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A Descriptive Model to Analyze Asymmetric Multilateral Negotiations

Majid Sheikhmohammady, Kaveh Madani

Abstract

In multi-lateral negotiations, parties can use their power (political, military, economic, etc.) to affect the final outcome of the game. In these games which are usually asymmetric, due to uneven powers of the negotiators, players seek reaching their most preferable outcome for which they can gain support from the other players. Conventional conflict resolution methods do not consider the power of negotiators as an element of the analysis. Here, we propose a method for studying multilateral asymmetric negotiations. This method considers the power of the negotiator as a determining factor in finding the final resolution. The proposed method is applied to find the most likely outcome of an international water conflict which has remained unresolved since 1993. In this game, five costal countries have been negotiating over the legal status of Caspian Sea without reaching any success, resulting in tragedy of the commons. The results of this study are compared with those of other studies on Caspian Sea conflict where the powers of decision makers have not been taken into account in the analysis.

Introduction

Kersten (2002) defines negotiation as "a process of social interaction and communication that involves the distribution and redistribution of power, resources, and commitments". Although there are many approaches to the theory and practice of negotiation, they all fall into one of the only two fundamental categories: 1) Positional negotiation, also called contentious or competitive negotiation; and 2) Integrative negotiation, also known as cooperative problem solving or group decision making. Positional negotiation is often referred to as *hard* bargaining, while integrative negotiation is *soft*. Hard bargaining focuses on winning, avoids compromise, may include hidden agendas, and may result in one-sided agreements. In contrast, soft bargaining is adaptable, focuses on finding win/win solutions, encourages compromise, and sometimes creates innovative solutions (Fisher et al., 1991). This research falls generally within the first category, but seeks to integrate ideas from both.

One common classification of models is as normative (prescriptive), and descriptive. However, this categorization is not exclusive, and one cannot necessarily ascribe a given model or methodology to only one category. The method which we propose here is mostly descriptive. The main objective of this method is to identify the most likely outcomes of a particular form of multilateral negotiation, based on the capabilities of the decision makers and their preferences over the known available alternatives. The negotiation problems modeled and analyzed by this method are distinctive because the set of possible agreements is discrete and pre-specified. Each decision maker has two concerns: first, achieving an alternative which is as preferred as possible; and second, building support among the other decision makers for this alternative. This method only

requires each decision maker's preference ordering of the alternatives, and does not require cardinal measures of preference. Generally, this method is applicable to multilateral negotiations with the following characteristics:

1) Decision makers in the negotiation look for a feasible resolution, in other words, a stable or enduring agreement. Apparently, each negotiator tries to attain his/her most preferable agreement.

2) If an agreement is reached, it must be an alternative from a pre-specified list, which all decision makers must accept.

3) Decision makers can possess different levels of capability (power or legitimacy) in support of an agreement, so the negotiation is not necessarily symmetric.

Proposed Definitions and Method

We now propose new definitions to identify the likely agreements and specify their likelihoods. Suppose that $N=\{1,2,3,...,n\}$ is the set of all decision makers (DMs) in the negotiation, and $A=\{a_1,a_2,...,a_q\}$ is the set of all alternative agreements. We assume $n \geq 2$ and $q \geq 2$.

Definition 1: DMs' Preference Rankings over Agreements

For $i \in N$, $\succsim_i$ is DM i's weak preference relation on A. Thus, $a_k \succsim_i a_j$ means i prefers a_k to a_j or is indifferent between a_k and a_j. The relation $\succsim_i$ is assumed to be reflexive and complete. Strict preference for DM i is the relation $\succ_i$, defined on A by $a_k \succ_i a_j$ iff $a_k \succsim_i a_j$ and $\neg(a_j \succsim_i a_k)$, where $\neg$ means negation. For $i \in N$, $\square_i$ is DM i's indifference relation on A; $a_j \square_i a_k$ iff $a_k \succsim_i a_j$ and $a_j \succsim_i a_k$. Preferences are usually transitive but not always, and the methodology developed herein can be used even when preferences are intransitive. We define $P_i(a_j) = 1 + |\{a \in A : a \succ_i a_j\}|$ to indicate the preference of DM i over the alternative a_j. For example $P_2(B) = 1$ means that alternative B is the best alternative according to DM 2. Likewise, $P_3(A) = P_3(D) = 4$ indicates that DM 3 is indifferent between alternatives A and D and considers these alternatives as his or her fourth preference.

