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WAR, REVOLUTION, AND TWO-LEVEL GAMES: A SIMPLE CHOICE-THEORETIC MODEL

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We focus on the decision problem of a government (or regime) facing external and domestic threats to its security. For simplicity, we treat this governmental actor as a unitary rational actor.[1] We also assume that this government (which we denote as actor i) faces threats from a set of other unitary actors, comprised of other governments j-1,2,...,J and domestic organizations or groups k-1,2,...K. Since government i must find some way to balance the threats posed by these various actors, and since dealing with tradeoffs between desired ends is the very essence of rationality, a rational choice approach seems particularly appropriate for modeling a government's efforts to manage two-level security problems.

We assume that government i is fundamentally concerned with minimizing the probability that it will lose a war with any government j or that it will be overthrown after a revolution instigated by domestic groups k. The ways in which i perceives and balances these various threats is discussed in more detail below.

Two-level games are inherently complex. In this paper we forego presentation of a specific, detailed formal model and instead discuss a general framework of analysis that is consistent with a wide variety of more specific game models. We focus our attention on laying out fundamental functional relationships that must provide the basis for any particular game model, but without at this point providing a detailed specification of these functions. For each of our assumptions we provide substantive and theoretical justifications and clarifications, with particular emphasis on the interaction between domestic and external conflict. How is a state's external security problem affected by an ongoing domestic revolt? And how is a state's domestic stability affected by external conflict? We will note a diverse variety of answers to these questions, each appropriate for different sets of circumstances, and each, we argue, consistent with the general choice-theoretic framework laid out in this paper. Our intention is to organize the various factors discussed in the literature through the lens of a general model that specifies a particular structure of interaction among these factors.

Modelling Actors' Models of Each Other's Behavior

An actor's "model" of the underlying sources of other actors' behavior lies at the core of our analysis, and indeed in any choice-theoretic analysis of interactive behavior. But in most applications of game theory the nature of the actors is specified by the analyst, thus making an independent consideration of actors' models of each other superfluous.

In standard games of complete information, all player's utility functions are presumed to be known by all actors (and by the analysts themselves), and, furthermore, each actor is presumed to know that all actors are rational and that all other actors share this knowledge that they are all acting rationally. In other words, a great deal of common knowledge is shared by all game players (see Binmore with Brandenburger, 1990). In signalling game models of incomplete information, players remain uncertain about the preferences of other players (and about other types of private information), but it is standard practice to sharply restrict the range of this uncertainty by specifying a well-defined set of possible actor types. In typical applications only two actor types are allowed, as in Powell's (1990) classic analysis of "resolute" and "irresolute" actors in nuclear crises. In these games as well, game players must share considerable common knowledge, including the permissible set of actor types and a common prior distribution over these types.

Although imposition of some assumption about preferences or actor type sets is a crucial step in the analysis of any specific game model, it is not so obvious that such assumptions are a reasonable approach in modeling behavior in general. We allow the actors in our model to remain uncertain about a wide variety of matters, including the opposing player's perceptions about the nature, probability, and utility of the feasible outcomes of war **as** well as that player's perceptions about the likely shape their relationship will take in future years. We assume only that these rational players are not immobilized by this uncertainty, that they are somehow able to use available information to make assessments about the likely future consequences of their actions. These assessments need not be accurate, but rational actors facing uncertainty will use information to formulate their beliefs about the actions of other rational actors.[2]

Since an actor's internal model of other actors is central to that actor's own evaluation of the available options, it is important to recognize conditions under which this model will change. Any information that would **lead** an actor to re-assess the relative likelihood of the feasible actions of other actors can lead the first actor to most prefer another alternative as optimal. After presentation of our basic framework, our subsequent analysis follows this basic logic of comparative statics: if a rational actor selects a different policy option than before, then something must have changed to **make** that actor prefer the new option to the old one. We will attempt to catalogue the places in which factors given prominent attention in the research literatures on domestic and international conflict can have this effect on the security policies of governments confronting two-level security problems.

War. Revolution, and the Status Quo as a "Relationship"

In order to sharpen the focus of our analysis, we restrict our attention to actor i's evaluation of the relative attractiveness of two options to other actors. Specifically, other governments choose between starting a war or maintaining the status quo, and domestic groups choose between instigating a revolt or supporting the status quo.[3] Thus, our analysis focuses on the models government i forms about the likely choices of all other actors j and **k** between war or revolution and the status quo.

