCR methodology have been made. For example, preference uncertainty in GMCR has been modelled using unknown (Li et al., 2004,2005; Yu et al., 2016), fuzzy (Bashar et al., 2012, 2016), grey (Kuang et al., 2015a; 2015b), and probabilistic (Rego and dos santos, 2015) preferences. Strength or degree of preference was proposed by Hamouda et al. (2004, 2006) and generalized by Xu et al. (2009).

Psychological factors incorporated into the graph model framework include hypergame analysis (Wang et al., 1988, 1989; Aljefri et al., 2017, 2018), attitudes (Inohara et al., 2007; Walker et al., 2012a, 2012b), and emotions (Obidi et al., 2005, 2009a, 2009b). To handle cooperation, coalitional analysis algorithms were designed for employment within GMCR (Kilgour et al., 2001; Inohara and Hipel, 2008a, 2008b; and Zhu et al., 2018). Procedures were constructed to trace the evolution of a dispute over time from a specified starting state to a final designated outcome (Li et al., 2005; Xu et al., 2010). To model power in conflicts, the concept of a hierarchical structure within GMCR was built (He et al.,

2013, 2017). Finally, to improve the computational efficiency of GMCR, a matrix representation of GMCR was proposed (Xu et al., 2009).

**2.3 Best Alternative to Negotiated Agreement (BATNA)**

Larry Stevenson and Jim Shapiro were partners in a successful construction company. However, due to a difference of opinion, Stevenson wanted to buy out his partner Shapiro, who was willing to sell at the "right price." After months of bargaining, Stevenson offered $8.5 million to purchase Shapiro's portion. Shapiro was not willing to sell for less than $10 million because he owned 49% of the company, which had a total worth of $20 million. Shapiro chose to fight in court over accepting Stevenson's offer. Shapiro made a mistake by not accepting Stevenson's offer; this mistake could have been avoided if Shapiro used identified his Best Alternative to a Negotiated Agreement (BATNA). A BATNA is a backup plan to be used if an ongoing negotiation results in an impasse such as the case with Shapiro and Stevenson (Bazerman, 2012). A BATNA will aid a negotiator by providing a threshold which can be used to determine whether the offer should be accepted or rejected. A BATNA should be determined before the negotiation talks, as failing to do so may result in the rejection of a deal that should have been accepted or accepting one that should have been rejected. There are four steps to determine a BATNA in a given negotiation:

1. List the alternatives: this includes all the options available in the event that an ongoing negotiation ends in an impasse.

2. Evaluate the alternatives: by giving a value for each alternative.

3. Choose the BATNA: choose the alternative with the highest value.

4. Calculate the Reservation Value (RV): this is the highest valuation a buyer is willing to pay or the lowest valuation at which a seller is willing to sell. This point will be used to determine whether a negotiator should accept or reject a deal.

In the Shapiro and Stevenson case, if Shapiro calculated had his BATNA, he would not have rejected the price offered by Stevenson. The lawsuit will cost around $500,000, with a 70% chance of success. However, if he loses the lawsuit, Shapiro will only receive $3 million. This is the formula that Shapiro should have used to determine his Reservation Value.

*Value if Shapiro wins   +   Value if Shapiro loses      -      Lawsuit cost = RV*

($10 M × 0.7)         +   ($3 M × 0.3) - $500,000      -      $500,000    = $ 7.4 M

Since Shapiro is the seller, he should accept any offer above $7.4 million, the RV. Stevenson's offer was 8 million, and so a mistake could have been avoided.

What should a DM do when a negotiation reaches a standstill? It is at this point that a BATNA can show the difference between experienced negotiators and amateur ones. In their 1991 book, *Getting to Yes: Negotiating Agreement Without Giving In*, Roger Fisher, William Ury, and Bruce Patton introduced the BATNA concept to help negotiators hone their skills (Fisher et al., 2011). Although BATNA is a professional term, even those without any idea of the term should think through any negotiation process they engage in. Knowing one's options in any negotiation gives one confidence about what to accept, what to ask for, and when to walk away. Although a BATNA may be considered an easy concept to grasp, it needs a strategy to succeed. Below are steps through which a negotiator can take their BATNA to the next level and gain advantage at the negotiation table:

1. *Translate your BATNA to the current deal:* This basically means that one should not assume that the deals being compared are similar word for word. One should strive to understand the details of each deal separately and then compare all the deals with a number of differentiating factors. In a BATNA, it is never a case of comparing 'apples to apples.' Were this the case, then a BATNA would be easy. Consider two examples: In the first example, imagine you are choosing between buying a rug at a bazaar or getting an identical one from a nearby stall for $100. In the back of your mind, you are sure that you only want to pay $100 for the rug, and in

theory, it would be easier to buy the rug from the stall. After all, the rugs are identical, and there would be no need to buy it for a higher price. In reality, however, options are rarely identical, and you should take time to think about the terms of each deal, or else you might pass up the better deal for a lesser one. In the second example, as the time to renew his home insurance approached, "Larry" conducted some market research to compare insurance prices. His insurer, "Acme," had been increasing rates at between 7-10% annually, and Larry was not sure whether he was getting the best deal in the market. Through his market research, he found an insurer who was offering a policy at 30% less than Acme (his current carrier. Larry was happy, but before making the decision to switch providers, he sought some policy guidance and interpretation from Acme. After going through the details of both policies, he realized that the deal from Acme was actually better than the new one he had found. Had Larry made a decision just on the face value of the two policies, he would have abandoned a better deal for a lesser one. To ensure that you pick the best option, it is therefore wise to consider each deal word by word and understand what each offers. Through such a process, you stand to make the best decision.

2. *Assess BATNAs with care:* Besides seeking to understand one's own BATNA, a negotiator should also seek to understand the BATNA of other party. Although it is difficult to assess the other party's BATNA, asking oneself what the other party would do without a deal gives insights into what options they have. For example, consider the case of a Mississippi farmer who had to make a decision on whether to sell his farm along the Mississippi River when the state allowed riverboat gambling. The farmland would be lucrative for restaurants and hotels that would complement the gambling. The farmer was thus sure that people would approach him to buy the land, and in no time, an entrepreneur who wanted to buy and develop the land approached the farmer. Following the first strategy, of taking one's BATNA to the next level,

the farmer approached a Professor of Agriculture to help him estimate the value of the farm. The land was valued at $3 million. With this information, the farmer then approached the negotiation table with a figure he would be willing to accept if offered. He, however, let the entrepreneur make the first offer. The buyer offered $7 million. Though this offer excited the farmer, who was only expecting a mere $3 million, he made a counteroffer of $9.5 million. Finally, they settled at $8.5 million. On face value, and looking at the farmer's BATNA, this appears to be a successful negotiation, but what difference would it have made had the farmer considered the buyer's BATNA, and what difference would it have made if the farmer had also consulted an expert on gambling? He would have known how much benefit the buyer would get from buying the farm and then factor it in during the negotiations. This could have raised the value of his BATNA beyond the $8.5 million.

3. *Think through two-level BATNAs:* At the negotiation table, it is highly likely that you are facing both the individual across the table and in the background also dealing with the organization that they represent. Skilled negotiators often think about the two parties and deal with them accordingly in the process of pursuing their BATNA. As an example, a certain vacation facility wanted some equipment installed on their premises, and the manufacturer sent a representative to negotiate with the vacation facility. "Frank" had been newly hired, and he was the one sent to negotiate the contract for the manufacturer. The result of the negotiations was successful for both sides. A few years after this successful negotiation, the manufacturer decided to hold its annual meeting at the facility to showcase their success story. The two organizations decided to review their modes of negotiation, and Frank revealed his BATNA. He explained that his BATNA was to look for another job just in case he did not seal the deal. As a result, Frank had to consider the incentives that the individuals in the company enjoyed, i.e., their compensation, the length of time they had worked for the company, and their long-term aspirations. Through

analyzing the individuals in addition to the organization they represent, you will gain a better understanding of their walk-away alternatives.

**Track BATNAs in Multiparty Negotiations.**

Negotiations between two parties can be easy. This is, however, not always the case. Often one has to negotiate with multiple parties, which makes tracking each BATNA a difficult task. Consider, for example, departmental heads meeting to negotiate on how to share scarce resources, or a family discussing the future of their business, or a number of consumers debating a lawsuit. According to Professor Lawrence Susskind of the Massachusetts Institute of Technology and Professor Robert Mnookin of Harvard Law School, multi-party negotiations are difficult to handle due to the fluctuating nature of each party's BATNA (Bazerman, 2012). Despite this, however, one should have a clear BATNA and know one's walk-away point. As an example, "Mark," who is unemployed, approaches his siblings to discuss their family business, which is marginally profitable. Mark prefers to start a consulting firm from the proceeds he gets after dissolving the firm. Mark's BATNA is to move to a different city where a colleague has offered him a job if the deal does not favour him. Mark expects that Leah, his sister, would ask for a huge share to accept a sale because she has been involved in the business. She would ask for 50%, though she would accept 40%, her BATNA.

In a multi-party negotiation, though it may be difficult or even impossible to determine each party's BATNA, one should try to understand how each party would try to align themselves. During the negotiations, each party's BATNA may fluctuate. In the above case, for example, if Mark succeeds in persuading his other siblings, Jaclyn and Tom, that the business should be sold, Leah would be defeated. In the spirit of staying together as a family, however, they decide to divide the proceeds in a manner that satisfies them all.

In a multi-party negotiation, a payoff matrix helps to keep track of the fluctuating BATNAs and preferences of each party. This matrix is a spreadsheet that has the parties arranged in rows, while the

columns contain the issues of discussion, and the resulting boxes contain the priorities of each party involved.

**Anticipate Hidden Hazards of BATNA Research.**

Question: Recently, I was engaged in negotiations with a company that supplied us goods. Following what I had learned from books and school, I started exploring options with other suppliers just in case the negotiations were not fruitful. I invested time and money in creating the options but was not interested in pursuing them in the end. Did I make a mistake by carrying out the research?

Professor Francesca Gino argued that it is wise for negotiators to invest in strengthening their BATNA and also their fall-back alternatives. Investing in outside options gives one power and opportunities to fall to in case the current deal fails (Bazerman, 2012). Creating these outside options involves sunk costs. In your case, conducting the research and creating options may enhance your chances at the negotiating table. That notwithstanding, the external investment may have consequences. First, knowing that your investment involved irreversible costs may affect your behavior at the negotiation table. It may make you feel entitled (Bazerman, 2012). Second, one may feel wasted and hence be overly optimistic to an extent of exploiting the other party. You may be tempted to cheat or be aggressive during the negotiation which damages your relationship with the other party. As you negotiate in your case, therefore, you need to consider the effect your outside options may have on you. Be keen on your ethical behavior during the negotiation and proceed in good faith. At the very end, you will emerge a winner and overcome the effect of your sunk costs.

## 2.4 Conflict Trigger

For a model in option form, a triggering move is an exercising option that will force the opponent to respond. The Graph Model will be divided into two areas: one before the trigger and one after the trigger. The idea is to analyze the conflict only after the triggering option is exercised to make the game simpler. The need to simplify a model is due to the extensive amount of work required to generate the

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preference ranking in GMCR. A user may not have the time or the resources to identify the preference rankings in real time. To illustrate this, CT will be applied to the Cuban Missile Crisis in 1962. The United States had two options: an air strike and a blockade. The USSR also had two options: withdraw and escalate. A user will have to quantify the cost of each of these options and the cost of the combination of these options in real time to identify the preference ranking. For example, a user will need to know:

1)      What kind of blockade can the US use?

2)      How much will this harm the USSR?

3)      What is the impact of the blockade on the country, business, relations, and citizens?

4)      How strong is the air strike?

5)      What are the possible targets of the air strikes?

The above list is only a sample of the questions that need to be answered to identify a preference. The CT will reduce the number of states in the model, which would in turn reduce the amount of work required to obtain the preference ranking set.

2.4.1 Identifying a Conflict Trigger

The requirements for an option to be a conflict trigger:

1)      It is the first option to be used in a conflict.

2)      It will trigger a response from an opponent.

3)      If the option is not used, the dispute will not move from the status quo (NNNN).

Once the CT is identified, the states in which the CT option is not used should be removed. In theory, this application may reduce the size of the model by 50%.

# Chapter 3
# OPEC-SHALE CONFLICT

## 3.1 Introduction

Economic sanctions are an essential foreign policy tool of Western countries that involve the withdrawal of customary trade and financial relations in order to alter strategic decisions that threaten the sanctioner's interests. An important conflict in which sanctions were utilized was the recent dispute between the Organization of Petroleum Exporting Countries (OPEC) and shale oil producers in the US. In an attempt to strengthen the dominance of its petroleum market, OPEC flooded the market with oil in order to decrease the price and thereby put pressure on shale oil producers. Because the major shale oil producers were not seriously harmed, the question arises as to why the OPEC sanctions did not work satisfactorily. Accordingly, the first objective of this research is to carry out a formal strategic analysis of this event using the Graph Model for Conflict Resolution (GMCR) to understand what actually happened. The second objective is to investigate the impact of the strength of the sanctions on the preference rankings of the Graph Model. In the following sections, the impact of the economic sanctions levied by OPEC on US shale oil producers is assessed. After a description of the historical background to this dispute, the OPEC-Shale conflict is formally modeled and analyzed. Conclusions are given in the final section.

## 3.2 Background

### 3.2.1 OPEC

The Organization of Petroleum Exporting Countries (OPEC) is an intergovernmental organization that aims to coordinate the policies of its members primarily to ensure consistent revenue and a regular supply in the oil market. OPEC is currently made up of fifteen sovereign countries: Saudi Arabia, Kuwait, United Arab Emirates, Iraq, Algeria, Angola, Ecuador, Gabon, Iran, Libya, Nigeria, Qatar,

Congo, Venezuela, and Equatorial Guinea (OPEC, 2018a). In 1949, Venezuela approached four oil-producing countries, namely Saudi Arabia, Kuwait, Iraq, and Iran, and suggested that they explore options to cooperate on oil-related strategies (OPEC, 2010). This initiative by Venezuela was in response to the practices and activities of seven large international oil companies (IOCs) known as the "Seven Sisters". The Seven Sisters cartel was established in 1928 and included Exxon, British Petroleum, Shell, Gulf, Texaco, Chevron, and Mobil (Stevens, 2016).

The main catalyst leading to the formation of OPEC came in 1959, after the IOCs' decision to reduce oil prices without seeking permission from the oil-producing countries. In response, the First Arab Petroleum Congress was organized in Cairo, Egypt, to discuss steps to prevent the loss of oil revenues, which were and still are considered a key economic driver. At the end of the meeting, it was agreed that the IOCs should consult the oil-producing countries before changing the posted oil prices. However, the adopted resolution had no "teeth" and the IOCs did not cooperate, and they unilaterally decreased the price again in August 1960. In response, the largest oil-producing nations, Iraq, Kuwait, Saudi Arabia, Iran, and Venezuela, held another meeting from September 10th to 14th 1960 in Baghdad, the capital of Iraq, at which they founded OPEC. The countries' representatives at the time are listed in Table 3.1.

**Table 3.1: 1960 OPEC meeting representatives**

| Country | representative |
|---|---|
| Venezuela | Dr. Juan Pablo |
| Kuwait | Ahmed Sayed Omar |
| Iran | Fuad Rouhani |
| Saudi Arabia | Abdullah Al-Tairki |
| Iraq | Dr Tala'at Al-Shaibani |

OPEC, which established a permanent intergovernmental organization headquartered in Geneva, Switzerland, perceived an urgent need to protect its members' most important non-renewable source of revenue. In 1965, the OPEC Secretariat relocated to Vienna, Austria after signing an agreement of cooperation with the Austrian Government (OPEC, 2010). As OPEC became fully operational, it evolved into an organization with a significant influence on global oil markets.

**OPEC Membership**

OPEC membership has three classes: Full Members, Founders, and Associate Members. The founders are the five nations, Iraq, Kuwait, Saudi Arabia, Iran, and Venezuela, that met at the Baghdad Conference in 1960 and signed the initial document formally establishing OPEC (OPEC, 2010). Full Members include the founders and those countries that were accepted at the Ministerial Conference. Associate Members include countries that do not meet the criteria to be considered as Full Members, but which are admissible under special conditions. Over the years, various countries have applied to be either Full Members or Associate Members based on their qualifications as listed in the OPEC Membership Charter, and countries have both joined and left OPEC. For example, Ecuador joined in 1973, left in 1992, and reapplied successfully in 2007. Indonesia became a member in 1962, and in 2009 withdrew its membership (OPEC, 2018).

