# THE RESOURCE COMPARISON MODEL OF COALITION FORMATION[1]

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Several models of coalition formation are briefly reviewed and a new model (resource comparison model) is presented. The resource comparison model, based on equity, is shown to be superior to Chertkoff's model (formerly the best predictor of first trial results of three major coalition formation studies). The new model takes comparative alliance preferences into account in a way that might be considered a formal rendition of Thibaut and Kelley's comparison level of alternatives applied to coalition formation. Further tests of the resource comparison model against other major coalition formation theories are suggested. With a relatively minor additional modification, the model is shown to be able to take legitimation of power into account as well.

There has been an expanding interest among social scientists in the phenomena of coalition formation ever since Caplow (1956) revived interest in Simmel's (1950) generally neglected concept, by the presentation of a theory to predict alliance preferences associated with all possible power relations among members of a triad.

The two most typical experimental paradigms used to study coalition formation involve either a hypothetical political convention (Gamson, 1961b; Riker, 1962; Chertkoff, 1966) or a modified parchesi game (Vinacke and Arkoff, 1957; Vinacke, 1959; Bond and Vinacke, 1961; Kelley and Arrowood, 1960; Stryker and Psathas, 1960; Psathas and Stryker, 1965; Senn, 1967). In the hypothetical political convention relative power differences involve different amounts of votes to be used toward a majority political decision. The modified parchesi game involves differential weightings of spaces each player can move his token toward the goal, with the possibility of allies combining their weightings to reach the goal faster. The payoff in either type of situation usually involves accumulation of points.

The most commonly researched power structure of triads involves an $A > B > C$, $A < (B + C)$ power relation, because the major theories of coalition formation make the most clearly differential predictions for triads with this power relation. The three major studies of this power configuration (Vinacke and Arkoff, 1957; Kelley and Arrowood, 1960; Chertkoff, 1966) operationalized power with either a 4:3:2 move weighting in the parchesi game, or a 40:30:20 vote weight in the convention situation.

With a 4:3:2 power structure three forms of 2-way alliances are possible: 4–3, 4–2, and 3–2. If allowed, 3-way (4–3–2) alliances might also be formed. The typical pattern found for male triads with a 4:3:2 power structure is a predominance of 3–2 (weak against strong) alliances (Vinacke and Arkoff, 1957; Kelley and Arrowood, 1960; Vinacke *et al.*, 1966; Chertkoff, 1966; Senn, 1967).

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## THREE CURRENT COALITION MODEL CONTENDERS

The original model of coalition formation in the domain of minimum resource theory which provided the impetus for the Vinacke and Arkoff study (1957) was developed by Caplow (1956, 1959, 1968). Although limited to triads, it did cover all possible three person power relations. Caplow predicted that only A–C and B–C alliances would form under the $A > B > C$, $A < (B + C)$ condition. He made no differential prediction in the expected frequency of these A–C and B–C alliances. The argument for these expectations involves a model of ally preferences such that any person would prefer to dominate as many other persons as possible, and in turn, be dominated by as few as possible. The person bringing greater resources into the alliance could thereby expect to dominate the alliance. Allies jointly dominate the outsider. Thus, A would desire B or C as an ally; and since he would dominate either in an alliance, A is indifferent as to which alliance he would form. As an ally, B prefers C because he could expect to dominate C, and B would not want to ally with A because A would dominate him. C is seen as indifferent toward both A and B, since either would dominate him in an alliance, but he would be willing to form either alliance thereby at least to dominate the non-ally through the power gained as an ally. So, mutual preferences should lead to A–C and B–C, but not A–B, alliances. Unfortunately, Caplow's predictions have not been particularly well supported by the data from the studies of a 4:3:2 power pattern, which have shown a clear predominance of 3–2 (B–C) alliances.

