Chapter 2

The equilibrium group number model

Studies of the growth and shrinking, fusion and fission of social groups have generally focussed on features of individual groups, forms of organization, or the success or failure of certain groups in competition, warfare, and conquest based on one or more of these internal features (Evans-Pritchard 1940; Tainter 1988; Roosens 1989; Kaufmann 1988; Kirch 1984; Johnson and Earle 1987; Carniero 1970; etc.). The approach suggested here differs from other models in that it focusses not on features within groups that cause them to expand or shrink, but rather takes the *number* of groups in a social system to be the variable of interest and models the general structure of forces at a system-wide level that affect the observed number of social groups.

Within a given social and ecological niche at a given time under given circumstances, there is one or more equilibrium number of distinct social groups of any given type. If there are more than this number of groups, the total number of groups will tend to decline, through conversion of individuals from one group to another, the merging of multiple groups, migration, demographic decline, or other means. If there are fewer than this number of groups, the total number of groups will tend to rise, through group fission, immigration, or other means. There may be a range of numbers of groups that are effectively equally stable, or even multiple local equilibrium numbers of groups separated by less stable numbers, but the extremes (zero and some arbitrarily large number) are clearly less stable and will not persist. The number of groups is inversely proportional to the mean size of the groups at any given regional population size, so the group number is a measure of social aggregation. The equilibrium group number model is an attempt to visualize how

various variables affect this measure of social aggregation.

Definitions

Some terms need to be defined and concepts discussed before elaborating the model. Perhaps most obviously, the term "social group" is problematic. Human organization tends to be segmentary and situational, with people uniting and dividing according to the context of action and the actors involved. The model describes the situation at a single level of grouping. There may be a different equilibrium number, for example, of nuclear family groups than of religious congregations in the same geographic region. Since most types of groups are situational, a given level of grouping may not actually exist as a corporate group at a given time, even though people know with more or less precision along what lines they will unite and divide should any particular situation arise. The Navajo might actually function as a corporate group only in contexts of opposition to the Hopi or analogous groups, but the Navajo can be considered to exist as a group in some sense even when such oppositions are not currently being acted out.

The objective reality of groups might also be questioned, since different people in the same vicinity may define even nominally the same groups in different ways. A poor person might assign individuals to categories of "middle class," "upper middle class," and "upper class" differently than would a wealthy person. In the specific case of ethnic groups that is of interest here, however, there is probably general agreement in most cases among most people about which individuals are members of which groups.

The model was conceived to describe the interaction of ethnic groups, although

the logic should hold for other levels of grouping or crosscutting lines of fission and fusion, as well. Despite minor differences, there is a surprising degree of agreement on the definition of the term ethnic group (Horowitz 1985, Francis 1976, Parsons 1975, Thompson 1989). I prefer an abridged version of Yinger's (1975) definition: an ethnic group is a group "whose members are thought by themselves and/or others to have a common origin and to share important segments of a common culture...[including] some mixture of language, religion, race, and/or ancestral homeland..." (1975:159).

Members of an ethnic group will often share aspects of their material culture, such as details of clothing, decoration of ceramics, or styles of house construction, which serve to intentionally or incidentally mark the boundaries of the group in contrast to others (Barth 1969; Hodder 1982; Wobst 1977). These material commonalities and differences are potentially detectable in the archaeological record. In the coastal Osmore case, a variety of material culture traits covary for each of several archaeological cultures. I take these constellations of material culture traits as markers of distinct ethnic groups. For the model, though, it is not important that they represent a particular named type of group, but only that the groups in question all functioned at the same level of social fission and fusion, that is, that they were definable in opposition to each other by their members as well as by archaeologists studying their material remains.

The concept of social and ecological niche refers to the broadly economic setting in which a group exists, defined by an inclusive set of variables including the geographical region occupied, resources exploited, and subsistence technology used, as well the group's position relative to other groups in terms of exchange and power

relations. This broadening of the ecological niche concept is meant to explicitly include those aspects of the niche that are defined by social relations. An enslaved group, for example, occupies a different social and ecological niche from the group that enslaves it, even if their dietary subsistence bases are the same. The niches are different because the slaves may depend upon resources obtained through or controlled by the slaveholders, while the slaveholders may have to exploit the slaves' labor to obtain some of the resources they require.