Membership in OPEC is open for oil-exporting countries that share the principles of OPEC. For a country to become a Full Member, it must submit a formal application that must be approved by at least three-fourths of the Full Members (OPEC, 2018). A non-exporting oil-producing country cannot become a Full Member; although such a country can be admitted as an Associate Member, it cannot participate in voting. When making decisions, Full Members have an equal voice regardless of the amount of oil their country produces. Since its establishment, OPEC has experienced times of low and high oil prices. As mentioned earlier, the objective of OPEC is to coordinate oil policies among its member states. When demand for oil increases and the supply is low, OPEC triggers an increase in

production to ensure that the market is well supplied. Also, in the event that the demand becomes lower than the supply, OPEC slows production to maintain a desirable price. The decisions OPEC has made at critical times have proved and demonstrated its ability to maintain a well-supplied oil market during times of unexpected events such as natural disasters and war.

OPEC has maintained an active communication and cooperation culture with stakeholders in the oil industry in order to ensure the stability of the market and to discuss embracing Corporate Social Responsibility (CSR) in all practices related to the production and distribution of petroleum products. It holds regular meetings with large non-OPEC oil producers like Russia and leading oil consumers such as the United States (US) and the European Union (EU). Also, OPEC holds important meetings with the International Energy Agency (IEA) (Sieminski, 2014). OPEC has maintained a culture of giving back to the community, especially with regard to developing nations. It achieves this objective through the OPEC Fund for International Development (OFID). Through OFID, OPEC supports economic development in developing countries by helping to finance development projects at substantially low interest. Moreover, individual OPEC member countries have established National Funds through which they make donations to developing countries via bilateral or multilateral agreements (Sieminski, 2014).

### 3.2.2 Shale oil

In recent years, shale oil production has increased substantially in the United States. This has come as a result of a sharp increase in oil prices since the 1970s. Due to this, the oil industry has come up with horizontal drilling techniques and hydraulic fracturing, which have led to the exploitation of vast volumes of shale oil at an affordable cost. Manescu and Nuno (2015) noted that in 2013, the United States produced 3.5 million barrels per day (mb/d) of shale oil, a threefold increase from 2010 production (Mănescu et al., 2015). Analysts have noted that by 2020, the United States will be producing 4.8 mb/d. The Organization of Petroleum Exporting Countries has controlled global oil

prices by holding onto their oil reserves, leading to high oil prices (Mănescu et al., 2015); however, the exploitation of shale oil has reduced dependence on crude oil. Furthermore, crude oil reserves are being depleted at a fast rate, and hence shale oil will play a critical role in meeting future energy demands in the United States and in the world overall.

Shale oil in the United States is a relatively recent development. It is important to note that crude oil production has been declining in the United States since the remaining reserves are located deeper in the ground and in rock formations that are difficult to drill into. Hence, shale oil production will increase and peak at 4.8 mb/d by the year 2020. On the other hand, shale oil is a nonrenewable energy source, and increasing production will lead to a decline in reserves. Due to this, shale oil production is expected to decline to 3.2mb/ day by 2040.

The rise of the United States shale oil sector has enabled non-OPEC countries to influence the global oil market. From 2009 to 2012, the United States oil supply increased at a yearly rate of approximately 6.7%. In essence, US shale oil production contributed to 2.5% of the global oil supply. In 2014, the Annual Energy Outlook report from the Energy Information Administration (EIA) noted that shale oil production increased by approximately 3.5% from 2012 to 2014 (EIA, 2014). One of the major factors that has led to increased shale oil exploration in the United States is high crude oil prices, and many oil companies have started to look for shale oil since they have efficient horizontal drilling techniques.

The United States is the leading shale oil producer in the world. The first shale oil production technologies in the United States were developed in the early 19th century, but these methods were expensive. The United States government offered incentives such as private ownership rights and easy access to global market funding to landowners and companies that wanted to engage in shale oil production (Alquist et al., 2014). Furthermore, the federal government offered tax incentives that allowed companies to make a profit when they engaged in shale oil exploration and production. Consequently, the United States has modern drilling rigs, pipelines, and refineries that produce high-

quality shale oil that is accepted in the global oil market. These factors have played a critical role in cementing the United States as the world's leading producer and exporter of shale oil. Countries with proven shale oil reserves include Russia, China, and Argentina. Despite having shale resources, however, many countries still lag behind since they do not have efficient drilling methods that can produce high-quality shale oil. As a result, most companies have not started to drill wells in those 3 countries despite the fact that these countries have approximately 46% of the world's proven shale oil resources. This is due to inefficient drilling methods and insufficient infrastructure such as modern drilling rigs and extensive pipeline networks (Mănescu et al., 2015).

The shale oil revolution has reduced the dependence of the United States on crude oil imports. This has helped to make the United States self-sufficient. The International Energy Agency predicts that the United States' crude oil imports will fall from 9.5mb/d in 2011 to 3.4mb/d in 2035 (IEA, 2012). The United States is one of the largest importers of crude oil in the world, and the shale oil revolution will reduce the amount of oil the United States imports, hence reducing demand. This will reduce global oil prices. The shale oil revolution has led to improvements and the building of new pipelines and railway lines to transport the oil, and refineries have also been improved to use new technologies that are highly efficient. In the global oil markets, the increase in the shale oil supply in the United States led to stability in Brent oil prices between 2011 and 2014. During this period, geopolitical tensions due to the Arab Spring led to lower oil supplies from Iran and Libya (Mănescu et al., 2015). Despite this, Brent crude oil prices remained relatively stable. The largest exporter of crude oil in the world is Saudi Arabia, and this plays a significant role in controlling the global crude oil market since the country can control supply and demand. The emergence of shale oil as a replacement for crude oil, however, has significant ramifications for the global influence of Saudi Arabia and OPEC. Over the last five decades, OPEC and Saudi Arabia have played a critical role in determining the supply of and demand for oil by creating

disruptions that increase oil prices, allowing them to profit, and thus the dominant oil suppliers have had the ability to influence importers by increasing or reducing the oil supply (Nakov et al., 2014).

This affects the production of goods in oil-importing regions and can lead to inflation in the long term, since industries have to buy oil at high prices, hence negatively affecting their profitability. The shale oil revolution has also affected Saudi Arabia's crude oil stockpiles. Additionally, the reduction in imports from oil exporters due to low demand affects the GDPs and economies of countries such as Saudi Arabia, since they depend on oil exports. Therefore, low energy prices may have an effect on the consumption and living standards of consumers in these countries. The main beneficiary of the shale oil boom is the United States, since it has the highest production and most efficient production methods. Moreover, countries that import oil will benefit from shale oil since it will reduce global market prices, which will help to increase the economic and GDP growth of these countries (Mănescu et al., 2015).

Cheaper oil will also help industries meet their transportation needs. On the other hand, oil-exporting countries will experience a drop in revenues. This will reduce their sovereign wealth funds and lead to short-term interest rates for these funds. This may lead to panic in the financial markets of oil-exporting countries, leading to inflation and high interest rates, which will in turn negatively affect the economic growth of those countries. Shale oil production in the United States will have significant effects on global oil markets. In this regard, the effects will depend on the amount of shale oil produced and the response of Saudi Arabia in its attempt to maintain stable prices to maximize the country's profit. Due to this, Saudi Arabia will work with the United States with the aim of sustaining oil prices and maintaining its place as the dominant player in the global crude oil market.

### 3.2.3 Financial Sanctions

Economic sanctions are an essential foreign policy tool of Western countries and involve the withdrawal of customary trade and financial relations in order to alter strategic decisions that threaten the sanctioner's interests. Economic sanctions are often used when diplomacy fails, and are viewed as

a low-cost, low-risk course of action compared to aggressive measures such as warfare. In 1990, economic sanctions were imposed on Somalia, Liberia, and the former Yugoslavia (SCR, 2013) in an attempt to force desirable behavior from the viewpoint of the sanctioning nation. They have grown to be popular and have demonstrated their effectiveness in various situations. Sanctions can come in the form of capital restraints, import and export restrictions, arms embargoes, and travel bans. The United States has used economic sanctions more than any other country, an example of which was the financial sanctions on countries and organizations supporting terrorists after the 9/11 attacks in 2001. President George W. Bush signed Executive Order 13224 on September 23, 2001 (State, 2001) to freeze the assets of individuals and entities suspected of supporting terrorism, and moreover, he gave the Treasury Department the authority to mark financial institutions as "primary money laundering concerns." Therefore, the Treasury Department, as long as there is a reasonable suspicion, can target entities without the need for evidence; these measures increase the risk for financial institutions engaged in suspicious activities. Violating the sanctions can lead to significant financial and reputational damage. In 2014, Bank BNP Paribas was found guilty of lending billions of dollars to blacklisted entities. The bank paid a fine of almost 9 billion dollars and lost the right to convert any currency into US dollars for a year  (Davlin, 2014).

**Historical Sanctions**

Voluntary sanctions were first introduced by the United Nations Security Council on the South African apartheid regime and Southern Rhodesia in 1963 (Davis, 2017). The wide range of sanctions which affected Rhodesia was a reaction to the unilateral declaration of independence from the white Minority Regime and the United Kingdom. The South Africa sanctions were a response to the apartheid regime, the pursuit of nuclear weapons, and its military aggression regionally. After the Cold War, sanctions were applied to Iraq for invading Kuwait in 1990 and for its weapons of mass destruction (WMDs) development programs in 1990 to 2003 (Dodge, 2010), and the former Yugoslavia breakup

in 1991 to 1996. Haiti was sanctioned during the 1993-1994 coup which led to the overthrow of President Jean-Bertrand Aristide (SCR, 2013). In the 1990s, the UN regimes most often targeted sanctions within the context of an intrastate conflict; some of the UN sanctions can be seen in Table 3.2.

**Table 3.2: The UN historical sanctions**

| Sanctioned Country | Date |
|---|---|
| Somalia | 1992 to present |
| Liberia | 1992 to 2001 |
| Yugoslavia | 1993 to 1996 |
| Angola | 1993 to 2002 |
| Rwanda | 1994 to 2008 |
| Sierre Leone | 1997 to 2010 |
| Kosovo | 1998 to 2010 |

**Sanction Objectives and Strategies**

The significant innovation of targeted sanctions by the UN Security Council was prompted by the perceived drawbacks of comprehensive sanctions in respect to the adverse lack of precision in targeting those who threatened international security and peace, and in respect to adverse humanitarian impacts. Though intrastate conflict resolution is the overall objective, there has been a trend toward using targeted sanctions for other objectives such as conflict resolution, nonproliferation, democratization, counter-terrorism, and civilian protection.

**Conflict Resolution**

Some current sanctions which can be categorized within the objectives of conflict resolution are: Somalia and Eritrea 1907, Taliban 1988 sanction regimes. Sanctioned regimes have been responding to intrastate rather than interstate conflicts (SCR, 2013). The council has three strategies to apply sanctions for conflict resolution: weakening the targets, reinforcing the implementation of peace

agreements, and/or facilitating settlement negotiation through inducing the targets to engage in mediation.

**Non-Proliferation**

Current United Nations sanctions concerning non-proliferation are the sanctions on the Democratic People's Republic of Korea (DPRK). The sanctions were initially imposed on the DPRK with the UN resolution of October 14th, 2006 in regard to the DPRK's October 9th, 2006 nuclear weapons testing (SCR, 2013). The five demands made were:

1) Ceasing of all missile launches and testing of ballistic nuclear missiles

2) Retracting the announcement to withdraw from the  Nuclear Weapons Non-Proliferation Treaty (NPT)

3) Return to the NPT along with International Atomic Energy Agency adherence such as inspection and monitoring

4) Provision of transparency measures beyond the safeguard agreement

5) Abandoning ballistic missile programs and any other existing weapons programs in an irreversible and verifiable manner

**Counter-Terrorism**

The first counter-terrorism UN sanctions were imposed on Libya from 1992 to 2003 in response to the Pan Am Flight 103 and UTA Flight 772 bombings in 1988 and 1989, respectively. Sudan was sanctioned from 1996 to 2001 for its alleged involvement in the attempted murder of Egyptian President Hosni Mubarak in 1995. Presently, only two counter-terrorism sanctions are in effect, against Al-Qaida and Lebanon. The development of the Al Qaida sanctions was in conjunction with the sanctions imposed on the Taliban, which were also territorially connected to Afghanistan (SCR, 2013). The major objective of sanctioning Al Qaida was to compel the Taliban's extradition of Osama Bin Laden. UN sanctions have evolved greatly, from comprehensive sanctions against states to targeted sanctions on

states and nonstate entities including individuals. There are five major types of UN targeted sanctions, which are: diplomatic, travel bans, asset freezes, commodity interdictions, and arms embargoes. However, diplomatic sanctions are no longer used by the UN (SCR, 2013). Table 3.3 shows the UN's application of targeted sanctions.

**Table 3.3: UN targeted sanctions**

| Application of Targeted UN Sanctions | | | | | | |
|---|---|---|---|---|---|---|
| Country | Sanction Number | Date | Travel Ban | Asset Freeze | Arms Embrago | Commodity Interdiction |
| Somalia | #751 | 1992 | * | * | * | * |
| Eritrea | #1907 | 2009 | * | * | * | * |
| Al-Qaida | #1267 | 2017 | * | * | * | |
| Iraq | #1518 | 2003 | | * | * | |
| Liberia | #1521 | 2003 | * | * | * | |
| DRC | #1533 | 2004 | * | * | * | |
| Cote d'Ivoire | #1572 | 2004 | * | * | * | * |
| Sudan | #1591 | 2005 | * | * | * | |
| Lebanon | #1636 | 2005 | * | * | | |
| DPRK | #1718 | 2006 | * | * | * | * |
| Iran | #1737 | 2006 | * | * | * | |
| Libya | #1970 | 2011 | * | * | * | |
| Taliban | #1988 | 2011 | * | * | * | |
| Guinea-Bissau | #2048 | 2012 | * | | | |

**3.2.4 OPEC-Shale Conflict**

In 2014, oil prices dropped due to a conflict between OPEC and US shale oil producers over oil market shares. As the world oil demand increased between 2010 and 2014, both OPEC and the shale oil producers aimed to increase their market shares. The oil price is affected by supply and demand: if

the supply of oil is lower than the demand, the price will increase, and if the supply is higher than the demand, the price will decrease. Saudi Arabia, the largest oil producer in OPEC, is the only nation that has a spare capacity of oil that can be utilized relatively quickly to balance the supply and demand. Figure 3.1 shows how the kingdom's changes in production directly impact the oil price. Note, for example, that when the price drops, Saudi oil production also decreases in an attempt to increase the price, which tends to be successful, and vice versa.

Since 2001, Saudi Arabia has generally been accommodating to global changes in oil production. In the 1$^{st}$ quarter of 2014, however, Saudi Arabia stopped adapting to the market, as depicted on the right in Figure 3.2. Figure 3.2 displays the world production (supply) and consumption (demand) from the first quarter of 2011 to the end of 2016, followed by a projection for 2017.
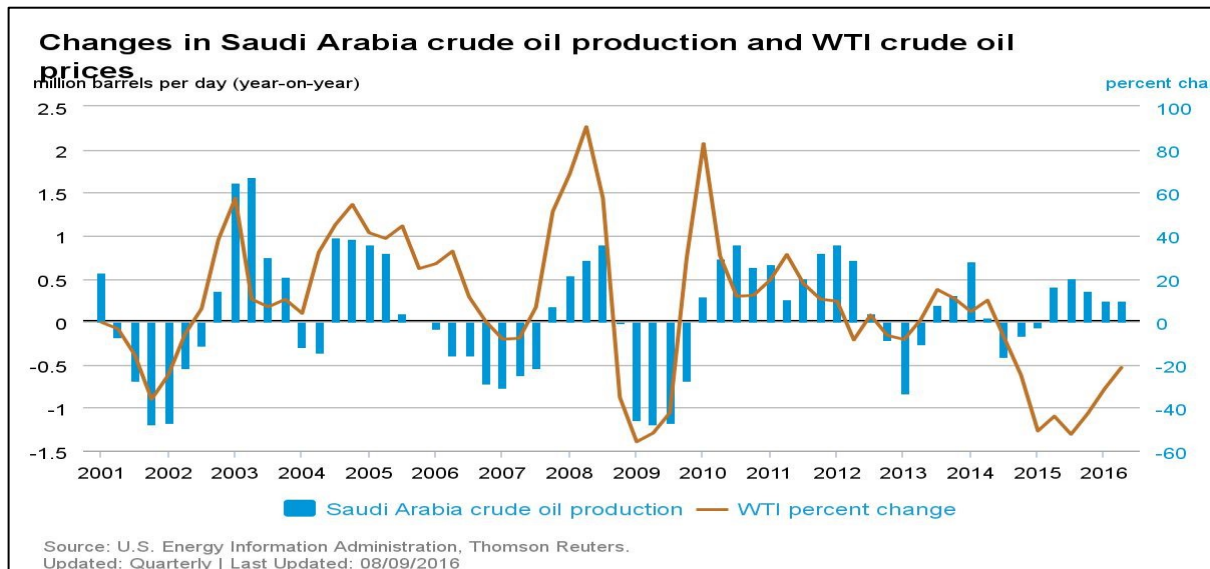


**Figure 3.1: Saudi Arabia's oil production and crude oil prices**
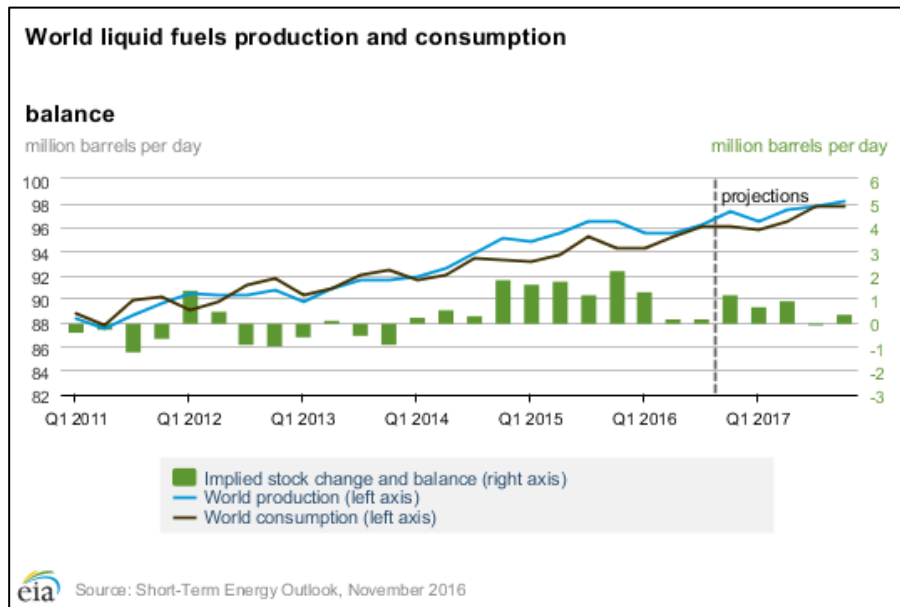
**Figure 3.2: World oil supply and demand**

Note that except for the first quarter (Q1) in 2012, world consumption was higher than production from the start of 2011 until Q1 2014, which is when OPEC started to increase its production. After that, production became higher than consumption, which resulted in a 70% drop in oil prices. The gap between the supply and demand was approximately 1.8 million barrel a day, which constituted an excess of about 2% in production (EIA, 2018). As the supply continued to rise, OPEC had to make a decision: it could either adjust its output at the cost of losing market share or increase its production and hope for the prices to drop to a point where shale producers are no longer profitable, which could destroy them.