Another model to account for male behavior (female behavior seems to be better accounted for by a quite different anti-competitive model of coalition formation) has been presented by Gamson (1961a, 1964), with a similar model presented by Riker (1962). The cornerstone of Gamson's minimum resource theory is the notion that any participant would expect others to demand a share of the payoff proportional to the amount of resources they contribute to the coalition, a parity norm. Thus the preferred alliances would involve the minimum necessary combination of resources to achieve a decision or to reach a goal. The parity norm is essentially an application of Homans' (1961) law of distributive justice to coalition situations.

To demonstrate the reasoning of Gamson's model, let us consider the argument under the $A > B > C$, $A < (B + C)$ power configuration. Player A contributes a greater share of the resources in an A–C alliance than in an A–B alliance, thus, under a parity norm he would expect the most favorable outcome by forming an A–C alliance. Player B would expect the most favorable outcome by forming an B–C alliance. And player C would expect the most favorable outcome in a B–C alliance. Since the B–C alliance is the only mode mutually preferred by any two of the three potential allies, it is the expected coalition in the $A > B > C$, $A < (B + C)$ case.

In some respects the expected B–C outcome under Gamson's model is counterintuitive, because it implies that there is strength in weakness for coalition formation under this triad power relation. Although Gamson's model also makes similar counterintuitive predictions for certain other 3-person, 4-person, and 5-person power relations, in some cases the strongest player does have an advantage in coalition formation. In general, Gamson's minimum resource predictions have received good support from the studies of male coalition behavior, since B–C alliances (3-2 alliances in the 4:3:2 pattern) generally predominate and payoffs are generally split at least in the direction of parity. Support for Gamson's predictions have also been found with 5-person groups (Gamson, 1961b) and in a study of American Presidential nominating conventions (Gamson, 1962).

Chertkoff (1967) recently presented a revision of Caplow's theory. Chertkoff's revision utilizes the same preference pattern for alliances as Caplow, but it takes into account both choice and reciprocation of choice. It makes the same predictions as Caplow's model except under the $A > B > C$, $A < (B + C)$ configuration. Then, according to the model, A chooses B half the time and C half the time. B chooses C all the

time and A not at all. And C chooses A half the time and C half the time. Thus, the proportion of B–C reciprocal choice equals .50, the proportion of A–C reciprocal choice equals .25, and the proportion of A–B reciprocal choice equals .00. Assuming that individuals try again every time a non-reciprocated A–B choice is made, the expected coalitions become B–C and A–C in a 2:1 ratio, with no A–B coalitions. It is clear that Chertkoff's revision of Caplow's model predicts the combined coalition outcomes of three major studies of coalition formation (Vinacke and Arkoff, 1957; Kelly and Arrowood, 1960; Chertkoff, 1966) better than Caplow's or Gamson's model (Table 1).

for three major coalition studies, all involving a 4:3:2 power relation. The expected outcomes are 67% B–C (3–2) alliances, 33% A–C (4–2) alliances, and 0% A–B (4–3) alliances. A particularly important aspect of Chertkoff's model is that the relative numbers of B–C, A–C, and A–B alliances predicted do not differ with particular values of power for A, B, and C. That is, the model predicts the same ratio of outcomes for a 20:19:18 or a 20:19:2 pattern as it does for the 4:3:2 pattern. This seems unlikely intuitively. A pattern such as 20:19:18 might be expected to yield coalitions very similar to those reasonably expected from an A = B = C configuration (equal numbers of A–B, A–C, and B–C alliances); and,

TABLE 1

COMPARISON OF FOUR COALITION MODELS WITH DATA

| | 4–3 | 4–2 | 3–2 | Total |
|---|---|---|---|---|
| Caplow's Predictions | 0 | 41.5 | 41.5 | 83 |
| Gamson's Predictions | 0 | 0 | 83 | 83 |
| Chertkoff's Predictions | 0 | 27.67 | 55.33 | 83 |
| Resource Comparison Predictions | 6.7 | 22.6 | 53.7 | 83 |
| Data[a] | 9 | 20 | 54 | 83 |

[a](3 major studies): Vinacke and Arkoff, 1957; Kelley and Arrowood, 1960; Chertkoff, 1966.