The boundaries and content of a social and economic niche depend in part on the resolution of the definition. In a society with a sexual division of labor, at a very fine resolution men and women in a single family could be said to occupy different niches. A society in which some families concentrated on farming while others emphasized herding could be viewed as occupying two distinct niches or one niche characterized by a mixed strategy of subsistence. A partial solution is to include in the niche definition all those aspects that are directly or indirectly exploited by the group or groups in question. In the previous example, the society would be said to occupy two distinct niches if the farmers and herders did not significantly exchange goods, services, or individuals, while it would be said to occupy a single, mixed-strategy niche if the farmers and pastoralists were significantly interdependent. This point becomes important when the model is applied to large formations such as states, which may include a wide range of ecological zones and economic specializations.

For present purposes, an individual's social sphere encompasses all those people that he or she is sufficiently aware of to classify into groups. Note that people outside an individual's own group, even enemies or foreigners, may nevertheless be part of that individual's social sphere if they are sufficiently well known to be classified into one

or another group. Very little information is necessary to classify people into groups of "others," so a social sphere will include virtually everyone an individual has ever met, seen, or been significantly informed of. Each individual has a different social sphere, but since interactions are often limited by supra-individual boundaries such as geographical divides (areas of low population between habitable valleys, for example), cultural and linguistic differences, military frontiers, or sheer distance, the outer limits of the social spheres of many individuals in a given area may tend to coincide, defining the social sphere of their society in general. The society's social sphere will be larger than any individual's social sphere, and will contain most or all of each individual member's social sphere. Social spheres, and especially societies' social spheres, may often be indistinctly bounded, and in some cases may be largely rhetorical constructs. Nevertheless, even if the limits of a society's social sphere cannot be clearly demarcated, the concept is still useful for describing in a qualitative way the concentration of interactions that comprise a society.

The equilibrium group number model describes processes that occur within a single social and ecological niche in a single society's social sphere. Where a society's social sphere includes multiple social and ecological niches, the model applies only to that subset of the social sphere that comprises a single social and ecological niche. Conversely, where a social and ecological niche is larger than a single social sphere, the model applies only to that portion of the niche that falls within the single social sphere under consideration. The social sphere serves to define a study universe that focusses on a single concentration of social interactions, while the social and ecological niche restriction ensures that the explanation refers to a single, homogeneous field of action.

Finally, a few words about the proximate mechanisms of changes in group number are needed. The tendency for the group number to change in a given circumstance does not in itself imply any particular mechanism for the change, and it neither implies nor rules out intentional action or awareness of the situation by the actors involved. Increases in group number are probably mostly effected by the splitting of groups already present in the niche ("division" and "proliferation," in Horowitz's 1985 typology), or by the addition of new groups to the niche. A new group could physically immigrate to the region, or could have been previously present in the region but have been exploiting a different niche.

Decreases in group number may also occur through a variety of processes. Group number may decrease when a group's size declines to zero as the end result of conversion of members to other groups through a variety of mechanisms labelled by Barth (1969) as "boundary porosity." Children may be preferentially adopted from one group into another, individuals may marry into some groups more than others, or people may simply change residence and affiliation. These are surprisingly common and rapid mechanisms. Barth (1969:22) cites the Yao, for example, as a case in which some ten percent of a regional population per generation shifted from a shrinking ethnic group to a growing one through adoption. Alternatively, group number can decline when a group's size shrinks to zero due to loss of members *in situ*, through demographic failure. Such a demographic decline could result from low fertility due to health status, marriage and childbearing practices, high mortality due to conditions of disease, hygiene, diet, war, or any number of other causes. Demographic decline may also reflect simple emigration from the region, either by individuals or by larger groups.

Finally, decrease in group number may not involve any shift in individuals at all, but rather shifts in the social and ecological niches that they occupy. If we are following the number of groups in a purely agrarian niche through time and one of the groups quits farming to become pastoralists, the number of groups in the agrarian niche has declined. Similarly, if one of the groups conquers and subdues another, the social, if not ecological, niches of both have diverged, and the number of groups in each of these new niches has declined.

Categories of forces and the Tension vs. Group Number (TGN) graph

One category of forces that influence the equilibrium group number includes psychological and economizing, or "rational-actor," forces. These forces are lumped together because they behave in a grossly similar way: rather than tending to increase or decrease the group number monotonically at a given time, they each tend towards some optimum number of groups. When the number of groups is high, these forces independently tend to reduce the group number, while when the number of groups is low, they independently tend to increase it. The optimum group number may be different for each of the various "psycho-rational" forces, so that the overall contribution of these forces to the equilibrium group number is a sum of differing pressures.