**3.3 Modeling**

All parameters should be identified in order to model this conflict. The first quarter of 2014 is chosen as the point in time for building the model, as OPEC had to make a decision that would shape the outcomes of this conflict. The two DMs are OPEC and the shale oil producers and are referred to as OPEC and SHALE respectively. OPEC has two options: one is to "Accommodate" the market by

lowering its production and thereby give up market share; the other one is to "Squeeze" the market by increasing output, which would reduce oil prices, making it unprofitable for shale producers and thus deterring future competition. SHALE has one option: to cut supply and give up market share by choosing to "Accommodate." These options result in eight states that are listed in Table 3.4, in which each column of Y and N form a state. A "Y" means that the option is selected by the DM controlling it. In contrast, an "N" indicates that this option is not chosen. For example, (NNN) is a representation of State 1 in which the first two Ns from the left are OPEC's option selections, and the third N from the left is Shale's course of action. State 1 (NNN) indicates that OPEC did not Accommodate and did not Squeeze, and Shale did not Accommodate. State 7 (NYY) indicates that OPEC did not Accommodate and did Squeeze, and Shale Accommodated. States 4, 6, and 8, marked in red, are identified as infeasible states. State 4 and 8 are infeasible because OPEC cannot select both actions at the same time, and State 6 is infeasible since neither DM is willing to share the market.

**Table 3.4: Set of possible states**

| | | | | | infeasible | | infeasible | | infeasible |
|---|---|---|---|---|---|---|---|---|---|
| OPEC | 1 Accommodate | N | Y | N | Y | N | Y | N | Y |
| | 2 Squeeze | N | N | Y | Y | N | N | Y | Y |
| Shale | 3 Accommodate | N | N | N | N | Y | Y | Y | Y |
| | State # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

**OPEC's Preferences:** OPEC wants to maximize its market share and thereby destroy the shale producers. This will lead to OPEC preferring states in which SHALE "Accommodates" and OPEC chooses "Squeeze." OPEC believes it has the greater right to the oil market share. Mr. Al-Naimi, the Saudi Arabia Oil Minister, was quoted as saying "[The policy to defend market share] is also a defense of high efficiency producing countries, not only of market share. We want to tell the world that high

efficiency producing countries are the ones that deserve market share. That is the operative principle in all capitalist countries", and, "As a policy for OPEC, and I convinced OPEC of this, even Mr. Al-Badri (the OPEC Secretary General) is now convinced, it is not in the interest of OPEC producers to cut their production, whatever the price is" (Behar et al., 2016).

**SHALE's Preferences:** SHALE wants to maximize its market share as well, and as a result, the states having OPEC as accommodating are more preferred than other states. SHALE is aware that OPEC can sanction it by flooding the market with oil because countries with high oil reserves and low discount rates, such as Saudi Arabia, prefer lower prices (Eckbo, 1976). However, SHALE was not aware of the strength of OPEC's sanctions. SHALE focused on improving its efficiency in order to be able to withstand lower oil prices. If OPEC chooses "Squeeze," then the shale producers will have a negative cash flow or Burn Rate. Usually, investors look at a company's burn rate and compare it to future gains.Therefore, SHALE has two preference rankings for both scenarios, according to whether the burn rate was higher or lower than the future gains, which are called tolerable and intolerable burn rates, respectively. Table 3.5 shows the preferences for both DMs.

**Table 3.5: Preference ranking**

| | Preferences | | | | |
|---|---|---|---|---|---|
| | Most prefered | > | > | > | Least prefered |
| OPEC | 7 | 5 | 3 | 1 | 2 |
| Shale- tolerable burn rate | 2 | 1 | 3 | 7 | 5 |
| Shale- intolerable burn rate | 2 | 1 | 7 | 5 | 3 |

Figure 3.3 shows the allowable transitions between the states for each DM. Only SHALE can unilaterally move the conflict to State 5 or 7, which are considered desirable for OPEC, from States 1

or 3 respectively. This means that OPEC has to make sure that at least one of the State 1 or 3 is less preferred to SHALE than States 5 or 7 respectively.
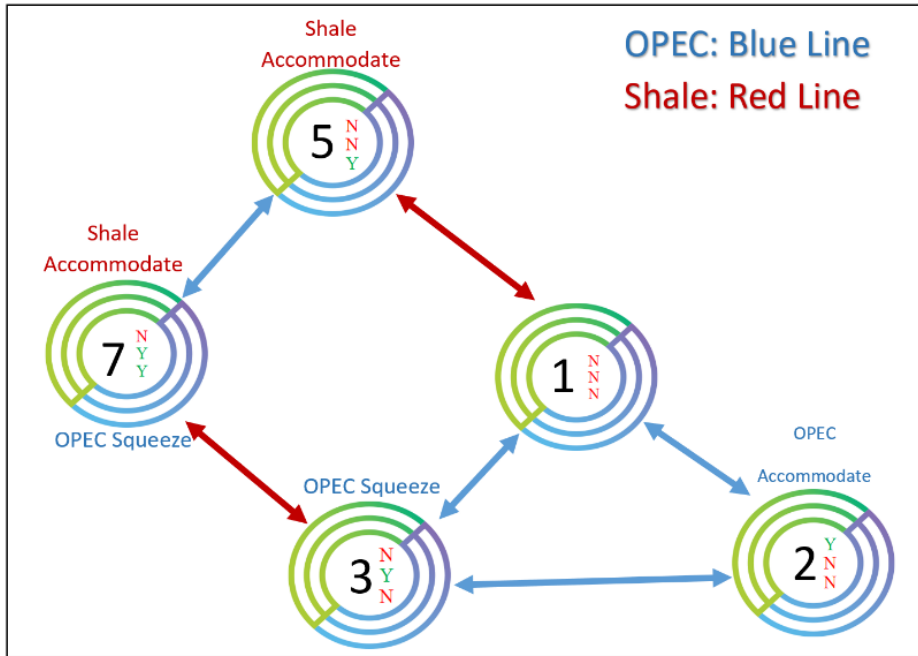


**Figure 3.3: Allowable transitions**

## 3.4 Analysis

In this section, a classical analysis is done first, then an inverse analysis can be done. The information gathered in the modeling phase is used as an input for the GMCR plus software (Kinsara et al., 2015b). Inverse GMCR, also embedded in the GMCR plus software, is used to identify the strength of the sanction Squeeze by determining which of the two preference rankings was chosen and therefore recognize whether the sanctions were tolerable or intolerable. In the real-world conflict, OPEC squeezed, and the oil prices crashed, but SHALE did not accommodate, which is State 3. At this point, inverse GMCR only requires choosing the end state, and it will generate the preference rankings that lead to the conflict ending in State 3. The bottom-left side of Figure 3.4 indicates that State 3 is selected

as the desired outcome, and the middle part of Figure 3.5 shows that State 3 (NYN) is an equilibrium. For this to be true, the preference rankings for OPEC and SHALE are given as:

OPEC: [7,5,3,1,2]    SHALE: [2,1,3,7,5]
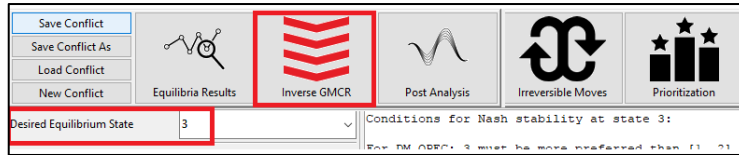


**Figure 3.4: GMCR + software - choosing desired equilibrium**



**Figure 3.5: GMCR + equilibria with tolerable Sanction**

SHALE's preference ranking matches the one with "Tolerable Burn Rate" given in Table 3.5. Figure 3.5 shows that the equilibria of the given preference rankings are Nash, GMR, SMR, and SEQ stable at State 3 (NYN). OPEC expected that by using the squeeze option, it would force SHALE to accommodate. Inverse GMCR is now used again to see the changes required in the preference ranking to have the conflict end in a more desirable state for OPEC. Desirable resolutions for OPEC are the states in which SHALE would accommodate, and those states are 5 and 7.

**State 5.** Inverse GMCR indicates that for the dispute to end in State 5 (NNY), then SHALE should prefer to accommodate over staying in State 1 (NNN). In State 1, neither DM accommodates, and the supply is slightly higher than the demand, which will result in a slight drop in the oil price. For SHALE to prefer State 5 over State 1, its cost of production should be very high, resulting in marginal or no profit in State 1. Realistically, OPEC cannot do much to influence the production costs of the shale industry, and therefore it is not possible for the conflict to end in State 5.

**State 7.** For the conflict to end in State 7 (NYY), SHALE must prefer to accommodate in response to the squeeze option by OPEC rather than staying in State 3 (NYN), in which OPEC would squeeze and the shale oil producers do not accommodate. This situation matches that of SHALE in which the sanction is intolerable. Unlike State 5, OPEC can influence the conflict to end in State 7. OPEC needs to increase the strength of the punishment to the point at which it is no longer bearable for SHALE. Figure 3.6 shows the equilibria under stronger punishment.
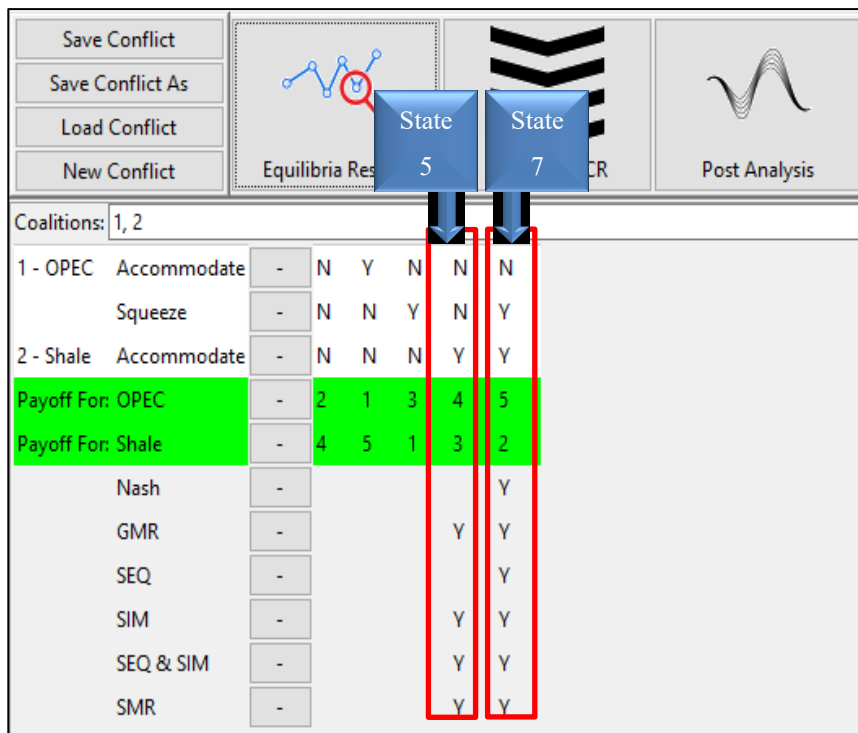


**Figure 3.6: GMCR + equilibria under intolerable sanctions**

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In Figure 3.7, the states are ranked from most-preferred on the left to least-preferred on the right for OPEC and SHALE at the top and bottom of the Figure 3.7 respectively. This preference information is also provided in Table 3.5 in a different format. Given this preference information, along with the knowledge of how a DM can unilaterally move to cause a conflict to change from one state to another, one can carry out a stability analysis. To ascertain, for example, if State 5 is GMR stable for OPEC, the following procedure is followed.

From State 5, OPEC has a unilateral improvement to State 7, which is more preferred than State 5. However, SHALE can unilaterally move the game from State 7 to State 3. Since State 3 is less preferred by OPEC than State 5, State 5 is GMR stable for OPEC. However, note that State 3 is less preferred than State 7 by SHALE. Hence, this possible sanction may not be feasible. This process of moves and counter moves when calculating GMR stability is displayed visually in Figure 3.8. State 7 is Nash-stable for both OPEC and SHALE, meaning that there is no unilateral improvement from State 7. For example, OPEC can unilaterally cause the conflict to move from State 7 to 5; however, because State 5 is less preferable than State 7 for OPEC, this is not a unilateral improvement, and therefore State 7 is Nash stable for OPEC. Because it is Nash-stable for both DMs, State 7 is considered a Nash equilibrium.
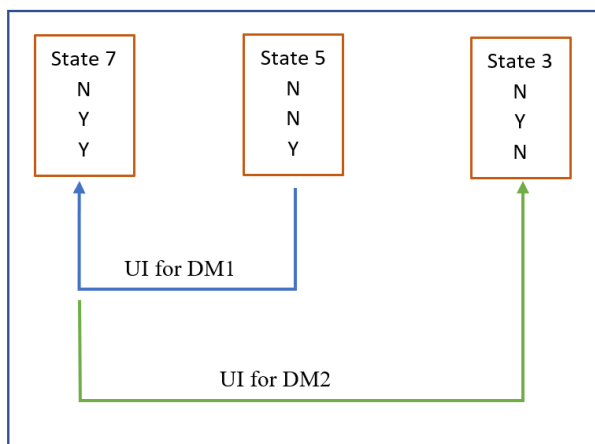


**Figure 3.8: Stability analysis for State 5 for DM1**

**Figure 3.7: Preference ranking in option form**

**3.5 Two Identical Graphs with Different Preferences**

If a DM has the option to financially sanction an opponent, the opponent usually cannot predict the severity of the sanction. Therefore, the sanctioned DM has different preferences based on its reservation point or whether it can or cannot tolerate the sanction. To model this situation, there will be two identical Graph Models with different preference rankings for the sanctioned DM, as seen in Figure 3.9 The graphs are identical because the options and moves are the same, and only the strength of the sanction is different. For example, in the OPEC-Shale conflict, the sanction "Squeeze" will remain the same in the two graphs; however, the strength of the sanction "Squeeze" is different. As a result, the equilibrium will be different for each graph.

**Choosing the Best Scenario**

The two-graph view enables the DM to envision the outcomes of both models and understand what is required to achieve a more desirable outcome. For example, OPEC will be aware that the conflict will end in either State 3 or State 7 based on the strength of their sanction "Squeeze." This allows OPEC to prioritize evaluating the option "Squeeze" more than "Accommodate" to end up with a more desirable outcome. They will also know what is at stake in case their opponent was able to tolerate their sanction.