A basic premise of our conceptualization is that these alternative outcomes are inherently uncertain events. It is standard practice to view war or revolution as uncertain, and to assume that players assign some probabilities to the various feasible outcomes of war or revolution. That is, each player can determine an expected utility of war by summing the products of the probability of each outcome's occurrence with the utility that player would receive from that outcome. Any change in the players' beliefs or evaluations (i.e., utility values) of these various outcomes can change each player's expected utility of war. However, we further assume that the set of feasible outcomes can change, especially as the result of technological or ideational innovations. The introduction of nuclear weapons on both sides of a rivalry, for example, could lead both sides to perceive a net decrease in their expected utility of war. Or the development of a new ideology may provide disadvantaged groups with an increased expected utility of revolution, since they can now imagine a way in which political structures could be rearranged to their ultimate advantage.

A novel aspect of our analysis is that we conceptualize the status quo as dynamic and uncertain. We assume that each actor can be said to derive a certain utility from that actor's "relationship" from any other actor at any given moment. This value may include expected future benefits or costs from continuation of that relationship. Over time, the particular value of utility received by each actor in a given relationship may change.

This notion of a changing relationship is perhaps easiest to convey for the case of domestic groups. Government i extracts resources from domestic groups (and from other sources) and produces goods and services (such as national defense) for these groups. Each group k can be said to enjoy a net utility from its "relationship" with government i, namely, k's evaluation of the benefits of i's production minus the costs of k's contribution. This utility level will include tangible and intangible factors, and the relative values of different group's relationship may be very difficult, perhaps impossible, to compare. However, all interpersonal comparisons of utility are conceptually difficult, and are not necessary in most rational choice models. What can be compared is a given group's utility at different points in time.

This same notion of the net value of a relationship can be extended to interactions between governments i and j. Government i may explicitly extract resources from j, as when j offers diplomatic or military support in a crisis. Furthermore, j may derive benefits from the support of i, or may bear costs associated with i's opposition to its policies. In this case, it is a bit more of a reach to describe j's benefits as the result of the production of goods or services by i. Perhaps it is better to say that j receives a higher utility from its relationship with i when i carries out policies that comport with j's own preferences. As before, although inter-actor comparisons are not meaningful, changes in either player's perception of the relationships can be.

For our analysis we are primarily interested in the changing value of the status quo from the point of view of governments j or groups k, but as perceived by government i. As discussed earlier, i's models of other actors plays a central role in our analysis. That is, we focus on factors that can lead to changes in i's beliefs about how j or k views its relationship with actor i. Some changes will be straightforward, such as the decrease in the status quo associated with increased extraction of resources from j or k, or the increased status quo value when more of i's policies comport with j's preferences. We discuss the implications of more complicated changes below.

In an abstract sense, the particular utility value received by an actor at a given point in time can be interpreted as a random selection from an overall distribution of possible utility values. Different types of relationship would be represented by distributions with different characteristics. For example, the mean value (to i) of its relationship with an allied state should be higher than the mean value of its relationship with a rival state. Also, as states become increasingly interdependent the variance of these status quo distributions should decrease, since both governments would have recourse to alternate means of redressing any imbalance in their multiplex relationships, whereas a great deal of variance might be associated with governments that interact only rarely on a small number of issues.

Furthermore, the nature of each relationship may vary over time, which we represent as a change in the characteristics of the underlying distribution. Thus, we distinguish two levels of change: (1) changes in the specific status quo for an ongoing relationship and (2) changes in the status quo resulting from changing relationships. The first is conceptualized as a random selection out of a given probability distribution, and the second as a change in the distribution itself.

In what follows we relate these two levels of changing relationships to the immediate and underlying "causes" of war, respectively. Briefly, the probability that the value of the status quo drawn at time t is less than the value to j or k of war or revolution will be defined as i's expectation of the probability of war or revolution instigated by j or k. The extent to which this probability constitutes a threat to government i is further conditioned by i's expectation that the appropriate form of interaction will occur.

Figure 1 provides an overview of the functional relationships discussed more fully below. This framework includes different types of variables, with these different types organized into separate columns in Figure 1. Briefly, past resource extraction and allocation decisions by all actors result in the production of relative capability levels (C,S) which in turn affect the probabilities (c,s) that j or k can remove i from office through war or revolution. These actions also lead i to update its model of the goals of other players, and of the nature of their current relationships. From these models i's derives an evaluation of the expected utilities that j or k would receive from war/revolution (u,v) and the status quo (x,y). Government i uses these evaluations to assess the (subjective) probability of war or revolution (w,r) arising from each of its relationships. The overall pattern of i's relationships defines its interaction opportunities, that is, the relative frequency (p) with which i interacts with each of j and k. These various probability terms combine to form the external and domestic threat levels (R,T) posed by j and k, which i then combines into an overall criterion function (z). We now discuss each of these steps in more detail.