The other principal category of forces has just a single member: the action of competition, or competitive exclusion. This force is different from the psycho-rational forces in that it does not tend toward some middling optimal value, but instead always tends towards a group number of one.

The action of these forces can be visualized on a graph of group number versus a

generalized variable representing the disequilibrium of the social system. Borrowing a suitably vague term from psychoanalysis, I call this variable tension; it is a single measure of what each force influencing group number tends to minimize. In the case of psychological forces, for example, tension is equivalent to dissatisfaction, discomfort, or need. When people behave in a way understandable to humanistic psychologists, one can say that they are minimizing their psychological need. In the case of rational-actor forces, tension is equivalent to disutility in the economic sense. Rational actors tend to maximize their "utility" and simultaneously minimize their "disutility," quantities that are fully as vague as "tension" and widely used in the economics and related fields. Tension is not a single, concrete quantity, but rather it serves a heuristic purpose in that it allows multiple processes to be considered together without concern for the hypothetical coefficients that might be used to normalize the variables, if they could be measured, to a single scale. The principal weakness in ignoring these hypothetical coefficients is that the relative magnitude of the contribution of each force in determining the final outcome is assumed to be comparable. It could be the case, for example, that psychological forces so outweigh rational-actor forces in practice that the latter could just as well be ignored. At the current state of social science research, such judgements would have to be based on little more than faith, and so I will simply assume that all the forces I consider have under at least some circumstances a noticeable effect on the resulting group number. Figure 2-1 illustrates a "Tension vs Group Number," or TGN, graph for a psycho-rational force in a hypothetical situation in which the optimal group number for that force is three.

The following sections describe a number of forces that affect group number, using TGN graph concepts to illustrate their behavior. Each force except that of

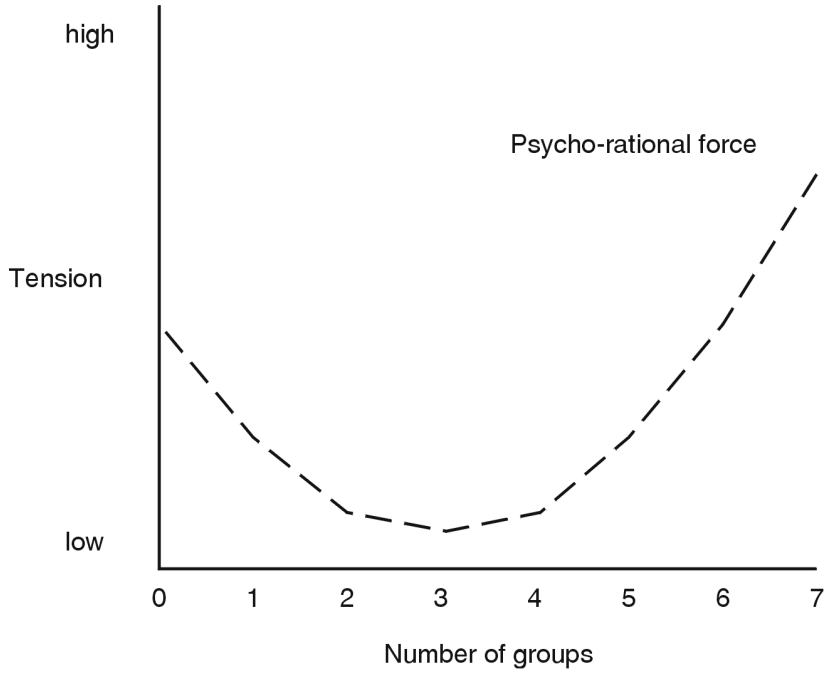

Figure 2-1. A psycho-rational force

competitive exclusion is argued to have a similar shape on a TGN graph, with at least one local optimum group number flanked by lower and higher group numbers that result in greater tension.

Psychological forces

Of the several psycho-rational forces, let us first consider the psychological tendency of humans to conceptually classify the people in their social sphere, including themselves, into a moderate number of contrasting groups. This tendency seems to be very widespread, if not universal, and probably relates to the "assimilation" and "contrast" effects apparently inherent in human cognitive processes involved in categorization of any type (see Horowitz 1985:67-8; Miller 1956). The effect is simply that people will lump or split the groups into which they divide their social sphere according to the context (Moghaddam and Stringer 1986; Turner et al. 1987). A person in a relatively homogeneous environment will categorize the people

around him or her on the basis of relatively subtle differences, while the same person in a more heterogenous environment will tend to categorize people on grosser grounds. In the US midwest, there may seem to be an important difference between people of Swedish and Norwegian ancestry, while Swedish-Americans and Norwegian-Americans in Los Angeles might classify themselves together in contrast to Asian-Americans and African-Americans.