**Figure 3.9: Two identical graphs with different preferences**

### 3.6 Summary

International conflicts are tough to predict, and often a mediator cannot quickly identify the most impactful action to alter an opponent's preferences. Added to this, it is often not possible to promptly and accurately calculate the effect of a sanction on a given entity, maki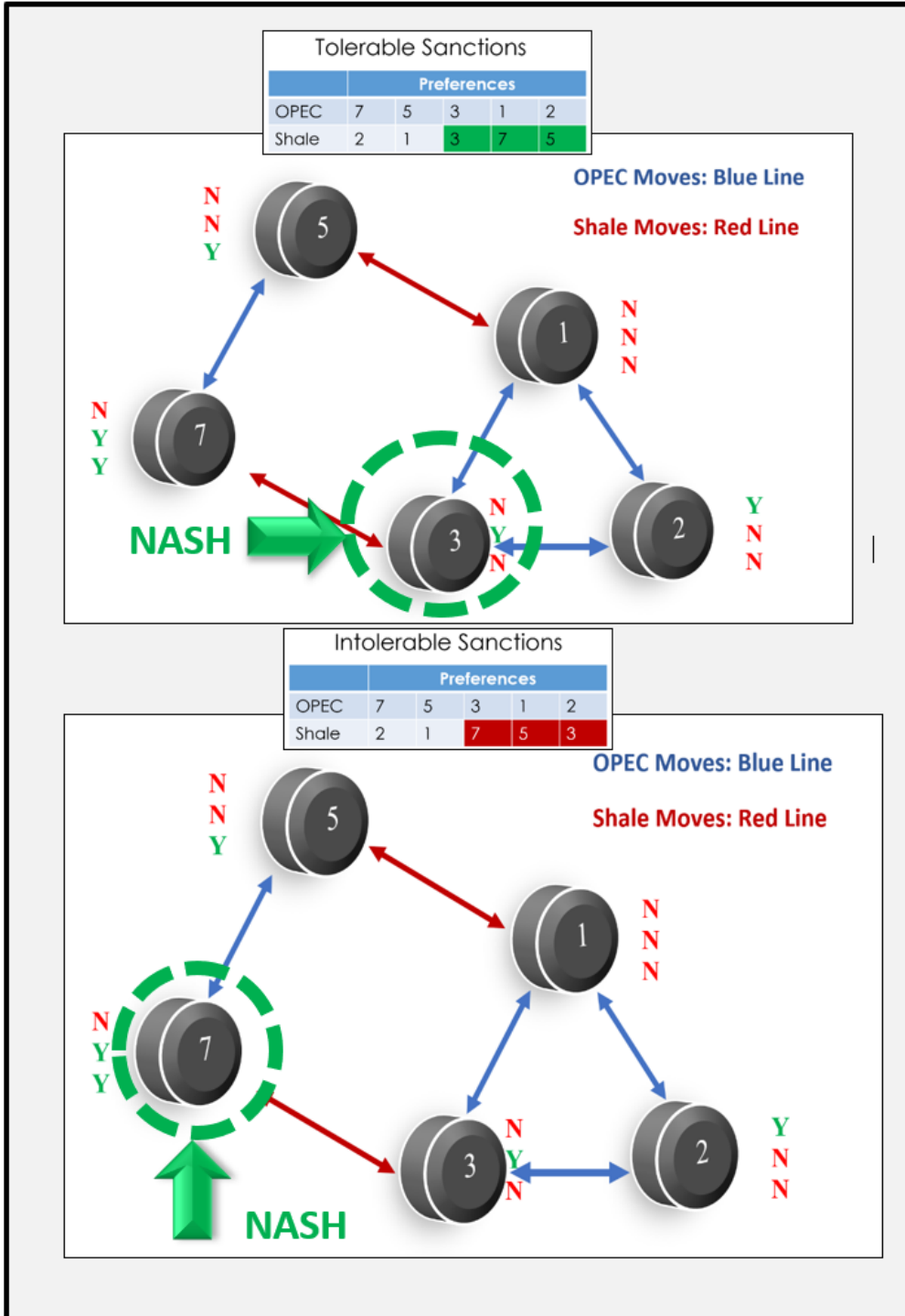ng it even harder for a mediator to choose an action to alter a dispute. Modeling the OPEC-Shale conflict using GMCR has provided a convenient and accurate analysis of the conflict, and mimics the outcome of a real-world dispute. Inverse GMCR was then able to identify the strength of the sanction by identifying the preference ranking of the shale oil producers. Also, a user can locate the most significant option to be altered to influence a dispute into ending in a more favorable resolution. In this case, inverse GMCR showed that increasing the strength of the "Squeeze" option will change the preferences of the opponent and therefore alter the resolution toward a more desirable one for OPEC. Moreover, the two identical graphs with different preferences view allow both DM to focus on the most impactful option to alter the results of the dispute. In the OPEC-Shale conflict, both DMs can view the graphs and understand that the two outcomes are a result of the option "Squeeze." This allows the Shale producers to improve their reservation point to tolerate the sanction from OPEC by making their production more efficient to end up in a more desirable state.

There is a definite relationship between the strength of an economic sanction and the preference ranking of a DM, but calculating how strong a sanction must be to change an opponent's preference ranking is very challenging. In this case, it was not easy for OPEC to estimate how low the oil price should be to make it unbearable for the shale producers. Moreover, the reduction in shale oil production costs should be factored into the analysis. Even if OPEC were able to calculate the proper strength of the sanction, it would be faced with another challenge: oil prices are not easy to predict. In 2014, a 2% excess in oil supply resulted in more than a 70% drop in oil prices. Also, demand is not elastic, and oil prices may stay low for an extended period of time before they go up again. GMCR can play a

significant role in conveniently analyzing disputes and thereby making better decisions, and hopefully, more work will be done to support mediators in calculating the impact of financial sanctions on conflicts and negotiations.

# Chapter 4
# SUDAN CONFLICT

## 4.1 Introduction

Ever since Sudan achieved its independence from Britain in 1956, the country has had conflicts over borders, oil, political instabilities, and tribal disputes. In this chapter, the conflict between North Sudan and South Sudan over oil is investigated. Specifically, at the last quarter of 2011. South Sudan was using pipelines to transport its oil through North Sudan to the port of Sudan, as shown in Figure 4.1.
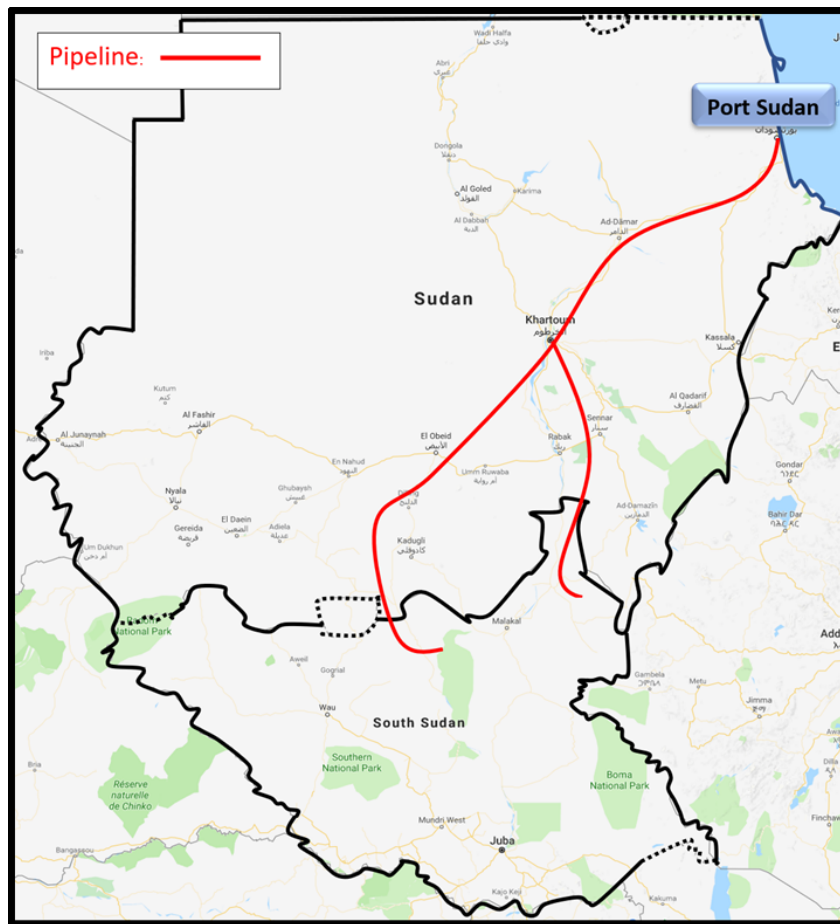


**Figure 4.1: North Sudan pipeline**

North Sudan's demand from South Sudan was to pay $32 per barrel transported via the pipelines, which the South perceived as extremely high. Due to that and the tension in the region, they counter-offered with only $1 per barrel (Ottaway et al., 2012). The result of the negotiations was an impasse, and as a result, South Sudan did not use the pipelines, and neither side was able to benefit from the revenues of approximately 300,000 barrels per day from the South Sudan fields (Pedersen et al. 2014; EIA, 2012) . Both GMCR and BATNA will be used for this conflict. GMCR will be used for modeling and analyzing this conflict, while BATNA will be used to aid decision-makers to make the right decision. Moreover, the "Conflict Trigger" (CT) theory will be tested in this dispute and then compared with the results without the use of CT. In the next section, an in-depth review is carried out on the Sudan conflict, followed by the modeling, analysis, BATNA, and the results and conclusions.

## 4.2 Background

The former Sudan has always been marked with conflicts based on several internal factors. Before it gained independence, Sudan was officially recognized as two regions: The South and the North, as shown in Figure 4.2.  A condominium between the British Empire which conquered the region and the Egyptians who had historically presided over Sudan identified the two regions. The North, which was perceived as the better part of the country, comprised mainly Muslims and Arabs. In contrast, the South mostly had a sub-Saharan African populace, and the region was deemed as 'useless' due to its fewer resources (Ottaway et al., 2012). As such, the South mainly fended for itself, at times with the help of missionaries, and with the colonial powers only stepping in to defend it against slave traders. However, the official boundary that divided the two regions of Sudan was not noticeably demarcated, as it passed through an area considered of little to no worth. As soon as Sudan gained independence, the boundary was nullified, and both regions were placed under the same rule. Nevertheless, the South continued to face the same historical perception of little worth, and this came along with little support from the

government. However, other historical issues faced both the North and the South, leading to several wars both within the two regions and against each other.
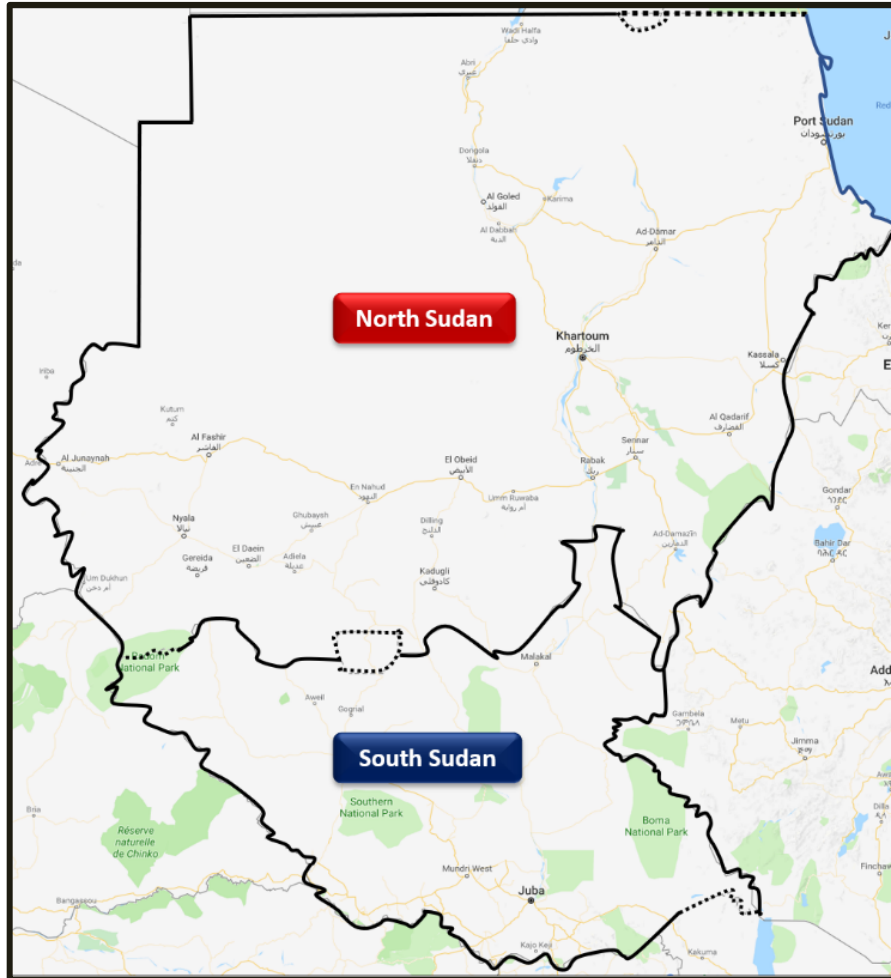


**Figure 4.2: South Sudan and North Sudan**

Political instabilities in the North saw the ruling parties continuously switch from civilian governments to military governments and from leftist ideologists to Islamist ruler. Such instabilities, in turn, affected the whole region, since the ruling powers of the North presided over the whole region. Similarly, tribal conflicts within the South saw the region deteriorate into internal clashes that would later be manipulated by the North to prevent rebellious uprisings from the South (Ottaway et al., 2012).

Most of the wars pitting the North against the South were carried out around the boundary created by the Anglo-Egyptian condominium. These wars only grew upon the realization that the areas around this boundary were rich in the country's number one source of income, oil. The 1978 discovery of oil around this area provided a greater motive for war between the North and the South. Furthermore, the skewed nature of this boundary meant that both regions would ultimately claim control over the region. As a result, the oil discovery led to the abandonment of the terms of an agreement between the North and the South signed in 1972 in Addis Ababa (Ottaway et al., 2012).

The agreement brought a sense of peace to the region, with fewer rebellions from the South against the ruling government and more autonomous control of the South through the federal system. President Jafaar Nimeiri later abandoned the agreement he had signed, and by 1980, he had dismantled the South's assembly, thus jeopardizing the federal system, and he attempted to split the South into three provinces. Three years later, rebellion against the North was turning into active war, and the overthrow of Nimeiri in 1985 furthered political instability in the North. By the time President Omar Al-Bashir took power in 1993, the North was facing continued war against the South in areas around the boundary. As a result, the initial attempts to quell war failed, and the region slipped into ever-greater war and an increased call for secession in the South.

At the time of Al-Bashir's presidency, there were several wars covering most of the Sudan region, with factors ranging from feelings of historical injustices in the South, the discovery of oil around the ill-marked boundary, tribal wars in the South, and political instabilities in the North. However, in 2005, international assistance came in to aid in abating the conflicts through the signing of the Comprehensive Peace Agreement (CPA) (Zambakari, 2013). Among the terms of the CPA was a provision for a referendum in the South to decide whether the region would be ruled by the North or form a newly independent country. Again, the international aid parties noted the need for a soft transition into new countries in case it came to that. The referendum that was later held in 2011 led to a huge vote in favor

of secession. Following the referendum, the North and South were meant to negotiate over contested issues for a peaceful creation of what would become known as the Republic of South Sudan. However, several factors did not allow for this peaceful transition, and the North (now Republic of Sudan) and the South (Republic of South Sudan) continued to engage in war.

First, the North failed to agree with the outcome of the referendum, as it felt that it reduced its status. The split would see the Republic of Sudan lose about a third of its total land mass. Furthermore, the South controlled around seventy-five percent of all the oil reserves in the region. Second, the South continued to face internal disputes along tribal lines and due to loopholes in its security systems. Consequently, the South was ill-prepared for negotiations with the North on the contested issues before the split occurred. By the time the two regions split, several issues had still not been tackled, and there was an increased threat of war again breaking out. This was prophetic, and as soon as the Republic of South Sudan was formed, war broke out between it and the Republic of Sudan.

Initially there were only small clashes between rebel groups in the North who demanded to be integrated with the South and the official army of the North – the Sudanese Armed Forces (SAF). Later, however, the clashes grew into full war between the two countries. At that time, the SAF routinely bombed several villages located in the Republic of South Sudan, while the Sudan People's Liberation Army (SPLA) encroached into the Republic of Sudan's territory. The SPLA had since the independence of the South been recognized as the official army of the new country (Ottaway et al., 2012).

The CPA was seen as a possible means to an end of the war, since it talked extensively of several issues that had caused the conflicts. The North and the South actively attended negotiations run by international agencies dedicated to finding a resolution between the two sides and to bring in a system of democracy in both countries. However, there were several hindrances that did not allow the practical implementation of the terms of the CPA. First, both regions were solely single-party states, and this meant that the calls for reason came from two seriously opposed sides. As such, the North failed to note

the seriousness of the South regarding the issue of the secession, while the South was bent on seceding regardless of all attempts made by the North to stop it.