<u>Defense Capacity (C) and Domestic Strength (S)</u>

This analysis builds on previous work by Most and Starr (1984, 1989) on relationships among domestic and external resources and threats. We adopt their basic notation, using C to denote a government's capacity to resist external attack, S its strength versus domestic opponents, R the external risks and T the domestic threats confronted by that government. Although we considerably elaborate on the R and T terms, the C and R terms are relatively straightforward extensions of their earlier discussions of C, R, S, and T.

C and S refer to related but not identical aspects of a government's ability to defend itself from external and domestic attack. Both can be conceptualized as the outputs of production functions that transform tangible (raw materials, troops, etc.) and intangible (ideology, leadership) resources into capability levels.[4] We assume that resources extracted by government i from either domestic or external sources can be applied to either C or S, although there may, in general, be a more natural connection between S and domestically derived resources. In other words, domestic and external resources are fungible in the sense that they are substitutes in the production of either C or S.

We further assert that the C and S production levels act as complements. That is, S is generally increased whenever C is increased, although at a lower rate of increase than C. Similarly, increases in domestic strength S generally translate into increases in defense capacity C relevant to external conflict, but the resulting increase in C is less than if comparable resources were expended directly in the production of C itself. In short, C and S increase or decrease together, but it remains useful to separate them conceptually.

One reason to separate these terms is that each, in general, should be subject to the "law" of diminishing marginal returns. That is, as the level of C increases further expenditures of resources will produce smaller increases in the level of C. As a consequence, a government that is very secure from external attack will eventually find it more worthwhile to invest in domestic strength, and vice versa.

Inherent in Most and Starr's previous analysis is the sense that other governments j similarly produce levels of defense capacity Cj, and that domestic groups k can be said to produce levels of strength S_k that can be compared to government i's levels of *Ci* and Sj, respectively. In this paper we use these relative capability levels to define the probability terms **Cj**, denoting the i's expectation of the probability that **j** would win a war with i, and s_k, denoting i's expectation of the probability that k would succeed in a revolt against i.

Strictly speaking, **Cj** and s_k are vectors that associate a specific probability value to each of the feasible outcomes of war or revolution. We also define u**j** and v_k to be vectors denoting i's perception of the utility values that **j** and k assign to each feasible outcome of war or revolution, respectively. For simplicity we collapse all feasible outcomes into two outcomes, depending on whether or not i survives the war or revolution by remaining in power. This enables us to use **Cj** or s_k as expressions of the probability that i will be defeated or deposed.

Government i combines these probability and utility expectations into i's evaluation of the expected utility **j** or k receives from war or revolution, defined by the vector (dot) products **cjuj** and $s_k v_k$, respectively. These expected values of war or revolution serve as thresholds in our later analysis of the distributions of the status quo value of i's relationships.

Over time these expected values of war and revolution can change as the actors re-allocate their resources to produce varying levels of C and S. Also, as discussed above, these expected values may change when technological innovations makes new outcomes feasible or ideational innovations make new outcomes imaginable. Furthermore, as i's model of the sources of the behavior of j or k changes, i's evaluation of these expected utilities may also change. For example, if a new regime takes power in j, or if a new leader emerges in group k, i may have to re-evaluate these expected utility terms. Although exogenous changes may occur at any time, endogenous changes in the expected utility of war or revolution resulting from resource re-allocations are relatively long-term changes. We now turn to shorter term changes in the perceived value of the status quo.

Value of the Status Quo (x,y) and Probability of War or Revolution (w,r)

We use x_j and y_k to denote i's evaluation of feasible values of the status quo to j and k, respectively, of i's current relationship with j and k. Part of i's model of j or k is i's evaluation of the probability distribution over all x_j and y_k values implied by their relationship. The particular values selected (by chance and many other factors) at time t will be denoted x_{jt} and y_{kt}. We do not specify the exact nature of these distributions, nor of the process by which particular values are selected in different time periods. Instead, our subsequent analysis focuses on changes in the mean and variance of these distributions as the nature of these relationships vary.

In most cases the mean value of the status quo, x_j, should be larger than j's expected value of war, $c_j u_j$, since most states are not at war most of the time. In other words, war is a rare event. Similarly, since revolutions are relatively rare, the mean value of y_k is (usually) larger than $s_k v_k$.