This flexibility in the criteria used for classification suggests that there is some optimal number of categories into which people tend to divide their social world. Increasing the variability that might be used for categorization does not simply increase the number of categories; it changes the characteristics used for categorization such that the number of categories does not get excessively large. Reducing the real variability does not simply reduce the number of categories people devise, but makes them more minute in their criteria such that the number of categories does not fall too low. Individuals evidently have some optimum number of groups into which they attempt to divide their social sphere, or possibly a range of numbers of groups that are acceptable. This number or range may vary from individual to individual, but conceptually it should be possible to characterize a population, if not all humans, with some mean value for this optimum number of categories.

The TGN graph of Figure 2-1 illustrates the action of this categorizing tendency for a hypothetical individual or population with an optimal number of categories equal to three. When, for example, our family of midwestern Swedish-Americans finds itself transplanted to Los Angeles, the types of characteristics they are accustomed to use for categorizing people yield an unacceptable plethora of groups: they find themselves far to the right on the graph, experiencing high tension. They adjust their

classification criteria, reducing the tension and getting the number of groups back down to an optimal (hypothetical) three. Wherever the family goes, they will refine or coarsen their criteria to minimize their psychological tension and approximate their psychologically optimum number of groups. This optimum number might vary over time or across different circumstances, but at any given moment and setting there ought to be a TGN graph that describes the categorizing behavior of the people in question.

The TGN graph includes a possible group number of zero. The condition of zero groups arises when the study region has no people in it. The psychological categorizing force cannot be said to act when there is noone present to do the categorizing, so for this force, the curve in Figure 2-1 should start at group number equal to one. Some of the "rational forces" discussed next, however, make sense even in an empty region.

Recall that we are modelling grouping at just one level at a time, specifically ethnicity for our purposes here. Our Swedish-American family may also categorize people according to age, kinship, language, hair color, or citizenship in certain contexts, all of which may be more or less independent of their categorizations of ethnicity, even though each classification scheme functions in a similar fashion.

Rational forces

In addition to the psychological tendency to categorize people, forces that may be called rational, materialist, or economizing also lead people to construct contrasting groups within their social sphere. These forces are varied, and may not be entirely independent of the psychological force already discussed. Whenever people join

together to act in concert, for example as households, hunting parties, territorial units asserting claims to farmland, or armies, they in some sense calculate the optimal size for the group in the given context. A group that is too small may be weak or inefficient, and may try to recruit more members, merge with another group, or dissolve itself, dispersing its membership among other groups in the vicinity. A group that is too large may be hampered by excessive costs of personnel, communication and coordination problems, and internal factions, and may tend to split apart or be reduced in size by defection of members who perceive better opportunities elsewhere.

For any given population, the optimal group sizes, which may vary from group to group depending on internal organization and other factors, imply an optimal number of groups into which the population can be divided. The TGN graph of Figure 2-1 illustrates the behavior of this optimal group size force for a hypothetical social sphere in which the best combination of group sizes yields a group number of three. Tension, in this case, is a composite measure of the various disutilities of non-optimal group sizes, and it is minimized when the people in question divide themselves into three groups. In the context of ethnic groups, the costs and benefits of different group sizes may relate to success in pressing group claims, economic coordination, ability to control a territory, and communication costs.

Perhaps less obviously, there may often be rational forces that affect group number directly, rather than through considerations of group size. In material, economic terms, when there are few groups, it may appear advantageous for some people to form a new group in order to exploit opportunities being missed or underutilized by the existing groups. These people might be opportunity-seeking immigrants from outside the region, or defecting members of existing groups. A new,

small group, if successful, could conceivably provide a greater return to its members and/or its newly created elite than could the large parent group which must divide its known returns among many members and its existing elite. On the other hand, in a situation involving numerous groups that are at optimal size by internal calculations, a reduction in the number of groups through mergers, for example, might yield groups that were internally less efficient but by virtue of their reduced number less prone to border disputes, conflicting resource claims, and so on. Possibly the greatest opportunity of all for new groups is presented by a region that is completely uninhabited. In this context it is sensible to say that tension is high when the group number is zero. There will be a strong tendency for people from outside the region to move into it, reducing the tension and raising the group number.

