THE APPLICATION OF AN INDUCTIVE MODEL TO A SITUATION OF CONFLICT: A GAME-THEORETIC CONCEPTUALIZATION OF THE CUBAN MISSILE CRISIS

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PREFACE

This thesis is concerned with the application of an inductive model to a situation of conflict and the purpose of this study is to test the hypothesis that an inductive game model can be applied descriptively to examine the Cuban missile crisis.

The game model as worked out provided a solution to the Cuban missile crisis that approximates the policies which the Soviet and American governments followed during October of 1962, and it also established that the Soviet and American governments acted rationally in the Cuban crisis of 1962, given the alternatives available to each party.

I would like to take this opportunity to express my appreciation for the assistance and guidance given me by the following members of my committee: Professor Raymond Habiby, who first nurtured my interest in International Relations, and who was always available for counsel and encouragement; Professor C. A. L. Rich, who assisted greatly in the clarity of my work; Professor Harold Sare, for his interest and assistance.

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CHAPTER I

INTRODUCTION

The importance of game theory has for sometime been recognized in the field of international relations. However, game theory has made only minor contributions toward providing a general approach or framework for studying the nature of conflict in the present international system.[1] William Welsh has stated that "despite the potentialities of the theory of games, there have been few attempts to use this approach analytically in the study of international conflict."[2] Traditional game theory is by nature rational and deductive. This has prompted foreign policy experts and political theorists to seek prescriptive applications from game models that would be of practical value for the decision-makers in government. Yet the demands made upon game theory as an applied, prescriptive tool are particularly severe, for game theoreticians are generally looking for the resolution of a broad class of problems rather than the optimum strategy for a particular conflict.[3] It would appear that the self-imposed limitations encountered in using static game models are often outweighed by the ambiguities of dynamic

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[1] William Welsh, "A Game-Theoretic Conceptualization of the Hungarian Revolt: Toward An Inductive Theory of Games," Communist Studies and the Social Sciences, ed. Fredric Fleron (Chicago, 1969), p. 422.

[2] Ibid., p. 420.

[3] Anatol Rapoport, "The Uses and Misuses of Game Theory," Scientific American, CCVII, 6 (December, 1962), pp. 109-111.

world politics and may be incongruous with the mathematical solutions that traditional or zero-sum games proposes. Anatol Rapoport has suggested that "if the insight-generating role of game theory is to be further developed, then the next step is toward a descriptive theory, not a prescriptive theory."[4]

Most of the criticism mentioned are directed at traditional or zero-sum game theory, whereby the players are competing for an all or nothing gain pending a particular move, thereby comprising a "pure conflict" situation.[5] The rules governing the moves of the players are determined before the game begins and cannot be changed during the course of the game. Traditional games, then, are by nature static and deductive, becoming weakest at their strongest point because the mathematical precision of the game is often undermined by the fluid character of most international disputes. Cooperative or non zero-sum games, however, seem to allow some induction to occur in the course of the game because the players are competing for limited losses and gains. Also, cooperative or mixed-motive games are more dynamic in character, stemming from the freedom of the players, in some game models, to choose different moves during the course of play.[6] Therefore, cooperative or mixed-motive games appear more conducive to inductive and descriptive analysis of international conflicts than traditional game theory.

The major problem to which this study is directed is a game-

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[4]Anatol Rapoport, Two-Person Game Theory: The Essential Ideas (Ann Arbor, 1969), p. 203.

[5]Morton Kaplan, "A Note on Game Theory and Bargaining," New Approaches in International Relations, ed. Morton Kaplan (New York, 1969), pp. 486-489.

[6]Ibid., pp. 492-494.

theoretic conceptualization of the Cuban missile crisis through the insights that an inductive game model might provide. Basically an inductive model would empirically test selected game theory generalizations by examining specific conflicts and then modify or corroborate these generalizations on the basis of observations, instead of deducing solutions to specific conflicts from broad game theory generalizations. The inductive model employed here will also attempt to correct some of the major flaws present in standard game theory analysis. For example, traditional game theory fails to deal with some of the basic moves that occur in actual games of strategy.[7] Concepts such as threat, enforcement, capacity to communicate or destroy communication are not typically included in game theory analysis. An inductive model would include the aforementioned concepts pioneered by Schelling and others, along with the necessary modifications in the structure and rules of the game necessitated by alteration of the fundamental nature of game play.[8] Our model will be characterized as a finite, "two person," non zero-sum game between the Soviet Union and the United States and will deal with the relations between these governments during the missile crisis. Specifically the study is designed to (1) outline the major limitations of game theory so that certain objections to traditional game theory can be avoided in constructing an inductive game model; (2) describe the salient events of the Cuban missile crisis in game-theoretic parlance, so that the dimensions of the conflict can be clarified; (3) attempt to make "comparative rationality estimates" of the behavior of the two

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[7] Thomas Schelling, The Strategy of Conflict (Cambridge, 1960), p. 84.

[8] Welsh, p. 428.

principal players during the crisis.[9] This involves asking which set of available courses of action seems most likely to have been optimum for the parties to the conflict, given the specified or assumed goals of the players.[10] Also, the analysis will utilize concepts developed by Schelling, Boulding and Welsh and will avoid using traditional game theory concepts whenever possible. Naturally, such an approach carries the danger of the unadulterated use of complex theory; but this appears to be a necessary step if students of international relations are to derive an analytical framework from game theory.[11] Therefore, one of the main goals of this study is to conceptualize a specific international conflict in game-theoretic terms for descriptive rather than prescriptive applications. It is hoped that such an undertaking will interject an inductive element into game theory that is presently lacking in most game theory research.

The hypothesis of this study is that an inductive game model can be applied to study situations of conflict (in this case the Cuban missile crisis). By conceptualizing the Cuban missile crisis in game-theoretic terms, it should be possible to establish the significant alternatives which were available to the United States and the Soviet Union during this confrontation. In short, the moves considered in a U.S.S.R.-U.S.A. inductive game model should lay bare the parameters of Soviet and American decision-making as they functioned throughout the missile crisis.

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[9] Ibid., p. 420.

[10] Ibid., p. 421.

[11] Rapoport, Scientific American, pp. 109-111.

A statement about the proposed methodology to be employed in this study now seems to be in order. The game-theoretic analysis of American and Soviet relations during the Cuban missile crisis will involve first an indication of the limitations of game theory. Second, the salient events of the Cuban missile crisis will be described in game theory parlance. This will involve an elaboration of the rules, moves, goals and a payoff matrix to be considered in the game. Third, a comparison of game model predictions with the actual behavior of the players will be made. Finally, by attempting comparative rationality estimates of the players' behavior, it is hoped that the game model's appropriateness and validity might be tested.

The main advantages of utilizing game theory to study the Cuban missile crisis are twofold: (1) concepts regarding the basic alternatives that each government might have seriously considered can be quantitatively examined in the payoff matrix of the proposed game model, (2) direct access to detailed and secret government data is not absolutely necessary to conceptualize the missile crisis, because game theory permits us to postulate the moves each government contemplated. Game theory analysis is an important approach to dissect the rationales underlying the decision-making process of a particular government in specific international conflicts which may appear to be incomprehensible to the average citizen.

CHAPTER II

THE NATURE AND LIMITATIONS OF GAME THEORY

Game theory has developed mainly as a branch of mathematics concerned basically with the formal aspect of rational decision.[1] Martin Shubik defines game theory "as a mathematical method for the study of some aspects of conscious decision-making in situations involving the possibilities of conflict and or cooperation."[2] And that "the essence of the game is that it involves decision-makers with goals and objectives whose fates are intertwined."[3] Examples of games relevant to political science are generals engaged in battles, diplomats involved in bargaining and negotiation, legislators trying to put together coalitions, etc.

The theory of games focuses on "general principles governing the logical structure of conflict."[4] However, the main concern of game theory is not the empirical study of how people make decisions (that includes the personality makeup and psychological motives of the players), rather, it is a deductive theory about the underlying conditions that the players' decisions would have to meet in order to be

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[1] Martin Shubik, "The Uses of Game Theory," Contemporary Political Analysis, ed. James C. Charlesworth (New York, 1967), p. 240.

[2] Ibid., p. 241.

[3] Ibid., p. 240.

[4] Rapoport, Two-Person Game Theory, p. 77.

considered rational, consistent, or noncontradictory.[5] Thomas Schelling has labeled this kind of theory normative or rational in scope when contrasted to predictive or explanatory theory in the social sciences.[6] Morton Kaplan remarked recently that "game theory is useful mainly as a source of insights that produce analogies applicable to the problems of international politics."[7]

Professor Morgenstern and von Neumann launched game theory as a tool for studying economic behavior over two decades ago in their classic work, A Theory of Games and Economic Behavior.[8] Since then political theorists have extended Morgenstern and von Neumann's ideas to the problems of military and political strategy. The cold war and its bipolar nature made it possible to apply traditional two-person game theory to the military and political stalemates of the time. That is why prescriptive solutions were sought from game theory while the descriptive or explanatory potentials were ignored.[9]

Game theory has enjoyed limited success in areas related to military and political strategy, but in situations of pure conflict it yielded important insights that helped define military deterrence strategy.[10] Two-person bargaining games without obvious solutions or "saddle points" also "made a genuine and original contribution in the

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[5]Thomas Schelling, "What is Game Theory," Contemporary Political Theory, ed. James C. Charlesworth (New York, 1967), p. 213.

[6]Ibid., p. 214.

[7]Kaplan, p. 486.

[8]John von Neumann and Oscar Morgenstern, A Theory of Games and Economic Behavior (Princeton, 1944).

[9]Rapoport, Two-Person Game Theory, p. 191.

[10]Schelling, The Strategy of Conflict, p. 207.

area of prescriptive theory."[11]

Political decision-makers need to consider many alternatives in resolving specific problems, so that they need a theory that will come up with solutions that have managed to elude their notice. Yet, game theory has been unable to provide these unsuspected answers for practitioners in the volatile world of international politics because the mathematical applications of game models are normally limited to situations of pure conflict in which one party gains or loses everything.[12]

For these reasons the future of traditional game theory as a deductive tool of political analysis appears dim unless mathematicians and social scientists can extend the boundaries of the theory of games to include new concepts that are verifiable and applicable to dynamic game situations. Professor Kaplan echoes these sentiments in the following quote: "no existing formal models of game theory are directly applicable to the problems of international politics."[13] Anatol Rapoport suggested a different avenue of approach for game theory that could continue to produce insights for studying military and political strategy when he advised social scientists and mathematicians to develop descriptive uses of game theory for explanatory rather than prescriptive purposes.[14] In the research that follows, an attempt will be made to insert the parameter values observed in a real-world crisis into an inductive model of conflict and then the predictions of our game model

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[11]Kaplan, p. 484.

[12]Ibid., p. 485

[13]Ibid.

[14]Welsh, p. 432.

will be compared to the outcome of the Cuban missile crisis, thus providing a basis for refining future descriptive models of international conflict.

Before proceeding to employ game theory analytically, consideration of the limitations and difficulties encountered in applying game models is in order. To begin with there are differences between traditional game theory a' la von Neumann and Morgenstern and the expanding theory of conflict proposed by Schelling and Boulding among others.[15] The analysis that follows will focus on the major criticisms leveled at traditional game theory, as well as the unresolved problems still encountered in spite of recent modifications of the theory.

The major attack on the applications of game models is that game theory invites its own abuse because uncritical use is so prevalent among unsophisticated social scientists.[16] William Welsh, who is aware of this, lists four reasons why game theory is particularly relevant despite criticisms to the contrary. Specifically, he says, the theory of games: (1) is relevant to situations of current political and military interest, (2) promises "solutions" to prescriptive problems of strategy, (3) has the prestige of derivation from the theoretically well-developed field of mathematical economics, (4) is sufficiently complex in its unabridged form to lead to the adoption of its "essential" concepts and ideas in a "relaxed" mode.[17] However, this does not eliminate the pitfalls, for uncritical applications may do more harm

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[15] Ibid.

[16] Kaplan, System and Process (New York, 1957), p. 188.

[17] Welsh, p. 424.

than good.

Problems normally met in using game theory are grouped under three major headings, namely: conceptual, logical, and operational. Conceptual problems include "those having to do with the lack of clarity in, or the lack of elaboration or possible extension of, the theory."[18] The major problems to contend with in assessing the conceptual limitations of game theory are: the rationality problem; limitations of scope; the static character of the "rules" of the game and the inadequate handling of cooperative or mixed-motive games. Logical problems "have to do with empirically relevant assumptions necessitated by the structure of the theory."[19] And operational problems are "those that deal more directly with fitting real-world data into the equations of the theory."[20] Welsh notes that in a sense all these problems are operational in nature or at least operationally relevant when a game model is constructed.[21]

Conceptually game theory assumes "rational" behavior on the part of the players, but since human behavior is sometimes anything but rational, critics argue that there is little to be gained from using a theory that makes such a claim. This attacks a fundamental problem of game theory, but does so inaccurately. Anthony Downs and Herbert Simon, to mention a few, have effectively used "rational" models of human behavior in decision-making theories.[22] Their models spotlighted ways in which

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[18]Ibid.

[19]Ibid.

[20]Ibid.

[21]Ibid., p. 423.

[22]Anthony Downs, An Economic Theory of Democracy (New York, 1957); also, Herbert Simon, Models of Man: Social and Rational (New York, 1957).

real-world situations differ from the theorist's model, thus allowing refinements to be made between the predictions of the model and reality. The real problem here stems from the way "rationality" is defined in traditional game theory, namely the lack of an exact definition and the inconsistency existing in the major works on the subject. Luce and Raiffa define rationality as "any assumption one makes about the players maximizing something, and any about complete knowledge on the part of the player in a very complex situation."[23] Naturally, such conceptual imprecision leaves something to be desired. Anatol Rapoport has suggested that rationality be classified according to the different levels present in the game and lists three levels of rationality possible in traditional game theory: (1) each player has a dominating strategy, (2) only one player has a dominating strategy and, (3) neither player has a dominating strategy.[24] Unfortunately this does not resolve the dilemma because, while zero-sum games normally have minimax and maximin strategies that are identical and are labeled "saddle points" (an entry in the strategy matrix of a game which is at the same time the minimum in its row and the maximum in its column or the best of the worst strategy),[25] in non-zero sum games this is not the best strategy, for the maximin assures a player only a minimal guaranteed payoff or security level whereas the minimax strategy keeps the other player's payoff to his security level.[26] Defining rationality in this situation

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[23]R. Duncan Luce and Howard Raiffa, Games and Decisions: Introduction and Critical Survey (New York, 1957), p. 5.

[24]Rapoport, Two-Person Game Theory, p. 55.

[25]Rapoport, Strategy and Conscience (New York, 1963), p. 312.

[26]Ibid., p. 46.

becomes difficult, for how does one ascertain the optimum strategy for each player in the game? That is, why at present are there four conflicting solutions to rationality in non-zero sum games called Braithwaite's solution, Nash's solution, Shapley's solution and Raiffa's solution?[27] If an agreement can be reached on the question of rationally solving negotiated games, progress might be achieved in the future.

Another conceptual limitation concerns the boundaries of scope in game theory. One major limitation concerning the scope of game theory is its failure to identify the "perceptual and suggestive element in the formation of mutually consistent expectations."[28] What this means is that the players' perceptions and motives are not allowed to modify the play once the game is started when in the real-world they are allowed to do so. Rapoport and others agree with Schelling's statement but argue that this "requires data and methodological tools which fall wholly outside of game theory."[29] It is true that the eventual separation of psychological and logical considerations in game theory would expand the scope of game theory, but for now probably the "most important achievement of game theory has been its ability to reveal its own limitations."[30]

A third conceptual limitation encountered in using the theory of games is the static character of the "rules" of the game. In traditional game theory the rules of the game are specified before the game

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[27]Rapoport, Two-Person Game Theory, pp. 104-122.

[28]Schelling, The Strategy of Conflict, pp. 83-84.

[29]Rapoport, Two-Person Game Theory, p. 93.

[30]Rapoport, Scientific American, p. 114.

begins and cannot be altered during the course of the game. This is one of the severely limiting factors game theoreticians must contend with in applying game models to social conflict. This is often unreal, as a player may have the means physically or psychologically to change the rules of the game during the course of play, thus changing the payoff matrix for the players. Clearly there are important differences between "rationality" under static and dynamic conditions, so game theory needs to be modified to account for the possibility of having different rules for different game models.[31] This criticism of traditional game theory has caused some theorists to seek an extension of the rules of the game to take into consideration the role of such situations as threats and commitments.[32]

Another area where game theory is conceptually weak is its inadequate handling of cooperative or mixed-motive games. Thus, game theory is weakest precisely where it is most relevant. Traditional game models deal mainly with "pure conflict" situations and in precise ways, whereas non-zero sum games still lack theoretical development or exact solutions to mixed-motive situations. Several aspects of cooperative games have been inadequately handled or ignored in traditional theory. For example, the possibility of coalition formation in n-person games are not considered in traditional game theory.[33] Game theory also has been unable to predict "what kind of coalition will form, under what conditions the coalitions might form, nor how the rewards will be divided in

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[31]Kaplan, System and Process, p. 172.