In general, i will expect j to start a war whenever i believes that j assigns a smaller value to the status quo than j expects to receive from a war with i. Given our notation, then, i expects war will occur whenever $x_{jt} < c_j u_j$. As shown in Figure 2, the area of the region under the curve of the x_j distribution to the left of the expected value of war $c_j u_j$ can be used to define i's expectation of the probability of war, w_j. Similarly, the area under the y_k distribution to the left of i's perception of k's expected value of revolution $s_k v_k$ can be taken to define r_k, i's perception of the probability of revolution.

By now it should be clear why we placed so much emphasis earlier on understanding the nature of i's model of other actors. Government i does not know with certainty any of the x_j, y_k, $c_j u_j$, or $s_k v_k$ terms. Yet, i does have access to a wide range of information on the possible preferences and likely behavior of j and k. As a rational actor, i uses available information to make some evaluation concerning the most likely source of external and domestic threats. We argue that this probabilistic formulation provides a general conceptualization relevant to a broad range of more specific models.

The basic inspiration for this somewhat convoluted formulation lies in the realization that wars and revolutions do not just happen. Instead, they emerge over some specific situation or issue at a particular point in time. Yet, in retrospect, it becomes possible to separate out the immediate triggers of war from the more fundamental underlying causes of war. It is this set of underlying causes that we intend to represent in our conceptualization of a "relationship" defined by a distribution over possible status quo values. By using different distributions to represent different underlying types of relations, we should be able to compare the relative likelihood of two governments launching a war against government i, or of two groups revolting against i. And it is exactly such contingencies that we argue governmental leaders are concerned about addressing, as they select among their policy options. The specific issue or event triggering a war or revolution may (or may not) come as a surprise, but these actors should have been able to make some meaningful assessment of the relative likelihood of the occurrence of some such triggering event.

Interaction Opportunities (p)

As discussed above, governments face a wide variety of threats. We have introduced two sets of probability terms that are relevant considerations as governments seek to balance external and domestic threats. Both the probability w_j that a situation will arise in which j will decide to launch a war against i and the probability c_j that i would be removed from power after such a war must be considered. Similarly, the probability s_k that k could succeed in overthrowing i must be combined with the probability r_k that a situation would arise in which k would prefer to make the effort to do so. Both values must be relatively high for a prospective opponent to be particularly menacing.

Consider the case of Canada and the United States. Canadian governments should realize that they could do little to prevent the United States from overthrowing their government, but they have little reason to expect the US to want to do so. Also, the US government has little reason to fear being overthrown by the US military, even though the military should be quite capable of seizing power should they choose to do so. But the US military is very unlikely to confront a situation in which revolution would be its most preferred option. Other governments, especially in the Third World, must be much more accommodating to the interests of their domestic military or external patrons.

A final ingredient in determining the relative magnitude of threats is the likelihood that any interaction will occur. In any given time period, government i interacts with a wide variety of actors over a wide range of issues. However, i is more likely to interact with some actors than with others, and some issues are more salient than others. We assign a probability term p_j or p_k to the relative frequency with which i interacts with j or k, respectively. Although we have previously kept the j and k terms separate, in this case we combine i's interactions with all actors into the same frequency distribution. That is, we assume that $\Sigma_j p_j + \Sigma_k p_k = 1$. We also use p to denote the vector (with K+J terms) of these interaction opportunity probabilities.

Any government must have some base of support, some set of domestic or external groups from which it draws the resources it needs to carry out its policy decisions. Some governments are firmly grounded in the support of domestic groups, whereas others are primarily dependent on external patrons. In our representation governments preoccupied with their interactions with domestic groups would have higher values of some Pk than most pj. Furthermore, governments dependent on external support would have a high value of Pj for their external patron, and relatively lower interactions with domestic groups and other governments. Thus, the interaction opportunity term can be used to represent the contrasting support bases of alternative types of regimes.

Previous research has demonstrated the importance of different aspects of interaction opportunities. [See Most and Starr on borders, Siverson and Starr (1990) on alliances as political analogues to borders and other geopolitical concepts, factors such as geographical contiguity, common alliance membership, extent of trading relations, ideological compatibility, cultural ties, etc.]

External Risk (R) and Domestic Threat (T)

We are now able to restate the external risk (R) and domestic threat (T) components of the original Most and Starr framework. We define the risk Rj that government i will be defeated by government j to be the product $p_j w_j c_j$. This term denotes the probability C_j that j will defeat i, conditional on the probability W_j that a situation will arise in their relationship such that j prefers war to the status quo, weighted by the relative frequency pj with which i and j interact, compared to all other actors. Thus, Rj provides a means by which the threats to i can be compared.