There may often be an optimum number of groups in terms of political considerations. In modern contexts, and conceivably in the past as well, an emergent minority group may be successful in pressing claims against the majority by establishing political legitimacy (see Roosens 1989). Individuals with shared interests may find it politically or otherwise useful to band together as a new group. When there are very few groups, the gains to be realized from forming such a new group may be large, and tension is reduced by increasing group number. As the number of groups increases, the utility of starting yet another group declines, the costs remain the similar, and it eventually becomes disadvantageous to splinter further. When there are many groups, it may be to the advantage of some to join together in order to increase their political and material legitimacy and leverage simply by reducing the number of voices making demands; when there are many groups, tension may be reduced by reducing group number.

The varied material and political rational forces directly affecting group number can be described with the same pattern on the TGN graph of Figure 2-1, yet again for a hypothetical situation in which the optimal group number is three. When the number of groups is low, there are advantages to be gained by formation of more groups through immigration or fission. When the group number is high, there are advantages to be gained from merging groups, or hard-pressed groups may disappear through attrition, emigration, or any of the other mechanisms described earlier. Tension in these cases can be construed as analogous to opportunity cost, that is, the material or political value of what will be lost by not changing group number. Whenever this opportunity cost is not minimal, rational actors will tend to take advantage of the opportunity, moving the group number towards its rational-economizing optimum.

The force of competition

The force of competition is different from the psycho-rational forces, as noted before, because it always tends towards a group number of one. This idea of competitive exclusion is borrowed from evolutionary ecology, but has broad applicability to social groups as well. As groups (or species) compete, some are more successful than others. Barring other effects that may act to maintain a high group number, the most successful group will grow most rapidly and will increasingly monopolize available resources. As the maximum number of individuals that the environment can sustain is approached, the most successful groups' growth is increasingly at the less successful groups' expense. Eventually the last member of the less successful group cannot maintain access to needed resources in the face of competition from members of the more successful group, and the less successful group disappears. As in ecology, competitive exclusion need not imply explicit conflict, that

is, predation or warfare. It requires only that groups differ in their abilities to satisfy their needs. Also, the disappearance of groups due to competitive exclusion need not mean individuals' physical demise, any more than did the reduction of group number due to other forces. Emigration and various forms of conversion to other groups are equally plausible mechanisms.

Tension in the case of competitive exclusion measures the unrealized ecological potential of the system. The natural tendency of biological increase drives the ecological system to realize ever more of its potential. I do not intend to imply that the most successful group is always the most efficient by any particular measure, but it is by definition the best among those present at capturing the system's resources, broadly defined. As less successful groups are out-competed by the more successful groups, the unrealized ecological potential is reduced. The action of this monotonic force of competition is described by the TGN graph of Figure 2-2. The shape of the curve is not obvious, that is, it is not clear whether it should be concave down or concave up, or even if there should be any typical shape at all that is independent of specific circumstances, but it will always slope down towards a group number of one.

This notion of competitive exclusion of social groups in the same social and ecological niche is not new; Frederick Barth (1969) capsulized it in his introduction to *Ethnic Groups and Boundaries*, in which he noted that ethnic groups occupying the same niche should either compete to exclusion or develop divergent specializations. There is also a widespread, if often unstated, assumption that some or all people have an inherent desire to increase their power and/or wealth, such that leaders will generally try to expand the reach of their control (Leach 1965). This assumption leads directly to competitive exclusion by way of psychology and economizing thought,