On the 30th of July 2005, six months after signing the CPA, John Garang – the leader of the South seen as warm to the idea of unity with the North – died in a helicopter crash (Young et al. 2006). The other leaders from the South never gave unity any serious consideration and only wished to be separated from the North. Nevertheless, the failed attempt to reconcile the two sides shows that either the international community failed to show more authority in the implementation of terms or that the two parties signed the agreement with no intention of honoring its terms. The failure of the CPA to provide grounds for peace, in turn, led to a series of further conflicts in the two countries.

Today, the Republic of Sudan and the Republic of South Sudan are faced with conflicts that cannot be attributed to any single source. Some of these conflicts go back to historical issues over territories situated along the new border, while other conflicts are seemingly a result of the poverty rates in the region and a huge dependence on oil as the main source of income. Furthermore, political instabilities in both countries mean that planned coups d'état and rebellions continue to surge. As such, the region has become a host to several conflicts that have since been categorized into four categories, as follows (Ottaway et al., 2012).

The first type of conflict involves the territories around the border between the two countries, with each side trying to exert its authority. There are several states whose positioning close to the new border has led to several wars. The states of Abyei, South Kordofan, and the Blue Nile, shown in Figure 4.3, were left in the North but have since been are contested.
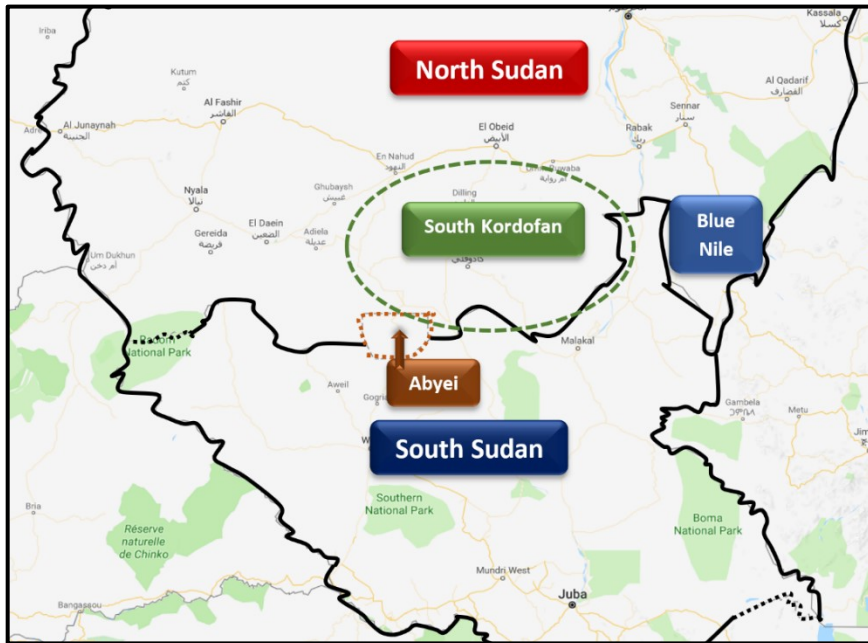
**Figure 4.3: State of Abyei, South Kordofan, and the Blue Nile**

As the South seceded from the rule of the North, the subjects of the location of Abyei and the system of rule in South Kordofan and the Blue Nile as per the CPA were not answered. As a result, war broke out along the border as soon as the South became independent. The wars started as remote collisions between the SAF and rebel groups springing up in some of these states. As time passed, the SPLA became involved in these clashes, and the war spilled over to the South. In April 2012, the SPLA seized the town of Heglig, which had oil fields, and the SAF crossed the border and targeted villages in the South (Johnson, 2012).

All attempts by international actors to mediate the conflicts around this issue have not provided any positive results. The CPA stipulated the creation of a commission made up of representatives from both countries to help provide a clear boundary between the North and the South. This new demarcation was meant to be done in the six months following the adoption of the agreement, but it never happened. There were many attempts to revive the North-South Technical Border Commission, but these also failed. In fact, since the signing of the CPA in 2005, these regions have experienced heightened wars

compared to before. The 2011 referendum would have had the inhabitants of the region, since it was contested, decide their fate as to whether to remain in the North or to go the South.

However, the government did not wish to lose control of a region it had presided over for so long, and it feared that the greater population of the Ngok Dinka in Abyei would vote for inclusion in the South. Furthermore, a boundary commission created in the state had demarcated the Heglig oil fields as part of the state. This inclusion of the Heglig fields brought about more conflicts with the North, bringing the matter to the attention of The Hague. In 2009, the Permanent Court of Arbitration in The Hague decreed that the oil fields in Heglig were not part of Abyei but were instead sections of Kordofan State (Ottaway et al., 2012).

Nevertheless, the issues over Abyei were far from over. As a result of the constant conflicts, the referendum to be carried out in Abyei was canceled. The cancellation came about as a result of disagreements between both sides on the legitimate voters in Abyei. The South insisted on having sole control over the permanent residents of the state, who was mostly Ngok Dinka (Ottaway et al., 2012).

In return, the North claimed that the nomadic tribe of Misseriya needed to vote on the issue, as it would greatly affect their lives. The issue over the involvement of the Misseriya in this referendum seemed a logical point but was impractical, as it was hard to correctly indicate which members of the tribe used Abyei. As well, the South felt that the North was attempting to change the referendum outcome in the North's favor. Moreover, the conflicts over Abyei continued due to the clear attempts of the North to seize the area by failing to honor the stipulations of the CPA regarding a referendum for the area. For instance, in 2011 the Sudan government removed the Abyei Administration, which was an action against the CPA provisions. In turn, the SAF laid siege to the main town in the state. This seizure again led to clashes between the North and the South, forcing the international community to come up with an agreement signed by both sides.

Further, there was the creation of the United Nations Interim Security Force for Abyei (UNISFA) to be made up of Ethiopians mandated to oversee the removal of the two armies from the region (Osterrieder et al., 2014). However, the two armies – the SFA and SPLA – did not fully abandon the area, and this hindered the work of the UNISFA. The North claimed that it would not leave the region until the UNISFA was fully staffed with 4,200 soldiers, a provision that was yet to occur. All other attempts to mediate the conflicts between the North and South regarding Abyei have not yielded any results. To add to this, the states of South Kordofan and Blue Nile have also been faced with multiple clashes. These clashes began in South Kordofan but later grew into Blue Nile State. The people of the Nuba tribe who reside in South Kordofan became absorbed into the Sudan People's Liberation Movement/Army (SPLM/A), as they rebelled against neglect by the government.

As a result, the region became targeted by the ruling parties of the North. These conflicts were later not given appropriate attention when the CPA was signed by the two sides. The CPA only looked at the issue of conflict in Blue Nile and South Kordofan through a protocol meant to deem the regions as part of the North, but sympathizers of the South wanted a unique system of administration for more autonomy. The protocol, which was signed in 2004, was meant to offer reconciliation on border issues and help reduce the conflicts. The attempts to incorporate the CPA's terms in these two states occurred more efficiently in Blue Nile compared to South Kordofan. In South Kordofan, the population had several disagreements over the census outcome and later over the election of the governor on a National Congress Party (NCP) ticket. Consequently, clashes recommenced in South Kordofan in 2011 before the South fully seceded from the North. These clashes were mainly between the SAF and rebel groups that emerged in South Kordofan.

The group that emerged, the Sudan People's Liberation Movement-North (SPLM-N), resisted disarmament attempts by the army, and the North felt that they might be getting assistance from the SPLA in the South. On June 28th, 2011, the government of the Republic of Sudan and the SPLM-N

reached a cease-fire by signing the Two Areas Framework in Addis Ababa (Ottaway et al., 2012). However, the government of the North failed to honor this cease-fire and attacked South Kordofan. The numbers of casualties have in turn only increased. As the collisions continued to heighten in South Kordofan, Blue Nile State soon became affected. The rebel group SPLM-N faced off with the SAF in September 2011 in Blue Nile state (Weekly, 2011).

President Omar Al-Bashir consequently removed the governor of the state and started plans for the state's disarmament. The continued refusal by SPLM-N members to disarm has led to increased battles in the state. Over time, the SAF took control over several towns in the state, forcing the SPLM-N away from a town called Mukja by February 2011. Meanwhile, the South sent SPLA troops into Heglig, with claims of the North bombing Unity State in the Republic of South Sudan. The Republic of Sudan retaliated with regular aerial bombing of Heglig that led to the SPLA moving out of the town. These cross-border wars have marked one type of conflict in the region. The second kind of conflict is a result of North-South disagreements over oil. The huge loss of oil reserves by the North has led it to constantly attack the South. Oil had formed a major source of income for Sudan since its initial exportations of crude oil in 1999 (Ottaway et al., 2012). At the time oil was first discovered in Sudan, the country was very poor, and as a result, oil was perceived as an easy source of income and this killed other sectors that would otherwise have helped the economy.

A continued neglect of the agricultural sector, for instance, has caused dire food predicaments both in the North and the South. In the event that the agricultural sector got a boost, the two regions would greatly benefit economically. Currently, agriculture employs around 80 percent of the population in the Republic of Sudan, yet the agricultural sector provides a dismal one-third of total revenues. Nonetheless, the Republic of South Sudan has failed to utilize their plentiful and rich lands to stabilize the economy, and seems to be completely reliant on oil, as it makes up to over 90 percent of their revenue (Patey, 2010).

By 2011, oil exports made up around 70 percent of the Republic of Sudan's revenue, and the thought of losing about 75 percent of that revenue did not help ease the situation. Furthermore, this conflict
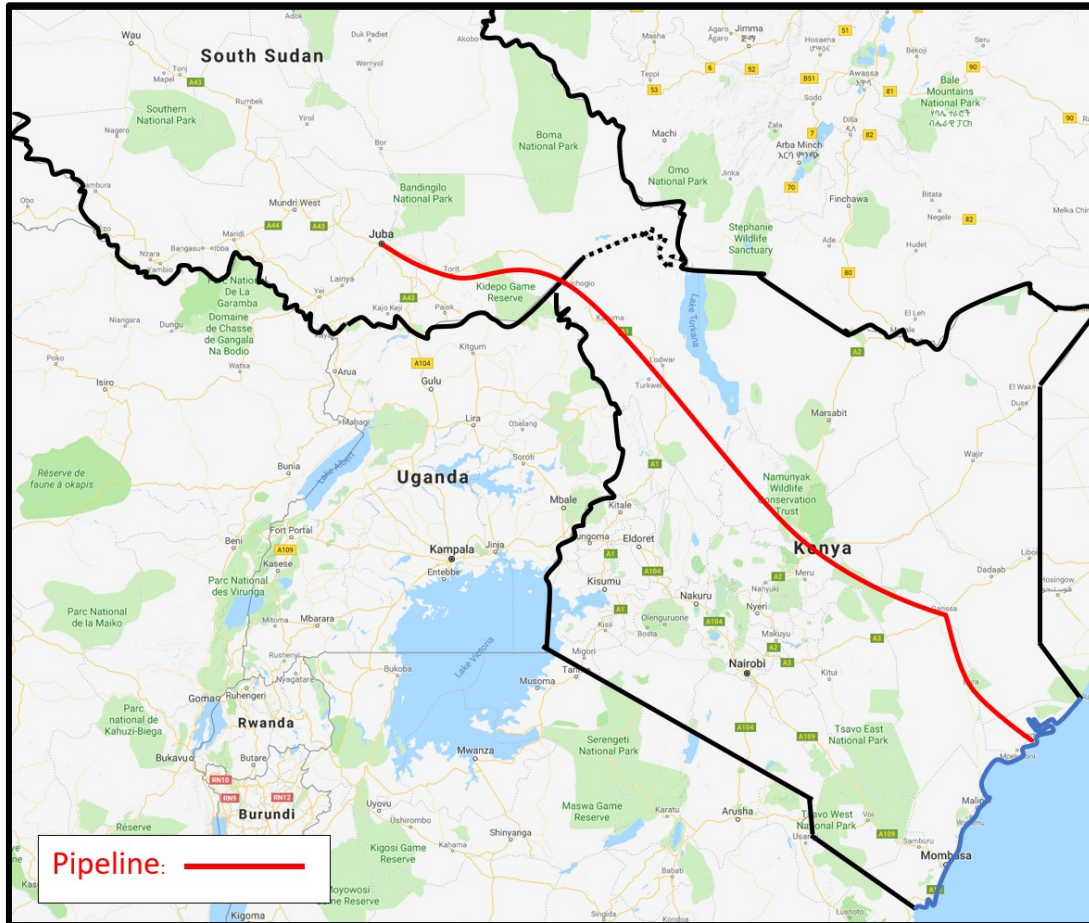


**Figure 4.4: South Sudan planned pipeline through Kenya**

became increasingly thorny after the Republic of South Sudan was forced to export its oil via a pipeline to Port Sudan, situated in the North Sudan. The other options available to South Sudan, of constructing its own pipelines or transport to the Kenyan coast, are very costly; the pipeline through Kenya is shown in Figure 4.4. The CPA had provided guidelines that had been followed regarding the distribution of oil revenue.

These guidelines saw two percent of the revenue being given to the states with the oil fields, and the rest equally divided between the North and the South. However, following independence, the Republic of South Sudan abandoned these terms and did not share the revenues. Consequently, the North lost an estimated $7.77 billion within four years of the South's independence. This loss led to an adoption of new and stricter oil transportation charges by the Republic of Sudan, whose port would be the point of export. Since then, there have been several failed attempts by the African Union High-Level Implementation Panel chaired by former South African president Thabo Mbeki to aid in the execution of the CPA. These conflicts based on oil have only increased over time. The clashes reveal how the North is still bitter over its revenue losses and is constantly looking for means to salvage whatever is available.

The case of imposing a $32 per barrel fee on the South for its use of Port Sudan is one example of such attempts. On the other hand, the South is resolute in showing its autonomy. In 2012, for instance, the Republic of South Sudan stopped producing oil due to the seizure of oil from the country worth $815 million by the Republic of Sudan. These continued clashes over the resource have driven the region into increased conflict (Ottaway et al., 2012). The third kind of clash is occurring within the Republic of South Sudan, as the legitimacy of the new government is challenged and the new authorities unfamiliar with how to exert their influence. Following the death of John Garang, the South came under the leadership of Salva Kiir, who did not have a similar level of respect for the people (Ottaway et al., 2012).

To add to this, the people of South Sudan had no concept of unity except for that against a common enemy, the North. Still, attempts by the government in the North to divide the South caused further challenges to the new country. The new country suffered from the historical issues that had marked the greater Sudan but were not resolved upon independence. Furthermore, the new country was faced by the challenge of inadequate amenities, and the fact that it is landlocked makes it even harder to develop

the nation. As such, the Republic of South Sudan has increasingly relied on oil revenue, leading to increased poverty and increased clashes between the people and the government. Moreover, the South is made up of several tribes, with the Dinka and the Lou Nuer comprising almost 60 percent of the population (Ottaway et al., 2012).

These tribes have consistently fought other more for historical reasons than for political purposes. For example, following the independence of the South, over 3,000 people lost their lives, and 140,000 people were displaced as a result of tribal wars on lands for pasture and water in Jonglei State alone. Such tribal clashes have also occurred in Warab and Unity States (Ottaway et al., 2012). Politically, the tribes have been incorporated fairly into the ruling political system, as seen by the fact that the vice-president of the nation, Riek Machar, is a Nuer. President Salva Kiir, on the other hand, is from the majority Dinka tribe. However, some politicians keep defecting from the governing party and creating armed militias instead of political oppositions. Machar himself defected from SPLM/A and started a military resistance before rejoining the SPLM/A in 2002. This tendency can also be observed in the case of George Author, who after failing to clinch the governorship of Jonglei State formed a militia called the South Sudan Democratic Movement/Army (SSDM/A).

Military resistance continues to get support from the government in the North and can easily access munitions due to the prolonged availability of arms in Sudan. These increased military resistance movements have caused more clashes in the Republic of South Sudan. The fourth type of conflict is found within the North. The authorities in the North are mainly made up of seniors and have reduced loyalty and respect for the people. This dissatisfaction has grown into issues of economics, with the country becoming increasingly poor over time. Issues of heightened food costs, lack of water, and other economically driven instabilities have rocked the Republic of Sudan. Over time, there has been an emergence of youth resistant groups such as the Girifina, opposed to Bashir rule but also lacking faith in the present opposition. For its part, the ruling party in the North has failed to show interest in handling

the issues that the people feel should be changed, thus increasing tensions. Such tensions have culminated in full-fledged clashes in some areas. In Darfur, for instance, there have been several uprisings against the government. Groups such as the Sudan Liberation Movement (SLM) and the Justice and Equality Movement (JEM) have constantly fought the SAF, which has since collaborated with another group, Janjaweed militia, against the SLM and JEM. The status of Darfur has deteriorated in a period where the United States has come up with strict sanctions against Sudan and Bashir has been marked for arrest for numerous war offenses by the International Criminal Court (Ottaway et al., 2012).

