Conflict of interest: an axiomatic approach

ROBERT AXELROD
Department of Political Science, Yale University

Introduction

In all of man's written record there has been a preoccupation with conflict of interest; possibly only the topics of God, love, and inner struggle have received comparable attention [Luce and Raiffa, 1957, p. 1].

Conflict of interest is the state of incompatibility of goals of two or more actors. The amount of conflict of interest in a given situation is important for two reasons: as a key explanatory variable (Deutsch, 1949), and as a dependent variable of significance in its own right.

This paper (1) gives a preliminary discussion of the axiomatic approach to be used, (2) reviews the utility theory which is employed in the analysis, (3) advances a list of properties which should be satisfied by any measure of conflict of interest in bargaining situations, (4) discusses the unique measure which satisfies these properties, (5) generalizes the measure to a different type of strategic interaction (the so-called Prisoner's Dilemma), (6) tests the hypothesis that the greater the conflict of interest the more likely it is that conflictful behavior will follow, and (7) suggests some other uses of the measure of conflict of interest.

Conflict, a term which is used in this paper interchangeably with conflict of interest, is a property of the preferences of the participants and the structure of the situation in which they find themselves. It does not refer to their behavior nor to the actual outcome of the situation. Of course the amount of conflict which a situation contains will affect the behavior and the outcome, and this fact will be used later to suggest hypotheses and to employ experimental results to test the hypotheses. Strictly speaking, however, what is tested is not the measure of conflict (since the measure is just a stipulative definition) but rather the theory about how people's behavior changes in situations with different amounts of conflict of interest. Whatever validity the measure itself has rests upon the extent to which it coincides with what is normally meant by the term "conflict of interest," or "the
amount of incompatibility of the players’ preferences in a given situation of strategic interaction.”

Game theory provides an excellent framework in which to conceptualize a discussion of conflict. The game theoretic description of a two-person interaction specifies the set of available strategies and the payoffs to each player for any strategy pair which occurs. For example, in a zero-sum game, whatever one player gets the other must lose. This situation has total incompatibility of goals; there is no room for cooperation. The opposite extreme is the case in which the interests of the players coincide exactly. In this partnership situation the outcome most preferred by one player is also most preferred by the other. Neither one of these abstract extremes is very frequent: zero-sum games are good approximations to certain military confrontations at the tactical level, and partnership games could be used to describe the ideal business partnership. The relevant problems in the social sciences fall between these extremes. These situations are mixed-motive games in that the actors have an incentive both to compete and to cooperate with each other (Schelling, 1960). An important question is to what extent a given game is like a zero-sum game and to what extent it is like a partnership game. In brief, the problem is to develop a measure of the amount of conflict in a given situation.

In order to do this, the meaning of conflict of interest will first be considered in the context of a particular kind of mixed-motive game called the bargaining game. It will be argued that any scheme which purports to measure conflict in the bargaining game should satisfy certain properties. If the properties are not very restrictive there will be many possible ways of measuring conflict. However, if they are too restrictive there will be no procedure which satisfies all of them simultaneously. The ideal case is a list of reasonable properties which is restrictive enough so that there can be no more than one possible measure, and not so restrictive as to eliminate all measures. With such a list there will be a unique measure of conflict. Just such a list of properties will be suggested for bargaining games, and the resulting measure of conflict will be presented.

This axiomatic approach forces one to accept the derived measure of conflict for bargaining games if he accepts the list of properties. However, if he disagrees that each of the properties should be required of a measure of conflict, then he is free to reject the proposed measure and to offer other properties which a measure of conflict of interest should satisfy. Our hypothetical friend also has the option of accepting the properties and the measure for bargaining games, but disagreeing with the manner in which the proposed measure is later generalized to cover Prisoner’s Dilemma games.

UTILITY THEORY

It will be necessary to have a cardinal index of utility so that a number can be assigned to the value each player attaches to each outcome. The following means of doing this has been provided by Von Neumann and Morgenstern (1947). Suppose a person prefers A to B and B to C, and suppose that the utility of A is arbitrarily set equal to one and the utility of C arbitrarily set equal to zero. Then there exists a unique $p$ between 0 and 1 for which the person is indifferent to (a) getting B for sure, and (b) a lottery with a $p$ chance of getting A and a $1-p$ chance of getting C. The utility of B is defined to be $p$. If B is almost as valued as A, then $p$ will be only
slightly less than one, and if B is not much preferred to C, then \( p \) will be almost zero.

