Universität Bielefeld/IMW

Working Papers
Institute of Mathematical Economics

Arbeiten aus dem
Institut für Mathematische Wirtschaftsforschung

Nr. 111

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WULF ALBERS

EQUAL DIVISION KERNEL AND REFERENCE COALITIONS IN THREE-PERSON GAMES: RESULTS OF AN EXPERIMENT [1]

JANUARY 1982

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I N T R O D U C T I O N

In recent years the analysis of conflict situations has attracted the interest of experimentally working social psychologists. Game theoretical formulations have often served in giving a more precise definition of the conflict situation. Whereas dyadic situations have been thoroughly investigated, i.g. the Prisoner's Dilemma game (PDG) or the so-called bargaining game, there is less information about situations involving at least three individuals in the literature, as of date. For the sake of simplicity, games with more than two players are referred to as n-person games. In the present discussion types of interaction situations shall be given specific attention, in which the individual payoffs in the formation of coalitions are not yet clearly prescribed. Such games are also referred to as games with side payments.

It is somewhat obvious that research on n-person games first began with the analysis of three-person groups, since these are the smallest groups in which subgroups may be formed. Furthermore, the bargaining process in three-person groups can be easily observed and therefore is well suited for experimental pilot studies. Most present empirical investigations have been primarily conducted with use of the weighted majority game, a special type of n-person games with side payments (cf. GAMSON 1964). As has been emphasized by RAPOPORT (1979), this limitation is neither necessary nor desirable. Games with side payments are more generally defined than the weighted majority game (cf. section 1.1) and lend themselves to the investigation of the following three questions:

(1) Which coalitions will most likely be formed?

(2) How shall the coalitions divide the payoffs if the contributions of the individual players to the overall payoff of that coalition are estimated?

(3) How will the bargaining process develop from the initial contact between the players and their first offers to the final outcomes?

1.1. Characteristic Function Games, Coalition Structure and Payoff Structure

Mathematicians, economists and social psychologists have formed concepts in the attempt to solve the above questions. Before these models are illustrated, some of the features of n-person games with side payments shall be presented along with some types of games that have been the subject of experimental analysis.

The characteristic function of a game assigns to each possible bargaining group S (i.e. to any subset S of the set $N = \{1,2,...,n\}$ of players) a specific value $v(S)$. This value may be interpreted as the payoff value of the coalition S. It is generally assumed that:

(1) $v(\emptyset) = 0$ and

(2) $v(S \cup T) \geq v(S) + v(T)$ for all $S, T \subseteq N$, when $S \cap T = \emptyset$ [2].

The first condition states that a coalition without any members receives zero payoff. The second condition implies that whenever two disjoint subsets S and T join together to form a larger coalition their common payoff should at least equal the sum of the payoffs of the two subsets. If this were not the case, the formation of the larger coalition would not be profitable. This condition is also referred to as superadditivity.

Neither in the social psychological nor the colloquial sense would coalitions be referred to having no members or only <u>one</u> member or <u>all</u> members. In the colloquial usage of the term, coalition, a real subgroup of the overall group is usually implied. For the sake of simplicity, however, one-person and grand coalitions (all n-players) shall be spoken of in the following.

The results of an n-person game are referred to as the payoff configuration. This consist of a payoff vector $(x_1,...,x_n)$ and a coalition structure $S_1,...S_r$. The coalition structure informs which coalitions have been formed where $S_i \cap S_j = \emptyset$ for any two different coalitions and $S_1 \cup S_2 \cup .. \cup S_r = N$ (note that players, who did not enter a coalition remain as 1-player coalitions).

whereas the payoff vector reveals which payoffs $x_1,\dots,x_n$ have been obtained by the n players.

1.2. Quotas in Three-Person Games

Table 1 presents some three-person characteristic function games. First a so-called inessential game is given, with $v(S) + v(T) = v(S \cup T)$ for all disjoint pairs of coalitions.

Table 1: Some simple three-person games

	v(1)	v(2)	v(3)	v(1.2)	v(1.3)	v(2.3)	v(1.2.3)
a)	10	3	2	13	12	5	15
b)	10	3	2	17	13	8	19
c)	0	0	0	17	13	8	19
d)	0	0	0	17	13	8	23
e)	0	0	0	4	1	3	4

Cooperation in such cases is basically unattractive, since an increase in profits is not expected in any coalition formation.The games b) through d) in Table 1 represent superadditive games where $v(S \cup T) > v(S) + v(T)$ for some disjoint $S,T \in N$. In such games it can make sense to cooperate in coalitions. The problem, however, is how the payoffs of the larger coalitions shall be distributed among its members. Even in games where $v(i) = 0$ for all $i \in N$ it seems reasonable that the adequate shares of the players in the two-person coalitions can be different. One way of evaluating these shares is given by the values w_1, w_2, w_3 which are defined by $v(1,2) = w_1 + w_2$, $v(1,3) = w_1 + w_3$, $v(2,3) = w_2 + w_3$. These values are referred to as quotas.

It is assumed that $w_1 \geq w_2 \geq w_s \geq 0$, in order to exclude negative contributions and to attain a lexicographic sequence of strength with respect to the quotas. Games of the type d) in Table 1, in which the grand coalition pays more than the sum of the quotas, as well as those games in which the grand coalition gives less than the sum of the quotas shall be considered here. In three-person games there are, therefore, three types:

(3) $v(1,2,3) < \Sigma w_i$; $v(1,2,3) = \Sigma w_i$; $v(1,2,3) > \Sigma w_i$.

When the < sign is valid, the game is referred to as a game with an empty core; in case of an = sign the core contains one element, and if the > sign holds, the game has a core with more than one element.

The core of a game is defined as the set of payoff vectors for which the following applies:

(4) $\Sigma x_i = v(N)$ (group rationality)

$\Sigma x_i \geq v(S)$, for all $S \subset N$ (subgroup rationality)

the subgroup rationality implies

$x_i \geq v(i)$ (individual rationality)

1.3 Solution Concepts

In mathematical game theory, where the concept of the n-person game in characteristic function form has been developed, a normative approach has been primarily applied. Conditions of appropriate behavior based on different assumptions of rationality are given according to which the consequences of the game behavior are derived. The corresponding normative concepts state what the player should do in the present situation according to the given behavioral principles. Social psychologists and economists, on the other hand, observe the actual behavior and attempt to draw conclusions regarding the determining principles that influence the participants in forming coalitions and allocating payoffs. The difference in these two approaches is fundamental in nature, since what a player should do can be arbitrarily defined. A psychological concept lending itself to interpretation that satisfactorily describes the actual behavior of the participants in all possible phases of the bargaining proceedings, under differing conditions, and based upon as few behavioral principles as possible would be ideal. Some solution concepts will be discussed in the following, which are often found in the literature. These concepts shall then be compared in the present experiment with respect to their appropriateness.

Quota Solutions

The quotas seem to be the simpliest form of a solution in three-person games that will be addressed in the following. It is assumed here that the subjects somehow compute their quotas and divide the payoffs accordingly, i.e. each player gets his quota in any two-person coalition and in the grand coalition, if the core contains more than one element. Note that the concept does not predict the probabilities of the coalitions, and does not give predictions for the payoffs in the grand coalition in cases with more or less than one element in the core. Regarding the one-element-core it is however reasonable to assume that coalitions, which any player i can be a member of, are equally attrative to him, since he can realize his quota in any coalition. By this all coalitions should be equally probable.

Quota-Remainder-Solution

With an empty or more-element core the quota solution is not applicable for the grand coalition. Under these conditions a quota-remainder-solution may be defined. It is assumed that the players in N start their considerations with their quotas as demanded and distribute the additional or missing payoff $v(N) - w_1 - w_2 - w_3$ equally. Therefore the solution vector is defined by

$$w_i' = w_i + \frac{v(N) - \sum_{i \in N} w_i}{n} \tag{5}$$

n = number of participants
w_i' = quota-remainder-solution value for player i

Bargaining Set

A dynamic interpretation can be given to the quota concept for the three-person game as found in the interpretation setforth by the bargaining set (AUMANN and MASCHLER, 1964). In a three-person game there is no argument which cannot be matched by a counterargument for a certain quota solution.

The following may serve as an example:

In game c) in Table 1 consider the quota allocation (11,6) in the coalition (1,2). If player 2 argues with an allocation more profitable for himself, i.e., (10,7), and threatens to otherwise leave the coalition (1,2) and form a coalition (2,3) with player number 3 with a respective (7,1) allocation, then player 1 can counter his argument by proposing the (1,3) coalition to player 3 with a (11,2) allocation. Player 1 can keep his 11 and still offer player 3 more than what player 3 could receive in the coalition suggested by player 2.

Shapley Value

The SHAPLEY-value (S-value, SHAPLEY, 1953) suggests that a player should receive the average additional amount gained by his joining any coalition. Every coalition is weighted by the number of different ways possible to form it in successive extension starting with the empty set and adding one person at a time. The S-value reflects the average ability of a person to contribute to the payoff of a coalition. It assumes that the grand coalition will be formed. Furthermore, the S-value states unequivocally how much should be won by each player, namely the amount

$$\varphi_i := \sum_{S \subseteq N,\, i \in S} \frac{|S \setminus \{i\}|! \cdot |N \setminus S|!}{|N|!} \left[v(S) - v(S \complement \{i\})\right]$$

The rationale of the S-value may be clarified by the following example:

$$v(A) = v(B) = v(C) = 0$$
$$v(AB) = 0.5 \; ; \; v(AC) = 0.5 \; ; \; v(BC) = 0$$
$$v(ABC) = 1.0$$

The players expect the grand coalition to form and therefore consider in which steps the grand coalition should be formed. Since they do not know the succession in which the players will join, the players assume that all possibilities may occur. The grand coalition may be formed in six differing successions:

(A-B-C), (A-C-B), (B-A-C), (B-C-A), (C-A-B), (C-B-A),

all having an equal probability of 1/6.

The player A calculates his value as follows: in two of the six possibilities he initiates the formation of the grand coalition. He may form a trivial coalition with himself, which, however, in the present example has a payoff of zero. His amount, therefore, is in 2/6 of the possibilities zero. One possibility is to join with B in forming the coalition AB. By his joining, player A has increased the value by .5. In the second possibility player A joins with player C in forming coalition AC and thus increased the value by .5. Finally there are two possibilities in which his joining of the pair coalition BC leads to the formation of the grand coalition ABC. In these cases player A adds 1.0 to the payoff. Player A therefore contributes zero in two of the six cases, .5 in two of the six cases, and 1.0 in two of the six cases. His S-value may be calculated as $(2/6 \times 0) + (2/6 \times .5) + (2/6 \times 1) = 1/2$. Accordingly, the value of B and C may be calculated as .25 respectively. Therefore, it may be concluded that the Shapley value measures the value each player contributes to the grand coalition.