Attempts to come to an agreement between the government and the rebel groups in Darfur have failed due to the presence of several militias in the area, and as a result, the groups constantly disagree on the terms provided in the government agreement clauses. The government only scored points when ten groups in the region agreed to sign the Doha Agreement. The agreement led to the creation of two new states in Darfur and the adoption of compensation strategies. However, the remaining groups that did not sign the agreement continue to cause violence in the region, and as such, Darfur is far from completely realizing peace. All in all, the Republic of Sudan and the Republic of South Sudan are still constantly waging war against each other, regardless of the numerous attempts made to bring an end to the wars. The main issues are: borders and control of areas around borders; oil; political instabilities; and tribal conflicts. The international community continues to debate and hold negotiations around these issues hoping that a reasonable compromise may be realized.

## 4.3 Modeling

The model's point of time is the last quarter of 2011. There are two DMs in this conflict, North Sudan and South Sudan, which will be referred to as NS and SS respectively. NS has two options: the first one is to "Request Fees" for using the pipelines, and the second is to "Blockade" by denying access to

the pipelines for oil transportation. In response, SS has two options: the first option is to "Accept the fees", and the second is to "Build a new pipeline" through Kenya.

The combination of options for NS and SS will form $2^4 = 16$ states. The options and states can be seen in Table 4.1; the DMs are on the left side of Table 7, followed by their options. Each column represents a state, and the state numbers can be seen in the last row. An "N" means No (the option is not used by the DM), and a "Y" means Yes (the option is used by the DM). (NYNN) is a representation of State 5 in which the first two letters refer to NS's option selections, and the last two letters are SS's choices. State 5 (NYNN) indicates that NS did not request the fees and did use the option blockade, while SS did not accept the fees nor did they construct the new pipeline to Kenya. Another example to envision this is: State 6 (NYNY) = NS, Fees Request (N) No, NS, Blockade (Y) Yes; SS, Accept the Fees (N) No, SS, construct new pipeline (Y) Yes.

**Table 4.1: Set of possible states**

| | **Options** | **States** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **North Sudan-NS** | **Fees request** | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y |
| | **Blockade** | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y |
| **South Sudan-SS** | **Accept the fees** | N | N | N | N | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y |
| | **New pipeline to Kenya** | N | N | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| | | | | | | | | | | | | | | | | | |
| **State number** | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

The removed states in this conflict are:

1) The states in which NS will not request fees will be removed to reduce the size of the model as per the "Conflict Trigger" (CT) approach. The option "Request Fees" is the CT, because:

A- It will trigger a response from SS; if the fees are reasonable, they will accept, and if not, SS will consider the new pipeline with Kenya. Moreover, the option "Request Fees" is the only CT because all other options are countermoves to the opponent's moves. For example,

the option "New pipeline to Kenya" is an SS reaction if the fees requested by NS are too high. Also, the NS option "Blockade" is a countermove if SS does not pay the fees.

B- It is the first option to be used in the dispute.

C- If this option is not used, the conflict will not move pass the status quo (NNNN).

As a result, all possible outcomes will begin with the option "Request Fees".

A sample of a sequence of events is as follows:

Fees Request (Y) > Accept Fees (N) > Blockade (Y) > New Pipeline (Y) > **Conflict Ends**

Fees Request (N) > **Conflict Ends**

Fees Request (Y) > Accept Fees (Y) > **Conflict Ends**

**Conflict Trigger Illustrated**

These states will be removed (N - - -), and a dash means both Y and N are included. In this case, all the states which include NS having an N (NO) for the option "Fees Request" will be removed regardless of what was chosen in the remaining options. The eight states can be seen in Table 4.2, marked in red, are removed. The remaining feasible states can be seen in Table 4.3, with a total of 8 states.

**Table 4.2: Removed states highlighted in red**

| | Options | States | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Sudan-NS | Fees request | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y |
| | Blockade | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y |
| South Sudan-SS | Accept the fees | N | N | N | N | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y |
| | New pipeline to Kenya | N | N | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| | | | | | | | | | | | | | | | | | |
| State number | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

**Table 4.3: Feasible states**

| | Options | States | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **North Sudan-NS** | **Fees request** | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Blockade** | N | Y | N | Y | N | Y | N | Y |
| **South Sudan-SS** | **Accept the fees** | N | N | Y | Y | N | N | Y | Y |
| | **New pipeline to Kenya** | N | N | N | N | Y | Y | Y | Y |
| | | | | | | | | | |
| **State number** | | 1 | 3 | 5 | 7 | 9 | 11 | 13 | 15 |

The only irreversible option is "Accepting the fees". It can be debated that the option "New pipeline to Kenya" can be irreversible; however, it is not an action that can be used immediately because construction will take time and the DM can bluff by starting construction to alter the opponent's decisions. The last step in the modeling stage is ranking the states from most-preferred to least-preferred for each DM. NS will prefer all of the states in which SS "Accept the Fees" and will not prefer any states in which SS will construct a new pipeline to Kenya. NS will use the option "Blockade" as a countermove if SS does not accept paying the fees. SS will prefer all states in which NS does not "Blockade". Also, if the fees requested are too high, then SS will prefer to build a new pipeline through Kenya over accepting to pay. As a result, SS will have two preference rankings based on the amount of fees requested. SS will prefer to accept the fees if the fees are lower than the Reservation Value (RV), and an RV will be calculated and used in later stages for the BATNA. This condition for SS will result in 2 preference rankings, one in which the fee is higher than the RV, and another if it is lower than the RV. The preferences for NS can be seen in Table 4.4. in the last row; the preferences are ranked from most-preferred on the left side to least-preferred on the right side. SS's preference rankings for High fees and Reasonable fees can be seen in Table 4.5, and Table 4.6 respectively.

**Table 4.4: NS Preferences**

| | Options | States | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **North Sudan-NS** | **Fees request** | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Blockade** | N | N | Y | Y | N | Y | Y | N |
| **South Sudan-SS** | **Accept the fees** | Y | Y | Y | N | N | Y | N | N |
| | **New pipeline to Kenya** | N | Y | Y | N | N | N | Y | Y |
| | | most preferred | | | | | | least preferred | |
| **NS Preferences** | | 5 | 13 | 15 | 3 | 1 | 7 | 11 | 9 |

**Table 4.5: SS preferences for the high fee case**

| **High Fees** | Options | States | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **North Sudan-NS** | **Fees request** | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Blockade** | N | N | Y | N | N | Y | Y | Y |
| **South Sudan-SS** | **Accept the fees** | N | N | N | Y | Y | Y | Y | N |
| | **New pipeline to Kenya** | N | Y | Y | Y | N | Y | N | N |
| | | | | | | | | | |
| **SS Preferences** | | 1 | 9 | 11 | 13 | 5 | 15 | 7 | 3 |

**Table 4.6: SS preferences for the reasonable fee case**

| Reasonable fees | Options | States | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **North Sudan-NS** | **Fees request** | Y | Y | Y | Y | Y | Y | Y | Y |
| | **Blockade** | N | N | N | N | Y | Y | Y | Y |
| **South Sudan-SS** | **Accept the fees** | N | Y | Y | N | Y | N | Y | N |
| | **New pipeline to Kenya** | N | N | Y | Y | N | N | Y | Y |
| | | Most prefered | | | | | | Least prefered | |
| **SS Preferences** | | 1 | 5 | 13 | 9 | 7 | 3 | 15 | 11 |

Figure 4.5 shows the Graph Model for two states. The red color represents moves by North Sudan (NS), and the blue color represents the moves by South Sudan (SS). State 11 is (YYNY), with NS choosing Yes for both options and SS choosing No to "Accept the Fees" and Yes to "New pipeline to Kenya". The red arrow indicates a move made by NS, the arrows on both sides indicate that this move is reversible, meaning that if NS moves from State 5 to State 11 it can move back to State 5.
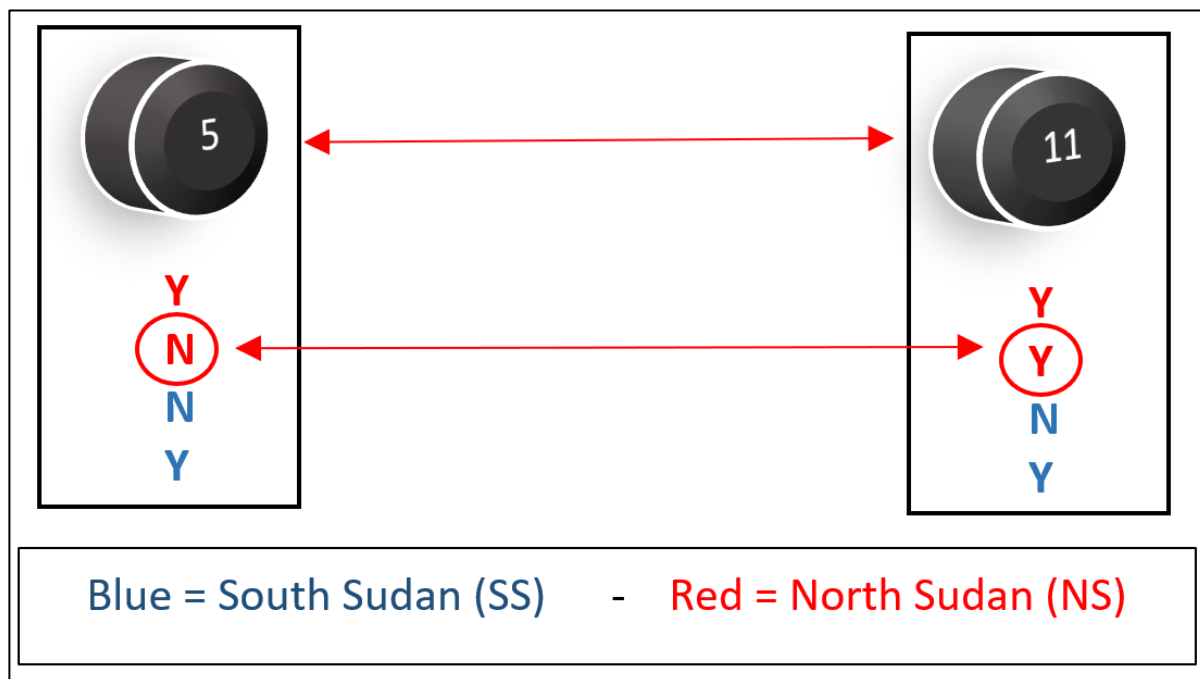


**Figure 4.5: States' transition – State 5 and State 11 – NS's move**

Only NS can move the game from State 5 to State 11 because the options that are changed between these two, marked in red, are states controlled by NS. As shown in Figure 4.5, the strategy is changed from (YNNY) to (YYNY); the second option, or second letter, is changed from an N in State 5 and to a Y in State 11 The remaining 3 actions stay the same after the transition between State 5 and State 11. Figure 4.6 shows the Graph Model for State 7 (YYYN) and State 11 (YYNY). The blue arrow indicates a move made by SS. Also, an arrow at one end but not the other indicates

that this move is irreversible, meaning that once SS moves from State 11 to State 7 they cannot move back. Only SS can transition the dispute from State 11 to State 7 because he options changed are controlled by SS. The transition will change the states from (YYNY) to (YYYN). Notice that SS's first action "Accept the Fees" will change from an N to a Y, and SS's second option "New pipeline to Kenya" will also change from Y to an N. The Graph Model for this dispute is shown in Figure 4.7. The modeling phase is now complete. In the next section, the analysis of this dispute will be carried out.
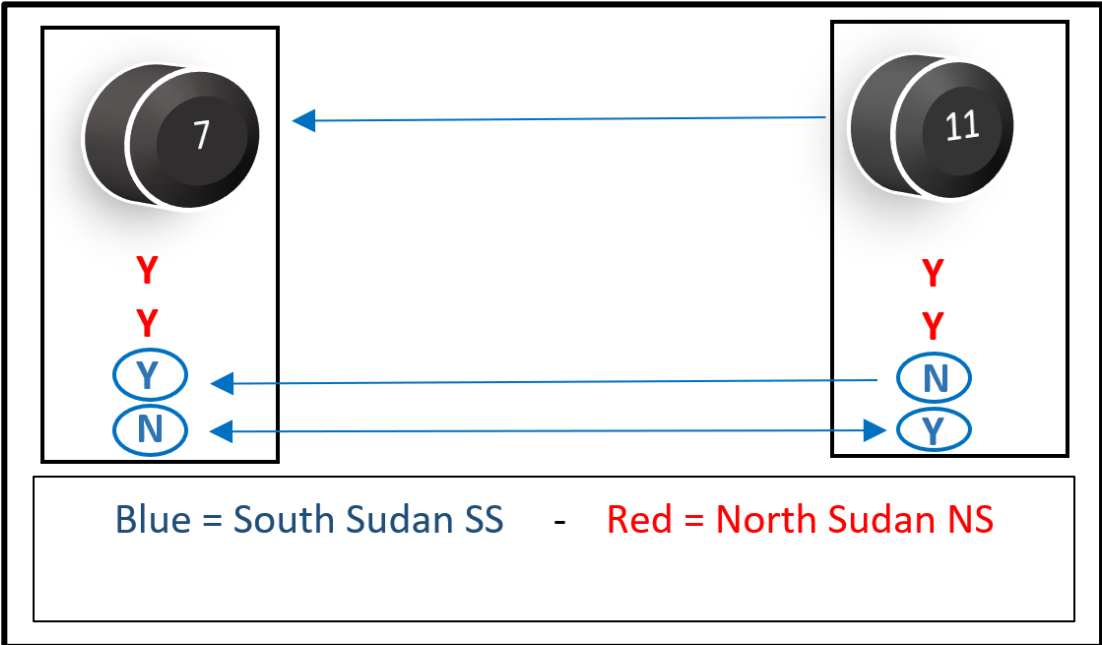


**Figure 4.6: Graph Model - State 7 and State 11 - SS's move**
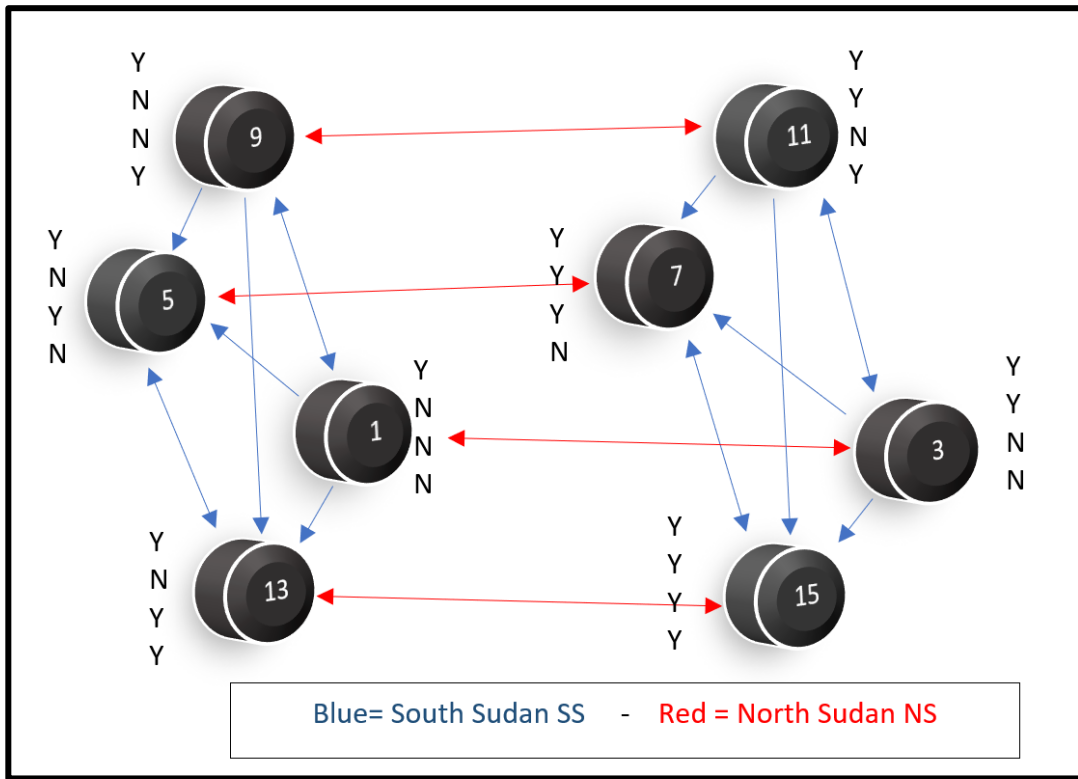
**Figure 4.7: Graph Model - Transitions**

## 4.4 Analysis

In this phase, the equilibria will be determined. GMCR+ software (Kinsara et al., 2015b) will be used to identify the equilibria of this dispute. The information gathered from the modeling phase will be used as an input for the GMCR+ software. Given that there are two preference rankings for SS, the equilibria will be tested for both scenarios. Since NS has the option to ask for either high fees or reasonable fees, SS will have a preference in each scenario.