[32]Schelling, The Strategy of Conflict, p. 84.

[33]Welsh, p. 426.

a coalition."[34] William Riker in his The Theory of Political Coalitions has offered a controversial yet challenging model that probes into this inflexible area of game theory, and one can now hope that future refinements of traditional game principles will offer some promise in reassessing the influence of coalitions.[35]

Another aspect of mixed-motive situations with which theoreticians have unsuccessfully dealt concerns the basic moves in actual games of strategy and the structural elements on which moves depend.[36] Concepts such as threat, enforcement and the capacity to communicate or destroy communication, are not considered in normal games.[37] Professor Schelling has attempted the extension or more specifically the reorientation of game theory along these lines. The major problem here is the game matrix. Once Schelling's modifications are added it can no longer adequately represent the game. The introduction of threats, commitments, alters the fundamental nature of game play to the extent that the game cannot be reduced to normal game form. Basically, this means the strategies available in the extended form of the game (a situation where the choices are known but all the possible strategies and outcomes have not been listed or normalized as yet) are affected by Schelling's alterations. Professor Welsh tried to ameliorate this problem by devising a game matrix that represents discrete sequential moves. This means that the game model would not represent the normalized game form. Instead,

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[34] Ibid.

[35] William Riker, The Theory of Political Coalitions (New Haven, 1962).

[36] Schelling, The Strategy of Conflict, p. 83.

[37] Ibid., p. 84.

the matrix "would represent the outcomes of sequential moves, each of which could be reconsidered at each juncture of play."[38] Thus, "the matrix could be fully specified ahead of initial play, but would include submatrices for each possible subsequent configuration."[39] One obvious objection of this scheme is that such a game matrix would be enormous, requiring linear programming techniques for its determination. Welsh attempts to resolve this roadblock by concentrating on those submatrices that seem to contain a "solution" in the game-theoretic sense. Rapoport seconds this reasoning by pointing out that the real importance of game theory lies not in its identification of possible outcomes and strategies, but rather in the conceptualization of games or the way by which game theorists limit the numerous strategies possible in a game.[40] For example, the simple game of Tic-Tac-Toe has $9 \times 7^8 \times 5^6 \times 3^4$ or 65,664,686,390,625 possible outcomes for the first player's strategies.[41] But of this number, 126 outcomes are possible when inflated values are eliminated and even less when equivalents are eliminated. Specifically, the simultaneous-choice section of the Cuban missile crisis model is even more theoretically complicated, coming out to [36!] divided by [6!], in other words, many trillions of possible outcomes! As Schelling rightfully concludes, "there is no exhaustive catalogue of even the simplest kinds of interdependence that can exist between the decisions

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[38] Welsh, p. 428.

[39] Ibid.

[40] Rapoport, Two-Person Game Theory, p. 43.

[41] Ibid., pp. 42-43.

of two people."[42] In order to avoid such mind-bogging numbers, my research will gratefully employ Welsh's game-theoretic conceptualizations regarding the use of discrete sequential moves and the a priori examination of submatrices that might contain a "solution." More will be said about this later in the study.

Another related problem with mixed-motive games is the difficulty of assessing precisely the impact of behavior and other forms of communication, especially speech, on the payoff.[43] According to Schelling the "tactical significance of moves (behavior) makes them qualitatively different from pure speech."[44] The nature of game play and the payoff matrix are undeniably affected by behavior, while this may not be the case in situations dealing with symbolic communication; so our problem is to ascertain the dynamic impact of moves and other forms of communication on the payoff matrix. By following Welsh's scheme we will suggest "that moves may alter the payoff matrix itself, while threats, promises and commitments alter the perceptions of the matrix held by the players."[45] The difference between verbal statements and moves cannot be overstated. However, the effectiveness of threats depends a great deal on their credibility, which is strongly influenced by the threatener's past and present behavior. Prior threats may likewise affect the player's evaluation of his opponent's projected move. Assigning payoffs for threats and moves is a highly subjective affair for they are

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[42]Schelling, "What is Game Theory," p. 220.

[43]Welsh, p. 428.

[44]Schelling, The Strategy of Conflict, p. 99.

[45]Welsh, p. 428.

partially interdependent.[46] Although this is hardly reassuring in a methodological sense, such a step is necessary if the proposed game model is to include recent contributions in game theory.

A final proposition apropos to the analysis of mixed-motive games concerns the tendency of game theoreticians to attribute empirical significance to mathematical solutions. Mixed-motive games often have solutions that depend on mutually perceived obvious conjoint strategies or those solutions with unique characteristics. These "focal points" depend on characteristics that differentiate them qualitatively from other available choices.[47] Thomas Schelling warns against accepting game characteristics that claim sophisticated mathematical solutions, for they might not have the power of focusing expectations that influence the outcome of the game. Also, mathematical game solutions may be based on maximizing a player's utilities which could be at odds with reality and politically disasterous if followed.[48]

The urgent need of game theory today is in the development of insights that will explain the mutual expectation process. This theoretical assistance has been beyond the scope of traditional game theory and probably will emerge from social psychology and other related social sciences.

The second major problem area pertaining to the limitations of game theory deals with its logical limitations. The discussion of logical boundaries will encompass two aspects: (1) the exclusion of unforeseen

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[46]Welsh, p. 428.

[47]Ibid.

[48]Schelling, The Strategy of Conflict, p. 113.

developments or events and, (2) the absence of an inductive component in the theory of games.

The exclusion of unforeseen events in game models means that the possibility of unanticipated developments affecting the nature of play is not considered in conflict situations. A postulate of game theory is that everything that could possibly occur in the progress of play must be known in advance of the start of play. This static assumption is highly unrealistic but a necessary condition of traditional game theory. The game theorist, if he follows this reasoning, will be forced to exclude highly significant tactical principles from his game model. Sequential moves, likewise, have no effect on the play of the game, while in real-life situations they may be of great significance. This assumption is not as serious a drawback as might be expected. For the assumption that everything is known in advance does not necessarily mean that game theory forces an artificial inflexibility on the players.[49] Indeed, a strategy in game-theoretic expressions is only "a set of directions which tells a player what he is to do in every possible situation in which he finds himself."[50]

The strategy of this study will specify responses to prior set moves as well as to anticipated simultaneous moves by other players. By doing this we hope to ameliorate the problem with which game theory confronts us by not allowing the play of the game to modify the environment. The distance between the assumption of the model and reality does not seem so incongruous if anticipated moves are specified by projecting

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[49]Welsh, p. 429.

[50]Rapoport, Two-Person Game Theory, p. 40.

possible strategies at the beginning of the game. This is especially so if we assume "that real-world decisional units might have strategies in the game-theoretic sense, depending upon their intelligence apparatus and the imaginativeness of their decision-makers."[51]

Another logical limitation of game theory concerns the lack of an inductive component in its development. The evolution of game theory has come about largely within mathematics, which relies on entirely deductive models for explanation. Rapoport and others have argued that the lack of an inductive element in deductive game models has been particularly disabling. At the general level inductive logic is needed if game theory is to progress toward providing an empirical base for the study of conflict situations.

It was mentioned earlier that game theory does not lack generalizations but, without verification of them in specific cases, much is left wanting. The process of modifying or corroborating generalizations on the basis of observation is the heart of the inductive process and is crucial for promoting inductive game models. More directly, "induction is necessary in the game-theory model to make the game-theoretic notion of "rationality" less restrictive."[52] Next, induction is needed "to introduce a dynamic component into a heretofore essentially static model."[53] Since the necessity of introducing a dynamic element into static game models was earlier discussed, some comment on the notion of rationality in inductive models now seems in order. The concept of

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[51]Welsh, p. 430.

[52]Ibid.

[53]Ibid.

"rationality" could be expanded to include an inductive trial and error method by which players could find their optimal strategies.[54] Rapoport reports that game theory which includes an inductive component could be extended to situations where the game matrix is not even known to the players. The players could then discover trial and error optimal strategies, the results of their choices then being known to them, thus allowing them opportunities to modify their play several times during the game.[55] Such a procedure is not considered in traditional games. This is ill-fated, for the process of making decisions that resolve international conflicts seems to have a strong, inductive trial and error features.

The third major problem area of game theory is its operational limitation. Operational boundaries can be reduced to four categories: (1) the arbitrariness of values in the payoff matrix, (2) assumptions about motives, (3) single play versus "supergame" orientations, (4) the overlapping of real-world games.

The arbitrary values in the payoff matrix are the focal point around which a game reverts. A game matrix is normally represented by the numerical outcomes or utilities possible to the players in a game. Even though the payoff matrix is of critical importance in the theory of games, there is no theoretical scheme available that assists in assigning utilities to outcomes.[56] Critics naturally argue that game models can be of only minor empirical significance if the values in the payoff

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[54]Rapoport, Two-Person Game Theory, p. 147.

[55]Ibid.

[56]Welsh, p. 430.

matrix must always remain arbitrary. The accusation of arbitrariness is not as damning as it might first seem. One can argue that (1) all theories must begin with some "arbitrary" elements, (2) the "arbitrariness" is as much a product of the inadequacies of our research methods in general as it is a product of the peculiar nature of game theory, and (3) the difference between the matrix values that could be obtained through ideal scaling techniques and those we can reasonably use in our study of conflict situations are likely to be so slight as to have minimal effect on the interplay between theory and data.[57]

In response to item one, the arguement could be made that all theories have some necessary givens and the payoff matrix is a necessary given in game theory. Second, it is unfair to hold the game theorist liable for the apparent liabilities of the payoff matrix. The methodological improvements called for appear not to be within the scope of game theory, but outside of it, in social psychology. Continued improvement is necessary in deriving values for the payoff matrix, especially in deriving the preference scales of the players, but there is little justification for completely discrediting game theory postulates because no methodology has yet been developed that will empirically deduce numerical values or the utility of these values in the payoff matrix. After all, no one tossed out the theorems of trigonometry because surveyors' instruments were not yet invented to take advantage of them. Similarly, the question could be asked, how much theory is verifiable in the study of international conflict to date?

In spite of these justifications for using game theory, it must be admitted that there remains a great interest among game theorists as to

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[57]Ibid., pp. 430-431.

how values placed in the payoff matrix might be empirically derived. Typically, the only demand in game theory has been that the values in the matrix be measured on an interval scale. This means the players, at a minimum, must have some idea of the ratio of differences among their preferences.[58] Similarly, decision-makers in the real-world must also assign utilities to outcomes, yet they seem to do no better than "on the spot estimates on the basis of hunches."[59] Social scientists conducting ex post facto examinations of crisis behavior of governments have been able to establish rank orderings of decisional preferences without direct access to the highest level of government. Unfortunately, only ordinal scales have been derived from such studies. The interval scale is one step higher in mathematical precision and scaling power than the ordinal scale.[60] Welsh suggests that interval scales can be derived from ordinal scales by analyzing past decision-making in conflict situations through systematic research that highlights the preferences and alternatives available to high policy-makers.[61] In doing so, the assignment of probabilities becomes crucial, especially in non-zero sum games where threats, commitments, etc., are involved and outcomes are calculated simultaneously for an opponent's action. The derivation of

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[58]Rapoport, Two-Person Game Theory, p. 28.

[59]Ibid., p. 198.

[60]Cf. Rapoport, Strategy and Conscience, p. 311. "Ordinal scales are those that have a measurement procedure which allows only the determination of the rank of a set of objects but not the distances between them, e.g. first choice, second choice, etc." "Interval scales are those that have a measurement procedure which allows only the determination of the ratios of pairs between the magnitudes but not the ratios of the magnitudes themselves, e.g. the Centigrade scale, and the Fahrenheit scales."

[61]Welsh, p. 432.

preference scales from an empirical study of conflict situation should be restricted by only minor distortions. Distortions of great magnitude are usually possible when "there is a wide gulf between actual preferences on the one hand and behavior (including verbal descriptions of preferences) on the other."[62]

The assumption made about the players' motives comprise the second operational limitation of game theory. One perplexity associated with "the arbitrariness of the payoff matrix concerns the building into the matrix of assumptions about the players' motives."[63] Utilities usually are translated into physical commodities, like money, prison terms, economic or military resources, toward which the players' motives appear reasonably clear. But, the players' attitudes toward payoffs are not as lucid when payoffs represent success or failure in carrying out foreign policy goals. The search for optimum strategies then becomes directly related to the original purposes of the policy. Rapoport gives the example of disarmament inspection whose purposes depend on whether the goal of inspection is to prevent evasions or to discover them once they are commited.[64] Unfortunately, the "effort to take into account in the payoff matrix of motivational patterns is no more or less 'arbitrary' than other aspects of matrix construction."[65] Certainly, the theory of games cannot signify motivational analysis of the players' behavior anymore than it can tell us how to assign values for the payoffs. However,

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[62]Ibid.

[63]Ibid.

[64]Rapoport, Two-Person Game Theory, p. 167.

[65]Welsh, p. 433.

game theory may dissect motives by linking them to distinctions among strategy preferences.

Another major operational problem relates to the single play versus "supergame" orientations of game theory. An important relationship in game theory exists "between the number of times the game is played and the nature of strategic choices."[66] Normally, it is assumed that "mixed-strategy" is compatible with situations of international conflict or, more precisely, that non-zero sum games without saddle points resemble international conflict. Yet, mixed-strategy solutions do not determine the outcome of any given play but only the long term average.[67] However, in military and political spheres the parties can be limited to single play orientations. Considerable doubt exists as to whether a given conflict is actually a "game" in itself or one play in a "super-game" repeated over and over again in the international system. The descriptive utility of game theory is not really affected by such considerations, for they remain within the realm of prescriptive solutions.[68] Furthermore, game theoreticians "could make mixed-strategy prescriptions probabilistically."[69] In other words, if strategy a were a player's optimum mixed-strategy four times and strategy b two times, then strategy a would be selected in a single-play game.

Our last operational limitation regards the overlapping of real-world games in situations of conflict. The overlapping of real-world

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[66] Ibid.

[67] Rapoport, Two-Person Game Theory, p. 167.

[68] Welsh, p. 433.

[69] Ibid.

games is difficult to ascertain with any precision, although few would deny their impact on the conflicts in the international system. Certainly, the Hungarian revolt was related to the Suez crisis in a way that influenced available strategies, but how much is difficult to say. The Cuban missile crisis might have been affected by the previous Berlin crises and the Bay of Pigs episode, but it is not clear how this would affect the nature of the game, for they occurred at an earlier time. Since no major international crisis, such as the Hungarian revolt or Suez crisis, was occurring at the time of the missile crisis, perhaps this operational limitation is not as serious as it might be in a conflict situation employing game-theoretic concepts.

Having explained my game theory approach and the general limitations that made the Welsh model the best to use in the Cuban missile crisis, the following chapter will undertake a historical-analytical study of the crisis.

CHAPTER III

THE SETTING OF THE CUBAN MISSILE CRISIS

The analysis that follows will attempt to employ a "relaxed" form of the theory of games that focuses on the descriptive or illustrative aspects of a situation of conflict.[1] Although systematic research has so far collected a huge amount of data on the missile crisis of a higher quality than most research projects concerned with conflict situations, probably very little would qualify as rigorous data-gathering. Many descriptive accounts of the major events and decisions of this conflict are used here.

Before attempting to characterize the game model, a brief sketch of the missile crisis will be undertaken. No attempt is made to reconstruct all the events of the Cuban missile crisis of October of 1962; rather, emphasis will be placed on those circumstances of major importance to our subsequent game-theoretic conceptualization. Speculation about the motives behind the Soviet decision to place offensive weapons in Cuba and the American reaction terms of motivation are not considered, for this is normally beyond the scope of game theory. Instead, consideration is given to events occurring between October 14 - 28.

The Cuban missile crisis began on October 14, 1962, when an Air Force U-2 reconnaissance plane flying over San Cristóbal photographed

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[1]Welsh, pp. 428, 438.

incontrovertible evidence that medium-range missile sites existed in Cuba.[2] Before this fly-over mission, there had been a growing controversy in Washington between members of Congress and the Kennedy Administration as to whether offensive weapons, especially missiles, were being placed in Cuba by the Soviets. Intelligence reports prior to October 14, 1962 had concluded that no offensive weapons were present on that island, although there was a growing body of contradictory evidence that this might not be the case.[3] President Kennedy, while campaigning before the Congressional elections of 1962, has staked the prestige of his administration on the claim that no offensive weapons were present in Cuba.

