Appendix 1

Measurement of the Variables

Axiomatic theory, if properly applied, ensures the proof of logically true propositions. Logical proof, however, does not guarantee that the propositions reveal anything of interest about the world in which we live. A logically true but empirically trivial or irrelevant theory is of little interest. Consequently, we are committed to employing empirical tests of the international interaction game when we can. Indeed, we are willing to be risk acceptant in our empirical strategy rather than abandon testing.

Not every proposition from our game requires a full empirical specification of its every term. Some propositions of the theory can be tested without evaluating the actual expected utility components at each terminal node. For instance, we claim that nations that are fond of their mutual status quo can wage war on one another. We can safely assume that nations are satisfied with the status quo when they are closely allied. Yet satisfaction with the status quo does not guarantee its maintenance or even peaceful relations among the satisfied states, as we prove in chapter 3. Therefore, an implication of the theory is that the conditions for war can arise between allies. The proposition requires only that we show that at least one such war has occurred. Many have: this is what makes having a theoretical explanation of the phenomenon interesting. Chapter 7 provides a detailed account of the diplomacy surrounding such an event—the Seven Weeks' War—thereby providing evidence for a deduction of the game without having to measure all of the variables required to derive the logical proof. Similarly, we deduce that in the realpolitik version of the game, acquiescence by one side to the demands of the other is an impossibility under any and all information conditions. To evaluate that proposition, then, we need only observe whether nations ever acquiesce. In chapter 3 we address that question by looking at the incidence of such events. No other variable is required to evaluate the proposition.

Still, many propositions can be evaluated only by appealing directly to observations of relevant variables in the game, and observation requires the development of instruments for approximating some constituents of the theory. The international interaction game implies a

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variety of testable propositions and clearly defines the theoretical variables of interest in each case. Unfortunately, few high-quality, reliable indicators of key components of the theory currently exist, so all of our empirical tests are necessarily preliminary and tentative. One hope of ours is that the theory will sufficiently interest researchers that appropriate data sets for evaluating beliefs and expectations will be developed. In the meantime, we are prepared to find ourselves out on an empirical limb by using coarse instruments in specifying fundamental variables.

The inadequacy of the available data necessitates focusing in the empirical tests on the extent to which real-world behavior manifests a central tendency to be supportive of our deductions. At this juncture, more stringent tests are simply not possible. Even for evaluating propositions that stipulate necessary and sufficient conditions, our standards are probabilistic. Our empirical concern is, then, with the tendency for the data to point in the direction of the propositions with regard to sign and statistical significance and, when appropriate, with their tendency to support the deduced shape of relations (as in several propositions in chapter 4). This last criterion is, we hasten to add, stringent by normal political science standards, even if the other two are conventional. Should our coarse measures fail to yield results that are statistically supportive of significant central tendencies, then we will consider the theory falsified.

None of the tests do or can fully exploit the potential predictive capabilities of the game, for none of them adequately assess beliefs, uncertainties, utilities for outcomes or costs, or probabilities. But at least the tests use systematic, universal indicators of these concepts, so we avoid any hint of making the data fit the theory by evaluating variables in different ways for different cases.

DOMAIN OF DATA

Most of the empirical evaluations reported in this book draw on data for dyadic relations in Europe between 1815 and 1970, although nothing in the theory suggests a European focus. Indeed, the theory is proposed as a general explanation of international interactions anywhere and at any time. However, practical considerations of resource constraints, availability, and reliability dictate our empirical focus. It will be useful if our tests are replicated on alternative data for Europe, on comparable data for other parts of the world, or on data from other historical periods.

To be eligible for inclusion in the data set, a state had to be sovereign

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and physically in Europe (according to Small-Singer criteria) or sufficiently active in European diplomatic affairs to influence calculations about European issues. By these criteria, we include Turkey but not, for instance, Iran, its neighbor. The United States is also considered part of the European system from 1916, for it became continually engaged in European affairs and, we believe, influenced European beliefs about foreign policy choices. The year is arbitrary. Our benchmark was the sinking of the *Lusitania*, but one might reasonably argue for 1914 or 1898 or even 1776. Likewise, one might contend that the post–World War I isolationism argues for the exclusion of the United States until its declaration of war against Germany in 1941. Although undoubtedly an important issue for those primarily concerned with U.S. policy, the precise date is a quibble in terms of our broader concerns. Alternative dates are unlikely to affect appreciably any of the empirical findings, nor would they influence at all any of our propositions, which are derived purely from the structure of the game and not from the data.