Two observations should be made about this way of measuring utility. First, the zero and unit points are arbitrary. The utility scale is like the scale on a thermometer. The Centigrade scale, for example, uses the freezing and boiling points of water to anchor its scale, but any two points could have been used. It is meaningless to say that 50°C is twice as warm as 25°C. However, one can say that 50°C is twice as far along from the freezing point of water to its boiling point as is 25°C. Likewise, if \( p_B = .25 \) and \( p_D = .50 \) one could not meaningfully say that D was twice as valued as B, but an accurate statement is that D is twice as far along from C to A as B is. The second observation is that utility is an index of the preferences of the player himself and in theory at least is measured by observing the choices the player makes when confronted with various lotteries. For example, if the player prefers 50 cents to an even chance of getting a dollar (or nothing) then the utility to him of 50 cents is greater than the average of the utility of a dollar and nothing.

**Bargaining Games**

**Definition of Bargaining Games**

The meaning of conflict of interest can now be discussed with respect to a particular kind of game. Among non-zero-sum games a distinction is made between those which allow communication and binding agreements and those which do not. Games which do are called cooperative games, but this terminology should not be taken necessarily to imply anything about the amount of conflict in such a game. The bargaining game is a particular kind of cooperative game whose distinctive aspect is that, while the players can agree to any one of a variety of outcomes, there is a single predetermined outcome (called the status quo point) which occurs if no agreement is reached. The game is represented in Figure 1 with each point in the shaded region corresponding to a feasible agreement. The first player desires an agreement on a point as far to the right as possible, and the second player desires one as high as possible. If they do not agree, they receive the payoffs associated with the status quo point. For simplicity it is assumed that the region of feasible outcomes is bounded, convex, and closed (i.e., contains its boundary), and that it contains some points above and to the right of the status quo point.

---

1 Nash (1950) gives the original definition of the bargaining game and "solves" it in the sense of proving that certain assumptions lead to the selection of a particular agreement.

2 Convexity is usually assumed to obtain because for any two feasible outcomes all the points between them are supposed to be feasible by arrangement of a suitable lottery.
Properties of Any Measure of Conflict in Bargaining Games

A list of properties which should be satisfied by any measure of conflict of interest in bargaining games will now be advanced.

The player whose utility is represented along the x-axis is arbitrary, so the amount of conflict should not depend on this choice. In other words it must not matter which player is called the first and which the second player. Thus the first property which is desirable in any measure of conflict is symmetry: invariance with respect to an interchange of the labels of the players.

Another arbitrary choice is that of the zero and unit points of the utility schedules of the players. The amount of conflict in a game must not depend on this choice either, so the second property is independence with respect to choice of zero and unit points of the players' utility schedules.

The next property is a formalization of the idea that if two games are almost alike then they should have almost the same amount of conflict. For example, suppose game G has a smooth curve for the boundary of its region of feasible outcomes, and that there is an infinite sequence of games Gi each with the same status quo point as G, but with regions which are closer and closer approximations to the curve of G. Since the games Gi eventually will become indistinguishable from G, their conflicts should eventually become indistinguishable from the conflict of G. This gives a property about continuity: for a game G and an infinite set of games Gi with the same status quo point, if the region of G is the limit of the regions of Gi then the conflict of G is the limit of the conflicts of the games Gi.

Without loss of generality it can be assumed that the measure of conflict always falls between two given numbers. For example, if two different measures of conflict differ only in that one gives a value twelve times as large as the other for any game, then these two measures are for all practical purposes the same, just as feet and inches are equivalent measures of length. For a reason which will become apparent later, it is convenient to take the maximum value of the measure of conflict in bargaining games to be one-half, with the minimum value zero. This gives boundedness: the bargaining games with the least and most conflict have conflict of 0 and ½ respectively.

The fifth and last property which should be satisfied by any measure of conflict of interest in bargaining games refers to the effect of adding new feasible outcomes. First suppose that two games have the same status quo point, and the region of feasible outcomes of one is entirely contained in the region of the other. Then the game with the smaller region appears to have at least as much and perhaps more conflict, since for any agreement reached in the game with the smaller region there would be a feasible outcome in the larger game which would be at least as desirable to both players. The trouble with this formulation is that when combined with the property about independence with respect to utility transformation it leads to an absurdity. The difficulty is that any bargaining game can

\[\text{Schelling (1960) might argue that two games could be identical in terms of their status quo point and region, but if one had a particular point which was made salient (owing to some considerations not included in the representation of the games solely in terms of utilities), then in that game tacit coordination would be easier, and thus it would be misleading to say they had the same amount of conflict.}\]
be represented in a way that makes its region contain the region of any other bargaining game. This would mean that any game has at the same time both more and less conflict than any other game.