### 4.4.1 High Fees

In the case of high fees, it is expected that SS will not accept paying them. GMCR+ predicts that there are two Nash equilibria, i.e., State 11 (YYNY), and State 13 (YNYY). A Nash equilibrium indicates that once the dispute reaches one of these two states, neither DM will have a unilateral improvement to

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another state. The dispute will most likely end in State 11 or State 13. GMCR+ results are shown in Figure 4.8. The numbers at the top right side of the figure are the state numbers and the numbers highlighted in green are the payoffs of each state. Equilibria in the scenario of high fees are not considered desirable endings for either side, because in both States 11 NS will blockade and therefore the oil will not be exported for revenue for SS, and NS will not get the extra revenues from the fees. State 13 is not desirable for NS because as soon as SS builds the new pipeline, NS will no longer get paid for fees. Moreover, state 13 is not desirable for SS because they will pay the fees and also pay for building a new pipeline through Kenya.

### 4.4.2 Reasonable Fees

The equilibria results by using SS's preference ranking for "reasonable fees" in GMCR+ show that the game would end in State 5 (YNYN), as shown in Figure 4.9. State 5 is the state in which NS will request the fees and SS will accept paying the fees and is a Nash equilibrium. Both DMs will prefer to stay in State 5 and not move away from it. The equilibrium in the reasonable fees case is considered desirable because both parties agree on a resolution that has a relatively high payoff compared to the high fee case.



**Figure 4.8: GMCR+ - High fees equilibria**

| Decimal | Filter | 1 | 3 | 5 | 7 | State 11 | State 13 | |
|---|---|---|---|---|---|---|---|---|
| 1 - North Sudan Request Fees | - | Y | Y | Y | Y | Y | Y | Y | Y |
| Blockade | - | N | Y | N | Y | N | Y | N | Y |
| 2 - South Sudan Accept fees | - | N | N | Y | Y | N | N | Y | Y |
| Construct new pipeli | - | N | N | N | N | Y | Y | Y | Y |
| Payoff For: North Sudan | - | 4 | 5 | 8 | 3 | 1 | 2 | 7 | 6 |
| Payoff For: South Sudan | - | 8 | 1 | 4 | 2 | 7 | 6 | 5 | 3 |
| Nash | | | | | | | | Y | Y |

**Figure 4.9: GMCR+ - reasonable fees equilibrium**

### 4.5 BATNA

After modeling and analyzing this dispute, the DMs will have two Graph Models with different preferences and payoffs, one being the "high fee" case and one being the "reasonable fee" case. In this section, the reservation value will be calculated such that it can be used as a reference to compare with the fees. As a result, the fees will be marked as high or tolerable after the RV is calculated. Additionally, the RV will aid the DMs by avoiding accepting a deal that is bad or refusing to accept a deal that is considered better than the alternative. NS has control in this conflict over choosing which game it wants to play. This is because the two games, or the two Graph Models, are based on how much NS will ask SS to pay. SS can also use this information to convince NS that one of the games will have a much higher payoff for both parties over the other, and therefore SS will increase its chances to get into a game which is a win-win via BATNA.

It is estimated that South Sudan's oil exports in 2011 were 300,000 barrels of oil per day (Pedersen et al., 2014). Equilibria in the case in which the fees are high will result in a blockade, and therefore SS

loses the opportunity to export the 300,000 barrels. Given that the price of oil in 2011 was on average USD100 per barrel (EIA, 2012), the total revenues will be approximately $30,000,000 per day, or $10,950,000,000 per year. If the only payoff to be considered in this conflict is oil revenues, the high fees equilibria will have a payoff of zero dollars due to the blockade. On the other hand, the reasonable fees equilibrium will result in a total payoff of roughly $11 billion per year.

In this dispute, the desirable game is the one with "reasonable fees". Given that 90% of South Sudan's budget is from oil revenues, a reasonable fee will allow SS to cover 90% of its expenses (Pedersen et al., 2014). To calculate the RV, South Sudan's budget and oil production cost must be identified. The oil production cost is estimated to be around $10.2 per barrel (Oil, 2008) (Knoema, 2018), and the total production cost per day is:

$$\text{total production} \times \text{production cost} = 300,000 \times \$10.2$$

$$= \$3,060,000 \text{ per day, or } \$1,116,900,000 \text{ per year.}$$

The oil revenues for 2011 are estimated to be $10.95 billion at the $100 per barrel price, and SS's budget in 2011 was $5.9 billion (Adeibo et al., 2013). SS needed to cover 90% of its budget from oil = 0.9 * $5.9 Billion = $5.3 Billion

**Oil profit = oil revenues – oil production cost – the budget**

Oil profit = $10.95 billion – $1.1169 billion – $5.3 billion

**Oil profit = $4.533 billion per year at $100 oil price**

Dividing the profit per year by the number of barrels per year will give the profit per barrel. The profit per barrel is **$41.31.** This is the RV, which means that if NS asks for this exact amount per barrel or lower, SS will be able to cover its expenses if the price of oil remains at $100 per barrel. NS demanded that SS pay $32; this amount is lower than the RV, which will allow SS to pay the fees and also have a safety cushion in case the oil price drops.

The foregoing information will help both sides reach a desired resolution. If SS had known at the time that this amount was below the RV, they would not have left the negotiation table. Now both SS and NS can identify the BATNA. Figure 22 shows both Graph Models with their payoffs. The use of the Graph Model and BATNA aids NS to understand that the amount requested should be viewed as reasonable or else the payoff will be zero as soon as SS builds the new pipeline to Kenya. Additionally, SS is able to identify whether the amount if reasonable or too high after determining the RV. By looking at the Graph Model and BATNA, both DMs are motivated to reach a win-win situation.
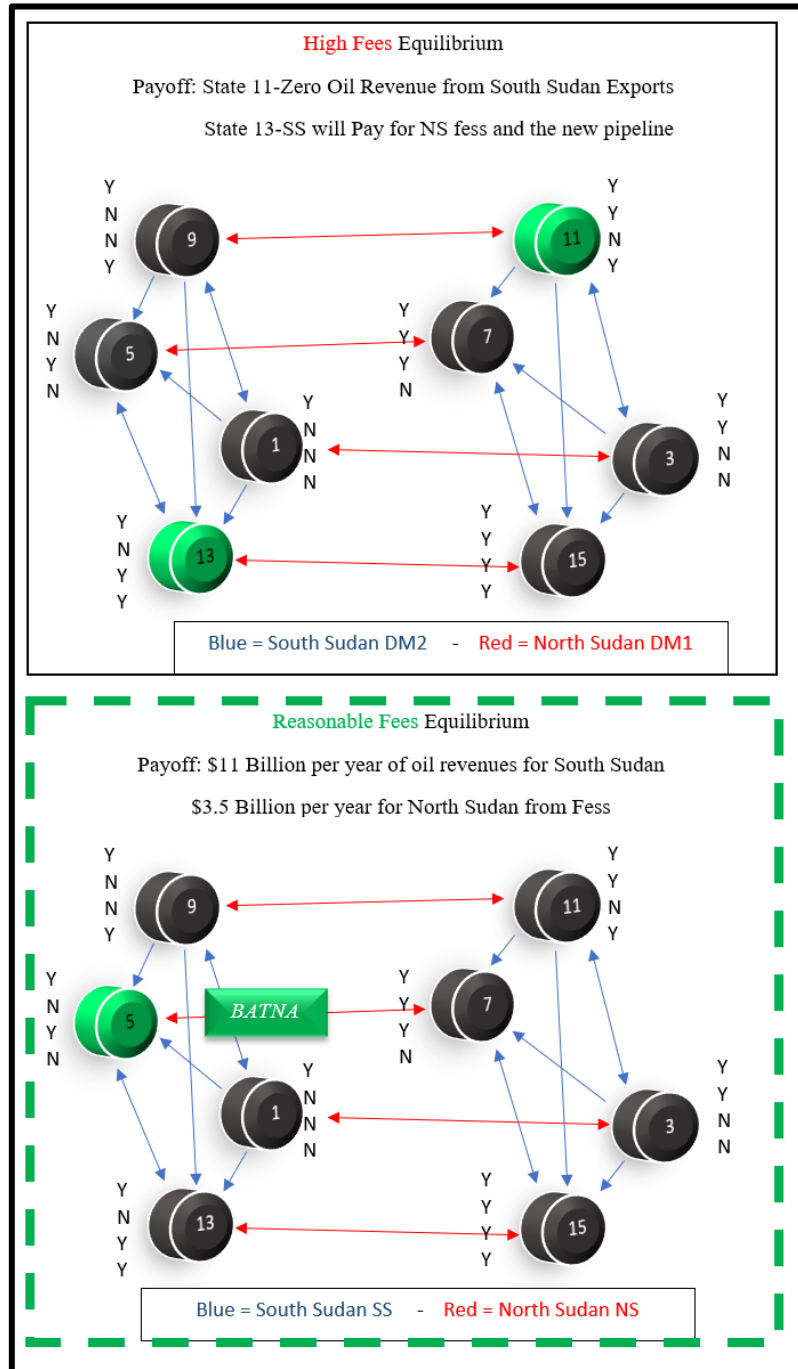
**Figure 4.10: Two Graph Models and BATNA**

## 4.6 Macro Model

Using the "Conflict Trigger" principle resulted in a simplified model. The results will be compared to the "macro model" results. The "macro model" is the original model with 16 states, without removing the states that does not have the conflict triggered. This step is done to verify that the results of the macro model remains the same after removing the states in which the conflict is not triggered. Table 4.7 shows the set of 16 states. State 4, 6, 12, and 14 are the states in which NS will not request fees and SS will accept paying the fees, making them logically infeasible states. In Table 4.8 the removed states are highlighted in red. The macro Graph Model is shown in Figure 4.11, the blue and red arrows are the allowable moves for SS and NS respectively. The preference ranking for the macro model is shown in Table 4.9.

**Table 4.7: Set of states- Macro Model**

| | Options | States | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Sudan-NS | Fees request | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y |
| | Blockade | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y |
| South Sudan-SS | Accept the fees | N | N | N | N | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y |
| | New pipeline to Kenya | N | N | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| | | | | | | | | | | | | | | | | | |
| State number | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

**Table 4.8: Removed states- Macro Model**

| | Options | States | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Sudan-NS | Fees request | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Y |
| | Blockade | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y | N | N | Y | Y |
| South Sudan-SS | Accept the fees | N | N | N | N | Y | Y | Y | Y | N | N | N | N | Y | Y | Y | Y |
| | New pipeline to Kenya | N | N | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y |
| | | | | | | | | | | | | | | | | | |
| State number | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

**Figure 4.11: Macro Graph**

**Table 4.9: Macro Model preferences**

| | most preferred | | | | | >>>>> | | | | | least preferred |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NS | 5 | 13 | 15 | 3 | 1 | 7 | 11 | 9 | 2 | 10 | 0 | 8 |
| SS- High Fees | 0 | 8 | 10 | 2 | 1 | 9 | 11 | 13 | 5 | 15 | 7 | 3 |
| SS- Reasonable Fees | 0 | 1 | 5 | 8 | 10 | 2 | 13 | 9 | 7 | 3 | 15 | 11 |

### 4.7 Macro Model Analysis

The preferences in Table 4.9 will be used in GMCR+ to identify the equilibria. The equilibria is shown in Figure 4.12 and Figure 4.13 for the reasonable and high fees respectively. Notice that in Figure 4.12, state 5 (YNYN) is Nash equilibrium which is the same equilibrium given in the CT model shown in Figure 4.9. Also, in Figure 4.13, the equilibria is state 11 (YYNY) and state 13 (YNYY) which matches that of the CT model shown in Figure 4.8.Given that the results of the macro model match that of the CT model then it is safe to conclude that simplifying the model using the CT principle had no effect on the equilibria in this model.



| | Decimal | Filter | 0 | 1 | 2 | 3 | State 5 | 7 | 8 | 9 | 10 | 11 | 13 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 - North Sudan | Request Fees | - | N | Y | N | Y | Y | Y | N | Y | N | Y | Y | Y |
| | Blockade | - | N | N | Y | Y | N | Y | N | N | Y | Y | N | Y |
| 2 - South Sudan | Accept fees | - | N | N | N | N | Y | Y | N | N | N | N | Y | Y |
| | Construct new pipeli | - | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y |
| Payoff For: | North Sudan | - | 2 | 8 | 4 | 9 | 12 | 7 | 1 | 5 | 3 | 6 | 11 | 10 |
| Payoff For: | South Sudan | - | 12 | 11 | 7 | 3 | 10 | 4 | 9 | 5 | 8 | 1 | 6 | 2 |
| | Nash | | | | | | Y | | | | | | | |

**Figure 4.12: Macro Model - reasonable fees equilibria**

| | Decimal | Filter | 0 | 1 | 2 | 3 | 5 | 7 | 8 | 9 | | | State 11 | State 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 - North Sudan | Request Fees | - | N | Y | N | Y | Y | Y | N | Y | N | Y | Y | Y |
| | Blockade | - | N | N | Y | Y | N | Y | N | N | Y | Y | N | Y |
| 2 - South Sudan | Accept fees | - | N | N | N | N | Y | Y | N | N | N | N | Y | Y |
| | Construct new pipeli | - | N | N | N | N | N | N | Y | Y | Y | Y | Y | Y |
| Payoff For: | North Sudan | - | 2 | 8 | 4 | 9 | 12 | 7 | 1 | 5 | 3 | 6 | 11 | 10 |
| Payoff For: | South Sudan | - | 12 | 8 | 9 | 1 | 4 | 2 | 11 | 7 | 10 | 6 | 5 | 3 |
| | Nash | | | | | | | | | | | | Y | Y |

**Figure 4.13:Macro Model - high fees equilibria**

## 4.8 The Added Value of a Conflict Trigger Model

The CT model reduced the size of the model from 16 states to 8 states by removing the states in which the conflict is not triggered. This simplification will aid a user because generating the preference ranking in real time is time-consuming, and the more states a model has, the longer it will take to generate the preference ranking. For example, in the Sudan conflict. A user who is modeling for South Sudan will have to calculate the value of constructing a new pipeline through Kenya and compare it to the fees of North Sudan. The valuation of the new pipeline and the politics, and the procedures involved will consume a significant amount of time and manpower. The need to simplify the model will reduce the amount of work and time required to utilize GMCR. Figure 4.14 illustrates the part of the model where the conflict is triggered, the yellow bracket. This area is the most concerning part to the user. South Sudan is more concerned about the part of the model in which North Sudan will ask them for fees, and that part of the model is the conflict trigger area. The green area is the part of the model where North Sudan will not ask for fees. Moreover, the green area includes the states in which North Sudan

will blockade, however, North Sudan will use that option if they ask for fees in order to pressure South Sudan if they refuse.
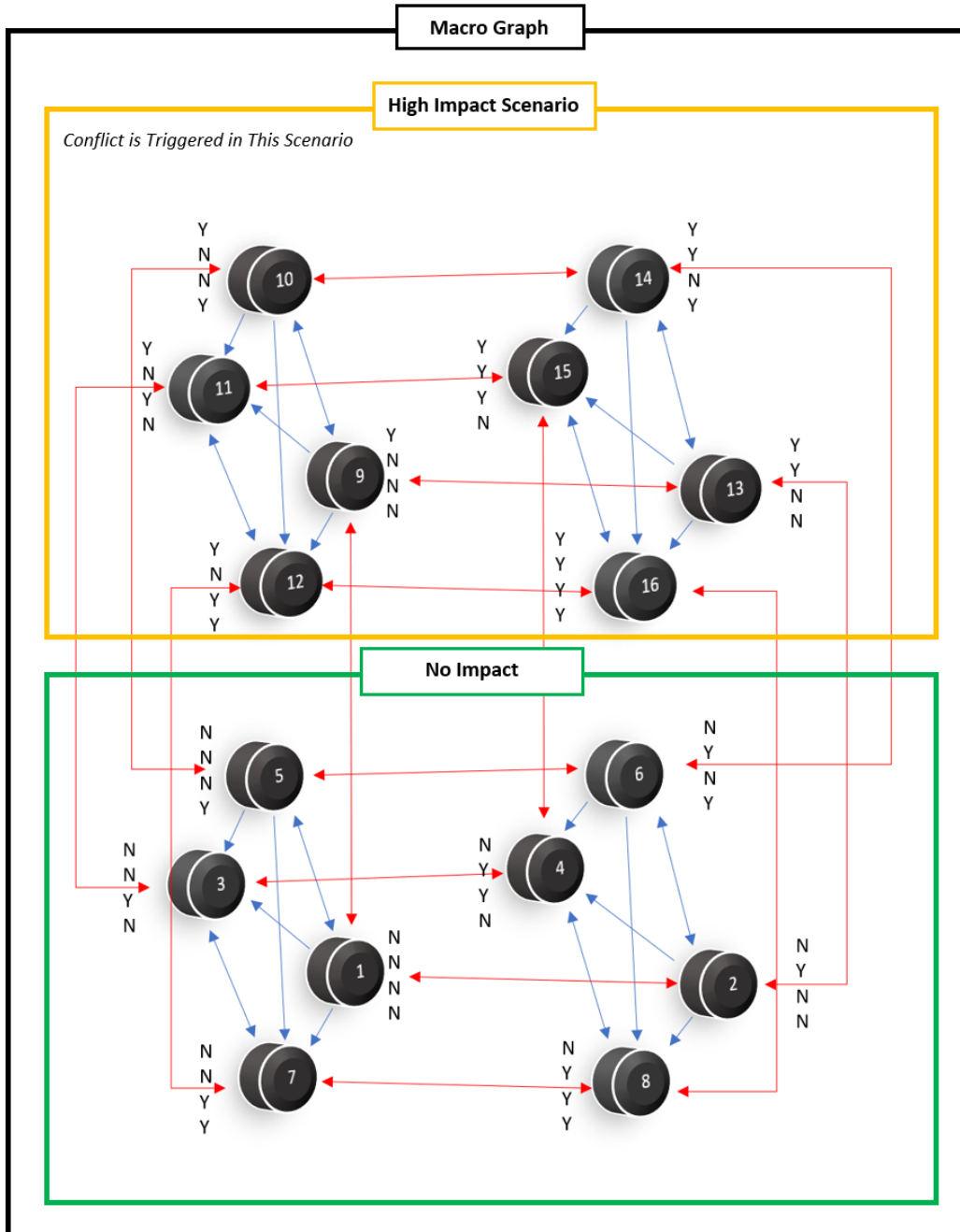


**Figure 4.14: Macro Graph - CT illustrated**

## 4.9 Summary

The use of GMCR gave a clear view of the conflict which enables the user to be more knowledgeable on the current situation, this will aid in making better decisions. GMCR also enables the user to make changes to the model and envision how the dispute will evolve as a DM execute his options. The use of BATNA illustrated that South Sudan made a mistake by not accepting the fees of North Sudan. The calculation of the reservation point in BATNA enables a DM to understand when to accept or reject an offer. In this case, if South Sudan used BATNA, they would have made the right decision. The integration of BATNA and GMCR will add value to a mediator because GMCR will provide enough information to understand what preference or actions are needed to end the dispute in the desired state.