The data set consists of 469 events in which a nation *A* and a nation *B* engaged in a dispute with one another. When, for instance, *A* engaged *B*, *C*, and *D* in a broad dispute, we include in the list of dyads only cases involving at least one or the other party at the outset of the dispute. We exclude third-party participation. Sometimes only one dyad is listed for a large conflict, sometimes many. We have tried to be responsive to the reasonable criticism that we underrepresented the world wars in earlier analyses. At the same time, we insist on general criteria that reflect ex ante circumstances, not ex post interpretations of history. For the Seven Weeks' War, for instance, we include Prussia's war with each of seven German states as separate dyads because each state made its own explicit choice to defend Austria's position or Prussia's. Most, but not all, of the German Diet members declared that they would join whichever side did not first use force. When push came to shove, most German states sided with Austria, but Mecklenburg-Schwerin sided with Prussia. They had perfectly good and straightforward geopolitical reasons for doing so, but then, that is part of the point of this theory.

Our coding runs into an important statistical issue. Many events consist of multiple dyads in which choices by some dyads are not independent of choices by other dyads. To the extent that the data violate the normal requirement that observations be independent of one another, the data are biased in favor of the realist perspective. The absence of independence between cases is a product of endogenous choices within the international system. Nation *C* fights *B*, know-

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ing that *A* has already chosen to fight, thereby inflating *C*'s chances of winning and the value of the demands *C* can hope to attain. *C*'s calculation is precisely part of the realist argument. If we fail to find support for the realist argument, the reader should realize that we have probably overstated the true level of support for that perspective.

The data used here represent the European subset of the militarized dispute data developed by the Correlates of War Project and by Charles Gochman and Zeev Maoz in particular. Daniel Jones of the Correlates of War Project at the University of Michigan is refining the disputes data, adding events as appropriate and eliminating or altering components of some of the events in the data set used here. Conscious that the data are at an early stage of development, we wish to be cautious and tentative in our assessments and ask the reader to bear in mind our view that noisy estimates are better than none at all. Because the errors in the data are unlikely to be systematically biased in favor of our theory, the errors should operate to depress relations.

In addition, our data set includes 238 observations consisting of randomly paired European dyads. To qualify for possible inclusion in this sample, the members of the dyad could not have engaged one another in a dispute during the specified year. These 238 observations serve as a means of estimating decisions to live with the status quo. They constitute a representative random sample of the nonevents so often excluded from empirical analyses of international interactions and yet so important in shaping strategic decisions. We can be confident that the sample reflects the population of events within a 95 percent confidence interval.

Sometimes the data analysis includes all 707 observations or as close to that as data availability permits. At other times, when the proposition in question presumes that a particular node in the game tree has been reached or when some other theory is being imposed on the game through the use of the assumptions of the theory, it is appropriate to pare down the data to the relevant subset of cases. When dealing with the escalation of a dispute, our data reflect the population of events in Europe over the time span investigated. When discussing the propositions, which encompass the full game tree, we include all 707 observations. Including them all creates a potential complication.

The 469 disputatious interactions constitute the population—or nearly so—of such events according to those who assembled the data set on militarized disputes. The 238 nondisputing dyads in our extended data set are but a small—though representative—sample of all such pairs of nations in Europe. How are we to interpret statistical

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results that seemingly weight actual events much more heavily than the more common nonevents?

Fortunately, the problem we encounter, though unusual in political science, is an everyday occurrence for medical researchers, for whom there is a well-known simple solution. Our mix of sample and population is equivalent to a medical research design that compares the population of patients with a particular diagnosis to a sample of healthy individuals. Clearly, there are too many healthy individuals, or nonconflicting dyads, to study all of them, but there are not too many patients, or disputatious European dyads, to evaluate the population of that category. The danger is that the disproportionate representation of the two subsets may distort the empirical findings. The solution is straightforward.

Christopher Achen addresses this question and shows that "the odds ratio (or its log, the 'logit') is not affected by the irrelevant pairs" (1990, 13). A proof is provided in his footnotes. So long as we utilize logit analysis for evaluating propositions that include the two subsets of data, there is no problem, even though one subset approximates the population of observations and the other is a small random sample of another set of representative cases.