## THE RESOURCE COMPARISON MODEL

The resource comparison model is presented as an alternative to Chertkoff's version of Caplow's model, so it is necessary to discuss Chertkoff's model in further detail for a basis of comparison. The discussion here is limited to the $A > B > C, A < (B + C)$ power configuration and focuses only on the first trial outcomes. Although Chertkoff's goodness of fit test is questionable, as he points out himself, his model yields the best prediction to date of the combined data

a 20:19:2 pattern might be expected to yield coalitions very similar to an $A = B > C$ pattern (equal numbers of A–C and B–C alliances and no A–B alliances). So, although Chertkoff's model is a better predictor of outcomes under a 4:3:2 pattern than either Gamson's model or Caplow's original model, it has some apparent limitations and aspects of its predictions are somewhat doubtful on intuitive grounds.

As an alternative to Chertkoff's model, a formal equity model (resource comparison

model) is presented below. The resource comparison model covers the more general set of cases encompassed under $A \geq B \geq C, A < (B + C)$ relationships of power and is not limited to the $A > B > C, A < (B \times C)$ case. So it is applicable to coalition formation in any triad where any two parties can defeat a third, but not applicable when one party alone has overwhelming strength. The predictions of the model depend on an equity norm whenever unequal power relations are involved. Whenever an equality norm operates instead (e.g. resulting from subjects' anti-competitive orientations or from a lottery allocation), the above unequal power relations reduce to the A = B = C case (Day, 1970).

As Chertkoff anticipates from his model, it would seem wise to anticipate that the resource comparison model would also make clearest predictions on the first trial, and perhaps only on the first trial. Many new factors appear to enter the picture after the first trial which are likely to modify the process of coalition formation. However, focusing on the first trial is not as limiting in terms of importance as it might at first appear. To begin with, it is an important case in itself, since numerous "real life" alliances are either one-time arrangements or, once formed, essentially permanent – e.g. marriages and legal partnerships. Even if the focus were on outcomes at asymptote, the first trial outcomes would be important from the point of view of specifying initial conditions, so that processes prior to reaching the outcomes predicted by asymptotic models of coalition formation (Ofshe and Ofshe, 1969, 1970; Kelley and Arrowood, 1960) could be better understood.

The resource comparison model might be considered a synthesis of an equity model of coalition formation (e.g. Gamson's minimum resource theory) and Thibaut and Kelley's (1959) comparison level of alternatives applied to alliances in triads, for it involves the relative comparison of alternative alliances under an equity (parity) norm. First, it is assumed that parity operates so that there are expectations in the group that payoffs should be divided according to relative resources or power. Let us also suppose that person A makes a comparison of his power with person B ($C_{A:C}$) and also makes a comparison with person C ($C_{A:C}$), while B and C make similar comparisons ($C_{B:C}$, $C_{B:A}$, $C_{C:A}$, and $C_{C:B}$). Then subject A might contrast the ratio of his power comparison with B against his comparison with C($R_{A:C} = C_{A:B}/C_{A:C}$) to determine his relative preference for alliance A–B. A's relative preference for alliance A–C would be the inverse ($R_{A:C} = C_{A:C}/C_{A:B}$). Subjects B and C would go through a similar process yielding relative preference values: $R_{B:A}$, $R_{B:C}$, $R_{C:A}$, and $R_{C:B}$. Let mutual preference (M) equal the product of the ratios of preference of any two potential allies – e.g. $M_{AB} = (R_{A:B})(R_{B:A})$. Since allies would be expected to form alliances in a process of initiation and reciprocation of offers reflecting the relative preferences of each party for the particular alliance the proportion of occurrence (P) of a particular 2-way alliance would be expected to be equal to the mutual preference value of the two potential parties divided by the sum of 2-way mutual preference values in the triad – e.g. $P_{AB} = M_{AB}/(M_{AB} + M_{AC} + M_{AC} + M_{BC})$. The mathematical sequence is summarized below:

*Definition of Terms*

(1) C's power = c; B's power = b; A's power = a.