In contrast, BATNA aids the mediator by showing how to reach the desired state. An application of BATNA-GMCR on the Sudan conflict in real time will aid both DMs to reach a desired resolution. Also, it will quantify the value of an option in which the model will switch from a desirable state.

# Chapter 5
# Conclusions and Future Work

The main contributions put forward in this thesis are: the introduction of a two identical Graph Model system with different preferences to illustrate the strength of sanctions, the use of BATNA to guide a DM into making an informed choice, and the employment of CT to reduce the size of the conflict model. The results are promising and provide worthwhile avenues for future research.

## 5.1 Advancements

Often, a DM in a dispute is overwhelmed by the number of variables that must be taken into account. GMCR allows a DM to be well informed of the situation and to envision the conflict from a macro view, thereby enabling the DM to efficiently understand the conflict and aiding him or her to make reasonable decisions. The application of GMCR to both the OPEC-SHALE conflict and the Sudan conflict has been demonstrated to be useful. For the case of the OPEC-SHALE conflict, SHALE had two preference rankings based on whether the financial sanction, "Squeeze," was tolerable or intolerable. The introduction of the two similar graphs with different preference enables a user to show how these two preferences produce two different equilibria. This information helps the DM to see the possible outcomes and identify which option will cause the game to switch from one graph to another. In this case, SHALE understands that with tolerable sanctions the outcome will be more favorable and hence SHALE can focus mostly on reducing its cost of production. In contrast, OPEC also sees that the option to squeeze decides the game to be played and therefore OPEC can calculate how strong this option should be for the game end in its favor.

In the Sudan conflict, the use of BATNA showed that South Sudan made a mistake by not accepting North Sudan's fees. The calculation of the reservation point with BATNA enables a DM to understand when to accept or reject an offer. In this case, if South Sudan had used BATNA, it would have made

the right decision, while, if North Sudan had used BATNA, it could have used the information to convince South Sudan that accepting the fees was the right option by using facts and numbers. The integration of BATNA and GMCR can add value to mediators because GMCR can provide enough information to show what preferences or actions are needed to end the dispute in the desired state. In contrast, BATNA aids the mediator by showing him or her how to reach the desired state.

## 5.2 Future Work

The CT principle provided results consistent with the macro model. However, the CT principle should be applied to more models of different sizes to verify that the findings remain consistent. It is also expected that a model may have more than one CT which needs to be investigated. Another idea is to expand the strength of sanction approach, which generated two Graph Models with different equilibria. In this thesis, the strength of sanction only had two levels of strength: tolerable and intolerable. However, this approach could be expanded to more than two levels. As a result, a user would be able to see two or more graphs based on the number of levels and identify the equilibria of each level. The user could then understand the consequences of triggering each possible graph. Finally, after further investigations of actual conflict situations, all of the main ideas put forward in this thesis could be generalized by attaching formal mathematical definitions and structures.

# Bibliography

Adiebo, K., Bandiera, L., & Zacchia, P. (2013). *Public expenditures in South Sudan: are they delivering.* The World Bank. Retrieved August 2018, from http://documents. worldbank. org/curated/en/2013/02/17682880/public-expenditures-south-sudan-delivering

Aljefri, Y. M., Bashar, M. A., Fang, L., & Hipel, K. W. (2017). First-level hypergame for investigating misperception in conflicts. IEEE Transactions on Systems, Man, and Cybernetics: Systems, (99), 1-18.

Aljefri, Y. M., Hipel, K. W., & Fang, L. (2018). General hypergame analysis within the graph model for conflict resolution. International Journal of Systems Science: Operations & Logistics, 1-16.

Alquist, R., & Guénette, J. D. (2014). Blessing in Disguise: The Implications of High Global Oil Prices for the North American Market. *Energy Polict, 64*, 49-57.

Bashar, M. A., Kilgour, D. M., & Hipel, K. W. (2012). Fuzzy preferences in the graph model for conflict resolution. IEEE Transactions on Fuzzy Systems, 20(4), 760-770.

Bashar, M. A., Obeidi, A., Kilgour, D. M., & Hipel, K. W. (2016). Modeling fuzzy and interval fuzzy preferences within a graph model framework. IEEE Transactions on Fuzzy Systems, 24(4), 765-778.

Bazerman, M. H. (2012). *BATNA Basics: Boost Your Power at the Bargaining Table.* Harvard Low School.

Behar, M. A., & Ritz, R. A. (2016). An analysis of OPEC's strategic actions, US shale growth and the 2014 oil price crash. International Monetary Fund.

Davis, B. (2017). The United States and South Africa during the Kennedy Administration 1961-1963: John F. Kennedy, the United States, and South Africa. Clark University.

Davlin, B. (2014). BNP Near Settlement With U.S. for up to $9 Billion. *Wall Street Journal*.

Dodge, T. (2010). The failure of sanctions and the evolution of international policy towards Iraq, 1990–2003. Contemporary Arab Affairs, 3(1), 83-91.

Eckbo, P. L. (1976). Future of world oil.

EIA (2012). Annual energy review 2011. Energy Information Administration.

EIA (2018). *Short-Term Energy Outlook ( STEO).* EIA.

EIA (2014). *Annual Energy Outlook.* Washington.

Fang, L., Hipel, K. W., & Kilgour, D. M. (1993). Interactive decision making: the graph model for conflict resolution (Vol. 3). John Wiley & Sons.

Fang, L., Hipel, K. W., Kilgour, D. M., & Peng, X. (2003a). A decision support system for interactive decision making-Part I: model formulation. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), 33(1), 42-55.

Fang, L., Hipel, K. W., Kilgour, D. M., & Peng, X. (2003b). A decision support system for interactive decision making-Part II: analysis and output interpretation. IEEE Transactions On Systems, Man, and Cybernetics, Part C (Applications and Reviews), 33(1), 56-66.

Fisher, R., Ury, W. L., & Patton, B. (2011). Getting to yes: Negotiating agreement without giving in. Penguin.

Hamouda, L., Kilgour, D. M., & Hipel, K. W. (2004). Strength of preference in the graph model for conflict resolution. Group Decision and Negotiation, 13(5), 449-462.

Hamouda, L., Kilgour, D. M., & Hipel, K. W. (2006). Strength of preference in graph models for multiple-decision-maker conflicts. Applied Mathematics and Computation, 179(1), 314-327.

He, S., Kilgour, D. M., Hipel, K. W., & Bashar, M. A. (2013). A basic hierarchical graph model for conflict resolution with application to water diversion conflicts in China. INFOR: Information Systems and Operational Research, 51(3), 103-119.

He, S., Hipel, K. W., & Kilgour, D. M. (2017). Analyzing market competition between Airbus and Boeing using a duo hierarchical graph model for conflict resolution. Journal of Systems Science and Systems Engineering, 26(6), 683-710.

Hipel, K. W., Fang, L., & Xiao, Y. (2018). Managing conflict in aquaculture. Marine Economics and Management.

IEA (2012). *World Energy Outlook.* Paris: OECD.

Inohara, T., Hipel, K. W., & Walker, S. (2007). Conflict analysis approaches for investigating attitudes and misperceptions in the War of 1812. Journal of Systems Science and Systems Engineering, 16(2), 181-201.

Inohara, T., & Hipel, K. W. (2008). Coalition analysis in the graph model for conflict resolution. Systems Engineering, 11(4), 343-359.

Inohara, T., & Hipel, K. W. (2008). Interrelationships among noncooperative and coalition stability concepts. Journal of Systems Science and Systems Engineering, 17(1), 1-29.

Johnson, D. H. (2012). The Heglig Oil Dispute between Sudan and South Sudan. Journal of Eastern African Studies, 6(3), 561-569.

Kilgour, D. M., Hipel, K. W., & Fang, L. (1987). The graph model for conflicts. Automatica, 23(1), 41-55.

Kilgour, D. M., Hipel, K. W., Fang, L., & Peng, X. J. (2001). Coalition analysis in group decision support. Group Decision and Negotiation, 10(2), 159-175.

Kilgour, D. M., & Hipel, K. W. (2005). The graph model for conflict resolution: past, present, and future. Group Decision and Negotiation, 14(6), 441-460.

Kilgour, D. M., & Hipel, K. W. (2010). Conflict analysis methods: The graph model for conflict resolution. In Handbook of group decision and negotiation (pp. 203-222). Springer, Dordrecht.

Kinsara, R. A., Petersons, O., Hipel, K. W., & Kilgour, D. M. (2015). Advanced decision support for the graph model for conflict resolution. Journal of decision systems, 24(2), 117-145.

Knoema. (2018). *Knoema*. Retrieved July 2018, from Cost of Producing a Barrel of Crude Oil by Country: https://knoema.com/rqaebad/cost-of-producing-a-barrel-of-crude-oil-by-country

Kuang, H., Bashar, M. A., Kilgour, D. M., & Hipel, K. W. (2015a). Strategic analysis of a brownfield revitalization conflict using the grey-based graph model for conflict resolution. EURO Journal on Decision Processes, 3(3-4), 219-248.

Kuang, H., Bashar, M. A., Hipel, K. W., & Kilgour, D. M. (2015b). Grey-based preference in a graph model for conflict resolution with multiple decision makers. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 45(9), 1254-1267.

Li, K. W., Hipel, K. W., Kilgour, D. M., & Fang, L. (2004). Preference uncertainty in the graph model for conflict resolution. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 34(4), 507-520.

Li, K. W., Hipel, K. W., Kilgour, D. M., & Noakes, D. (2005a). Integrating uncertain preferences into status quo analysis with applications to an environmental conflict. Group Decision and Negotiation, 14(6), 461-479.

Li, K. W., Kilgour, D. M., & Hipel, K. W. (2005b). Status quo analysis in the graph model for conflict resolution. Journal of the Operational Research Society, 56(6), 699-707.

Mănescu, C. B., & Nuño, G. (2015). Quantitative effects of the shale oil revolution. Energy Policy, 86, 855-866.

Nakov, A., & Nuno, G. (2013). Saudi Arabia and the oil market. The Economic Journal, 123(573), 1333-1362.

Obeidi, A., Hipel, K. W., & Kilgour, D. M. (2005). The role of emotions in envisioning outcomes in conflict analysis. Group Decision and negotiation, 14(6), 481-500.

Obeidi, A., Kilgour, D. M., & Hipel, K. W. (2009a). Perceptual stability analysis of a graph model system. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 39(5), 993-1006.

Obeidi, A., Kilgour, D. M., & Hipel, K. W. (2009b). Perceptual graph model systems. Group Decision and negotiation, 18(3), 261-277.

Oil, S. W. (2008). *Fatal Transactions.* Retrieved from https://www.paxforpeace.nl/media/files/sudans-whose-oil.pdf

OPEC, O. (2011). Annual Statistical Bulletin 2010/2011. Organization of Petroleum Exporting Countries, Vienna, Austria.

OPEC. (2018). *Member Countries*. Retrieved from OPEC: https://www.opec.org/opec_web/en/about_us/25.htm

OPEC. (2018). *Oil Market Outlook for 2019.* Vienna.

Osterrieder, H., Lehne, J., & Kmec, V. United Nations Interim Security Force for Abyei (UNISFA). In The Oxford Handbook of United Nations Peacekeeping Operations.

Ottaway, M., & El-Sadany, M. (2012). Sudan: From conflict to conflict (Vol. 8). Carnegie Endowment for International Peace.

Patey, L. A. (2010). Crude days ahead? Oil and the resource curse in Sudan. African Affairs, 109(437), 617-636.

Pedersen, A., & Bazilian, M. (2014). Considering the impact of oil politics on nation building in the Republic. ELSEVIER, 163-175.

Rêgo, L. C., & dos Santos, A. M. (2015). Probabilistic preferences in the graph model for conflict resolution. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 45(4), 595-608.

SCR, S. C. (2013, Nov 25). Special Research Report: UN Sanctions. *Security Councli Report*.

Sieminski, A. (2014). International energy outlook. Energy Information Administration (EIA), 18.

State, U. D. (2001, September 23). *Excutive Order 13224*. Retrieved from www.State.Gov: https://www.state.gov/j/ct/rls/other/des/122570.htm

Stevens, P. (2016). International Oil Companies. Chatham House.

Wang, M., Hipel, K. W., & Fraser, N. M. (1988). Modeling misperceptions in games. *Behavioral Science*, *33*(3), 207-223.

Wang, M., Hipel, K. W., & Fraser, N. M. (1989). Solution concepts in hypergames. Applied Mathematics and Computation, 34(3), 147-171.

Walker, S. B., Hipel, K. W., & Inohara, T. (2012a). Dominating attitudes in the graph model for conflict resolution. Journal of Systems Science and Systems Engineering, 21(3), 316-336.

Walker, S. G. B., Hipel, K. W., & Inohara, T. (2012b). Attitudes and preferences: Approaches to representing decision maker desires. Applied Mathematics and Computation, 218(12), 6637-6647.

Weekly, J. I. (2011). Sudanese armed forces launch offensive in Blue Nile state. *Jane's Information Group, 3*(36).

Xu, H., Hipel, K. W., & Kilgour, D. M. (2009a). Matrix representation of solution concepts in multiple-decision-maker graph models. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 39(1), 96-108.

Xu, H., Hipel, K. W., & Kilgour, D. M. (2009b). Multiple levels of preference in interactive strategic decisions. Discrete Applied Mathematics, 157(15), 3300-3313.

Xu, H., Kilgour, D. M., Hipel, K. W., & Kemkes, G. (2010). Using matrices to link conflict evolution and resolution in a graph model. European Journal of Operational Research, 207(1), 318-329.

Xu, H., Hipel, K. W., Kilgour, D. M., & Fang, L. (2018). Conflict resolution using the graph model: Strategic interactions in competition and cooperation (Vol. 153). Cham: Springer.

Young, J., & Lebrun, E. (2006). The south Sudan defence forces in the wake of the Juba declaration. Geneva: Small Arms Survey.

Yu, J., Hipel, K. W., Kilgour, D. M., & Zhao, M. (2016). Option prioritization for unknown preference. Journal of Systems Science and Systems Engineering, 25(1), 39-61.

Zambakari, C. (2013). In search of durable peace: the Comprehensive Peace Agreement and power sharing in Sudan. *The Journal of North African Studies*, *18*(1), 16-31.

Zhu, Z., Kilgour, D. M., & Hipel, K. W. (2018). A New Approach to Coalition Analysis Within the Graph Model. IEEE Transactions on Systems, Man, and Cybernetics: Systems.

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