Similarly, we define the threat T_k that government i will be removed from office by the revolt of domestic group k as the product $p_k r_k s_k$. This term denotes the probability s_k that group k could succeed in such a revolt, times the probability r_k that a situation will occur in which k would prefer revolt to the status quo, weighted by the relative frequency p_k with which i interacts with k, compared to all other groups k and governments i.

In this way we incorporate a diverse range of threats within a simple definition. Those governments which are most likely to be able to defeat i may not necessary be the ones with which it is most likely to go to war, and those governments with which i interacts most frequently need not be the one most likely to defeat i or even to go to war with i. Similar statements apply to interactions with domestic groups. For example, those groups most tightly interrelated to the government need not be the most likely to revolt. Although we do not pursue the matter further in this paper, different assumptions about functional relationships among these probability terms could be used to represent different international and domestic political systems.

Note that the probability of being defeated in war or revolution enters into our analysis at two different points. First, it affects the likelihood that another government or group will find it rational to start a war or revolution. Second, it directly affects the likely outcome of a war or revolution, should it occur. These two effects are directly connected to the related goals of deterrence and defense, should deterrence fail.

Criterion Function (z)

Thus far, we have specified, in generic form, one way in which actor i can compare the magnitude of the security threats it faces from other governments and domestic groups. It is not immediately obvious how we should expect i to balance these threats, that is, how i should define its criterion function. Practically speaking, it is impossible for any actor to totally eliminate all threats, but what profile of threats should be considered optimal?

It is possible that i could choose to simply minimize the sum of all these threats, but this criterion function might result in i facing one very large threat and several small ones. Another option would be to specify the utility value that i associates with being overthrown or unseated by different actors. However, we suspect that this value would be very low indeed, since it would effectively signify the demise of i as a governmental actor, and that the differences in value associated with being replaced by different groups would be relatively minor.[5]

We suggest the following criterion function, namely, that government i acts to minimize the maximum threat it faces. That is, i acts to minimize the maximum values of all Rj and T_k, or to minimize the value of z, defined as

$$z - \max \{ \max_j \, pJWJCJ \, , \max_k p_k r_k s_k)$$

In other words, i can order other governments and groups according to the overall threat they pose, and will concentrate its attention on reducing the threat posed by those actors most likely to have both the opportunity and willingness to attack and defeat i. But, as will be discussed shortly, efforts to reduce one threat may tend to augment other threats. Thus, under this criterion function, there may be a tendency for governments to focus on reducing their greatest vulnerability, thereby increasing the relative threat posed by other sources. Eventually they should shift attention to another source of threat, as new threats become more menacing that the one being reduced. In this way a government can establish a balance of threats, making themselves relatively equally vulnerable to attack from a wide variety of sources. In other words, a system of governments each pursing this goal would be likely to be characterized by a balance of power.

Resource Extraction and Allocation

In order to deal with security threats, a government must extract resources from domestic or external sources and allocate these resources to various military, diplomatic, economic, and ideological activities. Extraction and allocation decisions have direct consequences on long-term patterns of differential economic growth and on the perceived domestic legitimacy of a governing regime, both of which would be important factors in any complete representation of the production of relative capability levels. However, in this paper we present only a sketchy outline of the allocation side of i's decision problem.

We focus on the consequences of decisions to extract more resources from domestic groups k or other governments j. The basic mechanism by which resource extraction affects our model is that by doing so government i changes the nature of its status quo relationship with other actors.

Suppose i decides to extract more resources from group k. If i uses these resources to increase its C and S capability levels, this reduces the probabilities that any j or k can defeat it (ignoring for the moment possible counter-actions by these other actors). But another effect of this change is that the value of the status quo to k decreases, in effect shifting the entire y_k distribution to the left. Thus, the region under the curve to the left of expected value of war may increase or decrease, depending on the overall effects of moving both s_k (and thus the threshold defined by $s_k v_k$) and the entire y_k distribution to the left. If this area increases, then the probability r_k that this extraction effort will elicit a revolt by the affected group will be higher than before. There may (or may not) be a net gain in i's overall security, depending on whether or not k was one of the most likely threats in the first place. Ultimately, as more resources are extracted from the same group k, this group can be expected to attach much lower values to the status quo, even as these same resources (given diminishing marginal returns) convey lower increments to i's capability levels. Thus, the overall threat from k will tend to increase as more and more resources are extracted from it. (For lower values of extraction this threat may decrease for a while.)

The basic point is that by its resource extraction efforts government i can, in effect, re-shape the profile of security threats it faces, making some actors more threatening while it makes others less threatening.