DEPENDENT VARIABLES

The militarized dispute data set is coded on a five-point scale for nation *A* and for nation *B*. A sample of the coding that shows the dyads analyzed for the years of the two world wars is found in table A1.1. It is possible and even common for nation *A* to fall in a different category on the scale from nation *B*'s. Four categories reflect variations in the qualitative characteristics of the disputes, and the fifth is a quantitative variant of the fourth. Although not perfectly matched to our needs, the militarized dispute data set comes very close to providing the information required to evaluate the events in terms of the terminal nodes of the international interaction game.

The first level comprises events in which the nation did nothing. Level 2 includes events in which a nation made a demand but took no subsequent action. For events at level 3 there was a threat (presumably accompanied by a demand that, if satisfied, would vitiate the threat) but no use of force. By level four, there is not only a threat to use force but the actual use of force. Level 5 includes those events in which a nation used sufficient force to satisfy the Small-Singer criteria for an interstate war. Level 5, then, is a quantitatively more stringent version of level 4.

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Table A1.1
World War Dyads

1914			1939			1940		
Nation *A*	Nation *B*	Level	Nation *A*	Nation *B*	Level	Nation *A*	Nation *B*	Level
Austria-Hungary	Russia	5 5	Italy	France	2 4	Russia	Romania	4 1
Germany	Russia	5 5	Italy	Britain	2 4	Germany	Romania	4 1
Turkey	Russia	5 5	Russia	Estonia	4 1	Hungary	Romania	3 1
Austria-Hungary	Yugoslavia	5 5	Poland	Germany	5 5	Russia	Lithuania	4 1
Germany	Yugoslavia	5 5	France	Germany	5 5	Britain	Italy	5 5
Turkey	Yugoslavia	5 5	Britain	Germany	5 5	France	Italy	5 5
Austria-Hungary	Britain	5 5	Romania	Hungary	3 1	Switzerland	Germany	3 1
Germany	Britain	5 5	Romania	Germany	3 1	Greece	Italy	5 5
Turkey	Britain	5 5	Germany	Lithuania	3 1	Greece	Germany	5 5
Austria-Hungary	France	5 5	Italy	Yugoslavia	2 1	Russia	Latvia	4 4
Germany	France	5 5	Hungary	Yugoslavia	3 1	Russia	Estonia	4 1
Turkey	France	5 5	Italy	Albania	4 4	Italy	Yugoslavia	4 5
Austria-Hungary	Belgium	5 5	Italy	Germany	3 1	Germany	Yugoslavia	5 5
Germany	Belgium	5 5	Germany	Belgium	5 5	Hungary	Yugoslavia	4 5
Turkey	Belgium	5 5	Germany	Netherlands	5 5	Bulgaria	Yugoslavia	4 5
Germany	Norway	3 3	Switzerland	Germany	3 1	Italy	Britain	4 2
Britain	Netherlands	4 1	Germany	Denmark	5 5	Germany	Britain	5 2
Sweden	Germany	3 1	Germany	Norway	5 5	Hungary	Britain	4 2
Sweden	Russia	3 1	Germany	Sweden	5 1	Bulgaria	Britain	4 2
Sweden	France	3 1	Estonia	Poland	4 4			
Sweden	Britain	3 1	Russia	Latvia	4 1			
Germany	Denmark	4 3	Russia	Poland	4 4			
Portugal	Germany	4 4	Russia	Finland	5 5			

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Table A1.2
Distribution of Actions by *A* and *B*

	Action by *B*					
Action by *A*	0	1	2	3	4	5
0	238	0	0	0	0	0
1	0	1	0	0	2	0
2	0	26	1	8	4	5
3	0	70	5	33	8	7
4	0	53	9	38	90	10
5	0	1	2	7	0	89

The five levels are coded separately for each nation in a dyad, so each falls at a different level. *A* could fall at level 1 and *B* into level 4—representing a capitulation by *A* in the context of the international interaction game—or *A* could fall at level 3 and *B* at level 3, representing a dispute settled by negotiation. Table A1.2 displays the distribution of cases by the category of action into which nation *A* and nation *B* fell.

Each combination of event levels fits into one and only one empirical specification of a terminal event from the international interaction game. We define our dependent variables in terms of these combinations of levels. The dependent variable BIGWAR is all cases in which *A*'s and *B*'s level of disputatiousness falls into level 5. WAR is all cases in which for both *A* and *B* the level is at least as high as 4. That is, BIGWAR is a subset of WAR. As indicated by the international interaction game, then, WAR encompasses all events in which there was the reciprocal use of force.