The way out of this absurdity is to take a fixed representation of the utility schedules when comparing games. The most natural representation is to set the zero of the utility scale equal to the worst the player can get and the unit equal to the best he can get. The worst is obviously the status quo, and the best is the most desired of those outcomes which the other player is not sure to veto, i.e., the most desired of those outcomes which give the other player at least the same utility as the status quo point would give him. A game represented in this form has the status quo point at the origin, \( x_{\text{max}} = 1, y_{\text{max}} = 1 \), and will be said to be \textit{normalized}. Since the utilities of the players can be represented with any values chosen for their zero and unit, every game can be represented in normalized form without changing any of its essential characteristics. In particular, the property of independence guarantees that the conflict of the normalized version of a game is the same as the conflict of any other version of it.

Now suppose that new feasible outcomes which are mutually preferable to the status quo point are added to a game. Suppose further that this expansion of the region of the game does not change its normalization, but merely makes the region bulge within the same limits of \( x_{\text{max}} \) and \( y_{\text{max}} \) as before. Each new point can be regarded as increasing the maximum amount one player can get for a fixed level of utility of the other player. The amount of this increase determines how much the conflict has been reduced. This is the last property of the measure of conflict. If the increase in the maximum utility one player can get for any given level of utility of the other player is the same in two modified games, then the reduction of conflict is the same in the two games. In order to formalize this notion let \( G(x) \) be the best the second player can achieve if the first player gets \( x \), as measured in the normalized version of \( G \) (see Figure 2). (For values of \( x \) less than those which give the second player his best outcome, take \( G(x) = y_{\text{max}} \). The property of \textit{equivalent reducibility} can now be formulated as follows: if new feasible outcomes are added to games \( G \) and \( H \) in such a way that their normalizations do not change, and the change in \( G(x) \) is equal to the change in \( H(x) \), for all \( x \), then the change in the conflict of game \( G \) is equal to the change in the conflict of game \( H \).

Note how little this property asserts. The change in conflict in two games is only assumed to be equal if there are no problems of normalization and the change in \( G(x) \) is the same as the change in \( H(x) \) for each and every value of \( x \). Also note that the asymmetric treatment of the first and second players is of no consequence, since the property of symmetry already guarantees that an interchange of the labels of the players would make no difference. These two comments notwithstanding, equivalent reducibility is by far the most powerful of the five properties.

One final observation should be made before introducing the specific measure of conflict which satisfies these five properties. Two normalized games \( G \) and \( H \) might well have certain outcomes which are feasible in \( G \) but not in \( H \) and others which are feasible in \( H \) but not in \( G \). Nothing has been said so far about how to compare the conflict in two such games. Indeed, nothing need be said, because implicit in the five properties already listed is a scheme to determine precisely how much conflict is
conflict there is. The intuitive justification that this is indeed the correct measure of conflict of interest in bargaining games is simply that the more the region bulges outward, the less incompatible are the goals of the players.

Side payments provide an example of the use of the measure of conflict. By allowing side payments in a commodity which is linear in both players' utility, the region of feasible outcomes which both players prefer to the status quo is expanded to form a triangle. After normalization the new game has $G(x) = 1 - x$. The game then has the greatest conflict possible, since a triangular region does not bulge at all.5 The surprising result is that allowing side payments usually increases and never reduces the conflict in a bargaining game. The explanation is that, while the players have a common interest in achieving the joint maximum, their interests diverge on what side payments will be made.

The amount of conflict in an actual situation can be approximated with relatively little information. The case of a nonproliferation treaty between the United States and the USSR will serve as an example.6 An investigator is likely to be able to identify at least four feasible outcomes, namely:

A. No agreement is reached (i.e., the status quo point).
B. The Russian draft treaty.
C. The American draft treaty.
D. Some compromise treaty on the upper right boundary of the region of feasible outcomes (i.e., one which cannot

---

4 The proof is provided in the appendix. A parallel exists between the assumptions Nash (1950) uses to determine a unique solution to bargaining games, the conditions Arrow (1951) uses to show the impossibility of a certain kind of social welfare function, and the properties used here to determine a unique measure of conflict of interest in bargaining games.