The Soviet military buildup in Cuba began late in July, 1962, when large arms shipments began arriving there. All through August and into September the shipments continued unabated without any verifiable detection by American intelligence sources that the cargoes might contain offensive weapons, particularly IRBM's and MRBM's.[4] Finally, a reconnaissance flight approved by John Kennedy provided the evidence that set the crisis into motion.

President Kennedy was actually informed of the photographic proof of offensive weapons on October 14, 1962. His first reaction was the summoning of selected high government officials to consider the matter. This group, later tabbed the Executive Committee of the National

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[2]Robert Kennedy, Thirteen Days: A Memoir of the Cuban Missile Crisis, (New York, 1969), p. 24.

[3]Roberta Wohlstetter, "Cuba and Pearl Harbor: Hindsight and Foresight," Foreign Affairs, XLIII (July, 1965), p. 692.

[4]Graham Allison, "Conceptual Models and the Cuban Missile Crisis," American Political Science Review, LVXIII (September, 1969), p. 704.

Security Council, was to become the main decision-making body for advising the chief executive on the alternatives available and their feasibility for resolving the crisis.[5] The most crucial decision reached in the first meeting was that the response to the crisis should be timed with President Kennedy's public announcement of the situation.[6] Kennedy demanded utmost secrecy, realizing that this was essential if the United States was to grab the initiative in counteracting the strategic Soviet threat in Cuba.

At the first meeting several modes of action were considered to force the Soviets into removing their missiles out of Castro's socialist encampment ninety miles from home. One alternative to respond to the dispute was inaction, but this was never a bona fide choice. Yet, it was reportedly thrashed about by Secretary of Defense McNamara and others at the initial conference.[7] The crux of the argument for "doing nothing" was that "U.S. vulnerability to Soviet missiles was no new thing."[8] "Since the U.S. already lived under the gun of missiles based in Russia, a Soviet capability to strike from Cuba made little real difference."[9] This reasoning failed on two counts. First of all, the military capability of the Soviet Union would be increased by one-half in terms of megatonnage deliverable while the warning time available to

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[5]Theodore Sorensen, Kennedy (New York, 1965), p. 675.

[6]Kennedy, p. 31.

[7]Robert Crane, "The Cuban Crisis: A Strategic Analysis of American and Soviet Policy," Orbis (Winter, 1963), p. 537.

[8]Allison, p. 697.

[9]Ibid.

American defenses would be reduced to five minutes.[10] American credibility in Latin America and the rest of the world would, likewise, be in grave doubt if the Soviet Union's provocative act went unchallenged after President Kennedy's solemn warning to Russia not to place offensive weapons in Cuba.

Another possibility that was considered was the implementation of diplomatic pressures such as an appeal to the United Nations or the Organization of American States, or perhaps a summit conference. The removal of United States Jupiter missile bases in Turkey and Italy for the removal of Soviet missiles in Cuba was another course of action suggested by the so called "United Nations" faction.[11] Khrushchev offered a similar proposal in the now famous second letter sent to John Kennedy on October 27, 1962, thus changing the whole nature of the crisis. Meanwhile, if diplomatic pressures became the main effort, what was to halt the Soviets from making their missiles in Cuba operational? After all, negotiations are notorious for the time necessary to reach agreement, and the missiles were scheduled to be operational by December 1, 1962.[12] A suggestion was proposed that a secret emissary approach Khrushchev and demand that all offensive weapons be removed.[13] But this obviously would have given the Soviet Union the diplomatic initiative and might have led to an inflexible commitment by Khrushchev that would have increased the risk of a nuclear confrontation. Any strictly

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[10]Crane, p. 537

[11]Ibid, p. 538.

[12]E.W. Kenworthy, Anthony Lewis, and Max Frankel, "Cuban Crisis: A Step by Step Review," The New York Times (November 3, 1962), p. 1.

[13]Allison, p. 697.

diplomatic approach as a response to the crisis certainly appeared unrealistic to John Kennedy and the majority of the members on his ad hoc committee, since any concessions by the United States would have led to further demands by the Soviets. Similarly, the impact of American concessions would have obviously affected Europe, confirming the suspicions that the United States would sacrifice European interests when the going got tough.[14]

A third approach suggested in an article by Professor Allison was to send a secret mission to Castro offering him the choice of "split or fall."[15] The fallacy of this plan was that Soviet personnel guarded, constructed, and transported their own weapons and equipment, thus, their removal would have to depend on a Soviet decision. Anyway, who could imagine Castro making a secret deal with the United States against the Soviet Union after the Bay of Pigs and recent American economic sanctions?

A fourth plan of action seriously considered and then de-emphasized during the first meeting and in later sessions was the direct invasion of Communist Cuba to remove the offensive weapons.[16] Preparations for an invasion of Cuba would have led to the confrontation of 20,000 Soviet personnel and American troops. Such brinksmanship risked a nuclear exchange between the super powers and practically guaranteed a similar action in Berlin by the Soviets.[17]

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[14]Ibid.

[15]Ibid.

[16]Kenworthy, et.al., p. 1.

[17]Allison, p. 697.

One of the two proposals singled out for serious consideration in this initial conference was a surgical air strike against the missile sites. The logic of this plan was that a surgical air strike (unannounced) would eliminate the missile sites before they became operational.[18] This strategy would have, in addition, guaranteed the secrecy of the American intentions before the Russians found out that the United States was aware of the missile build-up in Cuba. The problem with this approach centered around the fact that the United States Air Force could not guarantee the destruction of all the missile sites without at least 500 sorties--hardly a surgical air strike![19] A related problem raised by Attorney General Robert Kennedy was the moral issue: should the United States order a surprise attack after having lived through Pearl Harbor herself? Finally, an attack on Cuba would almost certainly kill Russian personnel, provoking a likely military retaliation by the Soviets against Berlin or Turkey.

The final plan of action considered in the first meeting was some sort of blockade. This involved using indirect military action to pressure the Soviet missiles out of Cuba. Essentially, this proposal was to enforce an embargo on military shipments sailing to Cuba. As the week wore on the choice narrowed down to either a surgical air strike or a naval blockade, and in later meetings the blockade scheme gathered favorable support as the initial response to the Soviet missile threat.[20]

The blockade proposal also had its attendent difficulties in that

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[18]Kennedy, p. 37.

[19]Ibid.

[20]Arthur Schlesinger, A Thousand Days (Boston, 1965), p. 804.

it increased the risk of a Soviet-American confrontation. For example, a blockade by the United States would invite a similar move by the Soviets in Berlin. This could only escalate the conflict and a likely joint solution then might be the dropping of both blockades, giving the Russians more bargaining time for making their missiles operational.[21] A second complication was that if Soviet and foreign ships carrying suspected arms did not stop, the United States Navy might be obligated to fire the first shot, thus inviting retaliation by the Soviets. This became a real consideration as the crisis developed, because the possibility of a military confrontation between the nuclear giants had become a reality on the high seas. Third, a blockade or the "quarantine" strategy presented the dilemma that such a policy might be held to be illegal, even by the United States allies, who had always upheld the freedom of the seas.[22] A possible way out was a two-thirds favorable vote in the Organization of American States to circumvent any alleged violations of the United Nations Charter and international law, thus giving legal justification for the proposed American blockade. The biggest flaw in this proposed policy was the nagging thought in the minds of the strategists that this plan might not affect the status of the missiles in Cuba that were fast becoming operational.

The blockade alternative had several comparative advantages in spite of its apparent liabilities. Graham Allison lists four benefits:

> (1) It was a middle course between inaction and attack, agressive enough to communicate firmness of intention, but nevertheless not so precipitous as a strike. (2) It placed on Khrushchev the burden of choice concerning the next step.

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[21]Allison, p. 698.

[22]Kenworthy, et.al., p. 2.

> He could avoid a direct military clash by keeping his ships away. His was the last clear chance. (3) No possible military confrontation could be more acceptable to the U.S. than a naval engagement in the Caribbean. (4) This move permitted the U.S., by flexing its conventional muscle, to exploit the threat of subsequent non-nuclear steps in each of which the U.S. would have significant superiority.[23]

On the evening of October 22, 1962, President Kennedy addressed the nation and the world in his now famous "Quarantine" speech. It became apparent from this speech that the blockade alternative had become the dominant policy of the United States Government, coupled with strong threats for responding to the missile build-up. The United States Navy was to begin interdicting offensive weapons heading for Cuba on October 24, 1962.

In his address, John Kennedy stated that "to halt this offensive build-up, a strict quarantine on all offensive military equipment under shipment to Cuba is being initiated."[24] Continuing later in the speech, President Kennedy warned:

> It shall be the policy of this nation to regard any nuclear missile launched from Cuba against any nation in the Western Hemisphere as an attack by the Soviet Union on the United States, requiring a full retaliatory response upon the Soviet Union.[25]

Kennedy, then, addressing Chairman Khrushchev said: "I call upon Chairman Khrushchev to halt and eliminate this clandestine, reckless, and provocative threat to world peace and to stable relations between our two nations."[26] Kennedy further warned, "That is why this latest

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[23]Allison, p. 698.

[24]U.S. Department of State, Bulletin, Volume XLVII, No. 1220 (November 12, 1962), p. 718.

[25]Ibid., p. 719.

[26]Ibid., p. 718.

Soviet threat--or any other threat which is made either independently or in response to our actions this week--must and will be met with determination."[27]

The Soviet Union responded to Kennedy's address and the impending naval blockade by charging that such actions constituted a flagrant violation of international law. They likewise claimed that the Soviet weapons in Cuba were for defensive purposes to protect Castro's regime against any possible American invasion, and that provocative acts might lead to thermonuclear war.[28] Khrushchev's government called for the convening of the United Nations Security Council to examine the question of violations of the United Nations Charter by the United States and the threat to the peace that those actions constituted. However, aside from alerting all Soviet troops and Warsaw Pact forces, no retaliatory military action was taken. The immediate reaction centered around diplomatic initiatives both in the United Nations and later with the United States via diplomatic notes between the heads of state. Later in the week, however, previous threats of nuclear retaliation, if the United States invaded Cuba, were repeated by Soviet military and government officials.[29] Overall, the experts in Washington interpreted Soviet reactions to the initial American response as having been caught "off guard and were playing for time to think over the next move."[30]

Events from October 22 through October 28 tested the wisdom of John

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[27]Ibid.

[28]Nikita Khrushchev, "Khrushchev Remembers," Life (New York, December 18, 1970), p. 47.

[29]Crane, pp. 546-547.

[30]Kenworthy, et.al., p. 6.

Kennedy's blockade strategy and produced a variety of responses by the Soviet Union ending in a settlement to the crisis. On October 24, 1962, the interdiction of ships suspected of carrying offensive weapons to Cuba began. There is a great deal of controversial testimony as to what exactly happened when the United States Navy intercepted Soviet ships heading for Havana.[31] One thing seems certain, that without the intercession of Acting Secretary General U Thant, disaster may have occurred in the Caribbean. It is probably safe to say that Soviet and other foreign vessels passed through the "quarantine" after only onside inspection by the Navy, except for the boarding of the Soviet chartered ship Marucla.[32] Whether or not the naval blockade was rigorously upheld is difficult to assess with any certainty. The real importance of the American blockade was that it gave credibility to the Kennedy Administration's threats to escalate the blockade and, if necessary, to intervene militarily to remove the offensive weapons in Cuba. Likewise, this strategy allowed Khrushchev time to plan his moves without a naval incident blotching his response.

The following is a brief recapitulation of the important events leading up to Khrushchev's decision to remove the missiles under United Nations supervision in return for the promise that the United States would not invade Castro's Cuba and end her naval blockade.

On Wednesday, October 24, 1962, the day the interdiction of

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[31]See Khrushchev, "Khrushchev Remembers," pp. 47-49; also U.S. Congress, Senate, Committee on Armed Services, Preparation Investigation Subcommittee, Interim Report on Cuban Military Buildup, 88th Congress, 1st Session, 1963, pp. 1-17; also U.S. Congress, H.O.R., Committee on Appropriations, Subcommittee on Department of Defense Appropriations, Hearings, 88th Congress, 1st Session, 1963, pp. 25-28.

[32]Kennedy, p. 82.

offensive arms was to get under way, eighteen Soviet dry cargo ships approaching the interdiction zone on their way to Cuba stopped dead in the water.[33] Secretary of State Rusk was reported to have said at this time that, "We are eyeball to eyeball and I think the other fellow just blinked."[34] Later that day, American officials reported that fourteen ships had headed back for Soviet Union while six oil tankers proceeded toward Havana. The oil tanker Bucharest was permitted to proceed after the United States Navy was satisfied that it carried only petroleum. This represented a less severe policy stance than earlier statements had indicated.

Meanwhile, the crisis had reached alarming proportions among the statesmen and masses of the world. Bertland Russell, noted British philosopher and pacifist, made an emotional appeal to Khrushchev and Kennedy to act rationally in this escalating crisis before the super powers blundered accidently into thermonuclear war.[35] Of more significance, Secretary General U Thant called on the Soviet and American governments to suspend action for two or three weeks in order to cool off the conflict. His proposal called for the United States to end her quarantine temporarily in return for the Soviet Union's pledge that missile shipments to Cuba be suspended.[36] Khrushchev responded positively to the Secretary General's proposal and further called for a summit conference. President Kennedy, on the other hand, although

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[33]Ibid.

[34]Elie Abel, The Missile Crisis, (New York, 1964), p. 153.

[35]Kennedy, p. 74.

[36]U.N., Press Release, SG/1353, October 24, 1962, p. 2.

agreeing with U Thant's initiative for starting discussions to peacefully resolve the crisis, stood firm on his position that Soviet missiles had to be removed before the blockade would end.[37] The Soviets wanted very much to involve the United Nations in resolving the crisis, at least temporarily, but Kennedy was having none of that. Also, on that day the O.A.S. offered to help in the blockade of arms shipments to Cuba, after having unanimously backed the United State's blockade action the day before.

In the Security Council the representatives traded recriminating statements capped off by Ambassador Adlai Stevenson's classic retort to Ambassador Zorin the next day that, "I am prepared to wait until hell freezes over, if that's your decision."[38] This outburst was in response to a question Stevenson put to Zorin over whether or not Soviet missiles were in place in Cuba. All the while aerial reconnaissance revealed that work on the missile sites was going full blast.[39] In early exchanges of notes Kennedy and Khrushchev had threatened each other in no uncertain terms. Khrushchev claimed that he did not recognize the legality of the American blockade and would not order his ship captains to halt if flagged down by the U.S. Navy.[40] Yet, the events of October 24 revealed that both sides were actually prepared to back off from their stated inflexible positions which, if followed, could have led to a confrontation on the high seas.

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[37] U.S. Department of State, Bulletin, p. 740.

[38] Kennedy, p. 76.

[39] Ibid, p. 77.

[40] Ibid.

Thursday, October 25, provided signs that the conflict might be resolved without resort to violence. Khrushchev, in a yet unpublished letter sent to President Kennedy, was reported to have offered to remove the weapons under U.N. inspection for the American commitment that she would not invade Castro's Cuba in the future and with the understanding that the naval blockade would be ended.[41] Also, Chairman Khrushchev sent a letter to U Thant that day indicating that he would keep his ships away from the blockade area temporarily.[42] Similarly, John Kennedy agreed with U Thant's suggestion that immediate arrangements be made for negotiations on the crisis, but he remained adamantly opposed to the cessation of the American blockade until all missiles were out of Cuba.

Arnold Horelick, in evaluating Soviet responses during the crisis week, lists six reasons why the Soviets were prepared to change course precipitately and offer to withdraw their missiles: (1) The Soviet government had not secretly finished the missile buildup, and therefore could not present the U.S. with a fait accompli in Cuba; (2) The United States, by preserving secrecy of her response, presented the Soviet Union with a fait accompli: the quarantine; (3) The swiftness of American action dumbfounded the Soviets and left the option of violence up to them in responding to the blockade; (4) The prompt and unanimous support of the O.A.S. left little room for "waiting strategy" in diplomatic circles and made this alternative unfavorable to the Americans; (5) President Kennedy's decision to confront the Soviet Union directly

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[41] Ibid., p. 80.