Kernel:

Based on the bargaining set concept, DAVIS & MASCHLER (1965) have suggested the kernel solution. The kernel consists of comparing the various bargaining possibilities in alternative relationships. In order to clarify this concept an example illustrating this principle is given. Consider any two players i,j, who are members of the same coalition S. It is assumed that player i has taken into account all the possible coalitions which would include him as a member and exclude j. He compares these coalitions with respect to his present payoff x_i as to whether he would receive more or less assuming that the other prospective players are satisfied with the amount they could obtain in their present coalition.

The coalition offering player i the maximal surplus is for him the 'comparison coalition' with respect to j. It is further assumed that all other players in the coalition S place similar comparisons. According to the Kernel concept the relationships between the payoffs in the coalition

S are such that these maximal surpluses are equal for all pairs of players in S.

The maximal surplus of i with respect to j is therefore the maximal amount capable of being gained by player i (or the minimal amount lost by player i) if he withdraws from the coalition S in order to join another coalition T which does not need the consensus of player j. Furthermore, it is assumed that all other members of the coalition T are satisfied with the amount they are getting in their respective coalitions. In the example of game d) in Table 1 it may be concluded that the kernel solution suggests (11, 6, 0), (10, 0, 2) and (0, 6, 2) for the pair coalitions and (12.33, 7.33, 3.33) for the grand coalition. These solutions correspond to the quotas or quota-remainder solutions.

The Equal Division Kernel

Similar to the SHAPLEY value, the kernel takes into consideration what a player additionally contributes to another coalition by joining it. It is assumed that in changing to another coalition the player may count on receiving the whole surplus since the other players are assumed to be satisfied with their present payoff. A look at the actual behavior, however, suggests that this does not seem plausible. In order to be able to form a coalition in which he is a member and player j is rejected, player i needs the consensus of the new coalition partner(s). Assumingly, player i will only be able to obtain this if he suggests an acceptable allocation of payoffs in the new coalition. Based upon empirical observations, an equal division of the total payoff v(S) represents an orientation point within each coalition acceptable to each player, if in varying degrees. The stronger players see the equal division as the lower bounds of their demands, whereas the weaker players see it as their upper bounds (compare SELTEN's concept of the equal division core 1972 and equal division bounds.)

The concept of equal division kernel (CROTT & ALBERS, 1981) postulates therefore that the players observe the equal division as the first orientation point. In the second step of their analysis, the players consider their differing bargaining possibilities and therefore an equal division no longer seems to be an adequate solution. Each player compares himself with the other players in the coalition and calculates how much more (or less) he would receive if he were to enter into another more favourable coalition which would include him but exclude the other partners in his present coalition. He orients his estimation around the assumption that the payoff in the new alternative coalition will be equally divided.

To state the concept more formally the qual ivision ernel (EK) assumes, as the kernel, that player i, in comparing himself to player j, weighs out the alternative coalitions which would accept him as a member and reject player j. Contrary to the kernel concept player i assumes that the payoff will be equally divided in the new coalition. Similar comparisons are placed by player j. A coalition is then balanced if the payoffs (or losses) drawn by any two players i and j in comparison to their present payoffs are equally large if they change coalitions and divide equally in the new coalition. As usual, the concept is applied to the zero-normalized form of the game, i.e., the values of one-person coalitions are substracted. The zero-normalized version v' of an arbitrary characteristic function v is given by

(6) $$v'(S) = v(S) - \sum_{i \in S} v(i) .$$

Following the principle of individual rationality we assume that no player should get less than zero. Therefore we contend that coalitions with $x_i = 0$ for some member i are also in balance, but only if the maximal surplus resulting from a change in coalitions is larger for player i than for the other players in the coalition. The equal division kernel principle can be summed up in the following two conditions (cf. CROTT & ALBERS, 1981):

(1) A coalition S is referred to as being balanced with respect to a vector $x = (x_1,...,x_n)$, if for each two players i and j in S the difference Δ_{ij} of the surplus gained in the optimal alternatives is either

(7.1) $\Delta ij = 0$, or

(7.2) $\Delta ij < 0$ and $x_i = 0$, or

(7.3) $\Delta ij > 0$ and $x_j = 0$,

where

(7.4) $$\Delta ij = \max_{\substack{S \subseteq N \\ i \in S \\ j \notin S}} (e(S) - x_i) - (\max_{\substack{S \subseteq N \\ i \notin S \\ j \in S}} e(S) - x)$$

(2) The equal division kernel of a game with zero-normalized characteristic function v' is the set of all payoff configurations $(x_1,\ldots,x_n; S_1,\ldots,S_r)$ that contain only coalitions which are balanced with respect to $(x_1,\ldots,x_n)$.

Definition (1) states that in zero-normalized games each player in a payoff structure should receive at least his individual value, i.e., zero. If the payoff is greater than zero then the difference between the best possible profits(losses) expected to be gained in a coalition change compared to the existing payoffs should be equally large for both players. The equal division kernel suggests a solution for each coalition independent of specific antecedent events, and thus is independent of the bargaining history.

For all coalitions $S = (i_1,\ldots,i_s)$ in three-person games, the equal division kernel (EK) value can be calculated with the following formula:

(8) $$x_i = e(S) + 1/2 \ (w_i - \sum_{j \in S} w_j/|S|)$$

The equal division kernel is associated with THIBAUT & KELLEY's (1959) notion of the comparison level for alternatives. In actual social relationships each participant estimates his value expected in other relationships. The comparison level for alternatives is oriented according to the most favorable alternative relationships.

How the value of the alternative relationships is estimated from the participant is not, however, specified in the THIBAUT & KELLEY model.

As we know from the equity theory, an equal division of the payoffs among the participants is viewed as being a just modus of division with equal investments and costs on the part of the participants, though it is possibly more strongly suggested by the weaker participants (LEVENTHAL & ANDERSON, 1970). The players are in an asymmetrical situation with characteristic function form. In this situation tension arises (conceptualized by the social psychological equity theory) between a just division of payoffs and their own payoff-maximizing interests. The players are forced to consider the equal division since they can estimate the demands and expectations of the partners by such means. Another possibility of specifying the expectancies in alternative coalitions for the definition of balance consists of replacing the equal division values with the levels of aspiration. Such aspiration levels (AL), i.e. minimal goals, can be measued by means of a questionnaire before starting the bargaining session, similar to procedures used in dyadic bargaining (cf. CROTT et al., 1974, SCHOLZ, 1980, and TIETZ, 1976). These minimal goals can be seen as subjective orientation points derived from the experience of the bargaining parties and the structure of the tasks in the sense of THIBAUT & KELLEY's model.

The equal division kernel is related to the concept of the equal division core from SELTEN (1972). This concept has integrated for the first time equal division as a social-psychologically founded reference measure within a game-theoretical framework. The equal division core states that no member of a coalition should accept a payoff that is less than he might get by an equal division in an alternative coalition, which gives all members who also belong to the present coalition at least the same as the present payoff distribution. This, however, does not mean that the coalition members will equally divide the payoffs. It rather defines a range of payoff values for the different members of a coalition. In addition, the equal division core excludes certain coalitions, those not achieving the above defined 'equal division value' for all its members. For three-person games for any coalition which is not excluded by the equal division core the equal division kernel is the gravicenter of the equal division core and thus can be interpreted as a point predection corresponding to the equal division core.

Descriptive Generalization of the Equal Division Kernel Concept with the Reference Coalition System

The equal division kernel defines an equal division kernel value for each participant in all coalitions. Like the quotas, bargaining set or kernel, the equal division kernel does not generally predict which coalitions will be formed. On the other hand it is known that, unless prescribed by certain social or group norms certain coalitions occur very seldomly. Contrary to the results of a simple or weighted majority game, coalitions between the two weakest players, for example, are seldomly formed in games in characteristic function form. The reason for this may be found in the dominance relationship between the different coalitions. If, for example, none of the members of a coalition S can form a coalition T which would be prefered by all members of this prospective coalition over their present status then it can be assumed that the coalition S will remain with high probability stable and therefore frequently will be the final solution as well.

The criteria according to which the individuals prefer certain coalitions shall be analyzed here only for three-person quota games as investigated in the following experiment. It should be noted here that a dominance relation between the pair coalitions cannot be found according to the quota concept or the bargaining set/kernel concept, since all participants in each pair coalition obtain their quotas. Thus, they are indifferent between the pair coalitions. The Shapley value is limited from the beginning to the division in the grand coalition and therefore cannot contribute here either. In contrast to this, the equal division kernel offers reference points giving preference to different coalitions.

If we assume that within any coalition the players distribute their shares according to the equal division kernel concept, we get a unique payoff distribution for any coalition in any three-person game. Of course, it will usually happen that in comparing his payoffs in different coalitions a player may prefer one coalition to another. We assume that only those coalitions will finally be entered, which give optimal payoffs to all of its members.

These coalitions can be interpreted as undominated coalitions. They are called reference coalitions (cf. CROTT & ALBERS, 1981). Due to this mutual preference, the coalition (1,2) results more frequently, if the grand coalition does not appear to be more favourable. The grand coalition becomes a reference coalition, if its value is a certain amount larger than the sum of the quotas precisely if

(9) $$v(1,2,3) \geq w_1 + w_2 + w_3 + 1/4(w_1+w_2-2w_3)$$

The undominated coalitions are referred to as reference coalitions since it is assumed that each player wants to obtain, in any other coalition, at least the amount that he could obtain in the reference coalition. In addition and as a consequence of this principle other coalitions can serve as "substitutional" coalitions if players who are members of a reference coalition get the same amount as in the reference coalition. In our examples - if condition (9) does not hold - it is usually coalition (1,3) where player 1 gets his EK-value of coalition (1,2), while player 3 gets the rest of v (1.3).

The reference-substitutional coalition version (referred to here as the RC concept) is a descriptive extension of the equal division kernel concept and as such assumes that three principles determine the allocation behavior in coalitions (cf. CROTT & ALBERS, 1981):

1) The equal division within the coalition
2) The equal division kernel values of coalitions
3) The dominance structure between the coalitions
4) The formation of substitutional coalitions

Which coalitions are reference coalitions and which are substitutional coalitions is a question to be analyzed in the section 'Characteristics of investigated games'. Some general statements should be made here, however, to specify the RC concept:

1) Reference coalitions and substitutional coalitions result significantly more frequently than what may be expected by chance.
2) The division of payoffs lies between an equal division and the division predicted by the equal division kernel.

3) In a substitutional coalition the stronger player's share is significantly higher than his share in the reference coalition itself. In the latter an equal division is often utilized.