Governments can also reduce security threats by buying off potential adversaries. By distributing some of the resources extracted from one actor to increase the benefit of another, the value of the status quo distribution of the beneficiaries will shift to the right, decreasing the probability of a situation resulting in that actor starting a war or revolution. But, as before, those groups disadvantaged by this redistribution may have become more of a threat.

In sum, governments extract resources in order to reduce their exposure to domestic or external threats. But these very activities may increase some threats, and resource extraction should be interpreted as an effort to shift the threat matrix towards a more favorable configuration. Also, governments will be unable to achieve perfect security, and so all will be exposed to some extent to some range of threats. Although they can't eliminate threats, they can take systematic action directed towards changing the nature and the configuration of threats.

Summary

To recapitulate, this model/framework has the following points of connection to the literature/empirical changes:

1. Interaction opportunities (p). How likely are two governments to interact? How closely are groups associated with their government? Affected by factors of geopolitics, contingency, alliances, cultural ties.

2. Probability of defeat in war or revolution (c,s). Defined as a function of the relative capabilities of the potential combatants. Inputs to C,S production functions include distribution of capabilities/resources, domestic group resources, offense/defense balance, nuclear technology, new forms of military organization, differential growth rates, hegemonic cycles.

3. Expected value of war or revolution (u,v). What are the feasible outcomes of war or revolution? How are they changed by innovations in technology or political ideologies?

4. Nature of bilateral relationship (x,y). What is the value of the existing status quo? How are the mean and variance of these distributions affected by political and economic ideologies, nationalism, religious disputes, extent of interdependence

5. Probability of war/revolution (w,r), and levels of threat (R,T). Affected by all the above factors, as mediated through our model/framework.

Comparative Statics Analysis of the Mutual Effects of War and Revolution

Many combinations of move and countermove are consistent with this theoretical framework. In the remainder of this paper we focus on the changes in external and domestic security threats that result when one war or revolution is underway.

[The remainder of this paper discusses preliminary ideas towards possible applications of this theoretical framework. Many of these ideas are more fully developed in a series of recent convention papers by Harvey Starr.]

Any government facing an increase in domestic unrest should expect other governments to infer that its capacity to engage in war has decreased. Thus, the probability of a government being attacked from abroad should increase when that government is under increased domestic pressure.[6]

The same connection should hold for increased probability of revolt when a government is faring poorly in an ongoing war with an increasingly powerful external adversary.

An additional consequence of a government under stress (whether war or revolution) is that government's search for additional resources. Our framework is also relevant to considerations of the domestic group or external source a government will target as the focus its effort to extract more resources. As discussed above, any effort to extract resources shifts the relevant actor's status quo distribution to the left, making resistance to additional extraction efforts increasingly likely. Thus, governments under stress are likely to seek multiple sources of resources.

Just as government i can order all governments j and groups k from most to least threatening (based on the R and T terms), prospective targets for resource extraction can be similarly ordered from least to most likely to resist changes in the status quo by starting a revolution or war. As a consequence, governments under stress may tend to turn to different targets in sequence as each source becomes less and less attractive. As i's relationships change it may become exposed to threats from different directions.

Most analyses of the causes of war stop once a war has begun, but our conceptualization of the status quo as dynamic enables us to continue analysis once a war or revolution is underway. For once i is engaged in war with one government, other governments are then confronted with a new status quo. Third parties can be expected to join the battle in accord with their own interests. Similarly, domestic groups not actively engaged in revolt may join at some later point, after the actions of other groups have sufficiently weakened the government. Thus, it may be possible to order domestic groups according to their "revolutionary potential," based, in our terms on their respective values of T_k.

Our framework can be supplemented by a more dynamic representation of the ways in which one actors behavior affects each actor's utility values (for war/revolution and the status quo). [For example, research on diffusion effects?]

Equilibrium may take on a rather more subtle meaning in any formal model based on our theoretical framework. Since the status quo is inherently dynamic, utility levels will be changing even in equilibrium as new situations are drawn from the underlying distribution, but as long as these relationships remain the same the system can be said to be in equilibrium. Similarly, there is no reason to expect that equilibrium must be characterized by the complete absence of war. Any set of probability distributions over x_j and y_k will imply a certain probability of wars occurring, and it seems inappropriate to call a system in disequilibrium just because one of those wars is indeed occurring. Instead, different systems can be said to be characterized by different equilibrium probabilities of war.

For example, over the last few centuries territorial conquest has lost its previous prominence in calculations of economic power. Thus, there should be a long-term decline in the expected utility of war as perceived by governments guided at least in part by economic considerations. As a consequence, the equilibrium probability of war should have decreased over the last few centuries. (See Williams, McGinnis, and Thomas 1992 for further elaboration of this argument.)