[42] U.N., Press Release, SG/1357, October 26, 1962, p. 3.

and to ignore Castro also compelled the Soviet leaders to determine their course of action quickly; finally, (6) There was a speed and evident resolution with which the U.S. Government acted. This refers not only to the prompt and successful implementation of the quarantine and the rapid securing of O.A.S. cooperation and NATO support, but, above all, the impressiveness of U.S. conventional military build-up in the southeastern states and the alert measures taken around the world.[43]

The next day, October 27, 1962, the crisis heated up all over again when Khrushchev in a second letter to President Kennedy proposed that missile bases in Cuba be swapped for American missile bases in Turkey.[44] American policy-makers decided to ignore this letter and respond to the more satisfactory appeal made by Khrushchev the day before. President Kennedy indicated that the base swap deal was not acceptable.[45] He reportedly took his younger brother's advice and ignored the new tougher Soviet response, and so notified Khrushchev that the proposals in his letter of October 26 were acceptable as a basis of understanding for settling the crisis. That day a U-2 plane was lost over Cuba, shot down by a Soviet SAM missile. An atmosphere of severe crisis hung over Washington.

Premier Khrushchev set the world to breathing again in a message delivered over Radio Moscow on October 28, 1962. In this message he agreed to remove the weapons under U.N. inspection for the guarantee

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[43]Arnold Horelick, "The Cuban Missile Crisis: An Analysis of Soviet Calculations and Behavior," World Politics, XVI (April, 1964), p. 383.

[44]Kennedy, p. 89.

[45]White House Press Release, October 27, 1962, p. 1.

that the U.S. naval quarantine be ended and the promise that the U.S. would not invade Cuba.[46] President Kennedy immediately responded to Khrushchev's broadcasted letter. He agreed with Khrushchev's proposal and complimented him on his statesmanlike act which allowed the crisis to be resolved. Khrushchev, in a statement released on December 12, 1962, confided that at the time he made his speech he had been advised that a U.S. attack on the missile sites was imminent, and in order to limit his losses he had to move fast.[47] The risks of leaving missiles in Cuba outweighed the possible gains. Walter Lippmann, in commenting on the Soviet move concluded, "The Soviet Union yielded because its leaders found it highly credible that the United States would assume this incalculable risk."[48] He meant by this that the United States was prepared to invade Cuba and assume the incalculable risk of nuclear war, and evidently Khrushchev agreed with Lippmann. This sort of conjecture is really beyond the framework of game theory, which does not consider the motives of the players.

Although the crisis lingered on and the basic proposals were not carried out to the letter, for all practical purposes the crisis peaked and subsided on October 28, 1962. The American demand that the U.N. supervise the removal of Russian missiles was not met, but the U.S. satisfied this demand through aerial reconnaissance and onside board inspection. The naval blockade ended on November 21, 1962 and, except for the issue of removing the Soviet IL-28 bombers, the crisis was over.

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[46]U.S. Department of State, Bulletin, p. 715.

[47]Horelick, pp. 387-389.

[48]Walter Lippmann, "Cuba and the Nuclear Risk," The Atlantic, CCXI (February, 1963), p. 56.

CHAPTER IV

A GAME-THEORETIC CONCEPTUALIZATION OF THE CUBAN MISSILE CRISIS

It is an arbitrary process to view the Cuban missile crisis as a conflict situation involving mainly the United States and the Soviet Union. Other perspectives are certainly possible. For example, the missile crisis could be viewed as a n-person game matching the Western coalition versus the Communist coalition.

Having decided on this move, the focus of the remainder of the paper will dwell on two sets of questions following Professor Welsh's suggestions: (1) Is game theory helpful in conceptualizing this conflict? What are the major problems attendant to its use in connection with this particular case and what modifications to traditional game theory seem most appropriate? (2) Is it meaningful to use game theory predictively (as opposed to prescriptively) in making "comparative rationality estimates" of the behavior of the players and what dimensions of the conflict under study, if any, are thereby highlighted?[1]

The Cuban missile crisis will be characterized as a finite, two-person non-zero sum (negative sum) game. Basically, such a game is of the mixed-motive or bargaining variety suggested by Schelling's classification. A game of this kind is negative-sum in that there is no

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[1]Welsh, p. 438.

position in which the players would be better off than if they did not play the game. This is not the same as saying that there is no opportunity for the players to make gains for there are considerable gains at stake.

The "Cuban missile" game also is viewed as a game without perfect information. Generally, this is the case with decision-makers in government who must act on the basis of incomplete information. In game theory the condition of "perfect information" exists when each player knows exactly the position the other player has reached in the game.[2] In other words, the player knows exactly what he and his opponent have done up to that point. What is more, the conception of information is past-orientated in game theory. Future information variables are handled as factors influencing the degree of certainty, risk, or uncertainty, which typically characterizes the decision-making process in international affairs. This essentially means that future information variables in game-theoretic analysis are calculated in terms of risk and uncertainty.[3] Unfortunately, most game theory models are not equipped to handle future possibilities, for they normally are past-orientated.

In a game-theoretic sense it is far from obvious that the Cuban missile game is not one of perfect information. The Soviet Union and the United States both were informed in some cases of the other's planned moves. For instance, the Kennedy Administration informed the Soviet Government of its proposed blockade action. Also, both governments informed each other of what contingencies they could expect if

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[2]Rapoport, Two-Person Game Theory, p. 63.

[3]Welsh, p. 438.

certain moves were executed. One example of this was the Soviet warning to the United States that if they invaded Cuba the Soviets would retaliate with a nuclear strike. Yet many other conceptual problems remain. For example, it would appear that the level of American information about Soviet moves in the crisis area was higher during portions of the crisis than was the corresponding level of Soviet information about American moves. This is easily explained by referring to the American geographic proximity to the "arena of play" in the Cuban game. The buildup of American forces in the southeastern United States was generally known, but the information the Soviets had might not have been specific enough for the Soviets to plan counter-measures in the Caribbean area. Similarly, neither nation was aware of how the other would respond in the interdiction zone when the American Navy met Soviet ships, and Khrushchev's final concession or move was based on questionable information that U.S. military intervention was imminent in Cuba.[4] The players involved in the Cuban game thus periodically had information that might have approximated the condition of "perfect information," but the uncertainty of whether or not the players would initiate unexpected moves (such as surgical air strike or invasion by the U.S.) contributed to the situation of imperfect information.

The fact that the game is handled as one of perfect information is highly consequential analytically.[5] All games of perfect information have saddle points, whereas games without perfect information normally lack saddle points or equilibrium solutions. Likewise, games with

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[4]Horelick, p. 387.

[5]Welsh, p. 440.

perfect information have pure strategies, whereas games without perfect information usually have mixed strategies that are considered optimum. That is why a player without perfect information is faced with a situation whereby he cannot choose strategies rationally because his moves are dependent upon the known choices of other players.[6] How can a player respond to moves he knows nothing about? Decision-makers in the real world overcome this conceptual limitation of game theory by treating all conflict situations as if they were characterized by situations of perfect information, so conditional strategies are developed for responding to the moves of the other actors. The game theorist examining a conflict situation ex post facto may conclude that the decision-makers lacked perfect information, but this is really a moot point, for the actors normally act as if perfect information were available. By making the distinction between the behavior of the actors and the environment, the work load within this problem is somewhat alleviated.

There is still one other connection worth noting between the information content of the game and the existence of saddle points in a game; "there is no advantage in denying one's opponent information about one's moves, either intended or executed."[7] This is an important point for students of international conflict. For if we were to conceptualize the Cuban game as having perfect information, the game model "would predict that rational players would be quite open in their moves, to the point of making certain that all planned and executed moves were fully known

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[6] Ibid.

[7] Ibid.

to the other players."[8] Since this behavior was not seemingly present in the Cuban game, we must conclude that either the players were not acting rationally, or that the game did not have perfect information.

Game theory handles the conventional notions of information in a certainty-risk-uncertainty classification. These notions are defined as follows: (1) Decisions occur under conditions of certainty if each possible alternative move is known to lead invariably to a specific outcome. (2) Risk exists if each alternative action yields one in a set of possible outcomes, each outcome occurring with a known probability. (3) The decision realm is uncertainty if any alternative has a set of possible specific outcomes, but the probabilities of these outcomes are completely unknown or are not even meaningful.[9]

Ordinarily, we assume that real world decision-making occurs under a combination of risk and uncertainty. However, game theory normally treats all decisions as if they were made up of individual decisions taken under the condition of risk. Although this perspective is oversimplified, it is necessary, for game theory requires that probabilities be associated with all possible outcomes. Thus, a payoff matrix cannot be developed without a "specification of the perceived probabilities that each outcome will occur, since the utility of a given alternative depends not only on the desirability of its possible outcomes, but also on the occurrence of each."[10] The payoff matrix for the Cuban game will then arbitrarily assign certain probabilities for some of the more

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[8] Ibid.

[9] Ibid.

[10] Ibid.

important moves of the players, namely, for the moves of the players working under threat of risk.

Lastly, the Cuban game will be characterized as negotiable as opposed to non-negotiable. Negotiable games exist when the players have some element of common interest which can be utilized as leverage in the settlement of their conflicting interests. Such games come under the classification of mixed-motive or bargaining games, according to Schelling's terminology. The common interest in these games is represented by the urge to avoid a mutually disastrous outcome. In the Cuban game this would be the desire of both players to avoid a nuclear confrontation. Since the majority of big power confrontations on the international scene present the prospect of mutually disastrous results periodically, the actors normally attempt to concert their actions through explicit or implicit means.

The Cuban game will be basically concerned with an explicit bargaining game encompassing threats. Two other bargaining models will be presented briefly for illustrative and analogous reasons. The first is the explicit bargaining model which exists when cooperative behavior between two or more players is characterized by the communication of threats, promises, and commitments.[11] Explicit bargaining models are normally considered to be negotiable games. The Cuban game will deal with an explicit bargaining situation whereby communicated threats accompany the moves of the players. Also, the focal points or prominent strategies of the players in the explicit bargaining situation will be examined along with their counterparts in the other two games. The

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[11]Schelling, The Strategy of Conflict, p. 67.

second game model will be concerned with a situation involving tacit cooperation or bargaining. Tacit cooperation involves players in a situation where no communication of threats, promises, or commitments is allowed in reaching a solution to a problem.[12] Since players often arrive at the same outcome without communication as they do with it, it should be interesting to compare the equilibrium points present in both games. Naturally, tacit bargaining games are non-negotiable, as opposed to explicit bargaining games which are considered negotiable.

The other model will be characterized as an explicit bargaining game concerned exclusively with promises. This game model is basically an off-shoot of the first game and it will examine the possibility of promises providing an agreed upon solution to the Cuban crisis. It will be represented in a somewhat simpler payoff matrix than the explicit bargaining game involving threats, because the possibility of promises providing a solution to the crisis seems to be limited to relatively few moves.

Another area of the game-theoretic conceptualization that needs clarification concerns the decision units or players in the Cuban game. We are concerned with nation states as actors in the international system and the players in the game are the Soviet Union and the United States. Yet, any party that makes choices and receives payoffs could be considered a potential player in the game. Also, attempts by the Soviet Union to involve the United Nations in its basic strategy could have altered the basic nature of the game. However, game theory does not permit alteration of the basic structure of play once it begins and this

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[12] Ibid., pp. 58-67.

is another reason for advancing an inductive component into game theory. Finally, it must not be forgotten that the problem is further compounded by the contagiousness of conflict, which may be the central fact of political life.[13]

The arena of play is another concept that needs explanation in this analysis because it is an important part of the game conceptualization. For our purposes, the borders of Cuba plus the interdiction zone in the Caribbean bound the arena of play. Where the exact moves occurred in the arena of play is not of much value. It is important, however, in helping to define the nature of the relationship between the United States and the Soviet Union. Since traditional game theory is of little help here, the analysis will take advantage of Boulding's useful modifications. Kenneth Boulding advanced four important concepts concerning the arena of play in his classic work Conflict and Defense.

The first concept is viability. This refers to the ability and willingness of one party to a conflict to destroy or eliminate another party.[14] A player that cannot be destroyed or absorbed as an independent source of decision is said to unconditionally viable.[15] A party that can be destroyed or absorbed by another is conditionally viable, that is if the party that has the power refrains from doing so. A situation in which it does not pay for a party to extinquish another may be referred to as a secure or mutually conditional viability. Parties having secure conditional viability are faced with the problem

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[13]Welsh, p. 443.

[14]Kenneth Boulding, Conflict and Defense: A General Theory (New York, 1963), pp. 58-59.

[15]Ibid., p. 58.

of how to control the conflict process.[16] This last form of viability appears to be an accurate characterization of the relationship between the Soviet Union and the United States in 1962.

In discussing the concept of viability, we are suggesting that it is related to the location of the arena of play.[17] Hopefully, the connection between them will become clear after examining Boulding's second modifying concept, the loss-of-strength gradient or LSG. By examining the home base of two hypothetical nations located at A and B in Figure 1, we can measure a variable called "national strength" with the assumption that the national strength is maximum at its home base.[18]

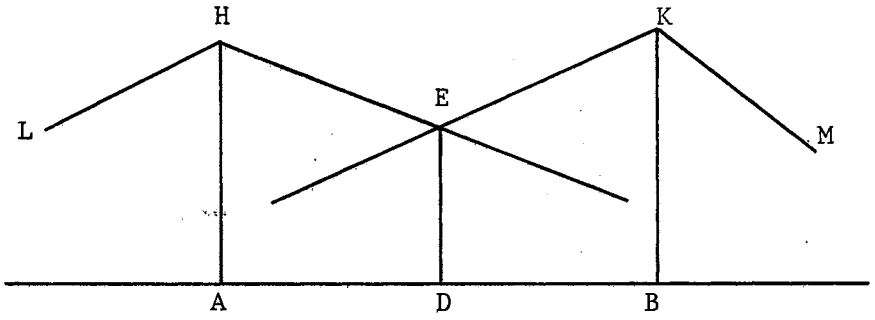

Figure 1. Loss of Strength Gradient (LSG)[19]

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[16]Ibid., p. 59.

[17]Welsh, p. 443.

[18]Boulding, p. 230.

[19]Ibid.

A nation's strength is measured by line AH for state A, and BK for state B. Continuing, the assumption is made that each nation's strength declines as it moves away from its home base. Following the slope of the lines HE and HL for state A, and the lines KE and KM for state B, the LSG's for the respective states are identified.

Boulding's third modifying concept is labeled the sphere of influence, or where the LSG's intersect.[20] Figure 1 shows a boundary of equal strength at D, where the strength lines intersect at E. To the right of line DE, state B is stronger or dominant; to the left of DE state A is stronger. It follows that the area where each nation is dominant is its sphere of influence. Professor Boulding's analysis suggests that it is generally to the advantage of a nation to extend its sphere of influence except: (1) beyond a point where it encounters diminishing returns of scale, i.e., a decrease in its home strength with each successive increase in the sphere of influence; or (2) when particular characteristics of an area over which influence might be extended would serve to weaken the dominant nation, regardless of the distance between the area in question and the home base of the dominant state.[21] An example of the latter might be the United States' involvement in Vietnam, where disproportionate amounts of men and equipment are extended by a dominant state to attempt to overcome a weaker North Vietnam.

Cuba clearly is within the American sphere of influence. In Figure 1, if the United States were state B, Cuba would be somewhere between point D and point B. It is also obvious that the continued inclusion of

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[20] Ibid.

[21] Welsh, p. 444.

Cuba within the American sphere of influence in 1962 would tend to increase the American LSG, but not to any great degree. Yet, since the variable of the characteristics of an area is independent of the variable of diminishing returns to scale, whether or not a nation includes an area in its sphere of influence, X miles from the home base, depends on whether or not it is advantageous. Thus, an area X miles from the home base may be disadvantageous to include in one's potential sphere of influence. In the Cuban missile game, the principle of diminishing returns would have argued against any effort by the Soviet Union to encompass Cuba further in its sphere of influence. What is argued here is that the Soviets should not have tried to increase their sphere of influence so far away from the home base at the risk of a military confrontation with the United States. So, in attempting to keep her missiles in Cuba, which would eventually have made her reinforce the Soviet personnel there, the Soviet Union would be at a decided disadvantage, since the Soviet Union's home base was 11,000 kilometers away. For the United States, the events of the Cuban missile crisis suggest a sizeable increase in the American LSG. This should counsel the Americans against trying to maintain a decisive influence in Cuba, even if a nuclear confrontation with the Soviet Union could be avoided during an American invasion of Cuba. The harm such a policy would do to American foreign policy in Latin America probably would not be worth the risks of removing the missiles and Castro's government by military intervention. Also, such a policy would deploy American troops in an area when they might be needed for an emergency somewhere else in the world.