Definition 2: Acceptability

Each DM may be willing to accept only some of the proposed alternatives as the outcome of the negotiation. For each DM, acceptability is denoted by a positive integer. DM i will accept alternative a_j iff $P_i(a_j) \leq \text{Acc}_i$.

Definition 3: State

A negotiation state consists of an alternative and a non-empty subset of DMs who support that alternative as the outcome of the negotiation. Thus, (a_j,C) denotes a negotiation state where $a_j \in A$ and $C \subseteq N, C \neq \varnothing$. The set of all states is $S = A \times (2^N - \varnothing)$. Note that $|S| = q.(2^n - 1)$.

Definition 4: Feasibility

An agreement can be implemented iff the supporting coalition is strong enough. Hence, a negotiation state is feasible if the coalition defined by the state is strong enough to enforce the agreement defined by the state. To reflect the different power or legitimacy of DMs in real-world negotiations, we denote w_i, the weight of DM *i* in the negotiation. If the sum of coalition members' weights is at least equal to the threshold, T, then the negotiation state is feasible. T is the minimum strength (total weight) of a coalition to enforce an agreement and must be determined before state feasibility can be assessed.

In summary, a weight $w_i > 0$ is assigned to each $i \in N$ and for each $a_j \in A$ a threshold $T(a_j) > 0$ is determined. A negotiation state (a_j,C) is feasible iff $\sum_{i \in C} w_i \geq T(a_j)$. If we simplify this further by assuming $T(a_1) = T(a_2) = ... = T(a_q) = T$, then (a_j,C) is feasible iff $\sum_{i \in C} w_i \geq T$.

Definition 5: Stability

A negotiation state from which there is no movement is called stable. Different types of movements are defined in later sections.

Definition 6: Fallback Distance (FD)

FD_i is a non-negative integer parameter describing DM *i*. DM *i* is willing to make an strategic disimprovement and accept a_k rather than a_j, even though $a_k \prec_i a_j$, if $P_i(a_k) - P_i(a_j) \leq FD_i$.

The proposed methodology is based on the analysis of stable states. To determine the stable states, we must describe the different possible movements (the likelihood of occurrence of different moves is not the same). Members of the coalition of a negotiation state might move to another state for the following reasons:

1. *Preferential Improvement:* The members of the coalition find a more preffered alternative.
2. *Agglomeration:* One or more extra DMs join the coalition because they support the agreement that the coalition is enforcing.
3. *Disloyalty:* One or more members of a coalition may form another coalition (on their own or along with other DMs) to support another agreement.
4. *Strategic Disimprovement:* One or more members of a coalition may join another coalition supporting an agreement that is less peffered. This strategic disimprovement must be a move from an infeasible state to a feasible one.

Caspian Sea Conflict

The Caspian Sea, the largest lake on the earth, has been the subject of one of the world's most intractable disputes, involving five littoral states of Azerbaijan, Kazakhstan, Iran, Russia, and Turkmenistan since the collapse of the Union of the Soviet Socialist Republics (USSR) in 1991. Before this time, the Caspian Sea was shared by Iran and the USSR and two countries were enjoying a stable relationship based on two mutual treaties of 1921 and 1941. Currently, there are five states bordering the Caspian Sea and there is a dispute over who owns which part of the Caspian Sea, or whether the five littoral states share the entire sea in some sense. The main motivation of the five states is the existence of immense amounts of petroleum in the seabed. Since 1992, the five littoral states have met on 26 occasions, at the presidential, ministerial and expert levels, in all five states and in many different cities. The last presidential negotiating meeting was held in October 2007 in Tehran. The lack of resolution has resulted in tragedy of the commons where petroleum production is increasing pollution and overfishing is contributing to the environmental degradation of this valuable natural resource. (Sheikhmohammady and Madani, 2008a)

Sheikhmohammady and Madani (2008a, 2008b) provided more details about the Caspian Sea conflict. Based on their discussion, five alternatives are available to resolve the legal status of the Caspian Sea, denoted as follows:

C: Condominium
D_m: Division based on the International Law applying to Seas
D_e: Equal Division (20 percent of the sea, and the seabed goes to each littoral state)
D_s: Division based on Soviet maps
DC: Division of the seabed based on International Law, and condominium on the surface

Based on assessments of the countries' national economic, political and military interests, and on their public statements, it is possible to infer that each state has strict preferences over the five alternatives. The states' preferences are as follows (where ">" means "strictly prefers"):