(2) $C_{X:Y}$ X's comparison of relative advantage in an alliance with Y.

(3) $R_{X:Y}$ X's ratio of comparison, relative preference for an alliance with Y.

(4) $M_{XY}$ Mutual preference for an alliance between X and Y.

(5) $P_{XY}$ Predicted proportion of X–Y alliances.

*Sequence of Expressions (Taking Predictions for the B–C Alliance as an Example)*

(6) $C_{B:C} = (\frac{b}{c})$; $C_{B:A} = (\frac{b}{a})$; $C_{C:B} = (\frac{c}{b})$; $C_{C:A} = (\frac{c}{a})$

(7) $R_{B:C} = C_{B:C}/C_{B:A}$; $R_{C:B} = C_{C:B}/C_{C:A}$

$$(8)\quad M_{BC} = (R_{B:C})(R_{C:B})$$

$$(9)\quad P_{BC} = \frac{M_{BC}}{M_{AB} + M_{AC} + M_{BC}}$$

*Substitution Back to Power Values in the Equations Under Step (6) and Reduction to Simpler Form Yields*

$$(10)\quad P_{BC} = \frac{a^3}{c^3 + b^3 + a^3}$$

*Similar Sequences Yield*

$$(11)\quad P_{AC} = \frac{b^3}{c^3 + b^3 + a^3}$$

$$(12)\quad P_{AB} = \frac{c^3}{c^3 + b^3 + a^3}$$

Table 1 shows a comparison of predictions by Caplow's model, Gamson's model, Chertkoff's model, and the resource comparison model against the empirical data of three major studies of the 4:3:2 power pattern (Vinacke and Arkoff, 1957; Kelley and Arrowood, 1960; Chertkoff, 1966). Chertkoff (1967) made a convincing case for the reasonability of combining the results of these three different studies. It is clear that the resource comparison model yields the best fit to the data by far ($\chi^2 = 1.09$, $df = 2$, $.70 > p > .50$).

A further test of the model might involve additional studies of the $A > B > C$, $A < (B + C)$ case, where a, b, and c are varied over a range of values. If the predicted shifts in the proportions of A–B, A–C, and B–C coalitions were found with a variation of the power (resource) values of a, b, and c, the model would be further supported. Any shifts of this sort would at the same time be evidence against the Caplow, Gamson, and Chertkoff models which all predict no differences across a variation of power values. One test of the range of the model would be provided by a study of the $A = B > C$ case, such as with the range of values used in Stryker and Psathas' (1960) study (6:6:5, 6:6:3, and 6:6:1). Data from the Stryker and Psathas study do not actually provide a test of the $A = B > C$ case, partly because of the extra restrictions as to which alliance could form, and also because a lottery allocation was used. In a study by Day (1970) a lottery allocation was found to lead to an equality norm, rather than an equity norm, with a consequent reduction of the apparent $A = B > C$ condition to an $A = B = C$ condition; and if fact, the data in the Stryker and Psathas study are in line with predictions from an $A = B = C$ model.