The first inference is a consequence of the characteristics of reference- and substitutional coalitions as described above. The second refers to the two leading viewpoints in the development of the equal division kernel concept. The equal share serves as an orientation point, upon which the participants possibly agree, particularly since it is more favorable for the weaker players. Depending on how much the subjects emphasize the differing bargaining possibilities, the upper limit for the stronger player may result. The third inference assumes, finally, that none of the players has reason to leave the reference coalition if he is not able to receive at least the same share in the substitutional coalition, possibly, of course, more.

The Equal Excess Model

KOMORITA (1979) suggests a model which refers to the principle of the valid threat. The threat to change to another coalition is referred to as being valid if the new coalition does not need the consensus of any one of the members of the existing coalition. In the so-called preliminary bargaining round, i.e., structuring phase before the actual start of the bargaining, the players avaluate their contribution to the coalition payoff for each valid coalition by means of the equal share of payoffs. In the first bargaining round the players refer to the results they expected to receive in the best alternative in the preliminary round, and use this as their initial starting point. Each player should then be assigned that value designated by himself in one of the existing coalitions of the first round. These initial values should then be summed over all players. If there is a remainder (positive or negative) in comparison to the actual coalition payoff, this remainder should then be equally divided among the members. This is repeated in the second round where the reference values for the best alternatives are derived from the first round, and so forth.

The formula as expressed in the KOMORITA model (KOMORITA, 1979)states:

$$(12) \qquad E^k_{iS} = \max_{S \neq T} E^{k-1}_{iT} + (v(S) - \sum_{j \subset S} \max_{S \neq T} E^{k-1}_{jT}) / |S|$$

Here, E^k_{iS} is defined as the payoff received by player i in round k within coalition S and furthermore, $\max_{T \neq S} E^{k-1}_{iT}$ is the expectancy of player i in round $k-1$ regarding his best alternative coalition. E^0_i is defined for each coalition by $e(S)$.

As may be inferred from the study by KOMORITA (1979), the formula may be further specified as:

$$(11) \qquad E^k_{iS} = \max_{\substack{S \neq T \\ i \in T \\ (S - \{i\}) \cap T = \emptyset}} E^{k-1}_{iT} + (v(S) - \sum_{j \in T} \max_{\substack{S \neq T \\ j \in T \\ (S - \{j\}) \cap T = \emptyset}} E^{k-1}_{jT}) / |S|$$

It is assumed that all participants calculate their corresponding equal excess value on the basis of their valid alternatives for all possible coalitions in each round. For two-person coalitions in zero-normalized games KOMORITA's model has unequivocal results. In the preliminary round 0 there is an equal division, in the first round an equal division kernel solution is produced and in all further rounds this process is repeated by the participants until the n-th trial, thus resulting in an increasingly unequal distribution of the payoffs. Thus, in three-person games the quotas result as an symptotive solution. For three or more-person coalitions the results deviate from the equal division kernel already in the first round, if all participants have valid alternatives. It is not, however, stated in KOMORITA's text how the individuals or sub-groups behave if such valid alternatives do not exist. Therefore the results remain uncertain for coalitions with more than two participants. According to the examples presented by KOMORITA (1979), it may be assumed first trial player A, who was allowed to play three more times, played with two players B and C who were playing for their first and only time.

In the following trial player A, playing for the second time, was assigned to two new partners who were playing for the first and only time. It follows that from the 216 subjects, 24 played four times (thus 24 x 4 trials). These players were assigned two inexperienced players, i.e., 192 subjects played once (2 players x 96 trials). A period of three to five days separated each bargaining session for those playing more than once.

Each subject received a token sum of 7.50 DM (approx. 4 American Dollars at this time) for participation and additionally the amount of the payoff in DM from the bargaining session (cf. payoffs in Table 2a). The subjects playing more than once had a payoff account in which the sums were added and paid off upon completion of the experiment.

2.2 Characteristics of the Investigated Games

The games given in Table 2 were conducted. They were constructed according to the following viewpoints:

1. The value of a one-person coalition is always zero.
2. The value of the pair coalition is the sum of the quotas for the respective players as given in the Table 2.
3. The quotas were varied in such a way that four differing quota-distribution types resulted, namely: one strong player against two equally weak players, one strong player against two variously weak players, two variously strong against one weak player and finally, two equally strong players against one weak player.
4. The value of the three-person coalition was either less than the sum of the quotas (conflict type I - empty core), equal to the sum of the quotas (conflict type II - one-element core) or larger than the sum of the quotas (conflict type III - more-element core).

Table 2: Characteristics of the investigated games 1-12:
Quota distribution and payoffs of the coalitions.

Structure: (1) (2) (3) (1.2) (1.3) (2.3) (1.2.3)	empty core	one-element core	more-element core
Q-Distribution I one strong vs two equally weak players w_1=9.00, w_2=3.00, w_3=3.00	game 1 0 0 0 12.0 12.0 6.0 10.5	game 2 0 0 0 12.0 12.0 6.0 15.0	game 3 0 0 0 12.0 12.0 6.0 19.5
Q-Distribution II one strong vs two variously weak players w_1=9.00, w_2=4.25, w_3=1.75	game 4 0 0 0 13.25 10.75 6.0 10.5	game 5 0 0 0 13.25 10.75 6.0 15.0	game 6 0 0 0 13.25 10.75 6.0 19.5
Q-Distribution III two variously strong players vs one weak player w_1=8.25, w_2=5.75 w_3=1.00	game 7 0 0 0 14.0 9.25 6.75 10.5	game 8 0 0 0 14.0 9.25 6.75 15.0	game 9 0 0 0 14.0 9.25 6.75 19.5
Q-Distribution IV two equally strong vs one weak player w_1=7.00, w_2=7.00, w_3=1.0	game 10 0 0 0 14.0 8.0 8.0 10.5	game 11 0 0 0 14.0 8.0 8.0 15.0	game 12 0 0 0 14.0 8.0 8.0 19.5

2.3 Independent Variables

Along with the two independent variables mentioned above,
(1) Quota-distribution (Q-distribution) type (four levels, v_1, v_2, v_3, v_4), and
(2) intensity of the conflict (three levels, k_1, k_2, k_3), the following experimental variables were introduced:
(3) Experience of the player in the first to fourth trial (four levels e_1, e_2, e_3, e_4),
(4) the role as strong or weak player (levels r_1, r_2) and the exchange of roles, i.e., the experienced player first plays the role of the strong player twice and then the role of the weak player twice (two levels, u_1, u_2). Due to economic reasons the experimental design is not completely crossed. In order to clarify the experimental design, the incomplete Latin square is presented in Table 3.

Table 3: Experimental sequence in Latin Square (under condition u_1). For more details see text.

		e_1 r_1	e_2 r_1	e_3 r_2	e_4 r_2
k_1	EP1	$v_3^{(+)}$	v_2	v_4	v_1
	EP2	v_1	v_4	$v_2^{(-)}$	v_3
	EP3	v_2	$v_3^{(-)}$	v_1	v_4
	EP4	v_4	v_1	v_3	$v_2(+)$

		e_1 r_1	e_2 r_1	e_3 r_2	e_4 r_2
k_2	EP5	$v_3^{(+)}$	v_2	v_4	v_1
	EP6	v_1	v_4	$v_2^{(-)}$	v_3
	EP7	v_2	$v_3^{(-)}$	v_1	v_4
	EP8	v_4	v_1	v_3	$v_2^{(+)}$

		e_1 r_1	e_2 r_1	e_3 r_2	e_4 r_2
k_3	EP9	$v_3^{(+)}$	v_2	v_4	v_1
	EP10	v_1	v_4	$v_2^{(-)}$	v_3
	EP11	v_2	$v_3^{(-)}$	v_1	v_4
	EP12	v_4	v_1	v_3	$v_2^{(+)}$

Table 3 should be read as follows:
In the square to the left in the first line, first column, k_1, EP1, e_1, r_1, u_1, v_3 signifies that under the condition of the empty core, k_1, for the experienced player number 1 allowed to play more than once EP1, in the first trial, e_1, the role of the stronger player, r_1, in the Q-distribution, v_3, is taken on. In the square in the middle, its fourth line, second column k_2, EP8, e_2, r_1, u_1, v_1 signifies that under the condition of a one element core, k_2, for the player number 8 allowed to play more than once, EP8, in the second trial for this player, e_2, the role of the strong player r, r_1, in the Q-distribution 1, v_1, is taken on.

Additionally, it should be noted that the Q-distributions 2 and 3 indicate variously weak and strong roles, respectively. This is indicated in the Latin square with a (+) or (-) depending on whether the player takes on the role of the relatively strong player (+) or the relatively weak player (-). In the second group (not presented in Table 3) the order is repeated. However in this group the experienced player must take on the role of the weak player in the first two trials and than the role of the stronger player in the last two trials.
In summarizing, the experimental design represents the following: the so-called experienced players play in four trials under one certain conflict condition with all four quota types in a sequence given by the Latin square. The three differing roles are taken on by the experienced players represented in the respective positions of stronger, less strong and weak players.

1. <u>Conflict strength</u> (k_1, k_2, k_3 - low, medium, high), a factor with independent measure.

2. <u>Quota-distribution type</u> (v_1, v_2, v_3, v_4 - 1 strong player vs 2 equally weak, 1 strong vs two variously weak, 2 variously strong vs 1 weak, and 2 equally strong vs 1 weak). <u>Repeated measure factor</u> in the Latin square.

3. Level of experience (e_1, e_2, e_3, e_4 - no experience, first experience, etc.). Repeated measure factor in the Latin square.
4. Exchange of roles (u_1, u_2 - first strong then weak, or first weak then strong).
5. Roles (r_1, r_2, - role of the strong or weak player). Repeated measure factor in the Latin square.

2.4 Procedures and Instruction

During the bargaining sessions the subjects were placed in three separate rooms. Each player immediately received a written instruction sheet as well as a questionnaire. The experimental instructions specified the proceedings of the bargaining. The subjects were informed as to the game and their role in it. Additionally, they were informed as to the roles of the two other players. The Ss could make contact with the other participants by means of an intercommunication apparatus. Before communication was possible, the subjects had to choose their coalition partners. This occurred by means of pressing a button that transmitted the desired coalition for each participant in the other rooms. The communication could begin when the coalition was agreed upon, e.g., player 1 chooses (1,2) and player 2 chooses (1,2). If a coalition was not agreed upon by all its members, the proceedings must be repeated until a coalition is agreed upon. The communication phase lasted two minutes respectively (recognized as being sufficient on the basis of preliminary testing). An acustic signal presented 10 sec prior to the end of the round indicated the end of bargaining. After the conversation between the coalition partners, which could not be heard from others, the participants were to write their demands and offers to their partners on a blackboard, which was transmitted via camera and monitor into the other rooms. The sum of the components of the payoff vector suggested by a person should be equivalent to the value of the coalition. There were no other restrictions. One of the participants in a pair-coalition round could, for example, suggest forming a three-person coalition with its corresponding payoff vectors, and in the three-person round, a two-person coalition with its corresponding payoff vectors could be suggested.