5 The reason for taking $\frac{1}{2}$ as the largest value of conflict in bargaining games is now clear. It allows the measure of conflict to have the simple geometric interpretation as the area beyond the region.

6 A group as well as an individual can be said to have a utility schedule if it acts consistently.
be rewritten without making it less satisfactory to at least one of the players).

It will be assumed that both sides rank these outcomes in the order of their own draft being most preferred, next the compromise, then the other's draft, and worst of all no agreement. For the normalized version of the game, the payoffs are $A = (0, 0)$, $B = (1, y_1)$, $C = x_2, 1)$, and $D = (x_2, y_2)$. Now suppose the investigator is able to go to both players and get an answer to the following question: "How sure do you have to be of getting your draft approved before you would be unwilling to settle for the compromise ($D$)?" This is precisely the question which defines the utility of $D$ relative to $0$ and $1$, so the answer will be $x_2$ for the first player and $y_2$ for the second player. Thus the investigator knows that the conflict is between about $\frac{3}{4}$ and $\frac{3}{4}$. The point of this exercise is that the value of each outcome need not be known to determine the amount of conflict within reasonable bounds. This is an important feature of the measure because it means that theoretical propositions which employ it may be testable with only limited amounts of data about the actual situation.

CONFLICT IN OTHER BARGAINING SITUATIONS

The measure of conflict of interest in bargaining games can be readily generalized to cover three new bargaining game situations.

1. A bargaining game can be treated dynamically. To formalize this, let $(x_j, y_j)$ be the demands of the players at the $j$th stage of the bargaining process. Take the conflict remaining at the $j$th stage to be the area between the region and the lines $x = x_j$ and $y = y_j$, in the normalized version of the game. Then the conflict resolved by a concession depends not only on the size of the concession, but also on the current demand of the other player. Another result is that the sum of the conflicts resolved by the concessions falls short of the conflict of the game itself if and only if no feasible agreement is reached.

2. If the assumption of convexity of the region is relaxed, conflict can still be taken to be the area of the unit square beyond the region of feasible outcomes. The maximum conflict of a nonconvex bargaining game is one.

3. In an $n$-person bargaining game, where each player has a veto over any agreement, conflict is the volume of the unit hypercube which lies beyond the region of feasible outcomes. In general, the maximum conflict for an $n$-person convex
bargaining game is $1 - 1/n!$. This means that the more people are required for agreement the more conflict of interest is possible.

**Prisoner's Dilemma Games**

**The Nature of the Prisoner's Dilemma**

The proposed measure of conflict of interest has so far been applied only to a particular kind of cooperative game—bargaining games. However, the definition of the measure can be readily generalized to apply to the most famous kind of noncooperative game, the Prisoner's Dilemma. An example of a Prisoner's Dilemma is given in the matrix of Figure 3a. Without communication with the other player, each must select one of two strategies, cooperation (C) or defection (D), and this determines which of the four outcomes will occur. The payoffs are displayed in the appropriate cell of the matrix with the row chooser's payoff listed first. In deciding which strategy to choose, a player will note that he will do better if he chooses D rather than C regardless of the other player's choice. If he is the only player to defect, he gets T, the temptation to defect, while the other player gets S, the sucker's payoff. In the example these values are 10 and -10 respectively. If both defect they each get the punishment P, here equal to -1. However, if both cooperate both get the reward R, here equal to 5.8 This then is the dilemma: each player separately can do better by defecting, but together they can both do better by cooperating.

**Conflict in Prisoner's Dilemma Games**

If the sample Prisoner's Dilemma game were changed so that there were degrees of cooperation (thus insuring a convex region of possible outcomes), and the players were allowed to talk to each other and make binding agreements, then the new game would be a bargaining game. In the notation of Figure 3b, the status quo point would be (P, P) since each side

---

8 The inequalities which define the Prisoner's Dilemma are $T > R > P > S$, and $2R > S + T$. This notation is suggested by Rapoport and Chammah (1965).
would select D if no agreement were reached. The maximum one player could get if the other got at least his status quo payoff is given algebraically by

\[ U = \frac{R(T - S) - P(T - R)}{R - S} \]

which is \( y_{\text{max}} \). In the example, \( U = 7 \). The game is normalized by the linear transformation of the payoffs which makes \( P = 0 \) and \( U = 1 \). When this is done, the conflict is measured by the area of the unit square which lies beyond the region of feasible outcomes, and this area is \( (T - R)/(T - S) \), no matter what \( P \) is. Thus if the sample Prisoner's Dilemma game were changed into a bargaining game, its conflict would be \( \frac{10 - 7}{10 - (-10)} = \frac{3}{20} = .15 \).