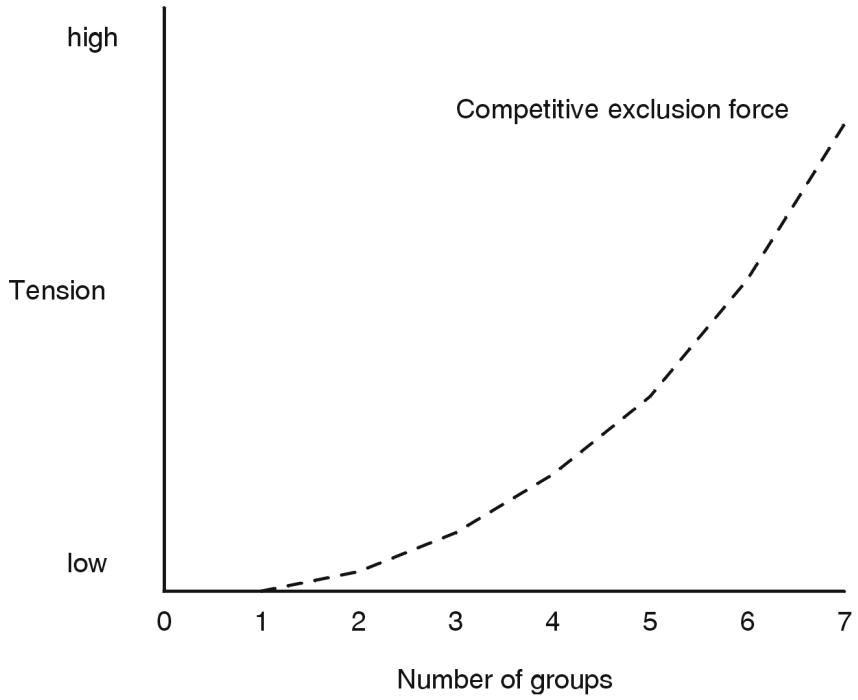

Figure 2-2. the force of competitive exclusion.

rather than ecology, since aggressive leaders will tend inexorably to reduce group number as they aggrandize their own group at others' expense through conquests, recruitment, and, conceivably, health and fertility advantages. This sense of competitive exclusion is at the core of Carniero's (1970) circumscription model of state formation.

The model

Considering all the forces that influence group number as tendencies to minimize tension allows us to sum the behavior of various forces for the given circumstances and evaluate their total effect. The psycho-rational forces are all described by curves with at least one local minimum (Figure 2-1). In reality, some may be more complex than the simple curve shown, having a range of equally optimal group numbers, or having multiple local minima. I suspect that such complex shapes are uncommon, but the possibility cannot be discarded. Summing all of these curves will produce a

composite psycho-rational forces curve that has one minimum or a few local minima. If all the forces have unique minima, and these minima do not happen to cluster in widely separated groups, then their sum generally will also have a single minimum. Even in those cases in which one or more of the forces is described by a curve with more than one local minimum, the sum of the curves will still tend to be concave down with one minimum or few local minima. Figure 2-3 illustrates the effect of summing a variety of hypothetical psycho-rational curves, and shows how adding multiple curves tends to damp out multiple local minima in the sum unless by chance multiple local minima of several curves coincide. The sum curve tends to assume a simple concave down shape with one minimum or just a few local minima, generally taking a smoother, simpler shape than the more irregular of the curves that contributed to it.

Where the sum does have multiple minima, the model will still behave as if there were a single minimum as long as the group number remains in the vicinity of one local minimum. Consideration of the transition from the vicinity of one local minimum to another could yield additional insights into aggregation and fission processes, including concepts for understanding threshold effects and large, sudden changes, but is beyond the scope of the present discussion.

Since the shape of the summed psycho-rational forces curve is at least as regular and predictable, if not more so, than the shape of any one of the individual psycho-rational forces, we can justifiably simplify the model by omitting the detailed shapes of the individual forces (which cannot be known precisely nor definitively separated from each other, anyway), plotting instead a single composite psycho-rational forces curve. This curve is influenced by all of the psycho-rational