*Extension to Incorporate Legitimation of Power*

With a modest modification, the resource comparison model might be extended to incorporate legitimation of power, as was done elsewhere with a modification of the Gamson minimum resource model (Day, 1970). Briefly stated, legitimation of power is concerned with the method of power allocation, or how people obtain the power they exercise and the prescriptive or proscriptive limits placed on power exercised through roles in society. In general, legitimation implies some sort of a normative consensual justification of power allocation such that the exercise of power (e.g. through leadership roles) is augmented when acquired properly and diminished when acquired improperly. Legitimation usually implies acquisition of power according to some basis of merit or investment (as suggested by Homans', 1950, law of distributive justice) so that recipients of power are seen by others as deserving power and the person with greater power develops expectations based on a feeling of deserving the right to exercise power for personal benefit. In treatises on legitimation there almost always is an implied consensual component of acceptance of authority and power by others such that those subject to the exercise of power by a leader are not inclined to undermine the leader's power and authority (Weber, 1947; De Jouvenal, 1948; French and Raven, 1959; Blau, 1964). That is, the follower is generally inclined toward augmenting the leader's power by compliance with or deference toward the person in power. Although not typically discussed in quite this way, legitimation implies a deferred or a restrained use of power by persons in lower power positions or in a follower role, and a vesting of decision making in the leader. Thus, there is an important implication that support of the leader results

from restraint in the use of power or by voluntary compliance, and that this support can be denied or withdrawn by the person in the low power or follower role. This view seems quite reasonable since interpersonal power relations almost always involve mutual control such that even the weaker party in the power relation has some control, often rather substantial, over the stronger party (Thibaut and Kelley, 1959).

Although most discussion of legitimation of power has been at an abstract theoretical level, there have been a few empirical investigations of this variable. For example, Raven and French (1958a, 1958b) compared behavior of subjects in small task groups which had either an apparently "elected" leader or an "illegitimate" leader who assumed power after intimidating the "elected" leader in a staged power struggle. Contrary to expectations, there were essentially no differences in compliance or in task accomplishments in group with an "elected" leader compared with groups having an "illegitimate" leader, but subjects were more affectively positive toward an "elected" leader. Another experiment studied effects in a Prisoner's Dilemma situation where one member of the dyad was given an initial extra resource (reward) under either an "arbitrary" or "merited" basis of allocation (Pepitone, 1967). Pepitone found that in the "merited" condition the rewarded (high power) player showed a higher percentage of competitive (exploitative) responses than the non-rewarded (low power) player. Under the "arbitrary" condition, the reverse was found; the initially rewarded player showed a lesser percentage of competitive (exploitative) responses than the non-rewarded player. Pepitone's study seems to show that under a legitimate distribution of power the high power person in a dyad expects greater rewards out of the dyadic interaction and is therefore more exploitative, while the low power player expects less and is more accommodative (less competitive). Under an illegitimate distribution of power the opposite occurs.

In another experiment (Day, 1970) the legitimation of power manipulation was achieved by allocating power to subjects in one of three possible ways. Amount of power was assigned by the experimenter by a legitimate procedure, a supposed consensual validation based upon "scores" on a social power or "leadership related" traits questionnaire; or it was determined by a neutral procedure, a lottery; or it was determined by an illegitimate procedure, an arbitrary reversal of the expected assignment in accordance with "scores" on the consensual power scale. The procedures served to emphasize particularly a consensual aspect of leadership, because they entailed "scores" on personal traits supposedly predictive of deferential attitudes by others toward the subject in power roles the subject might assume, rather than competence.

The expected relation of legitimation to coalition formation was based on a simple equity model which was basically an extension of Gamson's (1964) parity model of coalition formation. For subjects behaving according to an equity (parity) norm, the legitimate allocation condition was expected to lead to the predominance of 3–2 coalitions as is usually found under a 4:3:2 power relation. This expectation is based on the notion that when relative power is distributed legitimately, the highest power player in a triad can be anticipated to have relatively higher expectations, and therefore, demand a greater share of payoffs in an alliance. The lowest player should make the least demands. Thus, the 3–2 alliance would be mutually preferred, as predicted by the Gamson model.