Of course this change eliminates the dilemma aspect of the situation. In the Prisoner's Dilemma game, one player may well get more than \( U \) and the other less than \( P \). This would happen if one player defected while the other cooperated, resulting in payoffs of \( T \) and \( S \) respectively. Therefore it seems reasonable to take \( T \) rather than \( U \) as the unit of the utility schedules. \( P \) can be retained as the zero because each player can unilaterally guarantee himself at least this much. The area which determines the measure of conflict should be the area between the lines \( x = T \), \( y = T \) and the kinked line between the points \( (S, T), (R, R), \) and \( (T, S) \). This area is \( (T - R)(T - S) \) and is shown in Figure 3c. Using the normalization based on \( T = 1 \) and \( P = 0 \), the proposed measure of conflict of interest is:

\[ \text{conflict} = \frac{(T - R)(T - S)}{(T - P)^2} \]

(Prisoner's Dilemma)

In the sample game this is \( \frac{(10 - 5)(10 - (-10))}{(10 - (-1))^2} = \frac{5 \cdot 20}{11^2} = .83 \).

This example shows that a Prisoner's Dilemma game will have more conflict than the corresponding bargaining game, and this is a sensible consequence of the way the interests of the players are related in the two games. In a bargaining game the players can only gain by mutual cooperation, since each has a veto over any agreement, but in the Prisoner's Dilemma each player has an incentive not to cooperate no matter what the other player does.

**HYPOTHESIS AND DATA**

The measure of conflict itself is not testable, since it is only a definition. However, any hypothesis which relates the conflict in a situation to actual behavior is testable. The general hypothesis for Prisoner's Dilemma games is quite simple: if two Prisoner's Dilemma games are played under similar conditions and differ only in their payoff matrices, then it is more likely that the players will make a noncooperative choice D in the game with the greater conflict of interest.

The test of the general hypothesis requires a variety of games to be played under the same conditions so that factors other than the entries in the payoff matrix will be held constant.\(^9\) The only suitable published data for Prisoner's Dilemma games appears to be the work of Rapoport and Chammah.\(^10\) In the appropriate experiment (called the Pure Matrix Condition), pairs

---

\(^9\) Examples of some other factors are given in Oskamp and Perlman (1965).

\(^10\) Rapoport and Chammah (1965). In their first chapter entitled "In Search of an Index," they pose essentially the same question that is being asked here: how can observed behavior be related to an index derived from the payoff matrix?
of subjects were presented a matrix which they played three hundred times without being allowed to speak to each other. Ten pairs of college students were used for each of seven games. Table 1 lists these games in order of frequency of defection. The general hypothesis predicts that the rank-order correlation between the measure of conflict and the percentage of D responses will be high. The actual value is .84, which signifies a good fit between the hypothesis and the data. However, a word of caution is in order. Even though the correlation is high, it is still noticeably less than unity. This indicates that the proposed measure of conflict in Prisoner's Dilemma games does not always order games in exactly the same way the experimental results order them.

### ALTERING CONFLICT

The conflict of a Prisoner's Dilemma can be altered by adjusting any of the four parameters. The effect of changing a particular parameter is given by the partial derivative of conflict with respect to that parameter. Taking the partials and employing the inequalities which define the Prisoner's Dilemma shows that conflict of interest (and hence the predicted percentage of D) decreases if

\[
\frac{\partial \text{conflict}}{\partial R - S} \frac{R - S}{T - S} = \frac{(T - S)^2(T + P - 2R)}{(T - P)^3},
\]

which may be positive or negative as T + P is greater or less than 2R.