The bargaining was ended when every player participated at least in two rounds and the coalition partners signaled the end of the bargaining by agreeing on the payoff vectors (ratification of coalition). Thus three rounds were the minimum necessary in two-person conversations, at least two rounds in the grand coalitional debate. At the end of the bargaining session, the player allowed to play again was supposedly randomly selected. This random selection was, however, so programmed that the "experienced player" was always selected. All players were informed in advance that they could not get any money before the experiment was entirely completed and that the money they had won on the first, second,..., trial was put on a personal account until the end of the experiment. This restriction was introduced in order to guarantee that all "experienced" participants took part in the experiment until the last trial. After the fourth trial the experienced Ss were informed that, according to the random device, the experiment was finished for them now. Accordingly money was paid to the inexperienced players after the first trial and to the experienced players after the fourth trial. - The coalitional payoffs, as denoted in Table 2 , correspond to German Marks (DM, where 1 DM is approximately 1/2 Dollar).

2.5 Dependent Variables

The data analysis considered the following measures:

1. The first coalitional choices
2. The frequencies of different arguments in communication
3. The frequency of the four possible coalitions
4. The payoff vector(s) after the first, second and third round
5. The payoff vector of the final results.

2.6 Rationale of the Design

The construction of the games according to the distribution of strong and weak players serves the concept of similarity effects and the effects of role discrepancy, not regarded by the mathematical models. The value of the grand coalition was varied in order to test whether the predictions made by these models are valid for various core-sizes.

The mathematical models undergo a difficult test by means of the descrepant roles within the 12 games. Under these prerequisites, the models must predict distinctly different payoffs of the participants within the coalition. These differing outcomes are contrary to the expectancies that a direct application of the equity theory would develop due to the random nature of the assignment of roles, not based on achievement or merit (namely equal share). The conditions of communications were structured in such a way that, despite the necessary control, a certain relation to communicative behavior in actual negotiations could be produced. Face to face contact was the only form that was not allowed, not so much to limit the influence of sympathy or antipathy which could result from various levels of intimacy in the group of student participants, but rather to avoid many signals from being sent via nonverbal communication, thus avoiding analysis. Not only did the subjects have the opportunity to exchange offers and demands in the verbal communication but they could also support these demands and offers by means of argumentation, as well as commenting on those of their fellow players.

Furthermore, the subjects should have the option of bargaining exclusively with one player if this is desired by both players. Bargaining between two players, therefore, may occur without the third player being able to listen in or discover its results. The third player can, of course, receive this information of the results from one of the two participants in further bargaining, thus allowing for the possibility of bluffing.

The criterion that each player should participate two times in each bargaining session has been chosen to make it principally possible that each player could bargain with each of the others although they were not forced to. The opportunity existed for each player to refuse to bargain with another player if this player did not see this as being beneficial for himself.

This criterion of making contact twice seems also necessary in avoiding such bargaining strategies in which the payoffs in relation to the time expenditure are maximized. This could lead to two players forming a favorable coalition, immediately distributing the profits, and therefore obtaining premature results. The bargaining process is recorded by means of the tentative and final results of the coalition partners in the different rounds.

The data would be extremely taxed if a dynamic analysis of the complete bargaining process were undertaken. This should be left to further investigations with appropriate experimental designs. The present investigation of the process shall be limited to investigating the first choice of the coalition partner and the tentative results of the first three rounds, and the contents of communication.

3. PREDICTIONS OF THE MODEL, DATA ANALYSIS AND RESULTS

3.1 Focal points of the Analysis

The analysis in the present investigation shall be limited to the concurrance of the data with the predicted values of the mathematical models. The experimental factors "experience" and "role exchange" have been introduced. Experience has been introduced to see whether an experienced player obtains better results than the inexperienced players in similar situations. Role change has been introduced to see whether the role in which experience is gathered is significant. The analysis in regard to the experimental factors shall be presented in a later section. It should be noted in judging the general validity of the following analysis that the repetition of participation had, on the average, no effect on the frequency of coalitions and the payoff results. Singly, the main effect "role change" is notable, as an effect of differential experience. A relation cannot, however, be recognized between the role change with the goodness of fit of the formal models being considered, suggesting that under certain conditions one model is more appropriate than under others.

3.2 Predictions According to the Reference Coalition - Equal Division Kernel Model (RC/EK)

The following inferences may be derived from the reference coalition - equal division kernel model (RC/EK) with regard to coalition formation and payoff distribution:

(1) The data do not significantly deviate from the RC/EK model[3)], i.e. the deviations of the RC/EK predictions do not significantly differ from zero.

(2) The deviations displayed by the data from the predictions given by the models are minimized with the RC/EK model.

(3) According to the principle of reference-substitutional coalition, fewer grand coalitions are to be expected in empty core than would be expected in an one-element or more-element core.

(4) Reference coalitions and substitutional coalitions occur more frequently than do other coalitions.

(5) The deviations from the EK value of the reference coalitions are larger in the substitutional coalitions than in the reference coalitions themselves.

With regard to the first coalitional choices, the analysis of the demands and offers in the first three rounds by the equal excess model and the analysis of communication no specific predictions are derived. Although predictions could be derived from the RC/EK concept, we prefer to consider these as exploratory analyses.

3.3 Comparison of the Models

The models defined for pair and three-person coalitions shall be investigated in the following. This excludes the SHAPLEY value since it is only applicable for the grand coalitions with nonempty cores. The SHAPLEY value is, however, indirectly tested in that the EK model gives the same predictions for the grand coalitions. In addition to the RC/EK model and the EK model mentioned above, the equal share (ES) model and the quota model shall be tested. The quota model corresponds to the Kernel for pair coalitions.

For the grand coalitions, the predictions supplied by some of the models depend on the size of the core. The determination of the predictions given by the models is relatively simple with a one-element core. According to the quota and kernel models, the quotas result exactly then. According to the reference coalition principle, it is assumed that the payoff allocation should lie between the equal share in the reference coalition and the EK value in the reference coalition (1,2). Player 3 gets the remainder, thus defining a range value for player 3.

For the empty- and the more-element core some problems do arise in that some models do not explicitly state how the relative payoff should be divided among the players. It is assumed in these models that the negative or positive surplus (empty core and more-element core) as compared to the one-element core would be equally divided among all players in the grand coalition. When so defined, the quota (remainder) model agrees with the kernel.

The RC/EK model excludes some coalitions according to definition (structure of dominance). These coalitions are the (2,3), occasionally the (1,3) when role symmetry occurs and the grand coalition under the empty core condition (cf. Table 4). No sensible value can be determined according to the logic behind the RC/EK model for the nonpermissable coalitions. Since such coalitions do, however, occur occasionally, the results for this data set will be presented separately in advance. Out of the 96 coalitions in the experiment 11 coalitions (see Table 5) are to be considered non permissible in the sense of the RC/EK model.

Table 4: Characteristics of the investigated games: Reference and substitutional coalitions

		K_1		K_2		K_3	
		Ref.	Subs.	Ref.	Subs.	Ref.	Subs.
Quota Distribution	I	(1.2) (1.3)	--	(1.2) (1.3)	(1.2.3)	(1.2.3)	(1.2) (1.3)
	II	(1.2)	(1.3)	(1.2)	(1.3) (1.2.3)	(1.2.3)	(1.2)
	III	(1.2)	(1.3)	(1.2)	(1.3) (1.2.3)	(1.2.3)	(1.2)
	IV	(1.2)	(1.3)	(1.2)	(1.3) (1.2.3)	(1.2.3)	(1.2)

Table 5: Frequencies of "nonpermissable coalitions" and allocation modus

	(1.3)	(2.3)	(1.2.3) empty core
Equal Share	0	4	5
Others	1 *	1	0
	1	5	5

*This coalition occured in game 6. Here, the reference coalition was (1.2.3), i.e. (1.3) cannot serve as a substitutional coalition because v (1.3) = 10.75

3.4 Results

3.4.1 First Communication Choices

As presented in the section "Procedures and Instructions", each bargaining session began with the selection of a communication partner. Whereas the selection following noncompatible choices is probably strongly influenced by the previous results of voting, the first choice in the first round of bargaining may be viewed as a measure of the attractiveness of the respective coalitional partners or the coalitions themselves. With assumptions, as described by BRADLEY & TERRY (1952), GULLIKSEN (1953), LUCE (1959), and THUSTONE (1930) the probability of selecting a certain coalition is a function of the attractiveness of the coalition (cf. SELTEN, 1979, who comes to a similar conclusion concerning the coalitional preference in three-person games). This attractiveness on the other hand has been considered to be a function of the subject's profit expectations. The model, known in literature as BTL-model suggests the following relation between the probability $p_T(i)$ that an individual will choose the alternative (i) from the given set of alternatives and the attractiveness of that alternative, formally:

$$p_t(i) = \frac{a(i)}{\sum_{j \in T} a(j)} \tag{13}$$

Here, T is the set of all possible alternatives (in this case all permissable coalitions) in which the player can become a member and a(j) denotes the attractivity of alternative j. The probability of the individual choosing a certain alternative consists of the relation of the attractiveness of that alternative to the sum of attractiveness of all alternatives that can be chosen. If the various solution concepts like the equal share (ES), equal division kernel (EK) or quotas are to be tested for their general interpersonal validity, that is to say, if these concepts apply to all individuals, then the relative observed frequency with which the players have chosen the alternative i may be compared to the theoretically expected relative frequency. If the attractiveness of a coalition is assessed according to the equal share value, then player 1, for example, in the quota distribution (9, 3, 3) and v(1,2,3) = 10.5 would choose the coalition (1,2) with the probability:

$$p_1(1,2) = \frac{6.0}{6.0 + 6.0 + 3.5} = 0.387$$

Therefore, the probability with which player 1 would choose coalition (1,2) is found in the ratio of the attractiveness of (1,2) in the numerator and the sum of the attractivity values of all coalitions in which he could become a member in the denominator.

Although there are indications from empirical findings that the selection of coalition partners is not - as suggested by the BTL-model - a probabilistic process connected with the relative attractivity of the coalitions, it seems interesting to test if any of the models (ES, EK, Q) meet that assumption. The comparison of goodness of fit of the BTL-predictions for coalitional choices and the goodness of fit of the various models (ES, EK, Q) with the satisfied coalitional bargaining results might provide information about the nature of the process of selecting a coalition partner.