The sphere of influence concept itself does not adequately portray

the American posture during the Cuban missile crisis. The analysis must be broadened by adopting Boulding's fourth concept of critical boundary.[22] Obviously, the legal boundary of a nation is not always its most significant in influencing its behavior in the international system. Boulding argues that "most nations have a series of shells of boundaries of varying degrees of importance."[23] He further suggests "the outer shell may be a vague sphere of influence, violation of which elicits only diplomatic protests."[24] Finally, Boulding states, "boundaries of increasing importance are found as one moves successively closer to a nation's home base, until one encounters the final critical boundary, which cannot be violated without war."[25] It is probably safe to say that Cuba lay outside the critical boundary of the Soviet Union in 1962. What is more important for our analysis is whether Cuba lay within the critical boundary of the United States, especially as a strategic base for the Soviet Union. If Cuba was so perceived by American decision-makers, the fact that the removal of missiles in Cuba would have increased the potential American LSG would have been of secondary importance.

A game is complete when the players, strategies, moves, payoffs, and rules are specified.[26] The rules of a game normally specify the things a player may or may not do before attempting a move. Martin Shubik

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[22]Boulding, p. 265.

[23]Ibid.

[24]Ibid.

[25]Ibid.

[26]Kaplan, "A Note On Game Theory," p. 486.

further defines the rules of a game as "a specification of the distribution of resources and the strategic possibilities open to each participant."[27] Also, "included by implication in the rules are each participant's prospects (a subjective probability distribution of results) and payoffs (rewards for achieving given prospects)."[28] Strategy possibilities, including prospects and payoffs will be treated in the next chapter, which deals with the payoff matrix.

Certain crucial behavioral implications concerning the distribution of resources make it easier to identify our game model and make its application more meaningful. In the Cuban game, there are three such major rules or limitations:

1. The United States and the Soviet Union possess the conventional and nuclear military strength to inflict intolerable physical destruction upon each other, regardless of which nation might strike first.
2. The Castro regime is not able to offer sustained, successful resistance to military intervention by the United States to destroy the Russian missile sites there or to dispose of the Castro regime.
3. The Soviet Union is unable to engage in sustained, successful intervention to protect her missile sites or prop up Castro's government in the face of U.S. military intervention, unless the threat of nuclear war was utilized by the Soviet Union. In that case the capacity of the Soviets to

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[27]Martin Shubik, ed., Readings in Game Theory and Political Behavior (Garden City, N.Y., 1954), p. 6.

[28]Ibid.

intervene successfully to protect their missile sites and Castro's government would be determined by the American perception of the threat and thus cannot be specified as a rule of the game.

CHAPTER V

THE PAYOFF MATRIX FOR THE CUBAN MISSILE CRISIS GAME

In constructing the payoff matrix, the Soviet Union is Player A and the United States is Player B. The utilities will represent the perceptions which the players each have of their own payoffs. Within the cells or boxes of the matrix are the outcomes of simultaneous moves. We shall assume that each player correctly perceives the payoff of the other, in other words, he knows the value assigned to each payoff by the other player. However, this assumption cannot be made in situations involving outcomes of sequential moves involving a threat. In that case, a player can only be assumed to know his own utilities.[1]

The sequential section of the payoff matrix includes submatrices concerned with sequential moves. In including submatrices some attempt is made in the representation of the matrix to include the effects of "preplay" communication on the preferences of the players.[2] This is crucial, for without a modification of this type, Schelling's contributions to game theory could not be incorporated into the matrix. Thus, we will handle threats and promises and, in this way, make game-theoretic conceptualizations empirically relevant to the study of conflict.

Strategy 1 for each player is inaction. The submatrix for the

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[1] Welsh, p. 446.

[2] Ibid.

coincidence of moves 2.1 through 2.6 for each player represent simultaneous actions by the two parties. This means that the moves are undertaken by each player with the belief that he is moving first, but this in fact results in simultaneous choices. The usual circumstance in traditional game theory is simultaneous decision.

Strategy moves 3.1 through 3.8 for each player represent decisions to await the move of the other player, then to react in a predetermined manner. The submatrices including these strategies thus represent sequential actions. It follows, then, that three types of action may be followed by either player: inaction, an attempt to move first, or a decision to move second.

The matrix does not consider the possibility that each player might indefinitely await the move of the other. (This would be the coincidence of strategies 3.1 through 3.8 for each player). The possibility of mutual inaction is considered (1,1), but this contingency, that one or both players would already have a set of alternatives at hand, yet never use one of them seems highly unlikely.[3] Indeed, the fact that mutual (1,1) would be distinctly disadvantageous to Player B (the United States) argues strongly that the U.S. would choose a "first move" strategy if it became convinced that the Soviet strategy had been selected from among 3.1 through 3.8.

Similarly, it should be noted that the game probably would not be considered two-person if both "original" players selected strategy 1, although this might have been a possible solution. If both parties decided against any action at all, other parties to the conflict might

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[3]Ibid., p. 448.

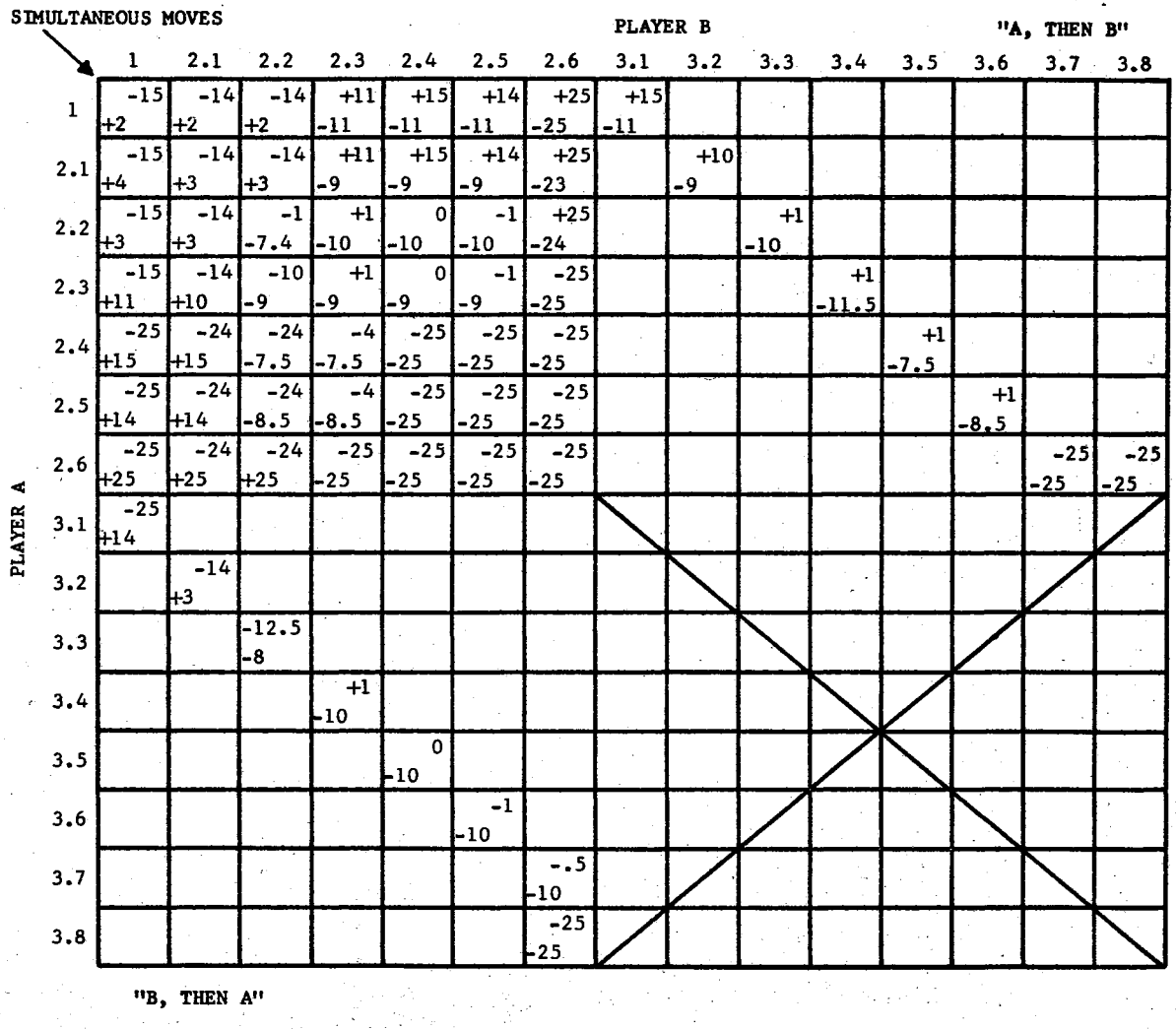

Figure 2. Payoff Matrix for the Cuban Missile Game

have entered the conflict, such as Castro's government, but the chances of this occurring were very small. If the characterization of the game as two-person is meaningful, logic suggests that 1,1 will not be the "solution." It is clearly not the solution in the formal game-theoretic sense.

The moves considered in the payoff matrix are as follows:

Players A (U.S.S.R.) and B (U.S.A.)

1 Inaction

2 I will move first:

- 2.1 Renounce unilateral action, press for bilateral agreement via the United Nations.
- 2.2 Press for diplomatic settlement to resolve crisis, but threaten nuclear retaliation if either party intervenes in Cuba.
- 2.3 Press for bilateral agreement accompanied by threats of military intervention, but execute indirect military action.
- 2.4 Threaten and immediately execute military intervention.
- 2.5 Do not threaten intervention but in fact execute it.
- 2.6 Order full nuclear strike.

3 I will await the move of Player B:

- 3.1 If B chooses 1, then I select 2.5.
- 3.2 If B chooses 2.1, then I select 2.1.
- 3.3 If B chooses 2.2, then I select 2.2.
- 3.4 If B chooses 2.3, then I select 2.2.
- 3.5 If B chooses 2.4, then I select 2.2.

3 I will await the move of Player A:

- 3.1 If A chooses 1, then I select 2.5.
- 3.2 If A chooses 2.1, then I select 2.3.
- 3.3 If A chooses 2.2, then I select 2.3.
- 3.4 If A chooses 2.3, then I select 2.3.
- 3.5 If A chooses 2.4, then I select 2.3.

3.6 If B chooses 2.5, then I select 2.2.	3.6 If A chooses 2.5, then I select 2.3.
3.7 If B chooses either 2.4 or 2.5, then I select 2.2.	3.7 If A chooses either 2.4 or 2.5, then I select 2.5
3.8 If B chooses 2.6, then I select 2.6.	3.8 If A chooses 2.6, then I select 2.6.

Many qualifying statements need to be made regarding this listing of strategies and the accompanying payoff (Figure 2). First, these moves obviously do not exhaust the logical actions that might have been feasible and/or actively considered by the Soviet Union and the United States in the Cuban missile crisis. Needless to say, the characterization of likely strategies rests on incomplete information.

The catalogues of strategies are certainly not identical for both players. In particular, note that in the event of prior U.S. action of any kind, the Soviet Union probably would not have considered military intervention in Cuba. Of course, if Russia were willing to commit suicide over the Cuban missile crisis, this would not hold true. This analysis, also, does not consider the possibility of a retaliatory Soviet intervention in Berlin because of the complexities involved in handling this in the strategy part of payoff matrix. Given that Cuba lay within the American sphere of influence, and definitely in the American's critical boundary in 1962, it seems reasonable to provide Player B in this game with the option for subsequent intervention in the face of prior Soviet intervention. That is, the United States would probably have risked a direct military confrontation with the Soviet Union over the missile crisis. However, this has not been established with 100% certainty, and also the probability of Soviet military intervention in Cuba to protect the missile silos and Castro's government was

very slight given the distance of Cuba from the Soviet's home base.

Second, the nature of the hypothetical "armed intervention" referred to in the listings of strategies is difficult to explicate. For our purposes this intervention could have ranged from limited military action to surgical air strike, to the physical transfer of men and equipment to Cuba. Clearly, there are other forms of intervention and these were probably considered in Washington and Moscow during the fall of 1962. Similarly, the scale of military intervention is important, but troublesome, when abstracting the many strategies possible for the United States and the Soviet Union. For example, does the U.S. Naval blockade equate with our use of military intervention? The answer to this question is yes, because the use of indirect military action to force the Soviet missiles out of Cuba was a form of intervention. However, this form of intervention was not a sure fire strategy for forcing the Soviets' hand and, thus, is given a smaller utility value than direct military intervention, which would have assured the removal of the missiles, but at the higher risk of nuclear war and, thus, a reduced payoff. Also, the Soviet Union already had troops in Cuba at the time of the missile crisis. Would not this already constitute some form of intervention? This study does not consider the Soviet presence in Cuba a form of intervention because more troops than the Russians could probably supply were needed to checkmate American military intervention. Thus, Soviet intervention would be present if the Soviet Union directly intervened to protect their missile sites or if they pressured the United States into inaction by indirect military action. The complexity of game theory requires us to take this admittedly narrow view of the missile crisis. Lastly, direct American intervention would be present

if the missile sites were destroyed by air or ground invasion, since this seemed to be one of the real alternatives open to the United States.

Third, some of the strategies in this game involve only, or primarily, the use of threats or commitments. The main form of cooperative behavior considered is explicit bargaining encompassing threats. For purposes of this analysis, we believe this conforms to the way the most crucial events occurred in 1962 between the United States and the Soviet Union. The other game models (tacit bargaining game and the explicit bargaining game involving promises) will be presented for strictly comparative and analogous reasons.

A fourth point of clarification concerning the nature of the strategies involves assumptions dealing with expectations and perceptions. In any sequential-move situation involving threats, there is a crucial uncertainty encompassing the players' respective perceptions of the threats.[4] Further, the question can be asked, what probability calculation is associated with Player A's perception of a threat by Player B, and vice versa? Or how closely does a perceived payoff under an opponent's threat of move X correspond with the perceived payoff if the opponent actually makes move X?

The significance of a threat does not rely solely upon the subjective probability in the mind of the threatened party that it will be carried out.[5] It depends also on the size of the threat itself, the prospective disutility to the threatened party if the threat is carried

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[4] Ibid., p. 450

[5] Ibid.

out. Yet, these two factors are not independent. For instance, Kenneth Boulding hypothesizes that, beyond a certain point, the relationship becomes inverse: the greater magnitude, the less the subjective probability.[6] According to Boulding, a smaller threat in certain cases is likely to have a greater effect on the threatened.[7]

In Figure 2, payoffs for cells representing sequential moves involving threats have been calculated according to the following scheme:

> If Player A (the Soviet Union) threatens first, Player B will calculate that the threatened action will take place with the probability of .4; a subsequent threat by Player B will be perceived by Player A as occurring with the probability of .7.
>
> If Player B threatens first, Player A will calculate that the threatened action will take place with P=.8; a subsequent threat by Player A will be perceived as occurring with P=.5.
>
> If Player A executes limited military intervention first, a subsequent threat by Player B to execute limited military intervention will be perceived as occurring by Player A with P=.8.
>
> If Player B executes limited military intervention first, a subsequent threat by Player A to execute limited military intervention will be perceived as occurring by Player B with P=.4.
>
> If Player A acts (intervenes) first, a subsequent threat to intervene by Player B will be perceived by Player A as occurring with P=.9.
>
> If Player B acts (intervenes) first, a subsequent threat to intervene by Player A will be perceived by Player B as occuring with P=.6.
>
> If the players threaten simultaneously, the threats will be perceived as occurring with the same probabilities as if each threat had occurred first.
>
> If Player A threatens Player B, simultaneously with intervention by Player B, Player B will assign a probability of .6

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[6] Boulding, p. 255.

[7] Ibid.

to Player A's threat.

If Player B threatens Player A, simultaneously with intervention by Player A, Player A will assign a probability of .9 to Player B's threat.[8]

Thus, this analysis rests on the assumption that the Soviet Union would have had slightly better cause to treat as valid a threat of intervention by the United States than would the United States in evaluating a Soviet threat. Even a cursory examination of the record of the two nations in carrying out threats and promises suggests that the U.S. performance is at least as consistent as that of the Soviet Union.[9] On the other hand, it is assumed that a Soviet threat to intervene militarily, made after American intervention, would be treated more casually than a corresponding American threat subsequent to Soviet intervention. This assumption is based on the apparent fact that the removal of missiles from Cuba was much more important to the Americans than to the Soviets, because Cuba lay within the United States' critical boundary. The Americans seemingly would have more willingly risked a general military conflict over the Cuban missile crisis.