### OTHER USES OF THE MEASURE OF CONFLICT

Many studies have examined the role of factors other than the entries in the payoff matrix. T-S has been suggested by Rapoport and Orwant (1962). Lave (1965) suggests S-R, T-R, and P-R.
matrix. The measure of conflict, which depends solely on these entries, can be used to compare the effects of these other factors. For example, the finding of Sampson and Kardush (1965) that young Negroes choose D less often than do whites can be expressed in terms of the amount of conflict which would have to be added to the game played by the Negroes in order to make their responses the same as the whites.

Another major focus of experimental studies of gaming has been the study of the learning process. The parameters of the learning models have been derived from the data of each particular game. However, the measure of conflict may provide a means of giving a priori estimates for these parameters, and thus increase the generality of the models.

THREE-PERSON EQUIVALENT OF THE PRISONER'S DILEMMA

In the three-person equivalent of the Prisoner's Dilemma a player still has two choices, cooperation (C) or defection (D), and D gives a higher payoff than C no matter what the other players do. If he is the only player to defect he gets T and the other two get S. If another player also defects these two receive t and the third gets s. However, if all three defect each player gets P, which is lower than the reward R each would get if all three cooperated.

Rapoport (1960) postulated two criteria to explain the percentage of D responses in the three-person Prisoner's Dilemma:

1. Advantage of defection over cooperation in expected payoff, and
2. Average advantage over non-defecting players.

In another article Rapoport, Chammah, Dwyer, and Gyr (1962) advance three more criteria:

3. Comparison of expected gain to self and to the maker of the opposite choice,
4. Comparison of expected gain to self and others in the same outcome, and
5. Frequency of D determined by minimax strategy.

Having calculated the indices based upon these criteria, the authors found that the fourth criterion gave the best fit. Algebraically this index is

\[-i = 2(T - S) + 2(t - s)\]

The measure of conflict proposed here for the normalized three-person equivalent of the Prisoner's Dilemma is simply the volume between \(x = 1, y = 1, z = 1\) and the region defined by the eight points of the game. The normalization, as before, is \(P = 0\) and \(T = 1\). Algebraically this is

\[\text{conflict} = \frac{(T - s)^3 - (t - s)(R - s)(T - S)}{(T - P)^3}\]

Rapoport et al. (1962, Figure 3, p. 44) report the results of experiments in which each of six three-person groups played eight games in random order for 800 turns without communication. Table 2 lists these games in order of frequency of defection, and shows the value and rank of each game on the index \(-i\) and the measure of conflict. The rank-order correlation of \(-i\) and the percentage of D responses is .72. The rank-order correlation of the proposed measure of conflict of interest and the percentage of D responses is .89.\(^{13}\) Thus, while both criteria are good predictors for the subjects' behavior, the proposed measure of conflict is substantially better.

A comparison of the two indices reveals

\[\text{There is only one chance in a thousand that this value would be attained by chance.}\]
that $-i$ is independent of $R$ and $P$, but the measure of conflict is a function of all six parameters. The partial ability of $-i$ to predict the percentage of $D$ responses is probably due to the fact that $P$ has the same value in seven of the eight games used, and $R$ did not change at all. If for a given game the reward for cooperation $R$ were lowered, or the punishment for defection $P$ were raised, common sense and the experience of the two-person Prisoner's Dilemma game suggests the players would be more likely to defect. The same prediction is supported by the measure of conflict (which would increase), but not by the index $-i$ (which would remain unchanged). Therefore, in the three-person equivalent of the Prisoner's Dilemma game, the proposed measure of conflict is better than the index $-i$ in two respects; it is a better predictor of behavior in eight experimental games, and it incorporates the effects of two parameters which were held nearly constant in these eight games. Furthermore, the measure of conflict in Prisoner's Dilemma games has the virtue of being a generalization of a measure derived from a list of intuitively justifiable properties about conflict of interest in a completely different type of strategic interaction, namely bargaining games.

Summary
Conflict of interest is the state of incompatibility of goals of two or more actors. The amount of such conflict is important both as an explanatory variable and as a dependent variable in its own right. By using an axiomatic approach a unique measure of conflict of interest has been developed for bargaining games. This measure has been generalized to apply to the Prisoner's Dilemma, and the hypothesis has been confirmed that the greater the conflict of interest the more likely it is that conflictual behavior will follow. In predicting actual behavior, the measure of conflict of interest derived by the axiomatic approach has been shown to be superior to indices which have been suggested by less formal approaches.