Since the BTL model also applies for subsets, it is more appropriate for our purposes here to base our calculations on the conditional probability for the pair coalitions assuming that these are not dependent on the value of the grand coalition according to the qual hare, equal division kernel and the quota models. Therefore, for our purposes the observations from all three levels of conflict may be merged into one relative frequency. Conducting this comparison for the four quota distributions indicates that for all four quota distribution types the predictions of all three models (ES, EK, quotas) are incorrect, quotas doing the worst, then the EK model and the ES model. Player 1 chooses throughout the coalition (1,2) more frequently and more seldomly (1,3) than expected. Player 2 chooses the coalition (1,2) more frequently and (2,3) less frequently than expected and finally, player 3 prefers the coalition (1,3) over (2,3) more than was expected. Thus, an evident tendency to choose the relatively stronger players as a coalition partner exists. The stronger player receives more coalition offers than that expected according to any model. Of the 12 Chi^2 tests (3 solution concepts, ES, EK, uotas x four quota distribution types, I, II, III, IV) conducted, 10 tests indicate a preference for the stronger player, significant at least at the 5% level. The single expectations are for the ES and EK models in the quota distribution type I (9-3-3), in which the role of the relative stronger player is not clearly defineable due to the equally weak roles (3-3) of players 2 and 3. Table 6 presents the results summed over all four quota distribution types.

Table 6: Expected frequencies according to the solution concepts, equal share (ES), equal division kernel (EK) and quotas (Q), compared to the experimentally observed frequencies for the selection of pair coalitions in the votes of the first round of bargaining

expected frequency/ observed frequency	relatively strong player	relatively weak player
ES	145.2	90.8
EK	136.2	99.8
Q	118.0	118.0
observed frequencies	179	57

χ^2 for ES, df = 1: 20.45 $p < .001$ *)

χ^2 for EK, df = 1: 31.80 $p < .001$ *)

χ^2 for Q, df = 1: 44.08 $p < .001$ *)

*) Since 24 experienced players played four times in the four quota distribution types, their choices subsequent to the first game are not independent, we did however not exclude the first coalitional choices of the experienced player on levels e_2, e_3 and e_4 since they did not differ significantly from the choices made by inexperienced players.

As may be seen in Table 6, the expected values do covary with the obtained values, but the BTL model underestimates the high probabilities and overestimates the low probabilities. This suggests for our case that the probability of choosing the stronger partner is under-estimated, a finding that has also been found by SELTEN (1979, p. 104) in an empirical test of his probability model. It may be concluded then that the BTL model is not adequate in predicting the choice behavior of any of the models presented here.

The expected and observed relative frequencies have been correlated thus producing an estimate of the covariation. The grand coalition has been included here, since a larger number of observations with the same prediction is not needed for this procedure. (Table 7 see p. 32)

On the average, approximately 50% of the variance is accounted for by the ES model, 34% by the EK model and a mere 3% by the quota model. This result corresponds to our expectations since, as described earlier, the expectancies of the participants is first determined by the equal division. Subsequently, the EK concept becomes meaningful through the comparison of the alternative possibilities in later steps of the bargaining process.

3.4.2 Analysis of the Contents of Communication

The communication exchanged in the various rounds has been recorded on tape. The arguments concerning the allocation rules were subsequently counted. Personal arguments (i.e. expression of gratitude, praise or reproaches) as well as comments of more general nature (e.g. appeals for fairness) have not been considered. A total of 634 relevant arguments were identified, of which 317 vaguely referred to the strength or weakness of the players (e.g. "I'm stronger than you are", or " I feel as if I were in the worst position"). Such vague arguments coincide with the expectancies of each model, even the Equal Share model, since the stronger player may refer to his strength so that he at least gets an equal share of the payoffs. The remaining arguments are exhibited in Table 8, p. 33.

Table 7: Correlations (corrected for attenuation) between the expected frequencies for the equal share concept (ES), equal division kernel concept (EK) and the quota concept (Q) with the observed relative frequencies*) for the choice of partners in the first round of each bargaining session.

	Quota Distribution			ES	EK	Q	n =
1)	9.00	3.00	3.00	0.55^{++}	0.52^{++}	0.30	27
2)	9.00	4.25	1.75	0.80^{+++}	0.61^{+++}	-0.03	27
3)	8.25	5.75	1.00	0.77^{+++}	0.71^{+++}	0.32	27
4)	7.00	7.00	1.00	0.74^{+++}	0.50^{++}	0.11	27
	Over all Quota Distributions*)			0.71^{+++}	0.58^{+++}	0.17	108

\+ : = $p < .05$ (for n - 27 critical value 0.38, two-tailed)
++ : = $p < .01$ (for n = 27 critical value 0.49, two-tailed)
+++: = $p < .001$ (for n = 27 critical value 0.60, two-tailed)

*) The observed relative frequencies taken from 8 observations, i.e. the four groups in one Latin square are taken together. Since the games were played with 3 core types by 3 players and 3 possible coalitions for each of them, 27 relative frequencies (n = 27) result.

*) In the overall correlations, repeated measures are contained for the experienced player, which have been included since the experinced player did not exhibit significantly different behavior in voting from the inexperienced players.

Table 8: Content analysis of verbal communication frequencies and percentages of identifiable and inambigious arguments

Arguments related to reward allocation		
1) Suggesting an equal split in the present tentative coalition	119	65%
2) Related to an equal split in other, alternative coalitions	39	21%
3) Related to what has been tentatively agreed upon in earlier coalitions	25	14%
4) Taking up explicitely the logic of quotas, bargaining set or kernel	1	1%
	184	
Arguments related to coalition formation		
5) Suggesting the enlargement of the coalition within a two-person communication	29	30%
6) Suggesting a grand coalition in a two-person communication	29	30%
7) Promoting the grand coalition by bloc forming of two players	38	40%
	96	
8) Rest of all other identifiable and inambigious arguments related to reward allocation or coalition formation	37	

Effects of power status of the player

	strong	weak	Chi^2 (1)	p <
total no. of arg. incl.vague arg.	389	245	16.34	
Equal Split (1)	58 (73)	61 (46)	8.0	.01
Agreement in earlier coalition	22 (15)	3 (10)	8.1	.01

(1) under the assumption of independance

The first argument listed in Table 8 refers to an equal share (65% of the groups). The second argument corresponds to the aspects of the equal division kernel or reference coalition system (21%). The third argument (14%) may be seen as related to the reference coalition but may also be used in other contexts. Argument (4) only occurred once (1%) refers to the quotas. Arguments 5 to 7 are concerned with the formation of coalitions and are aimed at the formation of the grand coalition with various intentions. Among these arguments, the tendency to form blocs, although not considered by any of the present models, comprises the largest proportion of the arguments (40%).

The lower part of Table 8 considers the usage of the various arguments depending on whether the arguing player was in a strong or weak position. Stronger players refer less to the equal share in their arguments than was expected and more frequently refer to the results of other coalitions. This latter argument reveals a functional relationship to the reference coalition system, because only the stronger player can make reference to the results of the previous bargaining in other games with success.

Therefore, it may be concluded that the content analysis indicates that the primary components of the debate were either vague arguments concerning the strength or weakness of the players or concerning the equal share argument. Whereas the argument dealing with the strength or weakness of the players was used with an equal frequency by both weak and strong players, the equal share argument was applied considerably less frequently by the stronger player. Additionally, the equal share argument in an alternative coalition, which, along with the vague strength argument and the equal division is a component of the EK and RC concept, played an important role. Contrarily, the quota argument only appears once (the bargaining set or kernel argument is not observed at all).

3.4.3 Frequencies of Coalition Structures

Table 9 presents the frequencies of the various coalitions in the three games investigated. Pair coalitions represented 49% of those coalitions formed; grand coalitions 51%. As expected according to the hypothesis 3, pair coalitions were most frequently formed in the empty core (cf. Table 10). Pair coalitions were least frequently formed in the more-element core ($\chi^2 = 36.30$, df = 2, $p \leq .001$). In accordance to the RC/EK concept, the coalitions (1,2) and (1,3) compared with (2,3) were more frequently formed than that expected by chance (40 vs 7; $\chi^2 = 7.08$, df = 1, $p \leq .01$). Among pair coalitions, reference coalitions appear more frequently than substitutional coalitions ($\chi^2 = 3.82$, df = 1, $p \leq .05$, cf. Tables 4 and 9). This also applies for three-person coalitions, however in this case, the difference between the reference and substitutional coalition is confounded with the core size.

Table 9: Frequencies of coalitions in the games 1-12 (Q-Distribution I-IV)

<table>
<tr><th></th><th>(1,2)</th><th>(1,3)</th><th>(2,3)</th><th>(1,2,3)</th></tr>
<tr><td>I
(1 - 3)</td><td colspan="2">8</td><td>3</td><td>13</td></tr>
<tr><td>II
(3 - 6)</td><td>7</td><td>4</td><td>1</td><td>12</td></tr>
<tr><td>III
(7 - 9)</td><td>7</td><td>5</td><td>1</td><td>11</td></tr>
<tr><td>IV
(10-12)</td><td>7</td><td colspan="2">4</td><td>13</td></tr>
<tr><td></td><td colspan="3">47</td><td>49</td></tr>
</table>

Table 10: Observed and expected frequencies of pair and three-person coalitions in dependence on the core type K_1, K_2, K_3

	K_1	K_2	K_3	
Pair Coalitions	27 (15.66)	17 (15.66)	3 (15.66)	47
Three-person Coalitions	5 (16.33)	15 (16.33)	19 (16.33)	49
	32	32	32	

3.4.4 Demands and Offers in the First Round

Subsequent to the exchange of communication, the subjects were requested to record the amount they had finally demanded in that round and how much was offered to them by their partner. Some of the groups (32 of a total of 96) obtained suggested allocations that concurred already in the first round. In 23 of these 32 groups, an equal share distribution of the payoffs was agreed upon as a preliminary outcome. This does not mean, however, that all of these groups agreed upon an equal split in their final round; 12 of them did indeed ratify an equal share allocation, 11 groups, however, ended with unequal splits. Considering all allocation suggestions of the first round, also those that were not agreed upon, indicates that the relatively strongest players suggested an unequal split more frequently than did the relatively weaker players. Here, the stronger players prefered allocations giving them more, whereby the weaker players attempted to get an equal split.

In order to quantify the results, the relative frequency with which the relatively stronger player suggested an unequal split in his favor, an equal split and an unequal split in favor of his partner were determined, these calculations were also conducted for the relatively weak players. The results indicate significant differences ($\chi^2 = 31.98$, df = 2, $p < .001$, under the assumption of independence[4)]). This finding indicates that the stronger player suggests the equal split less frequently, and an unequal split in his favor occurs more frequently than that expected by a random distribution.

3.4.5 The Analysis of the Bargaining Process by the Equal Excess Model

The number of rounds needed to reach ratification of a coalition varied between 2 and 13, with a median of 5. The median number of rounds having compatible offers was, however, only 2. As already mentioned, demands and offers are referred to as compatible whenever the demand of one player and the offer of the other player or players sum to $v(S)$.