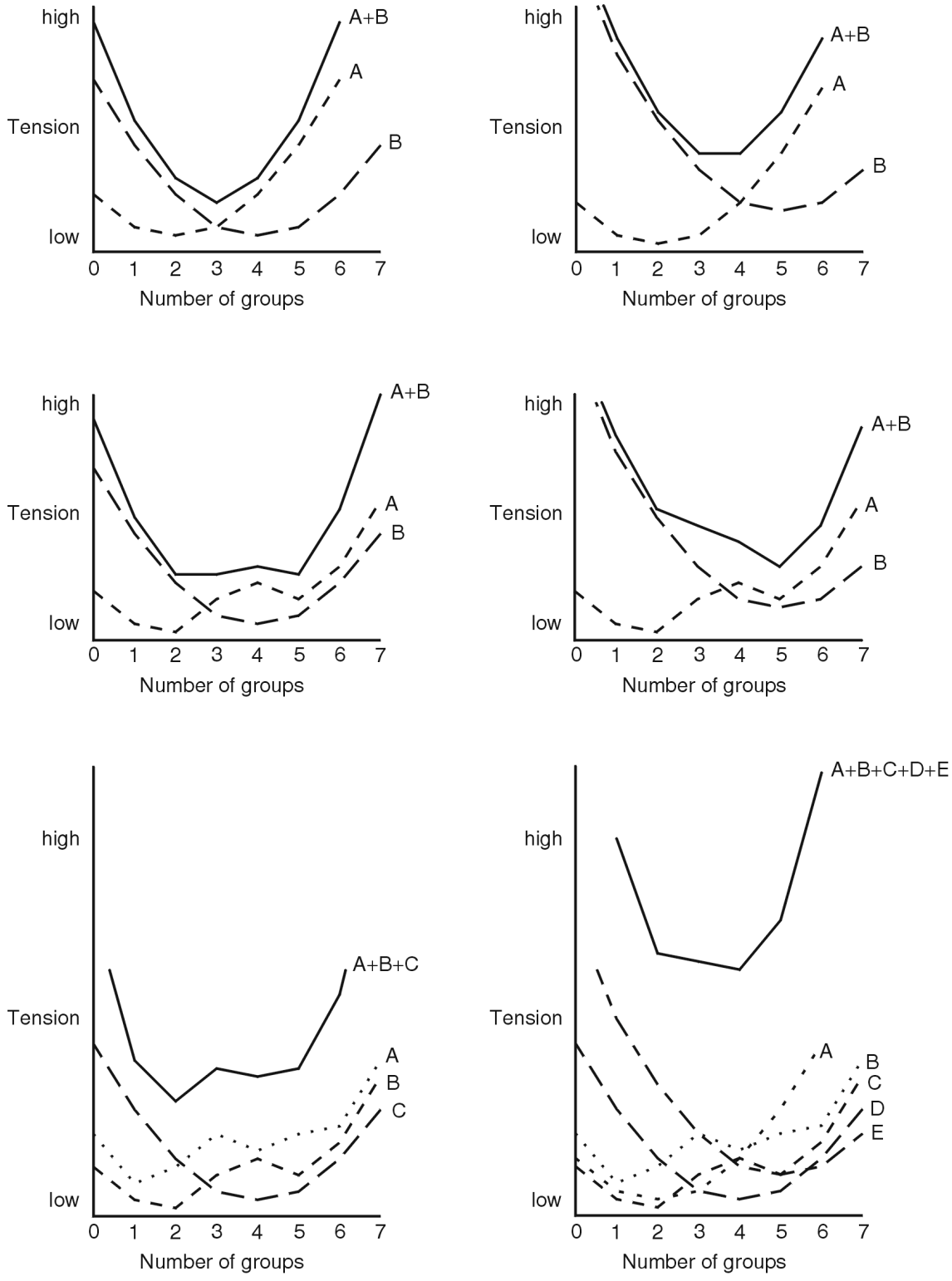

Figure 2-3. The effects of summing force curves.

forces. For example, a change in political circumstances that made the founding of new groups relatively more advantageous would shift the entire psycho-rational curve to the right, even if other psycho-rational forces such as the cognitive constraints on classification were not affected.

Similarly, we can add the composite psycho-rational curve to the competitive exclusion curve to produce a total curve representing all the forces so far considered. Figure 2-4 shows both curves and their sum, illustrating the interaction between them. Since the competitive exclusion curve is monotonic, while the psycho-rational curve has a minimum, the two categories of forces reinforce each other to reduce the group number when it is high, but oppose each other when group number is low.

Moreover, adding the competitive exclusion curve to the psycho-rational curve tends to damp out local minima in the total forces curve towards the right side of the graph. This effect tends to emphasize the left-most local minimum in the psycho-rational curve and reduce the effects on the total forces curve of local minima at higher group numbers, which again makes the use of simple curves with single minima appear to be a reasonable simplification.

In summary, the equilibrium group number model provides a metaphor in which a variety of processes affecting group fission and fusion can be described in a consistent way. Various psychological and rational-maximizing forces acting on the optimum group number can be summed to a single psycho-rational curve on a TGN graph, which can reasonably be visualized as having a single minimum. The force of competition, in contrast, is a monotonic curve that always trends downwards towards one. The sum of the psycho-rational and competition curves determines the equilibrium group number for the given social sphere and circumstances.