REFERENCES


Rapoport, Anatol. “Some Self-Organizing
CONFLICT OF INTEREST: AXIOMATIC APPROACH

SAMPSON, EDWARD E., and MARCELLE KARDUSH. "Age, Sex, Class and Race Differences in Response to a Two-Person, Non-Zero-Sum Game," Journal of Conflict Resolution, 9, 2 (June 1965), 212–20.

APPENDIX

Theorem. The measure of conflict of interest in bargaining games proposed in this paper is the only measure which satisfies symmetry, independence, continuity, boundedness, and equivalent reducibility.

Proof. A normalized game whose negotiation set is the straight line between the two points \((x_0, 1)\) and \((1, y_1)\) will be represented by \((x_0, 1)/(1, y_1)\).

The proof will proceed by demonstrating that, for any given bargaining game, all measures which satisfy the five properties give the same value.

1. By equivalent reducibility and convexity of bargaining games, the game \((0, 1)/(1, 0)\) has maximum conflict. By boundedness, this game must have conflict of \(\frac{1}{2}\).

2. Now consider the game \((0, 1)/(1, 1-1/n)\) where \(n\) is an integer. Let \(G_0 = (0, 1)/(1, 1-i/n)\). Then \(G_0\) has minimum conflict by equivalent reducibility and thus has conflict of 0 by boundedness. \(C(G_0) = C(G_0) = C(G_0)\) by equivalent reducibility. Also \(C(G_0) = (1/n)[\sum_{i=1}^{n} C(G_i) - C(G_{i+1})] = (1/n)\cdot [C(G_n) - C(G_0)]\) by the preceding sentence and by algebra. Therefore \(C(G_i) = (1/n)(\frac{1}{2} - 0) = \frac{1}{2}(1/n)\).

3. For the game \((0, 1)/(1, 1-m/n)\) where \(m\) and \(n\) are integers, the use of equivalent reducibility \(m\) times shows that the conflict must be \(m\) times the conflict of \((0, 1)/(1, 1-1/n)\), so the conflict of this game must be \(\frac{1}{2}(m/n)\).

4. Irrational numbers are also easy to handle. If the game is \((0, 1)/(1, 1-\omega)\), then a series of games can be devised of the form \((0, 1)/(1, 1-\frac{m}{n})\) such that \(\lim \frac{m}{n} = \omega\). The conflict of the \(\omega\)th game (by step 3) is \(\frac{1}{2}(\frac{m}{n})\), and thus by continuity the conflict of the limit is just \(\frac{1}{2}\lim \frac{m}{n} = \frac{1}{2}\omega\).

5. A game of the form \((1-\omega, 1)/(1, 0)\) must have the same amount of conflict as the game \((0, 1)/(1, 1-\omega)\), since conflict is symmetric. By step 4, this means the conflict is \(\frac{1}{2}\omega\).

6. Now consider the game \((x_0, 1)/(1, y_1)\). By the reasoning in step 4, this must have \((1-\omega)\) times the conflict of the game \((x_0, 1)/(1, 0)\). The latter game has conflict \(\frac{1}{2}(1-\omega)\) by step 5, so the former has conflict \(\frac{1}{2}(1-x_0)(1-y_1)\).

7. For a normalized game, \(H\), whose negotiation set is \(k\) straight line segments between \((x_i, y_i)\) and \((x_{i+1}, y_{i+1})\), let \(a_i\) be the intercept of the extension of the \(i\)th line segment with the line \(x = 1\). Consider a series of games \((x_i, 1)/(1, 1-\omega(a_{i+1} - a_i))\) where \(a_0 = 1\). By step 6, each of these games has conflict \(\frac{1}{2}(1-x_i)(a_{i+1} - a_i)\). Using equivalent reducibility \(k\) times, the conflict of \(H\) is \(\sum_{i=1}^{k} \frac{1}{2}(1-x_i)(a_{i+1} - a_i)\).

8. Any normalized game whose negotiation set includes a smooth curve can be approximated by a sequence of games whose negotiation sets are straight line segments. By continuity, the conflict of such a game is then given by the limit of the conflicts of the kinked games, and the conflicts of the kinked games are determined by step 7.

9. Now the conflict of the general bargaining game is determined. There is a unique way to put it in normalized form, and any game in normalized form has its conflict determined by the process described in step 8. Therefore the amount of conflict in any bargaining game is uniquely determined by the five properties.

The demonstration that the measure proposed in the paper satisfies the five properties is left to the reader.