A major relationship exists between the sequence of moves in a game and the credibility of threats. The ability to grab the initiative in a conflict situation may neutralize or even reverse the strategic advantage otherwise enjoyed by a (physically) more powerful opponent. This means an apparently weaker party in a bargaining situation often has greater influence on the outcome, provided it can threaten or commit

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[8]The scheme above is arbitrary and is based in part on a statement reported to have been said by President Kennedy that the odds of nuclear war were .4 in the Cuban missile crisis, in Theodore Sorensen's Kennedy, p. 705.

[9]Welsh, p. 451.

itself to a given position prior to any threat or action by the other party. One of the many tactical positions facing a potentially powerful threatener, therefore, is how to get into a position in which he gives up freedom of action at the onset, thereby making his threats more believable.

Another relationship existing between the sequence of moves and credibility of threats is mentioned below. As will be suggested in more detail later, the Soviet Union was generally at something of a bargaining disadvantage vis-a-vis the United States.

An early credible threat of military intervention by the Soviet Union might have been the most effective means of influencing the outcome of the conflict favorably to its interests; yet, the prior Soviet threat of nuclear retaliation (if the U.S. intervened in Cuba) may have alleviated the comparative Soviet disadvantage of not being able to issue a threat before the initial United States' response. Threats and intervention may, of course, be quite distinct. But for threats to be credible, the threatened party must perceive relatively high congruence between intentions and threats. The Kennedy quarantine probably provided such congruence between threat and potential action.

A few words of explanation of the payoff matrix is necessary, dealing mainly with absolute values assigned to outcomes. In this game the application of payoff values has been assigned subjectively. It is argued here that the analysis is worthwhile arbitrariness notwithstanding. However, it should be stressed again that, if game theory is to develop an inductive theory of conflict, efforts must be made to derive payoff values empirically.

All values in the payoff matrix are calculated on the basis of the

following stipulations:

Player A (U.S.S.R.)

1. Allowed by U.S. inaction to continue missile buildup . + 2
2. Successful armed intervention in Cuba to protect missile buildup . . . . . +15
3. Successful armed intervention in Cuba to protect missile buildup without prior threat . . . . . +14
4. Execute indirect military action that causes the U.S. to back down allowing missile buildup to continue . . +11
5. Agree to remove offensive weapons from Cuba . . . . . -11
6. Support the concept of U.N. action without unilateral threats . . . . . + 2

   Support the concept of U.N. action coupled with Soviet threats . . . . . + 1
7. Military confrontation with U.S. over Cuban missile crisis . . . . . -25

Player B (U.S.A.)

1. Permit missile buildup to continue . . . . . -15
2. Permit missile buildup to continue, bolstered by Soviet reinforcements . . . . . -25
3. Successful military intervention to remove offensive weapons . . . . . +15
4. Successful military intervention to remove offensive weapons, no prior threat . . . . . +14
5. Execute indirect military action that causes Soviets to withdraw offensive weapons. Utilize threats . . . +11
6. Support U.N. action for propaganda value . . . . . + 1

7. Military confrontation with the U.S.S.R. over the Cuban missile crisis . . . . . -25

For outcomes involving threats, payoffs are calculated by multiplying values by probabilities. The calculation procedure varies slightly according to the sequence and configuration of moves. First, let us take the case of a threat following intervention by the other player. For example, examine the cell in the lower left hand ("B, then "A) submatrix showing the intersection of Player A's subsequent strategy 3.5 with Player B's prior move 2.4. The payoffs shown are -10 for A and 0 for B. The payoff for Player A (the United States) involves no probability calculation. Player A knows what Player B has done, for B has announced and executed intervention. Thus the value to A is -11, the utility of moving Soviet offensive weapons out of Cuba, less +1, the value of advocating United Nations action, or -10. Player B's payoff, however, involves a probability calculation, since A's strategy in this case 3.5 involves a threat. We have assigned a probability of .6 to a threat by Player A (the Soviet Union) subsequent to intervention by Player B (the United States). Thus B's payoff equals +15 (successful military intervention to remove Soviet offensive weapons) less the value of subsequent Soviet military intervention and resulting Soviet-American confrontation = -25, times its probability .6 or -15. The payoff to Player B, therefore, is +15 minus -15 = 0.

A second illustration might deal with a threat by one player followed by a threat by the other. In this case the payoffs for both players involve probability calculations. Examine the cell immediately above the one we have been discussing. This is the cell showing the intersection of Player A's subsequent strategy 3.3 with Player B's prior

strategy 2.2. In this case, the United States (Player B) has threatened intervention, and the Soviet Union (Player A) responds by pressing for a diplomatic settlement to the crisis, but also threatens military intervention to the extent of nuclear retaliation against U.S. intervention in Cuba. As shown, the payoff for A is -8, for B -12.5. Player A's payoff is equal to the value of the outcome if B does intervene -11, less +1 for supporting the U.N., times the probability associated with the threatened move .8 = -8. Similarly, Player B's payoff is equal to the value of the outcome if A does intervene -25 times its probability .5 = -12.5.

A third type of calculation is necessary in the case of simultaneous threats. Examine the payoff 2.2,2.2 in the simultaneous-move submatrix. Player A's payoff is -7.4. This is obtained by (a) subtracting the U.N. "bonus" point +1 from the value of American intervention -11, and multiplying the result by its probability .8; (b) assigning the residual probability .2 to the value of the resulting situation if the Americans (Player B) did not intervene +3, and multiplying these values; and (c) summing up results of step (a) and (b). The payoff to Player B is calculated similarly and comes out -1.

A catalogue of the calculations made for every move in the payoff matrix for the explicit bargaining game encompassing threats, or the main inductive game model for the Cuban missile crisis, is contained in Appendix A of this report.

Before examining the "comparative rationality estimates" of the players in our main Cuban game, a short detour will be made to briefly develop two other bargaining models previously mentioned. These models are inserted here for comparative and analogous reasons.

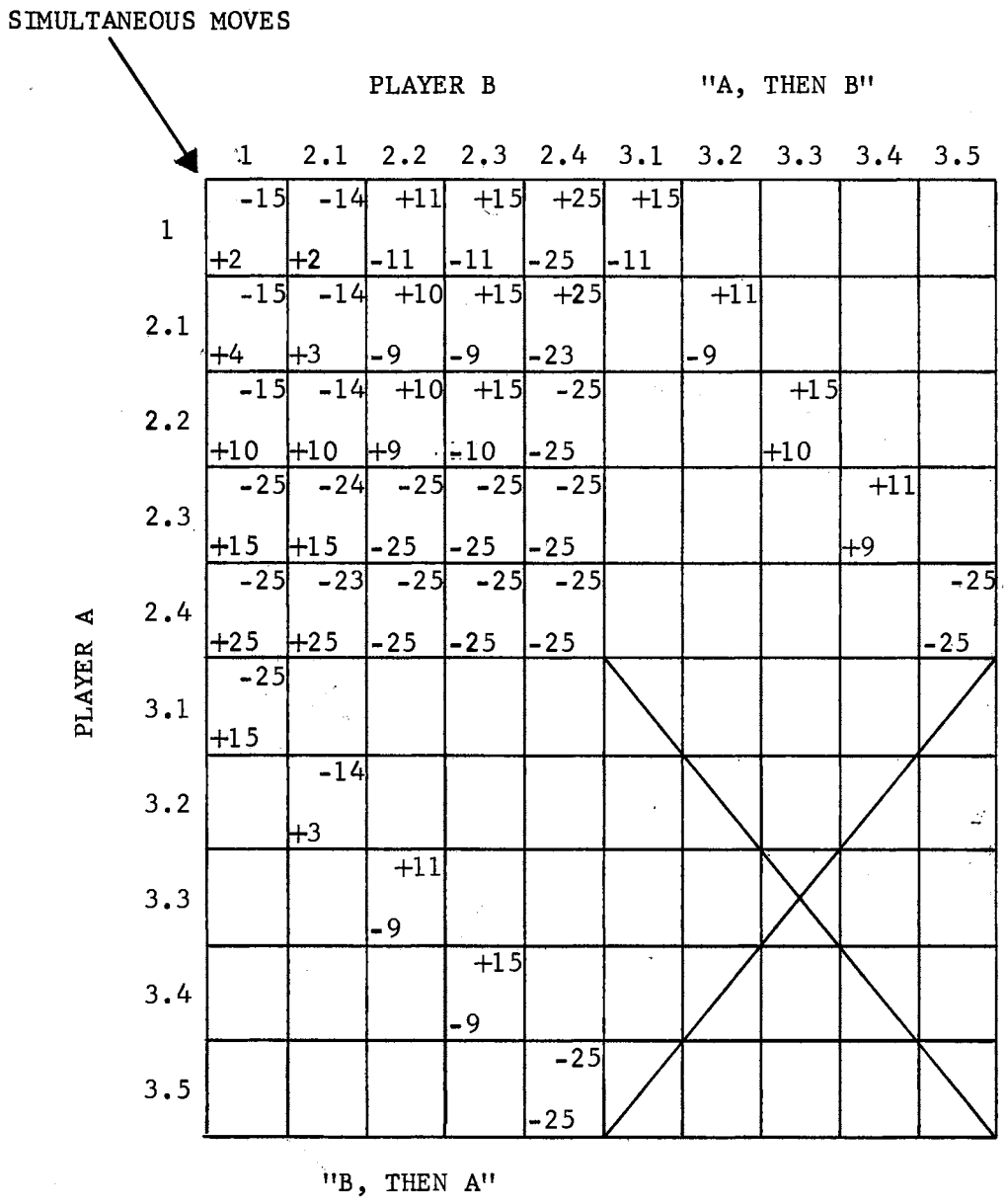

Figure 3. Payoff Matrix for the Tacit Cuban Game

The first model to be constructed is a tacit bargaining situation. Basically, the moves considered in a tacit game cannot be communicated and are reached through logic and common sense. Five such moves are listed in our tacit Cuban game: inactivity, United Nations action, limited military action or intervention, direct military intervention, and nuclear strike. All these moves are made without the benefit of threats, commitments, or promises. The moves considered in the payoff matrix are borrowed from the main game and are as follows:

Players A (U.S.S.R.) and B (U.S.A.)

1 Inaction

2 I will move first:

- 2.1 Renounce unilateral action, back U.N.
- 2.2 Execute limited or indirect military action.
- 2.3 Execute direct military intervention in Cuba.
- 2.4 Order full nuclear strike.

3 I will await the move of Player B:	3 I will await the move of Player A:
3.1 If B chooses 1, then I select 2.3.	3.1 If A chooses 1, then I select 2.3.
3.2 If B chooses 2.1, then I select 2.1.	3.2 If A chooses 2.1, then I select 2.2.
3.3 If B chooses 2.2, then I select 2.1.	3.3 If A chooses 2.2, then I select 2.3.
3.4 If B chooses 2.3, then I select 2.1.	3.4 If A chooses 2.3, then I select 2.3.
3.5 If B chooses 2.4, then I select 2.4.	3.5 If A chooses 2.2, then I select 2.4.

The values are likewise borrowed from the main game and interjected into the payoff matrix. Also, the moves are identically calculated as they were for Figure 2, minus the effect of threats. Any significance

attached to the moves in Figure 3 will be deferred until the next chapter, where short-run equilibrium points will be calculated and discussed.

A second model deals with an explicit bargaining situation involving promises. This model will only consider four courses of action or moves. This seems appropriate because of the limited number of possible promises available to the parties for resolving the Cuban missile crisis.

The moves considered in the payoff matrix are as follows:

i. I will not promise to remove missiles (U.S.S.R.).

ii. I will promise to remove missiles (U.S.S.R.).

I. I will not promise not to invade Cuba and end my naval quarantine (U.S.A.).

II. I will promise not to invade Cuba and end my quarantine (U.S.A.).

The payoff matrix also borrows values from the main game and they are as follows:

	I.	II.
i.	-15 +2	-14 +2
ii.	+10 -9	+12 -9

Figure 4. Payoff Matrix for Explicit Cuban Game Involving Promises

The discussion of the significance, if any, of this model will be delayed until the next chapter, where possible saddle points will be discussed. This model is a 2 X 2 traditional game model, so its results should not be overstressed.[10]

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[10]Schelling, Strategy of Conflict, p. 138.

CHAPTER VI

COMPARATIVE RATIONALITY ESTIMATES OF THE PLAYERS' BEHAVIOR

With the construction of the payoff matrix in the preceding chapter, it is now feasible to attempt comparative rationality estimates of the behaviors of the two players. The game-theory model will be employed to predict which course of action should have been followed by each player. The predictions of the model will then be compared and contrasted with the actual behavior of the Soviet Union and the United States during the Cuban missile crisis of 1962. Hopefully, such a comparison will shed light on those characteristics of the conflict which are highlighted by game-theoretic analysis.

An important distinction between predictive and prescriptive uses of the model must first be made. The purpose is not to question, "What should the players have done?"[1] That is a prescriptive question implying an attribute of "correctness" to the model. Such questions are beyond the scope of this analysis and indeed most political analyses. The main concern in what follows is to predict behavior, given a set of explicit assumptions.

A closer look at the payoff matrix provides a point of departure for comparative rationality estimates (or asking which set of available

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[1] Welsh, p. 453.

courses of action seems most likely to have been optimum for the parties to the conflict, given the specified or assumed goals for each).[2] The following observations are suggested by the matrix:

1. Player B (the United States) at first appears to begin the game at something of a disadvantage. The events occurring in the Cuban area in late October of 1962 were forcing the U.S. to take a move, for mutual inaction by both players would have resulted in an absolute loss and relative disadvantage for Player B. The only position payoff for Player B in the simultaneous-moves segment of the matrix is in the pursuit of strategy 2.3, 2.4, or 2.5, ranging from indirect intervention to direct intervention. However, these are the strategies of the highest risk, as they assume the possibility of simultaneous Soviet intervention or nuclear attack on the United States.

2. Player A (the Soviet Union) could come out ahead with any of its simultaneous-move strategies, depending on the strategy selected by Player B. Player A, however, would suffer absolute loss and/or relative disadvantage if Player B should choose either 2.3, 2.4, or 2.5, the only strategies offering Player B any chance of gain, or even relative advantage. Therefore, the simultaneous-moves segment of the matrix appears to represent a case of near pure conflict.

3. Player B would seem ill-advised to knowingly permit Player A to move first, since the only prior move by A which would result in gain and advantage for B is A's strategy 2.1, for which B's response is 3.2, or in other words 2.3. If the Soviet Union commits itself to working through the United Nations and avoiding unilateral action, the United

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[2] Ibid., p. 420.

States could execute limited military intervention (naval blockade) without an obvious serious risk.

According to the matrix, there is one other condition of prior Soviet action under which the United States would realize a slight relative advantage while suffering a minor absolute loss. This is under Player B's strategy 3.6, which is a threat to intervene after unannounced intervention by Player A, 2.5. At first glance this cell of the matrix seems unrealistic. If the Soviet Union intervenes first, would it be reasonable to assume that the U.S. could achieve relative advantage merely by threatening also to send troops into Cuba or bomb the missile sites? Game theory suggests that this may indeed be the case, depending on the probability the Soviet decision-makers gave to the American threat. We have assigned a probability of .9 to American threats subsequent to Soviet intervention. Thus, the payoff 2.5, 3.6 to the Soviet Union is the value of reinforcing missile sites +14 plus the value of Soviet-American military confrontation -25, times its probability or -22.5. The payoff for the Soviet Union, thus, is -8.5. The payoff to the U.S. is calculated similarly and comes out at +1. There will be no war, since the American strategy in this case, at least temporarily, is only to threaten intervention, and Player B, the U.S., has gained a relative advantage by utilizing a threat, even though the threat came after an apparently decisive U.S.S.R. action. What all this suggests is that a rational U.S.S.R. would have withdrawn its reinforcements, including the other personnel and offensive weapons, placed as a result of its bold action, in the face of a subsequent threat by the United States to intervene.

4. Similarly, if Player B concedes the first move, Player A can

achieve absolute gain only if B chooses 2.1 or 2.2. That is, if the Soviet Union awaits an American move, the U.S.S.R. would experience a positive payoff only if the United States chooses to do nothing, or work only for a United Nations involvement. The latter course of action would seem to have been unacceptable to the U.S., for there was a real question as to whether the U.N. would or could intercede effectively on behalf of the U.S. to force the missiles out of Cuba. Furthermore, inaction was obviously illogical for the United States. The Soviet Union then could not achieve relative advantage unless the prior American move was other than 2.3, 2.4 or 2.5.