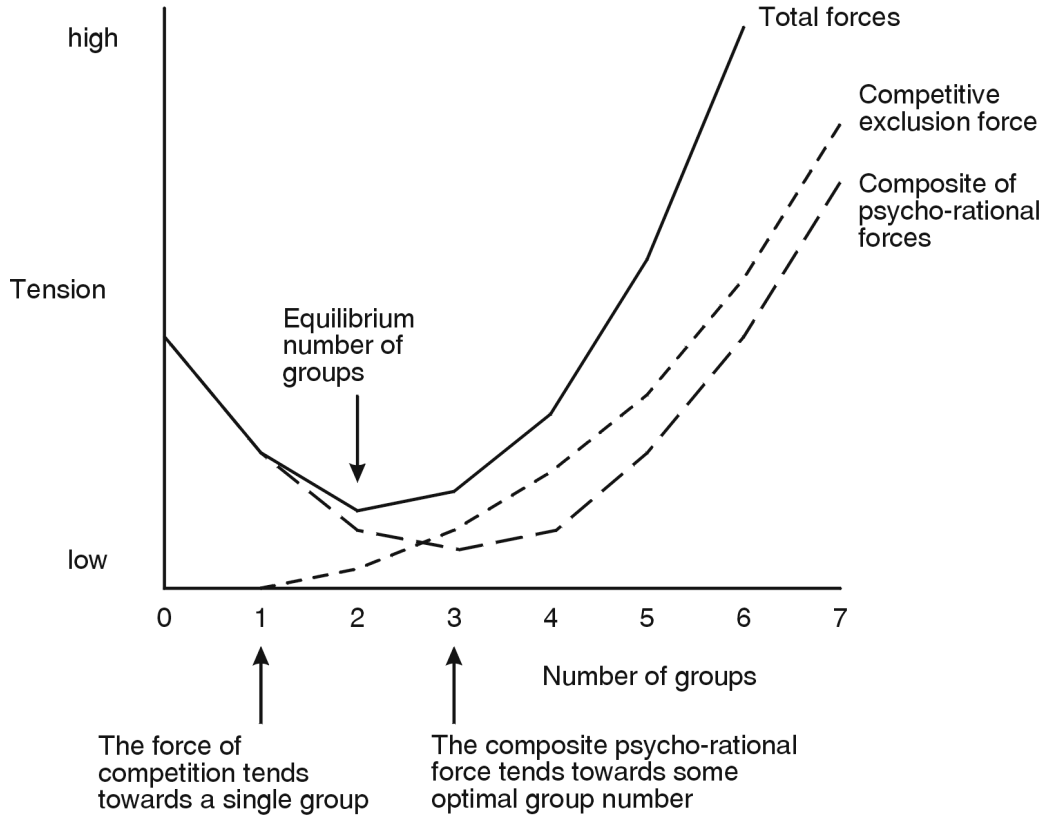

Figure 2-4. The sum of psycho-rational forces and the force of competitive exclusion.

Various social and ecological changes can affect the psycho-rational curve, the competition curve, or other parameters of the model such that the equilibrium group number does or does not change. The following chapters name and describe six predictable effects of some of these changes, and illustrate the explanatory utility of these effects in understanding the prehistory of the coastal Osmore valley, Perú, and the southern Andes in general. The social sphere size effect describes the effect on group number due to increase or decrease in the population or geographic and social area of a social sphere, which may have played a role in the expansion of the Tiwanaku state. The minimum viable group size effect describes what happens when a social sphere becomes very small, which may have been the case during the BR

Early Ceramic Period in the coastal Osmore valley, when Tiwanaku dominated the middle valley. The cascading divisions effect and the concept of salient level extend the social sphere size effect to consider its implications for fragmenting administrative hierarchies, and seems to fit the collapse of the Tiwanaku hierarchy in the middle Osmore valley and perhaps elsewhere. The gold rush effect describes the proliferation of social groups when the competition and psycho-rational curves shift in response to the opening or widening of a new social and ecological niche, as is shown to have happened in the coastal Osmore valley at and after the collapse of Tiwanaku. The competitive exclusion effect explains the decline in group number when one or both curves shift back in the opposite direction as a niche becomes crowded, which happened in the coastal Osmore towards the middle of the Late Intermediate Period. The group number fixation effect specifies the conditions under which a single group can monopolize an entire social sphere, as the Chiribaya seem to have done later in the Late Intermediate Period. Finally, a concluding chapter summarizes the theoretical arguments and substantive results, and evaluates their significance and implications.