Negotiation, or Nego, is all cases in which the level for *A* is less than 4 and the level for *B* is less than 4, and the level for *A* and *B* is greater than zero, and *A*'s level equals *B*'s level. In other words, both sides made demands, and neither side used force. Acquiescence by *B* is defined as all cases in which *A*'s level is greater than *B*'s, and *A*'s is less than 4. Acquiescence by *A* is all cases in which *B*'s level is greater than *A*'s, and *B*'s is less than 4. Occasionally, when we wish to be more conservative in our definition of an acquiescence, we will refer only to cases in which *A* or *B* was at level 1 while the foe was at a level greater than 1 and less than 4 (and often specifically at level 3). In all cases of acquiescence or negotiation, no deaths occur. Capitulation by *A* is defined to be all cases in which *A*'s level is less than

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4, and *B*'s is greater than 3, and a capitulation by *B* arises whenever *B*'s level is less than 4 and *A*'s is greater than 3.

The remaining 238 events not drawn from the militarized dispute data set are assigned to level 0: neither *A* nor *B* made a demand or threatened the other with punishment and so accepted the status quo. When the theoretical conditions required for the status quo to be the equilibrium outcome are met, we code a dummy variable called SQ as 1.0, coding it as zero otherwise. When the actual conflict category for *A* and *B* is zero, we categorize the actual outcome as maintenance of the status quo by coding a dummy variable called STATUS QUO as 1.0.

With these operational specifications in hand, we can codify the terminal event of each observation in our data set. There are 238 instances in which the status quo prevailed, 189 events that satisfy the criteria for WAR, 89 that satisfy the criteria for BIGWAR, 35 that satisfy the criteria for negotiation, 101 that satisfy the criteria for acquiescence by B, and only 8 that satisfy the criteria for acquiescence by *A*. In the data set, *B* capitulated 110 times, and *A*, 26 times.

INDEPENDENT VARIABLES

In chapter 2 we delineate the expected utility associated with each outcome of the game for each player. We begin by identifying the measurement procedure used to estimate each of the variables mentioned in table 2.2.

Utilities

In the theory proposed here, decision makers choose among constrained alternatives. The alternatives are assigned utilities—the value the decision maker attaches to the specified outcome—that are constrained by the probability of their arising. The utility estimates are an attempt to evaluate the intensity of preference for the alternatives. We have defined utilities across three outcomes: gaining one's demand, $U^i(\Delta_i)$; giving the other side its demand, $U^i(\Delta_j)$; and retaining the status quo, $U^i(SQ)$. Each terminal node of the game reflects the value of at least one of these outcomes and often more than one, and each terminal node specifies a particular set of constraints on the expected utility of the outcome: its utility (including associated costs when germane) discounted by the likelihood of reaching the relevant terminal node of the game and realizing the outcome.

At first blush one might conclude that estimating how much a given

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leader or set of leaders valued a given outcome is readily done for historical events. For instance, it seems reasonable from our contemporary vantage point to suggest that President Johnson must have greatly valued preserving South Vietnam as a noncommunist state or that President Nixon must have greatly valued the information gathered by the Watergate burglars. Each, after all, lost his presidency apparently as a direct consequence of the pursuit of the designated goal. But such a view of estimating utilities is wholly unacceptable. It relies on ex post knowledge of how things turned out. President Nixon may have thought Watergate was too trivial to jeopardize his presidency and realized its impact too late. President Johnson might have thought that preserving the South Vietnamese government was only moderately desirable and may not have anticipated the anguish it would cause in the United States or the eventual threat it would represent to his reelection. Knowing how things turned out can be a misleading basis for inferring back to the value of the outcome.

To estimate utilities for alternative outcomes correctly, we must not take advantage of information that could not have been known to the decision makers when they were choosing (Creasy 1851). Alas, we have yet to uncover a measurement procedure that simultaneously (1) ensures no dependence on hindsight; (2) requires no case by case, ad hoc judgments by researchers; (3) is fully replicable by any researcher; and (4) is truly a measure of utility. However, we have devised measures that satisfy (1) through (3) and that provide information we believe is highly correlated with (4).