5. It is clear, then, that Player B (the United States) can benefit only by choosing moves 2.3, 2.4 or 2.5, sooner or later. The question is merely when. There is considerable reason to believe that the U.S. must seize the initiative and take the first move. Permitting the Soviet Union to move first eliminates the chance the United States has to use any of its strategies rationally. The payoff matrix suggests, on the other hand, that Player B's preferred outcome is 2.1, 3.2, so the best possible American outcome would be a prior Soviet Union commitment to work through the U.N., followed by limited military intervention and threats of direct intervention by the United States. This ideal solution was not, in fact, completely obtained; yet was approximated in the 1962 solution to the crisis. From the American perspective, however, the difficulty is that if the Soviet Union is permitted to move first it will probably not choose strategy 2.1.

6. Let us assume, then, that Player A (the Soviet Union) recognizes that Player B's preferred strategy is 3.2. This yields initiatives to the Soviet Union, and Player A might consider a strategy other

than 2.1. Indeed, the game-theory model suggests that, if permitted to move first, Player A would select strategy 2.2, that is to press for a diplomatic settlement, but threaten nuclear retaliation for U.S. intervention in Cuba. This strategy yields a comparatively small loss for Player A while producing a small gain for Player B. We must assume, however, that Player B can and does pursue the same line of reasoning. Having seen that Player A could cause an unfavorable outcome for Player B by moving first and selecting 2.2, Player B would have to move first or simultaneously with Player A, since neither player can be certain that his opponent will not move first. Under this condition, Player B must choose 2.3, 2.4 or 2.5, and Player A (the Soviet Union) must accept an absolute loss. Player B, the United States, having acted first or simultaneously will select from the limited to direct intervention strategy. The Soviet Union could "balance" the payoffs only by opting for a direct military confrontation with the U.S. and produce an undetermined loss to both players. Thus, for Player A, strategy 2.2, supporting a diplomatic settlement, but threatening nuclear retaliation if Player B intervenes directly in Cuba, appears to be a dominant strategy. It is important whether Player A moves before, simultaneously with, or after Player B, but knowledge of Player B's intentions would not alter Player A's preferred strategy. In this sense, 2.2 is Player A's "minimax" strategy.

7. We may suppose, then, that Player B recognizes that Player A will select 2.2. Player B may settle for 2.3 as his basic strategy, for 2.4 or 2.5 could bring about the incalculable risk of nuclear war. The sequence of moves is important. The payoff for Player B is +1 if he moves before or with Player A; however, a prior move by Player A might

block Player B's chance to use his limited intervention strategy rationally. Thus, the United States would be driven into an early selection of 2.3, limited intervention with threats. The solution -- 3.4, 2.3 -- approximates the policies actually pursued by the United States and the Soviet Union in Cuba in 1962.

It must be emphasized that the "solution" presented in this game is not a pure strategy solution in the strict game-theoretic sense; the game has no long-range equlibrium point and the optimum choices for both players depend very much upon perceptions of intentions and/or threats by each player.[3] Nevertheless, if we make the necessary assumptions concerning perceptions of intentions, the one outcome produced is a "focal-point solution," as Schelling calls it.

The probable convergence of expectations on one of these "focal-point solutions" can be demonstrated by direct graph analysis.[4] For this, the matrix is modified to the form appearing in Figure 5. The nodes of the graph represent intersections of strategies. For the simultaneous-move area of the graph, vertical arrows indicate Player A's preferences, and the horizontal arrows show Player B's preferences, while bars across lines of the graph indicate the absence of preferences between adjacent nodes of the graph.[5] For sequential moves, the arrows show the preferences of the player who moves first.

In Conflict and Defense, Boulding suggests that there may be a "shortsighted" equilibria in non-zero-sum games without pure-strategy

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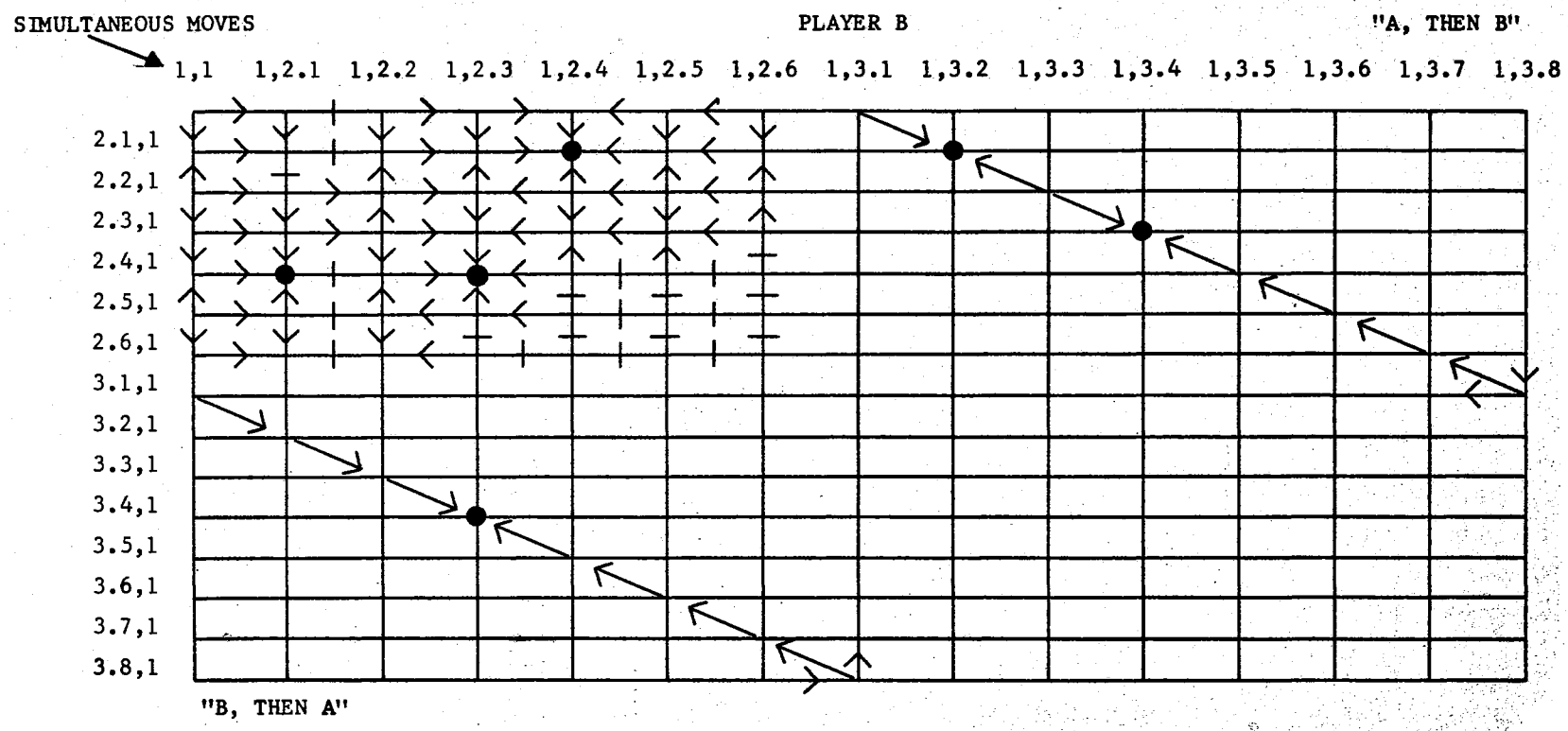
[3] Ibid., p. 456.

[4] Boulding, pp. 42-43.

[5] Ibid.



KEY: a) For "Simultaneous Moves" area of graph, read vertical arrows as Player A's preferences, horizontal arrows as Player B's preferences.
b) In the lower left-hand portion of the graph, the arrows indicate Player B's preferences.
c) In the upper right-hand portion of the graph, the arrows indicate Player A's preferences.
d) Dashmarks (—) or (|) indicate no preference between adjacent nodes of the graph.
e) Large dots (●) indicate possible shortsighted equilibria.

Figure 5. Directed Graph for the Cuban Game

saddle points.[6] While these equilibria do not qualify as game-theoretic solutions, they may represent "common sense" solutions. Indeed, the shortsighted equilibria may be useful as operational indices of Schelling's focal point solutions.[7] They could represent outcomes reached through either explicit or tacit bargaining.

Complicated non-zero-sum games generally have shortsighted equilibria. As Figure 5 shows, the Cuban game has six such equilibria denoted as large dots.

All of the shortsighted equilibria are meaningful and dependent on certain contingencies. One of the six, it should be noted, is the solution arrived at earlier -- 3.4, 2.3.[8] Since this strategy has been already discussed, the examination of other shortsighted equilibria will follow: (1) If either the U.S. or the U.S.S.R. settles on 2.1, 2.4 or 2.4, 2.1 equilibrium points, this strategy could easily lead to nuclear war, for it is doubtful that either party would be content with 2.1 if the other directly intervenes.

(2) Another equilibrium point is 2.4, 2.3. This move was Soviet intervention to reinforce the missile sites while the U.S. executed limited military intervention coupled with threats. Since the odds against Soviet intervention to protect her developing strategic base in Cuba were small, this equilibrium point is of little value in this particular game model. In contract, if the game was a tacit bargaining game in which the Soviet Union moved first and the United States second

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[6] Ibid.

[7] Welsh, p. 458.

[8] See pp. 76-77.

to force the missiles out of Cuba, this equilibrium point would be quite significant. This game is concerned, however, with the events taking place after October 14 and concentrates on the explicit nature of the conflict situation.

(3) and (4) Two other equilibria remain 3.2, 2.1 and 2.3, 3.4. The first point represents the Soviet appeal for U.N. action while the U.S. executes limited military intervention coupled with threats. This is close to the actual policies followed by both governments, but does not account for the Soviet threats indirectly or directly communicated. The last point or 2.3, 3.4 represents Soviet limited intervention with strong threats followed by the same action by the U.S. Had this policy been carried out, one could well imagine a naval confronation or some other form of confrontation. This equilibrium point certainly is anything but logically compelling for resolving the crisis.

Before concluding this chapter one general limitation on the use of directed graph analysis needs to be underscored. First, which shortsighted equilibrium emerges as the final outcome depends on (1) the order of moves in the game, and (2) where one "turns" on the conflict system; i.e., the point at which one begins to analyze the preference dynamics.[9] To repeat, complex non-zero-sum games usually have numerous shortsighted equilibria.

Finally, an attempt is made to compare the equilibria points present, if any, in the other game models, Figure 6 and 7.

In the model involving tacit bargaining, the directed graph in Figure 6 shows the following relationships with the main game. First of

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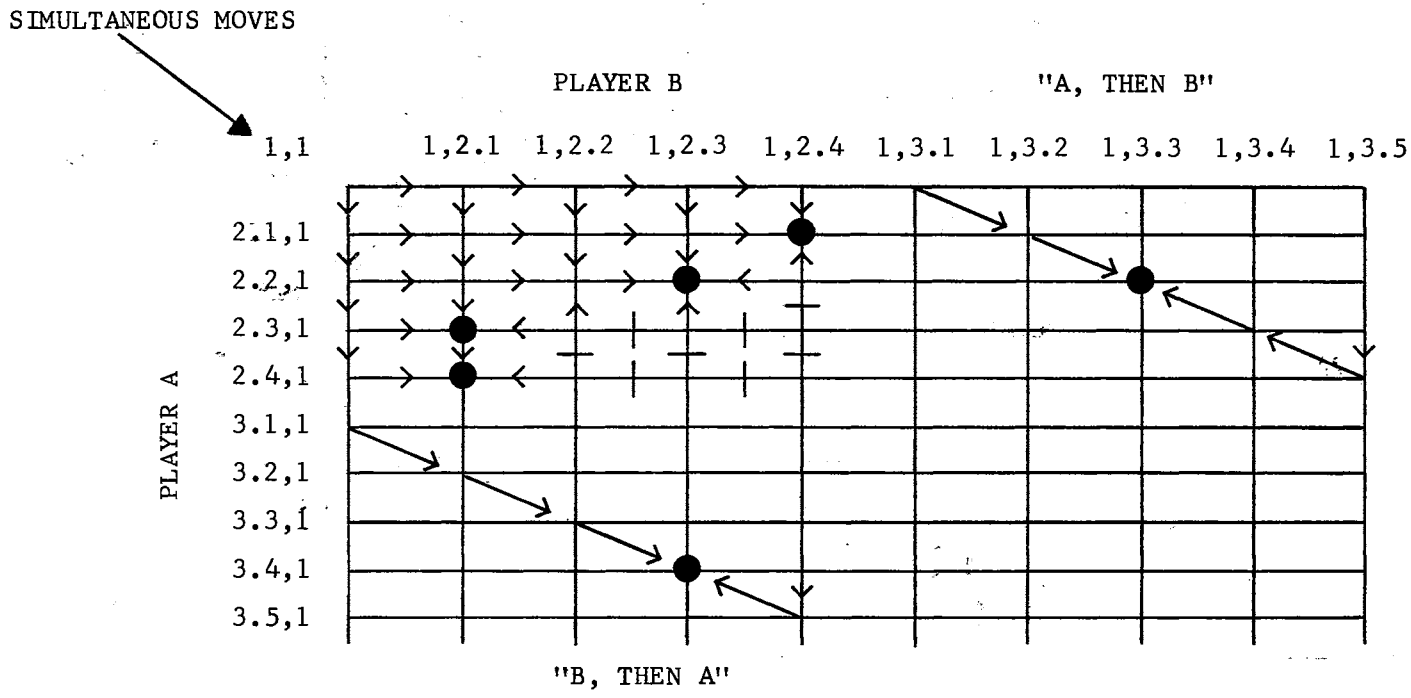
[9]Welsh, p. 458.



KEY:
a) For "Simultaneous Moves" area of graph, read vertical arrows as Player A's preferences, horizontal arrows as Player B's.
b) In the lower left-hand portion of the graph, the arrows indicate Player B's preferences.
c) In the upper right-hand portion of the graph, the arrows indicate Player A's preferences.
d) Dashmarks (—) or (|) indicate no preference between adjacent nodes of the graph.
e) Large dots (●) indicate possible shortsighted equilibria.

Figure 6. Directed Graph for Cuban Game-Tacit Model

all, one must answer the question of whether or not the players arrived at the same solution without communication of threats as with communication. In the directed graph for the tacit game there are six short-sighted equilibria, none of which approximates the solution arrived at in the main game. Indeed, if these equilibria were settled upon as a policy during the crisis, we would have had moves ranging from nuclear strike to direct intervention had the other party chosen either U.N. action or limited intervention. Out of the six equilibria derived, only one 2.3, 2.2 is approximately the same as 2.4, 2.3 in the main Cuban game. This involves direct intervention by Player A simultaneous with limited intervention by Player B. Schelling's postulate that players sometimes arrive at the same decision without communication seems woefully out of place in the Cuban crisis. Without communication between the Soviet and American governments, the risk of a nuclear war as a result of a preemptive strike or direct intervention in Cuba would have increased significantly.

The last model we want to briefly consider concerns the explicit bargaining situation involving promises. In Figure 7 there is an equilibrium point, for the arrows chase each other to 1,2.1; that is, the United States will promise not to invade Cuba and to end the quarantine in return for Soviet inaction. This clearly was not the solution to the Cuban crisis as time unfolded. Unless different values are assigned for Soviet actions or promises, there seems to be no solution to this particular game that would be acceptable to the parties involved. Yet, the Soviets must eventually promise to remove the missiles or suffer losses ranging from nuclear war to direct intervention of Cuba by the United States.

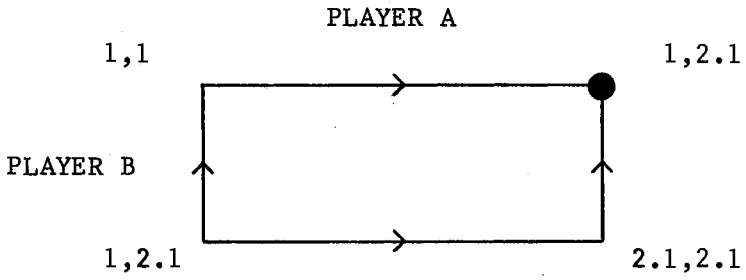


Figure 7. Directed Graph for Explicit Game Involving Promises

CHAPTER VII

CONCLUSION

The purpose of this study was to test the hypothesis that an inductive game model could be applied descriptively to study situations of international conflict. The game-theoretic conceptualization of the Cuban missile crisis was to provide the instrument for employing and testing Professor Welsh's basic inductive model. The apparatus of our game model was successfully applied and the Cuban missile crisis, a situation of international conflict, proved amenable to inductive analysis. All the major requirements for constructing an inductive game model were met, in that the basic moves, values or utilities and payoff matrix were devised and logically implemented in the game.