Since the equal excess model (EE model) by KOMORITA (1979) makes a prognosis of the bargaining process the predictions of that model shall be compared with the data observed here. Strictly the compatible allocation suggestions shall be considered here since a round without compatible suggestions is considered as not being complete. Furthermore, this procedure has proven to be fair with respect to the EE model since with increasing rounds the predictions of this model become increasingly worse.

In order to achieve a lucid and concise presentation for the various games investigated,Table 11 presents the deviations from an equal split. Here, the observed deviations are presented along with the expected deviations according to the EE model. This comparison has been conducted up to and including the third round, since subsequent to the third round the number of cases per coalition is too small. The results are presented separately according to the coalition (1,2), (1,3) and (1,2,3). The entries present

Table 11: Mean deviation of the demand given by the strongest player from an equal share value in the first three rounds with compatible suggestions (observed) compared to the mean deviation expected according to the EE-model by KOMORITA

	Round 1			Round 2			Round 3		
Coalition	n	observed	predicted	n	observed	predicted	n	observed	predicted
(1,2)	32	+ 0.16	+ 1.12	16	+ 0.44	+ 1.79	10	+ 0.62	+ 2.00
(1,3)	14	+ 1.29	+ 1.37	13	+ 1.39	+ 2.10	9	+ 1.93	+ 2.70
(1,2,3)	35	+ 0.86	+ 0.57	15	+ 0.88	+ 1.96	7	+ 0.69	+ 2.85

the weighted mean scores over all four quota distribution types (weighted according to the number of cases). For the grand coalitions values v(1,2,3) = 10.5 and v(1,2,3) = 19.5,a standardization (equal egalization) to the payoff of 15 DM can be made, without violating the EE model. The coalition (2,3) has not been considered here, since only three observations were relevant for the trend analysis.

As may be seen in Table 11, the observed payoff distributions over the three rounds considered here are not as differentiated as expected by the EE model. For pair coalitions, a certain trend from rounds 1 to 3 may be observed, but this trend is considerably less than that expected by the EE model. Furthermore, no tendency has been found for the three-person coalitions in the predicted direction. Considering the results of the first round indicates that the observed values for the coalition (1,2) are too small, for (1,3) approximately correct and for (1,2,3) too large.

In order to test the difference between the predicted and the observed results only one parameter is needed which provides exhaustive information for the pair coalitions and is sufficient for three-person coalitions concerning the process of bargaining. This parameter is referred to as the k-value (k = theoretical number of rounds) that is calculated for the outcome of the relatively stronger player according to the EE model (i.e. the theoretical k-value). This value is compared with the number of the observed compatible rounds (observed k-value).

The results of a sign test indicate that the observed k-value in 27 of 35 cases is larger than the theoretical k(χ^2 = 9.26, df = 1, $p < .005$) for the pair coalitions. For the three-person coalitions on the other hand the observed k-values are larger in only 24 of 44 cases (n.s.). This latter result may be explained by noting that for three-person coalitions substantially fewer rounds exhibit compatible allocation suggestions compared to pair coalitions. A look at the median indicates that three-person coalitions have only 1 compatible round prior to ratification, whereas pair coalitions demonstrate 3 compatible rounds before ratifying. Since the predictions given by the EE model are most appropriate for the first round and become worse with increasing numbers of rounds, those coalitions are observed separately which needed only one compatible round and those which needed more than one compatible rounds. If only one compatible round occurs, the EE model tends to over-estimate the outcomes of the pair coalitions (4 : 2; only 6 observations!). The outcomes of the three-person coalitions are under-estimated in this case (17 : 8). For the groups in which more than one compatible round was observed, the EE model over-estimates the outcomes of the pair coalitions (23 : 5) as well as the three-person coalitions (17 : 2). That is of a total of 47 outcomes with more than one compatible round, 40 were predicted too high by the EE model (Binominal test $z = 4.68$, $p < .001$).

The same tendency applies, when only groups with experienced players (second to fourth trial) are analyzed. There is no noteworthy trend as prescribed by the EE model when exclusively experienced groups are considered. It is concluded therefore that for these data the EE model must be rejected. On the other hand, it should be noted that in our "experienced groups" only one experienced player bargained with two inexperienced partners. It may be conjectured that the bargaining process may well occur in groups with exclusively experienced players more like that predicted by the EE model.

3.4.6 Payoff Vectors

The comparison of the goodness of fit of the data between the range and point predictions presents difficulties due to the differing demands of the fundamental models. It is therefore not recommended, as may be suggested, that the mean of the range prediction be compared with the corresponding point prediction. This is due to the fact that the range prediction does not necessarily assume that the results coincide with the middle value of the range. An alternative to this problem would be to match up the range predictions with the point predictions. This could be achieved by determining equally large ranges which would contain the point predictions and then computing the frequencies with which the actual results lie within these ranges (cf. Table 12).

Here, the RC/EK model exhibits the highest number of correct predictions (frequency within range). The next best are the ES and then EK models. The Quotas have the lowest number of correct predictions. The comparison of the correct predictions implies however a disadvantage, that being the inability of assigning the results to the one or the other models if the ranges are small and if more-person coalitions are present. The following analysis has, therefore, been conducted: The range and point predictions have been pairwise matched and then compared. An equally large range, as those determined by the range predictions (RC/EK) has been determined around the point predictions (ES, EK, Q) in order to determine an unbiased fit. If the result of a given player lies within the predicted range then this result receives the distance value of 0. If the result lies under the lower limit of the predicted range then the point value of the lower limit is substrated from the point value of the result. Similarly, if the result lies above the upper limit of the predicted range then the point value of the upper limit is substrated from the point value of the result. Although the signs of the values are appropriate in testing in which direction the data deviate from zero, the mean absolute deviations (calculated per coalition) are used to measure the exactness of the predictions made.

The deviations from zero for the predictions of the different models shall be first considered. If primarily negative or positive deviations occur, then it may be assumed that the deviation is not strictly due to chance. Only one payoff value for a pair coalition needs to be taken into consideration since the other indicates the same deviation only with the sign being opposite. In the grand coalition the values are only partially dependent and because of this it is possible for 0, 1, 2, or 3 values to deviate from the predicted range. Therefore, all three roles are considered in the three-person coalition. Table 13 presents the results of these comparisons with the aid of a sign test for the four models being considered here (⊗ and ± signs for the direction of the deviation: ≡ $p \leq .05$, only ± signs for the directions: ≡ $p \leq .20$). That means that we apply the 20% level as criterion - as is usually done - add however the 5% significances for better information. It should be noted here that within the three-person coalitions the significant values are dependent upon one another and that the results are also dependent between differing quota-distribution type, being that the experienced player participates more than once. - The RC/EK model was the only model that did not show significant deviations. The quota model has only one result that does not deviate significantly. The equal division kernel (EK) indicates 5 and the equal division (ES) 9 systematic deviations.

Table 12: Number of predictions falling within predicted range for the various models

	n	ES	RC/EK	EK	Q	outside of all ranges
Q-distribution I (games 1-3)	19	12	15	5	0	1
Q-distribution II (games 3-6)	20	8	10	4	0	9
Q-distribution III (games 7-9)	23	8	14	0	1	6
Q-distribution IV (games 9-12)	22	8	14	12	10	4
f - within range		36	53	20	10	
f - outside of predicted range		49	32	65	75	20

Table 13: Deviations of the data from the various predictive models, separated according to pair and three-person coalitions (sign test). Direction of the deviation indicated by ±; the symbol ⊗ indicating significance of at least $p \leq .05$. Direction sign only (+ or -) indicating $p < .20$. Note that in quota-distribution I the roles of player 2 and 3 and in quota-distribution IV the roles of player 1 and 2 coincide. Therefore player 1 and 2 coincide in those games.

	QD	Pair Coalitions	Three-person Coalitions		
Player:		1	1	1	3
ES	I		(+)		( )
	II		( )	( )	(⊗ -)
	III	⊗ +	(⊗ +)	(⊗ +)	(⊗ -)
	IV		(⊗ +)		(⊗ -)
RC/EK	I		( )		( )
	II		( )	(+)	( )
	III		( )	( )	( )
	IV		( )		( )
EK	I	⊗ -	(-)		( )
	II	⊗ -	(⊗ -)	(⊗ +)	( )
	III		( )	( )	(⊗ -)
	IV		( )		( )
Q	I	⊗ -	(⊗ -)		(⊗ +)
	II	⊗ -	(⊗ -)	(⊗ +)	(⊗ +)
	III	⊗ -	(⊗ -)	(⊗ -)	(⊗ +)
	IV		(⊗ -)		(⊗ +)

ES = equal share

RC/EK = reference coalition / equal division kernel prediction

EK = equal division kernel

Q = quotas (quota-remainder solution)

Similar tendencies can be found in Table 14. The mean absolute deviation in the coalition is determined here, which is considered to be the measure for the exactness of the prediction given by a model. Table 14 should be read according to columns, i.e. the first column indicates the comparison of the ES model with the remaining models considered here. Therefore, as may be observed in the Table, the ES model fares in two cases worse than the RC/EK model (-), in two cases better than the EK model and in two cases better than the quota model (+).

Table 14: Differences in the exactness of prediction made by the various models (Criterion: mean absolute deviation per coalition: = $p \leq .05$; sign test)[1)]

		ES	EK	RC/EK	Q
ES	I		⊗ +		⊗ +
	II		⊗ +		⊗ +
	III			⊗ -	
	IV			⊗ -	
EK	I	⊗ -		⊗ -	⊗ +
	II	⊗ -			⊗ +
	III			⊗ -	⊗ +
	IV				
RC/EK	I		⊗ +		⊗ +
	II				⊗ +
	III	⊗ +	⊗ +		⊗ +
	IV	⊗ +			
Q	I	⊗ -	⊗ -	⊗ -	
	II	⊗ -	⊗ -	⊗ -	
	III		⊗ -	⊗ -	
	IV				

1) Like in Table 13, however, a + means that the model in the row fared better (smaller absolute deviation) than the model in the column, whereas a - indicates the opposite.

As can be determined in observing Table 14, the quota model gave the worst predictions in comparison to all other models being investigated here. The quota model indicates in 8 of the 12 possible cases significantly larger mean absolute deviations. Singly, in the quota distribution type (4) does the quota solution provide a relatively high number of correct predictions, which is presumably due to the fact that the reference and substitutional coalitions coincide here with the RC/EK- and the EK-predictions as well. The EK model follows, which did better than the quotas, but was worse than the RC/EK and ES models. The next model, ES, predicted better than the quotas and the EK model but fared worse than the RC/EK model. The RC/EK model proved to make the best predictions in comparison to the other models.