Notes

1. A similar analysis could be applied to the security problem as perceived by various factions or individual leaders within that government, but in this paper we do not address the additional problems of social choice that would arise from a more realistic representation.

2. In short, we assume these players are Bayesian rational actors. For further justification of this Bayesian approach to game theory, see McGinnis (1991, 1992); McGinnis and Williams (1991, 1992, 1993); Williams and McGinnis (1990).

3. By letting the value of the status quo change over time in a specific manner other options could be specifically included in this model, including the options of negotiated solutions or resource transfers specified in the game models of Bueno de Mesquita (1981) Bueno de Mesquita and Lalman (1992), and Niou, Ordeshook, and Rose (1989), among others.

4. For a similar formulation of security defined in terms of utility and capability production functions, see McGinnis (1990).

5. These differences might be useful in distinguishing the consequences of the loss of a war on democratic or authoritarian regimes, as in the model of Richards, et al. (1992).

6. whether or not government i itself instigates external conflict in order to reduce domestic dissension is another question, namely, the displacement hypothesis (citations to Levy, etc.?). Our focus remains on the more defensive aspects of managing threats to security and less on decisions to go to war per se.

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Figure 1. Summary of Functional Relationships

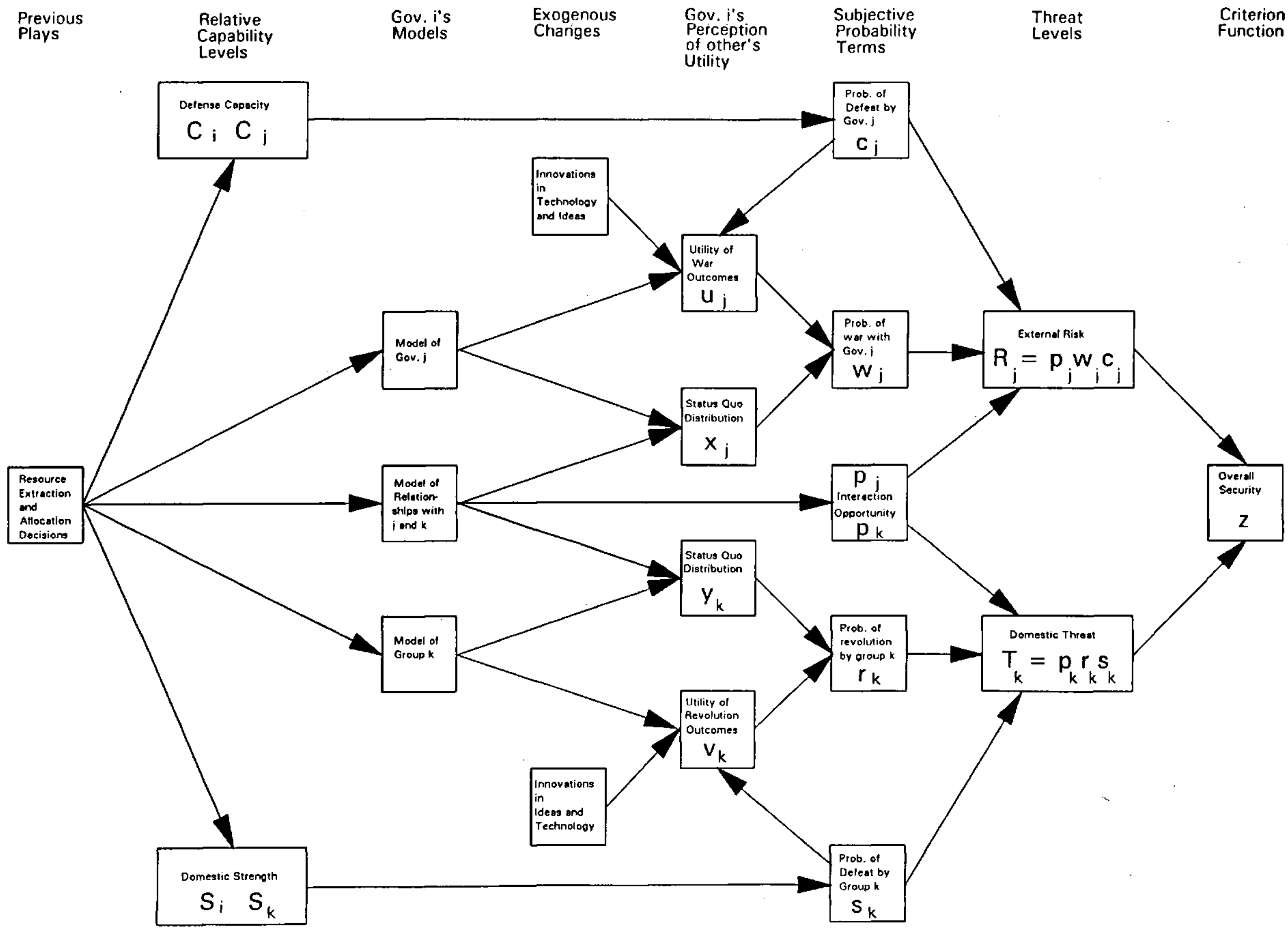
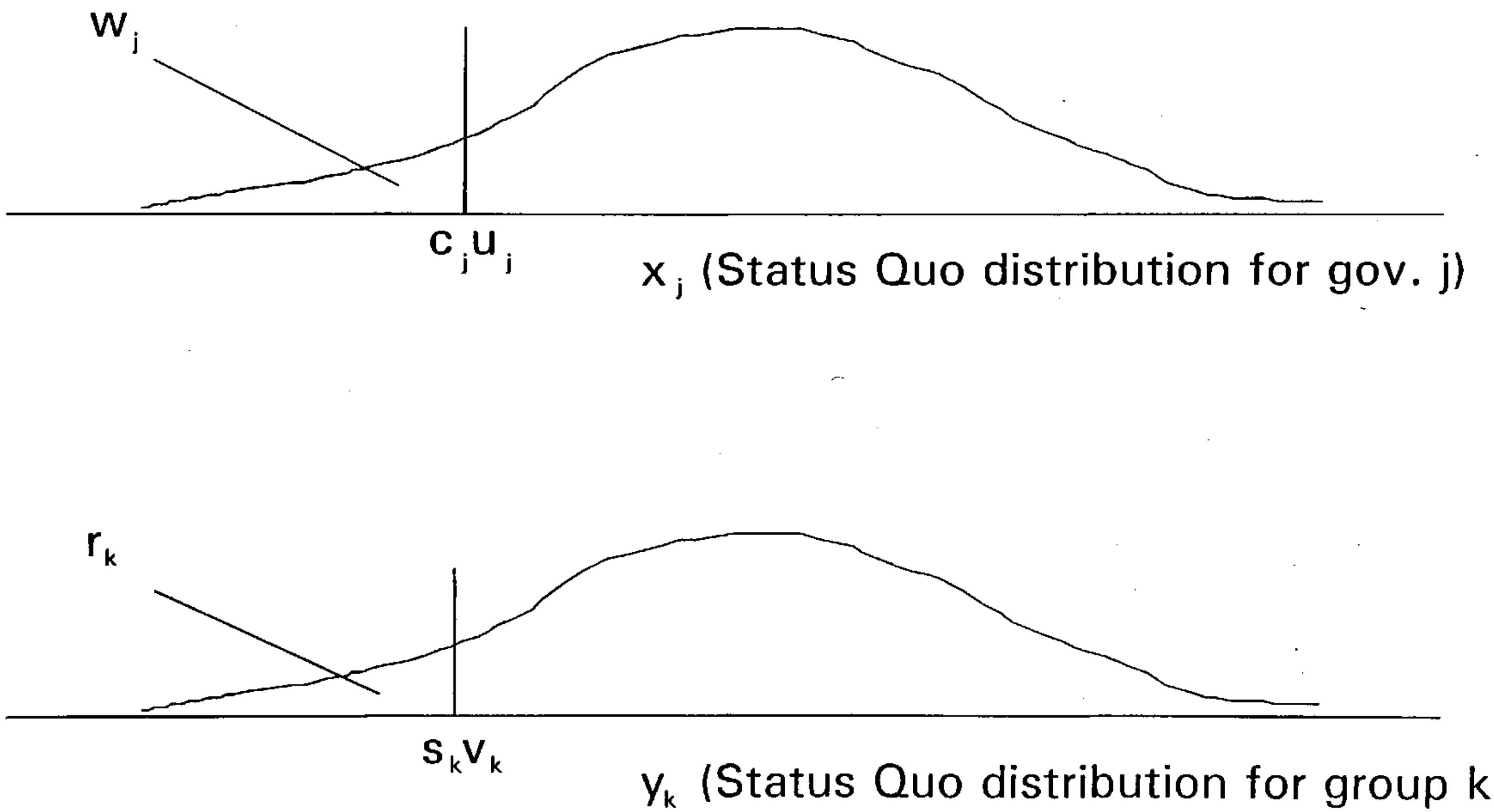


Figure 2
Probability of War or Revolution



Note: The cu and sv thresholds are the expected utility of war and revolution