Azerbaijan: $D_s > D_m > DC > D_e > C$
Iran: $C > D_e > D_m > DC > D_s$

Kazakhstan: $D_s > D_m > DC > C > D_e$

Russia: $C > DC > D_s > D_m > D_e$

Turkmenistan: $D_e > D_s > D_m > DC > C$

It is important to note that "Equal Division" does not result in equal shares in the revenue. Each state would receive 20 percent of the total surface (and seabed) of the Caspian Sea, located adjacent to its shores. Since oil and gas resources are not uniformly distributed across the sea, the distribution of resources among states would be unequal. In contrast, the condominium alternative proposes that each state simply receive an equal share of the total revenue from joint exploitation of the resources.

Decision Makers' Weights in the Caspian Sea Negotiations

The most challenging step in modeling the Caspian Sea negotiations based on the proposed methodology is estimation of the DMs' weights. In cases such as the Caspian Sea conflict estimation of the DM's weights is not as straightforward as cases such as the decision mechanism of the Security Council of the United Nations or the voting system of the European Union. In these examples, DMs' weights reflect their level of legitimacy in the voting system and modeling is easier than cased in which the weights of the DMs are not clearly stipulated. DMs' weights in the Caspian Sea conflict must be determined based on their capabilities in the negotiation process.

The powers of the DMs must be estimated quantitatively by the analyst. In these cases, the fundamental issue is the notion of power itself: What enables one party to gain something from another patty in a negotiation? Power is a basic concept in both physics and political science. To the physicist, power has a precise definition, nevertheless, to the political scientist, it is vague. It is hard to go very deep into an analysis of negotiations without invoking the concept of power. The natural science definition of power faces many conceptual problems when it is imported into the social sciences. In physics, power is defined simply as work done divided by the time taken to accomplish it. Time has a standard measurement and work is defined by the force, which is required to move an object, and the distance. Since the early 1930s, social scientists have had a good working definition of power as *the ability of one party to move another party in an intended direction*. However, there are two main difficulties in measurement of power. First, resources come in many shapes and sizes, making it difficult to aggregate them within a single measure. Second, resources sometimes come shapelessly, for instance in leadership or moral rights, obligations, or commitments. Therefore, it is very difficult to measure precisely the power of DMs in negotiations.

In the negotiations over the legal status of the Caspian Sea, the weights of the decision makers are not pre-specified. We proceed to estimate the power of the countries involved in these negotiations by applying a Multiple Criteria Decision Analysis (MCDA) model. It should be emphasised that this is only an estimation and that precise measurement of the nations' powers is not possible because some criteria like diplomatic efforts or negotiators' tactical skills are not quantified and therefore, cannot be easily measured.

Table 1 lists all criteria that are considered to be important determinants of countries' capabilities in the Caspian Sea negotiations. For each criterion, associated indicators are also given.

Table 1. Criteria and associated indicators applied to estimate the weights of the negotiators involved in the Caspian Sea Conflict

Criteria	Indicators
Economic Independence and Self-Sufficiency	GNI/capita Net trade / GDP GDP/ Claimed Caspian Sea Oil and Natural Gas
Military Status of the Country	Annual Military Expenditures Military Expenditures/ GDP Active Troops/ Population Nuclear Power Status
US Support	US Financial Support US Political Support
Political Influence and Structure	The Territory of Political Influence Democracy Level

To evaluate the weights of the decision makers in the negotiations over the Caspian Sea, the importance of each criterion should be determined. The Data Envelopment Analysis (DEA) method can be applied to find the most favourable set of relative importance of different criteria for each country. We use the DEA method to combine indicator values to obtain weights for the countries. DEA is an increasingly popular management decision tool initially proposed by Charnes et al. (1978). It is a linear programming based technique originally designed to measure the relative performance of a number of producers or decision making units, where the presence of multiple inputs and outputs makes comparisons difficult. During the last decades, a significant amount of research has focused on DEA for both theoretical extensions and practical applications. Cook and Kress (1994) discussed relationships between DEA and MCDA and proposed a DEA-based MCDA method to handle both cardinal and ordinal criteria. Based on the DEA concept, the weight of a criterion for a specific country could be different from the weight of that criterion for another country. The comparison is conducted in a fair manner by permitting each country to maximize its possibility of obtaining the best aggregate evaluation result.