An analysis of variance has been conducted with the deviation scores described at the beginning of the present section, i.e. the absolute value ($|d|$) of the observed outcome minus the payoff predicted by the model. This analysis has been conducted in order to establish whether the goodness of fit of the modesl varied in dependence on the various characteristics of the game (e.g. intensity of conflict, quota distribution type, etc.). Theoretically the exactness of prediction should not be in dependence on the various characteristics of the game, because these models claim to have general validity. - Three factors are considered: A: $\equiv$ Intensity of conflict (indépendent factor), B: $\equiv$ Quota distributions (repeated measurement factor) and C: $\equiv$ Models (repeated measurement factor).

This analysis has been conducted although the distributions of these measures do not fulfill the parametric requirements demanded for ANOVA, a limitation, for which according to BOX (1953) and WINER (1962) the F ratio is not unduly sensitive. The results of the ANOVA is presented in Table 15. The dependent variable used here is the mean $|d|$ for each coalition. With the exception for the RC/EK concept, there are no cases with missing data, since one of the possible coalitions was always formed. Since the RC/EK model makes no prediction for some coalitions (i.e. for the coalitions (2,3), the coalition (1,2,3) with an empty core and (1,3) with a more-element core, (see here Table 5)), in case one of these did happen to occur as an experimental result, the mean of the deviations of the remaining permissable coalitions has been used as an estimate.

Table 15: Significant results of the analysis of variance with |d| -measures

Source	SS	df	MS	F	p
Factor A (Intensity of Conflict)	4.5	2	2.45	6.11	<.01
Error for A	8.42	21	0.40		
Factor C (Models)	51.59	3	17.20	47.78	<.001
Interaction A x C Intensity of Conflict x Models)	9.00	6	1.5	4.17	<.01
Error for C	18.05	63	.29		
Interaction B x C (Quota Distribution x Models)	22.09	9	2.45	6.82	<.001
Error for B x C	73.74	189	.39		

Simple effects for A x C - and B x C interaction (including the non-significant F-ratios)

A on c_1 (I.C. on RC/EK)	1.06	2	.53	1.43	>.20
A on c_2 (I.C. on EK)	2.72	2	1.36	3.68	<.05
A on c_3 (I.C. on ES)	7.88	2	3.94	10.65	<.001
A on c_4 (I.C. on Q)	2.23	2	1.12	3.03	<.10
B on c_1 (Q.D. on RC/EK)	.54	3	.18	.46	>.20
B on c_2 (Q.D. on EK)	.98	3	.33	.85	>.20
B on c_3 (Q.D. on ES)	12.67	3	4.22	10.82	<.001
B on c_4 (Q.D.) on Q)	10.33	3	3.44	8.82	<.001

The main effects, Intensity of Conflict (core type) and the Predictive Model, indicate that the precision of prediction is on the average dependent on the value of the grand coalition. Furthermore, the models demonstrate various degrees of appropriateness. The appropriateness of the models is on the average best with the more-element core and worst with the one-element core (i.e. main effect, intensity of conflict). On the average, the RC/EK model provides the most appropriate predictions (mean error of estimate $|d| = .22$), followed by the EK model ($|d| = .48$, next the ES model ($|d| = .54$) and finally the quota model ($|d| = 1.22$). Moreover, the interactions, Intensity of Conflict x Predictive Model and Quota Distribution Type x Predictive Model is of interest, since these could answer our questions as to the dependency of the exactness of the predictions provided by the models on the game characteristics. As may be observed in Table 15, the simple main effects indicate that the exactness of prediction provided by the ES model is not only dependent on the quota distribution type ($p < .01$) but also on the intensity of conflict ($p < .001$). The exactness of prediction for the quota model is also dependent on the intensity of conflict ($p < .10$) and quota distribution ($p < .01$). This is also true for the ES model on the intensity of conflict and quota distribution factors ($p < .001$) respectively; for the EK model singly on the core type ($p < .05$). The RC/EK model is the only one that proves to be equally appropriate under all quota distribution and core types ($p > .20$), respectively).

The results of the simple main effects are graphically presented in Figures 1 and 2. As is clearly indicated in the Figures, singly the RC/EK concept demonstrates independence of the factors, core and distribution type.

If the average mean absolute deviation is subdivided according to the Q-distribution (I to IV), reference or substitutional coalitions and pair or three-person coalitions then it may be observed that an obvious

Figure 1: Interaction "Models x intensity of Conflicts" ($p < .001$)
Goodness of fit of different models depending on the value of the grand coalition)

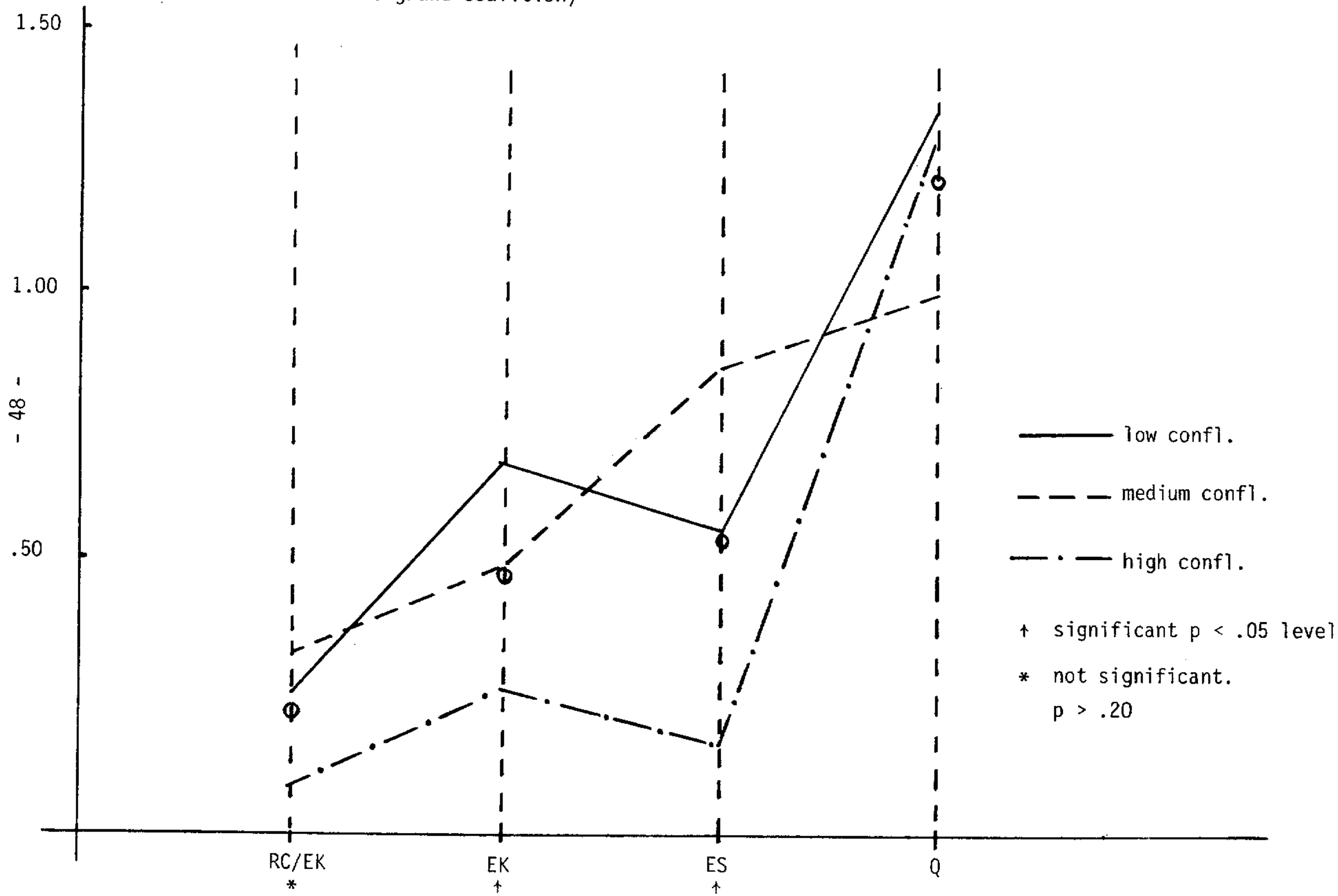
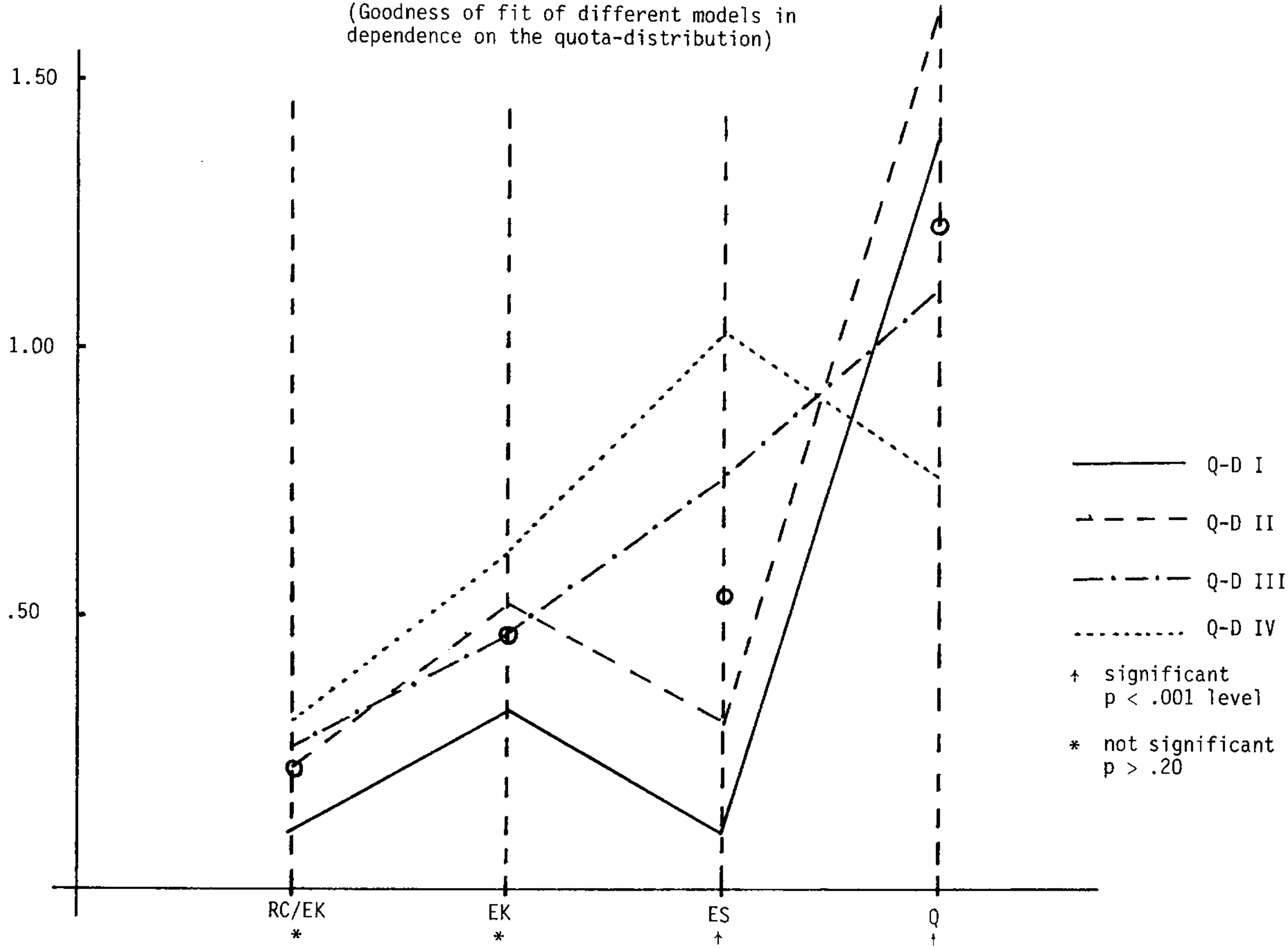


Figure 2: Interaction "Models x Quota-Distribution" ($p < .001$)
(Goodness of fit of different models in dependence on the quota-distribution)



discrepancy in the level of the average mean absolute deviations for a model appears only between the reference and substitutional coalitions.