A corollary to the main hypothesis was that a game-theoretic conceptualization of the Cuban missile crisis would establish the significant alternatives and solutions available to the United States and the Soviet Union, so that the predictions of the game model should then have determined whether or not the players acted rationally in resolving this crisis.

According to the solutions offered in the main model, our players did indeed act rationally given the range of basic moves stipulated and their values in the payoff matrix. Had either player settled on a short-range solution other than 3.4, 2.3 (the U.S. moves first and presses for bilateral agreement accompanied by threats of military

intervention, but executes limited military intervention, while the U.S.S.R. presses for diplomatic settlement to resolve the crisis, but threatens nuclear retaliation if the U.S. intervenes directly in Cuba), the odds for nuclear war would have increased sharply. The sequential section of the game model also predicted the resolution of the crisis as opposed to the solutions offered by the simultaneous section or the traditional part of the game model, which if followed, could have led to a nuclear confrontation between the United States and the Soviet Union. In other words, if the traditional game strategists in the U.S. military had been heeded, probably military intervention or direct invasion would have been resorted to in Cuba, however, with the communication of threats between the players in the sequential part of our model, different perceptions of the payoff matrix were possible, and the solution provided closely resembled the final compromise arrived at by the Soviet and American governments.

In the context of the game model, we need next to ask whether or not there was a winner in the Cuban missile crisis. The results of our game when compared to the actual behavior of the Soviet and American governments shows the U.S. achieved a small gain in the 3.4, 2.3 solution, or the solution that closely resembles the policies followed by both governments. The small gain came about in the period of October 14 - 28, yet, if the game could be extended to the present, the Soviet policy during the Cuban missile crisis might well be considered the winner in this crisis based on the "no invasion" pledge she obtained from the Americans. This type of conjecture, however, is beyond the scope of our inductive game model. Certainly, the predictions of the descriptive game model seem to discredit those political scientists who

claim that the Cuban missile crisis was a major foreign policy victory for the Kennedy Administration in 1962.

Overall, many improvements are needed before inductive game models can provide an empirical basis for studying international conflict. For example, the arbitrary selection of numerical utilities in the payoff matrix remains a thorn even in Welsh's inductive game model. Also, there are almost as many limitations and problems attendent to using game theory as there are benefits to be accrued. In the Cuban game the logical and conceptual limitations of game theory prevented us from assessing the impact of past games on the crisis, such as the Berlin crises and the Bay of Pigs invasion, not to mention the immediate possibility of a Berlin Blockade in the listing of moves in the game. Similarly, the exact nature of the bargaining game model unduly restricts the picture of the missile crisis because the game was basically tacit in nature before October 14 and basically explicit after that date. This in turn, limits the scope of the crisis to too small a time span.

In spite of these problems, inductive game models appear to provide a legitimate framework for conceptualizing and examining international conflicts. This is especially true if such studies are limited to descriptive applications in international relations. After all, the model did "predict" a possible solution to the Cuban missile crisis that approximated the actual behavior of the Soviet and American governments. However, Welsh's prediction that this kind of analysis will eventually lead toward an empirically based, inductive theory of games for studying international conflict appears to be overly optimistic at the present time.

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APPENDIX

A CATALOGUE FOR MOVES INVOLVING CALCULATIONS IN THE PAYOFF MATRIX

1. A's payoff for 1, is +2 or the value of being allowed to continue the missile buildup; B's payoff for 1, is -15 or the value of allowing the missile buildup to continue.

2. A's payoff for 1, is +2 or the same value as last move; B's payoff for 2.1 is -14 or the value of allowing the missile buildup to continue -15 plus +1 for supporting U.N. action.

3. A's payoff for 1, is +2 or the same value as last move; B's payoff for 2.2 is -1.4 or the same value as last move.

4. A's payoff for 1, is -11 or the value of being forced to remove missiles; B's payoff for 2.3 is +11 or the value of forcing Soviet missiles out of Cuba by indirect military action.

5. A's payoff for 1, is -11 or the same value as last move; B's payoff for 2.4 is +15 or the value of successfully intervening in Cuba to remove missiles with prior warning.

6. A's payoff for 1, is -11 or the same value as last move; B's payoff for 2.5 is +14 or the same value as last move minus +1 for not giving prior warning.

7. A's payoff for 1, is -25 or the value of allowing itself to be destroyed by nuclear strike; B's payoff for 2.6 is +25 or the value of successful nuclear strike against the Soviet Union without response.

8. A's payoff for 2.1 is +4 or the value of being allowed to continue the missile buildup +2, minus +1 for B's supporting U.N. action; B's payoff for 1, is -15 or the value of allowing the missile buildup to continue.

9. A's payoff for 2.1 is +3 or the value of being allowed to continue the missile buildup +2, minus +1 for B's supporting U.N. action, plus +2 for supporting U.N. action or +3. B's payoff for 2.1, is -14 or the value of allowing missile buildup to continue -15 plus +1 for supporting U.N. action or -14.

10. A's payoff for 2.1, is +3 or the same as last value as last move; B's payoff for 2.2, is -14 or the same value as last move.

11. A's payoff for 2.1, is -9 or the value of being forced to remove missiles -11 plus +2 for supporting U.N. action or -9; B's payoff for 2.3 is +11 or the value of forcing Soviet missiles out of Cuba by indirect military action.

12. A's payoff for 2.1, is -9 or the same value as last move; B's payoff for 2.4, is +15 or the value of successfully intervening in Cuba to remove missiles with prior warning.

13. A's payoff for 2.1, is -9 or the same value as last move; B's payoff for 2.5, is +14 or the same value as last move minus +1 for not giving prior warning.

14. A's payoff for 2.1, is -23 or the value of allowing itself to be destroyed by nuclear strike, plus +2 for supporting U.N. action to resolve missile crisis; B's payoff for 2.6, is +25 or the value of successful nuclear strike against the Soviet Union without response.

15. A's payoff for 2.2, is +3 or the value of being allowed to continue missile buildup +2, plus +1 for supporting U.N. action coupled with threats or +3; B's payoff for 1, is -15 or the value of allowing missile buildup to continue.

16. A's payoff for 2.2, is +3 or the same value as last move; B's payoff for 2.1, is -14 or the value of allowing missile buildup to continue -15 plus +1 for supporting U.N. action.

17. A's payoff for 2.2, is -7.4. This is obtained by (a) subtracting the U.N. bonus point +1 from the value of American intervention -11, and multiplying the result by its probability .8; (b) assigning the residual probability .2 to the value of the resulting situation if the Americans did not intervene +3 and multiplying these values; and (c) summing up results of step a and step b equals -7.4; B's payoff for 2.2, is -1. This is obtained (a) multiplying the result of Soviet intervention -25 by its probability .4; (b) assigning the residual probability .6 to the value of the resulting situation if the Soviets did not intervene +15 and multiplying these values; and (c) summing up results of step a and b equals -1.

18. A's payoff for 2.2, is -10. Player A's payoff involves no probability calculation for A knows what B has done, namely, B has announced and executed limited military action or intervention. Thus, the value to A is -11, the utility of being forced to remove the missiles from Cuba less +1 for supporting U.N. action. B's payoff for 2.3, is +1. Player B's payoff involves a calculation, for A's strategy involves a threat subsequent to any threatened intervention by B. We have assigned a probability of .4 to a threat by A subsequent to intervention by B. Thus, B's payoff equals +11 or the value of successful limited military action or intervention, less the value of a subsequent Soviet-American

military confrontation -25 times its probability .4 or -10. The payoff for B, therefore, is +11 plus -10 or +1.

19. A's payoff for 2.2, is -10. Player A's payoff is calculated the same way as the last move. B's payoff for 2.5, is 0. B's payoff is calculated the same as the last move except that the probability of Soviet intervention is increased to .6, times the value of a subsequent American-Soviet confrontation -25 equals -15. Adding the value of a successful Soviet intervention +15 plus the value of possible confrontation =0.

20. A's payoff for 2.2, is -10. Player A's payoff is calculated the same as the last move. B's payoff for 2.5, is -1. B's payoff is calculated the same as the last move except +1 is deducted from the value of successful intervention because no prior warning was given.

21. A's payoff for 2.2, is -24, or the value of allowing itself to be destroyed by nuclear strike, plus +1 for supporting U.N. action coupled with threats. B's payoff for 2.6, is +25 or the value of a successful nuclear strike against the Soviet Union without response.

22. A's payoff for 2.3, is +11 or the value of successfully executing limited military action or intervention that causes U.S. to back down, allowing the missile buildup to continue. B's payoff for 1, is -15 or the value of allowing the missile buildup to continue.

23. A's payoff for 2.3, is +10 or the same as the last move less +1 for threats. B's payoff for 2.1, is -14 or the same value as the last value plus +1 for supporting U.N. action.

24. A's payoff for 2.3, is -9 or the probability calculation of military confrontation between the U.S.S.R. and U.S. or .8 times -25 = -20. Added to the value of proposed limited military action +11 = -9. B's payoff for 2.2, is -10. B's payoff requires no probability calculation for A has already executed limited military action or intervention or -11 plus +1 for supporting U.N. action = -10.

25. A's payoff for 2.3, is -9 or the same as the last move. B's payoff for 2.3, is +1. B's payoff is obtained by multiplying the threat of U.S. - U.S.S.R. military confrontation or .4 times -25 or -10 plus the value of limited military intervention +11 = +1.

26. A's payoff for 2.3, is -9 or the same as the last move. B's payoff for 2.4, is 0 or the value of successful intervention +15 plus the probability of confrontation .6 times -25 = -15 added to +15 = 0.

27. A's payoff for 2.3, is -9 or the same as last move. B's payoff for 2.5, is -1 or the same as last move less +1 for not giving prior warning.

28. A's payoff for 2.3, is -25 or the value of a military confrontation with the Soviets over the Cuban crisis. B's payoff for 2.6, is -25 or the same as A's.

29. A's payoff for 2.4, is +15 or the value of a successful military intervention in Cuba to protect the missile sites. B's payoff for 1, is -25 or the value of allowing the missile buildup to continue aided by Soviet reinforcements.

30. A's payoff for 2.4, is +15 or the same as the last move. B's payoff for 2.1, is -24 or the same as the last move plus +1 for supporting U.N. action.

31. A's payoff for 2.4, is -7.5 or the value of military intervention +15 plus the risk of military confrontation .9 times its value -25 = -22.5 plus +15 = -7.5. B's payoff for 2.2, is -24 or the same as the last move.

32. A's payoff for 2.4, is -7.5 or the same as the last move. B's payoff for 2.3, is -4, equals the value of military confrontation -25 times its probability .6 or -15 plus +11 for limited intervention = -4.

33. A's payoff for 2.4, is -25 or the value of a military confrontation over the Cuban missile crisis. B's payoff for 2.4, is -25 or the same as A's.

34. A's payoff for 2.4, is -25 or the same value as last move. B's payoff for 2.5, is -25 or the same as last move.

35. A's payoff for 2.4, is -25 or the same value as the last move. B's payoff for 2.6, is -25 or the same as the last move.

36. A's payoff for 2.5, is +14 or the value of successful intervention in Cuba without prior warning. B's payoff for 1, is -25 or the value of allowing the missile build-up to continue bolstered by Soviet reinforcements.

37. A's payoff for 2.5, is +14 or the same as the last move. B's payoff for 2.1, is -24 or the same as the last move plus +1 for supporting U.N. action.

38. A's payoff for 2.5, is -8.5 or the value of successful intervention with no prior threat +14 less the probability .9 of a military confrontation times its value -25 = -22.5 plus +14 = -8.5. B's payoff for 2.2, is -24 or the same as the last move.

39. A's payoff for 2.5, is -8.5 or the same as the last move. B's payoff for 2.3, is -4 or the value of limited military intervention +11 plus the probability of confrontation .6 times its value -25 = -15 plus +11 = -4.

40. A's payoff for 2.5, is -25 or the value of confrontation. B's payoff for 2.4, is -25 or the same as A's.

41. A's payoff for 2.5, is -25 or the same as last move. B's payoff for 2.4, is -25 or the same as A's.

42. A's payoff for 2.5, is -25 or the same as last move. B's payoff for 2.6, is -25 or the same as A's.

43. A's payoff for 2.6, is +25 or the value of successful nuclear strike with no response. B's payoff for 1, is -25 or the value of not reacting to nuclear strike.

44. A's payoff for 2.6, is +25 or the same as last move. B's payoff for 2.1, is -24 or the same as last move plus +1 for supporting U.N. action.

45. A's payoff for 2.6, is +25 or the same as last move. B's payoff for 2.2, is -24 or the same as last move.

46. A's payoff for 2.6, is -25 or the value of a nuclear war with B. B's payoff for 2.3, is -25 or the same as A's.

47. A's payoff for 2.6, is -25 or the same as the last move. B's payoff for 2.4, is -25 or the same as A's.

48. A's payoff for 2.6, is -25 or the same as the last move. B's payoff for 2.5, is -25 or the same as A's.

49. A's payoff for 2.6, is -25 or the same as the last move. B's payoff for 2.6, is -25 or the same as A's.

50. A's payoff for 3.1 or 2.5, is +14 or the value of successful intervention less +1 for no warning. B's payoff for 1, is -25 or the value of allowing the missile buildup to continue bolstered by Soviet reinforcements.

51. A's payoff for 3.2 or 2.1, is +3 or the value of being allowed to continue the missile build-up plus +1 for supporting U.N. action less +1 for U.S. supporting U.N. action. B's payoff for 2.1, is -14 or the value of allowing the build-up to continue plus +1 for supporting the U.N.

52. A's payoff for 3.3 or 2.2, is -8 or the value of possible U.S. intervention .8 times its value -11 less the U.N. bonus point = -8. B's payoff for 2.2 is -12.5 or the value if Soviets did not intervene -25 times its probability .5 = -12.5.

53. A's payoff for 3.4 or 2.2, is -10 or the value of being forced to remove missiles plus +1 for supporting U.N. action. B's payoff for 2.2, is +1 or the probability calculation of the value of Soviet intervention -25 times its probability .4 = -10 plus the value of limited intervention +11 = +1.

54. A's payoff for 3.5 or 2.2, is -10 or the same value as the last move. B's payoff for 2.4, is 0 or the value of successful intervention +15 plus the value of Soviet-American confrontation -25

times its probability .6 = -15 plus +15 = 0.

55. A's payoff for 3.6 or 2.2, is -10 or the same as the last move. B's payoff for 2.5, is -1 or the same as the last move less +1 for not giving prior warning.

56. A's payoff for 3.7 or 2.2, is -10 or the same as the last move. B's payoff for either 2.4 or 2.5, is -.5 or the same as last move dividing the difference between 2.4 and 2.5 or +1, for -.5.

57. A's payoff for 3.8 or 2.6, is -25 or the value of nuclear confrontation. B's payoff for 2.6, is -25 or the same as A's.

58. B's payoff for 3.1 or 2.5, is +15 or the value of a successful intervention in Cuba. A's payoff for 1, is -11 or the value of losing missile sites in Cuba to American intervention.

59. B's payoff for 3.2 or 2.3, is +10 or the value of limited military action or intervention less +1 for U.N. bonus point. A's payoff for 2.1, is -9 or the value of being forced to remove missiles plus +2 for supporting U.N. action.

60. B's payoff for 3.3 or 2.3, is +1 or the value of limited intervention plus the value of probable confrontation .4 times -25 = -10 plus +11 = +1. A's payoff for 2.2, is -10 or the value of being forced by limited intervention to remove missiles -11 plus +1 for supporting U.N. action coupled with threats.

61. B's payoff for 3.4 or 2.3, is +1 or the value of successful limited intervention +11 plus the possibility of confrontation .4 times its value -25 equals -10 plus +11 = +1. A's payoff for 2.3, is -11.5 or the value of limited intervention +11 plus the value of confrontation -25 times its probability .9 = -22.5 plus +11 = -11.5.

62. B's payoff for 3.5 or 2.3, is +1 or the same as last move. A's payoff for 2.4, is -7.5 or the value of successful intervention +15 plus the probability of confrontation -25 times its probability .9 = -22.5 plus +15 = -7.5.

63. B's payoff for 3.6 or 2.3, is +1 or the same as the last move. A's payoff for 2.5, is -8.5 or the same as last move less +1 for not giving warning.

64. B's payoff for 3.7 or 2.5, is -25 or the value of a confrontation. A's payoff for either 2.4 or 2.5, is -25 or the same as B's.

65. B's payoff for 3.8 or 2.6, is -25 or the value of a nuclear war. A's payoff for 2.6, is -25 or the same as A's.

VITA

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Master of Arts

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