Different parameters Caspian Sea negotiations model are shown in Table 2. The numbers in the weight column of this Table are the results of applying a MCDM model using the DEA method. Acceptability and Fallback Distance of the five Caspian Sea states were calculated by using definitions 2 and 6 based on the historical background of the conflict.

Table 2. Negotiation parameters

Country	Weight	Acceptability	Fallback Distance
Azerbaijan	4.91	2	1
Iran	4.55	1	1
Kazakhstan	4.48	2	1

Russia	9.98	1	1
Turkmenistan	3.26	3	1

In the Caspian Sea negotiations, there are five decision makers and five alternatives, so the number of the negotiation states is $5 \times (2^5 - 1) = 155$. We know that some bilateral treaties or multilateral agreements among some of the five states have already occurred since the collapse of the USSR. But these agreements may not endure, because the five presidents of the Caspian Sea states agreed, in their joint declaration at the end of the Tehran meeting in October 2007 that the legal regime of the Caspian Sea should be determined unanimously.

Results

We applied the proposed methodology to predict the most likely outcomes of the Caspian Sea negotiations. Since the five Caspian Sea states have agreed that the legal regime of the Caspian Sea should be determined unanimously, it is reasonable that the threshold of all alternatives is set at T= 27. In this case, only unanimous agreements over the five alternatives are feasible. There are 38 stable states, however, only the five unanimous agreements are feasible. Results indicate that among the five unanimous agreements, state $(D_m, \{A, I, K, R, T\})$ is the most likely enduring legal status of the Caspian Sea, and $(D_s, \{A, I, K, R, T\})$ is second most likely. In other words, unanimous agreement over the division of the Caspian Sea based on International Law applying to Seas is the most likely state that might evolve as the ultimate outcome of the negotiations. Under this division method, also known as "sectoral division", full maritime boundaries of the five countries would be established based on the median lines from the shores of the littoral states, using the principle of equidistance to divide the sea and the undersea resources into national sectors" (Sheikhmohammady and Madani, 2008a).

Discussion

Table 3 shows the predicted outcome of Caspian Sea negotiations based on different methods which have been applied to this case. The previous studies on Caspian Sea conflict had applied normative methods for predicting the outcome and therefore, their results are different from the mostly descriptive method which was used. The normative methods used before had ignored the powers of negotiators in this conflict while the proposed method addresses the powers of the parties in negotiations. The majority of previously applied methods had found D_s (division based on the Soviet Maps) as the final resolution of this conflict while D_m was found to be the final outcome of the negotiations when the parties use their powers to change the outcome to increase their gain. If negotiators use their power (which is always true for cases like the example studied here), the final outcome might not necessarily be socially optimal (as suggested by Social Choice rules), belong to the compromise set of the problems in which negotiators have equal powers (Fallback Bargaining Procedures), be the state which is stable under different solution concepts for static games (found by Graph Model for Conflict Resolution (GMCR)).

Table 3. Predicted outcome of Caspian Sea negotiations based on different methods

Method	Rule	Result	Concept
Proposed Method	----------	D_m	Predicted Outcome
Social Choice Rules *(Sheikhmohammady and Madani, 2008a)*	Condorcet Choice	D_s	Socially Optimal Alternative
	Borda Scoring	D_s	
	Plurality Rule	D_s or C	
	Majoritarian Compromise (MC)	D_s	
	Median Voting Rule (MVR)	D_s	
	Condorcet's Practical Method (CPM)	D_s	
Fallback Bargaining Procedures *(Sheikhmohammady and Madani, 2008a)*	Unanimity Fallback Bargaining (UFB)	DC or D_m	Compromise Set
	3-Approval Fallback Bargaining (3-Approval FB)	D_s or D_m	
	4-Approval Fallback Bargaining (4-Approval FB)	D_s	
	Fallback Bargaining with Impasse	*No Agreement*	
Graph Model for Conflict Resolution (GMCR) *(Sheikhmohammady el al., 2006)*	----------	D_e	Equilibrium

Conclusions

A new methodology was applied to identify the most likely outcome of the continuing negotiations over the legal status of the Caspian Sea, considering the powers of the conflict parties. We found division based on International Law applying to Seas as the ultimate legal status of the Caspian Sea. Comparison of the result of this study with previous studies on this conflict shows that normative methods predict a different outcome for this conflict. However, those methods do not consider the powers of negotiators in the conflict and therefore, their results might not well reflect the reality of this conflict.

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