In the illegitimate condition there should be relatively less 3–2 alliances and relatively more 4–3 and 4–2 alliances in comparison to the legitimate condition. This expectation is based on the idea that when relative power is distributed inequitably, the high power player would not be seen as justified in demanding so much of the payoff and he would be expected to act accordingly, while the low power player would feel justified in demanding more of the payoff, particularly since he was unfairly disadvantaged by the allocation, and he would be expected to act accordingly. Thus, the high power player becomes a relatively more desirable ally, while the low power player becomes a

relatively less attractive ally. Comparing the legitimate and illegitimate expectations, the predictions have become even more counterintuitive than in Gamson's original formulation. When power is legitimately acquired, possessing high power tends to leave a person out of alliances, and consequently defeated; while in the case of illegitimate acquisition of power, high power gets a person into an alliance and the strong are likely to unite against the weak. Under a parity norm the neutral condition might be expected to yield a frequency of 3–2 alliances intermediate between the legitimate and illegitimate conditions; since the source of power was more fortuitous, demands based on equity should be much weaker, although in the same direction as for the legitimate condition. In several respects the modified Gamson model of coalition formation (Day, 1970) united two of the theoretical traditions in the study of social power discussed by Schopler (1965), field theory (French and Raven, 1959; Cartwright, 1959) and interaction theory (Homans, 1950; Thibaut and Kelley, 1959).

With a modest modification, the resource comparison model could also be extended to incorporate legitimation. The model would continue to be based on an equity norm, but based on parity resulting from the power (resources) individuals *should* have, rather than simply resulting from the power individuals *do* have. Under the legitimate condition subjects in Day's experiment should have had their respective power of 4, 3, and 2 moves on a turn; and predictions would be based on a = 4, b = 3, and c = 2, as demonstrated with the unmodified model. Under the illegitimate condition the subject given 4 moves should have had 2 moves and the subject given 2 moves should have had 4 moves, based on "leadership" scores. So, under the illegitimate condition the "merited" values of power serve as the basis for parity and the values substituted into the formula for predicting alliances become: a = 2, b = 3, and c = 4; rather than a = 4, b = 3, and c = 2. Using the "merited" power values gives a set of predictions inverse to the legitimate condition. Under the neutral condition, chance allocation, the subjects had equal "merit" as evidenced by an equal opportunity in the resource allocation. So, under the neutral condition we have a shift from an $A > B > C$, $A < (B + C)$ case to an $A = B = C$ case resulting from equal merit (an equality norm). As an illustration, predictions of the model are compared with the results for American males in Day's experiment (Table 2). This data probably should only be taken as suggestive, because there are not enough cases for a totally convincing $\chi^2$ goodness of fit test, but it seems apparent that the model is a good predictor from visual examination of Table 2. A more conclusive test of the resource compari-

TABLE 2

RESOURCE COMPARISON MODEL VERSUS AMERICAN MALE DATA

| Alliance | Predictions | | | Data | | |
|---|---|---|---|---|---|---|
| | L[a] | N[b] | I[c] | L | N | I |
| 4–3 | 0.5 | 3.0 | 6.5 | 1 | 2 | 7 |
| 4–2 | 1.6 | 3.0 | 2.7 | 1 | 4 | 1 |
| 3–2 | 3.9 | 3.0 | 0.8 | 4 | 3 | 2 |
| Total | 6.0 | 9.0 | 10.0 | 6 | 9 | 10 |

[a]L = Legitimate condition

[b]N = Neutral condition

[c]I = Illegitimate condition

son model modified to handle legitimation of power in coalition formation remains to be done; however, the minimum number of triads required for a convincing $\chi^2$ goodness of fit test for merely the legitimate and illegitimate conditions seems formidable (a total of perhaps 100 triads).

In summary, the formal resource comparison model based on equity is clearly superior in several respects to Chertkoff's model (formerly the best predictor of first trial results of three major coalition formation studies). The resource comparison model takes comparative alliance preferences into account in a way that might be considered a formal rendition of Thibaut and Kelley's comparative level of alternatives applied to coalition formation. Further tests of the resource comparison model against other major coalition formation theories have been suggested. With a relatively minor additional modification, the new model seems to be able to take legitimation of power into account as well.

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