The model showing the least deviations for the reference coalitions is the RC/EK model. This model demonstrated on the average approximately a mere 2% of the potential deviation range. Approximately twice that amount is demonstrated by the deviations of the ES model, three times as high for the EK model, and more than twelve times as high for the Quota model.

In contrast to the reference coalitions the average mean absolute deviation for the substitutional coalitions for all of the models is relatively high, but, here again, lowest in the RC/EK model. The reason for the relatively high deviations in substitutional coalitions may be found in a careful observation of the coalitions' outcome. It seems evident that there are at least two prefered procedures for behavior in substitutional coalitions: equal division in the coalition or demands made from the reference coalition.

We can therefore conclude that the expectancies (1) to (3) predicting a goodness of fit for the RC/EK concept and (4) predicting the more frequent occurance of reference and substitutional coalitions than would be expected by chance, as formulated in section 3.2, are supported. Expectancy (5), according to which larger deviations of the reference coalitions from the EK value were expected in the substitutional coalitions in comparison to those in the reference coalitions themselves, cannot be confirmed without certain limitations. The reason for this is that some groups divide equally in the substitutional coalition. Therefore, the tendency, though present, is not clearly distinguishable. If the conditions setforth by the expectancy (5) are somewhat relaxed by formulating that the deviation from the <u>equal division value</u> for the coalition in the substitutional coalition should be larger than that in the reference coalition, then the results for the Q-distribution type I - IV according to the <u>median</u> chi^2 test are $p \leq .10$, $p \leq .10$, $p \leq .01$ and $p \leq .01$ respectively. The results of this two-tailed test confirm the relaxed formulations, since they lie in the expected direction in all four cases.

4. SUMMARY AND CONCLUSIONS

Under the condition of complete information concerning the profit tables of the members and with equal investment, the role of equal division of payoffs has been confirmed in investigations with two-person bargaining situations (cf. CROTT et al. 1976, 1978a, 1978b, 1979, ROTH & MURNIGHAN 1980). Under these conditions, the equal division is viewed as being the realisation of the equity principle. On the other hand, the several investigations indicate that along with the equity principle the aim of individual profit maximization plays an effective role. Whereas demands for equal division and individual profit maximization are compatible for the partner disadvantaged by the power structure of the game, equal division is less acceptable for the stronger player, since this would mean dispensing with the utility of his advantage. The concept of the equal division kernel (EK) attempts to formulate these results into a positive mathematical model and then generalize these results in a more descriptive model of reference coalitions (RC/EK).

Observing the single payoff results, it does not seem promising that the predictions made by an a priori point solution concept do not systematically deviate from the actual results. As has already been confirmed for the definition of the equal division kernel and the reference coalition model (cf. CROTT & ALBERS 1981) in a reanalysis of the data of ten experiments with a total of 144 cases, the payoff division within a single coalition corresponds to different prominent point solutions. Among these, the most frequently represented point solutions are the equal division and the equal division kernel. As also found in the present investigation, the quotas have given the least correct predictions. Upon reviewing the data of the present study it seems that the only plausible solution concept must be in the form of a range model. The equal division kernel and its descriptive extensions have been introduced as a multi-phasic analytical process which determines a range between the equal division and the equal division kernel.

The analysis of the first coalitional choices, the content of communication, the first offers and the allocation of payoffs indicate that the equal split principle plays a central role in the decision-making behavior of subjects in existing or alternative coalitions. There is also evidence for the fact that the predictions of all concepts using in some way the equal share principle demonstrate a substantially smaller mean deviation from the observed results than does the quota model. Finally, the analysis of the bargaining process also supports the equal share principle.

The analysis of first coalitional choices shows that none of the models considered (ES, EK, Q) predicts Ss' choices appropriately on the basis of the BTL-assumptions, and thus indicates that the actual choice behavior does not follow the probabilistic idea of the BTL-model. The subsequent coalitional analysis however demonstrates on functional relationship between the theoretical probabilities according to the BTL-model for the ES- and for the EK-model and the observed relative frequencies.

The preliminary contracts settled upon in the various rounds have been analyzed with use of KOMORITA's equal excess model, according to which the payoff allocations should begin in the first stage with an equal split and in the further stages of the investigated games should asymptotically approach a distribution that corresponds to the quotas. Independent of the experience of the players, the present findings indicate no noteworthy tendency as prescribed by the EE model. Singly, a slight increase over rounds could be observed for pair coalitions, an increase that did not, however, exceed that predicted by the RC/EK concept but deviated substantially from the EE predictions (as becomes also evident in the analysis of the final payoffs). With an increasing number of rounds, the tentative payoff allocations predicted by the EE model increasingly deviated from the observed tentative outcomes. Contrary to the predictions of the EE-model, allocations did not gradually approach the quotas with extended bargaining. A critical assessment of these results should note, however, that the "experienced groups" of the present study only contained one experienced player, the remaining players being inexperienced. It may be conjectured that the EE model is more appropriate for the analysis of mature behavior in groups with homogeneous levels of experience.

Observing the number of correct predictions and the payoff allocations reveals information as to the relative goodness of fit of the predictions made by the various models operating with the equal split principle.

In the various non-parametric and parametric analyses the RC/EK model demonstrates the most appropriate fit. Furthermore, in the parametric analysis (ANOVA) this model has proven to be independent of the type of quota distribution and intensity of conflict, i.e. there are no significant differences in the goodness of fit under the various quota distributions of intensities of conflict.

It should be added that the quota and the equal share values define bounds that are expected to be approximated by the observed outcomes, where deviations from the quota-concept are only expected in the direction of an equal share and deviation from the equal share-concept are only expected in the direction of the quotas. On the other hand, the EK value represents the median range and is thus in a better position to produce predictions of smaller deviation from the observed scores than re the ES and quota models. This argument does not, however, apply to the RC/EK concept that has demonstrated the smallest deviations. The range of predictions given by this model is considerable. Frequently, the outcomes predicted by this model, depending on game definitions and coalition type, are almost as extreme as thos predicted by the quotas or equal share model (e.g. the quota distribution type IV, substitutional coalitions).

Whereas the RC/EK model predicts surprisingly well for the reference coalitions, its predictions are less exact for substitutional coalitions.

Assumingly, this is due to the differing division modi employed by the experimental groups. Many groups do not view the substitutional coalitions as such but rather behave as if they were in a reference coalition. That is to say, that the subjects, as in the reference coalition, view the equal division within the coalition as the initial orientation point and then, by comparing alternatives, determine the equal division kernel. Accordingly, the results would be expected to fall between the ES and EK values for the substitutional coalition. Other groups behave according to the RC/EK concept in substitutional coalitions.

Contrary to the predominant number of corresponding models, the RC/EK model not only predicts the payoff allocation, but also limits the number of possible coalitions. Some coalitions are theoretically not allowed to occur. In the present experiment these coalitions do occur, but their occurance is significantly less frequent than that of the coalitions expected by the RC/EK model.

Nonpermissable coalitions in the sense of the RC/EK model, occur frequently in the groups with quota distributions I and II. The RC/EK model does not offer an explanation for this phenomenon. This is possibly due to the tendency towards solidarity among the weaker players (bloc formation). This tendency may be seen as arising from the structure of the games in groups I and II, thus belonging to the investigational goals of the present experiment.

Furthermore, the content analysis reveals the importance of bloc formations, a factor that has not been considered by any of the models being investigated here. The incorporation of such (possibly unstable) bloc formation into behaviorally oriented models appears to be a necessary theoretical task.

Although the RC/EK concept agrees very well with the present data, generalizations should be avoided. The possibility that the formation of the substitutional coalition, as conceptualized by the RC/EK model, may have been promoted by the special aspects of the experimental design cannot be completely excluded. An appropriate variation of the proceedural conditions could produce evidence derived from the bargaining process especially as to the function of the reference coalitions. If social-psychological research is to contribute to the theory of power by the experimental results of coalition formation and payoff allocation in more-person games, then it appears expedient that the effect of various procedures (e.g. exchange of offers, conditions of information, communication and ratification) on the coalitional preference and the allocation of payoffs should be further investigated.

Footnotes

1) The present experiment has been planned by the first author with Roland SCHOLZ (University of Bielefeld) and has been conducted with the assistance of Th. KAUFMANN, M. KSIENSIK and M. POPP (all from the University of Mannheim). Research has been financed by the Deutsche Forschungsgemeinschaft with assistance from the "Land Baden-Württemberg" as part of the special research project "Wirtschafts- und Sozialwissenschaftliche Entscheidungsforschung" of the University of Mannheim. The authors wish to especially thank Mrs. Gudrun HÖRNER-SCHWARZ (Univeristy of Freiburg) and Mr. Th. SCHERMER (Hamburg) for their assistance in the statistical data analysis, as well as Mr. Mark GREENLEE (University of Freiburg) for his rendering of the text into idiomatic English. Mrs. Jutta GRAF and Mrs. Margit POPP (both University of Mannheim) assisted in the concent analysis.

2) The characteristic function is the defined for the sets of all players. For the sake of simplicity, instead of $v(\{i\})$ the shorter form $v(i)$ and accordingly for $v(\{i,j,....\})$ also $v(i,j...)$ shall be denoted.

3) These procedures of testing the null hypothesis are standard methods for tests of models. In this case a low level of significance has been chosen to work with and the model is retained in the case of the null hypothesis.

4) The first demands are in a complex way dependent, since the results for two players per group are recorded. To compensate, a higher level of significance has been selected ($p < .001$).

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