In an ideal world, an indicator of utility would encompass all four points. When trying to understand the values or the motives of other people, it is usual to scrutinize their choices. Common sense suggests that doing so is the appropriate way to learn about intentions, perceptions, and expectations. This is, indeed, the foundation of the venerable case study method. But closely scrutinizing the details of each case runs the grave risk of being nonreproducible, highly dependent on the judgments of the individual researcher, and contaminated by post hoc knowledge of how things turned out. It is all too easy for such an approach to violate all four of the strictures we have stated. Consider how Attila's reputation suffers because his history was written by his enemies or how heroic Chinghis Khan is to Mongolians and how barbaric he is considered by many Westerners.

When studying contemporary foreign policy choices in what the policy community calls real time, a case study method is appropriate. In real time, analysts cannot know the outcome and therefore cannot unwittingly bias an assessment of goals through hindsight. What is

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more, in real time they can pick the issues over which decisions have to be made without the further danger of ex post contamination. Using an ex ante method ensures that choices are made on the basis of what seems important at the time, rather than what turned out to be important later. To recognize the problem imposed by ex post knowledge, we have merely to consider the connotation that the agreement reached at Munich between Britain and Nazi Germany carries today: unwarranted appeasement of a greedy, grasping dictator, a foolish policy of capitulation. Then recall that at the time, Neville Chamberlain returned to a hero's welcome in Britain. In 1938 people believed that he had guaranteed "peace in our time." That phrase did not carry its current unpleasant implications.

One method for estimating utilities for current issues is set out in Bueno de Mesquita 1984 and delineated in greater detail in Bueno de Mesquita, Newman, and Rabushka 1985, Beck and Bueno de Mesquita 1985, and elsewhere. That method depends on the exploration of an individual's preferences with area or subject experts. We use here a similar methodology for converting data into estimates of utility, but we do not—because we cannot—use data as reliable as those provided by experts in studies done in real time.

The utility components of the international interaction game are estimated using the procedure developed by Bueno de Mesquita (1975, 1978, 1981, 1985, 1990). The similarity in national alliance portfolios is utilized as a revealed choice measure of national preferences on questions related to security issues. We assume that the more similar the patterns of revealed foreign policy choices of two states, the smaller the utility of any demand that one such state makes on the other and, concomitantly, the smaller the difference between $U^i(\Delta_i)$ and $U^i(\Delta_j)$. Conversely, the more dissimilar the revealed foreign policy commitments of two states, the greater the assumed utility for achieving the conditions contained in a demand between them and the greater the difference between $U^i(\Delta_i)$ and $U^i(\Delta_j)$. We define the stakes in a dispute as that difference and operationalize a variable called STAKES as the estimated difference, following the procedures delineated here.

The use of alliance patterns as a basis for estimating the magnitude of demands between states suffers from several limitations, which have been discussed at length in Bueno de Mesquita 1981 but which warrant some repetition, clarification, or elaboration. Large differences in alliance commitments do not guarantee large policy differences or, when demands are made, large demands. Likewise, great similarities in alliance commitments do not guarantee small demands. Still, we expect—and have found—that those who are in the same alliance camp

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are less likely to have big differences that need redressing than those allied with distinctly different nations.

A further limitation of the indicator we propose is that formal alliance agreements probably change more slowly than the informal relations between states. Still, the pattern of alliances is more responsive to change than is the existence of individual bilateral agreements. The indicator we use depends not just on the presence or absence of a bilateral arrangement between two states but also on the extent to which they have revealed a commonality of interests through the overall portfolio of commitments they have made (or not made) to all other states in the international system, here defined as Europe and states active in European affairs.

Formal military alliances are not adequate to track all the ways in which nations relate to each other, including economic exchange, cultural transactions, defensive military activities, aggressive military postures, and so forth. Still, they do focus on the set of interactions most likely to be relevant for our concerns: the origins and escalation or peaceful resolution of disputes.[1]

Alliance formation may itself be part of an elaborate signaling game. Alliance policies may not be an accurate reflection of preferences precisely because strategic actors realize that alliances may be seen as revelations of true preferences. If so, alliance similarities as indicators of revealed preferences may not move monotonically with actual interests, and our alliance indicator may itself be biased in favor of a realist or neorealist view of alliance formation as a means of augmenting national power or national security. To the extent that such a bias exists, it should imply that the true relation between realism (or neorealism) and behavior is even weaker than that reported here.

The measure of similarity in alliance commitments that we use has several important strengths that are also worth repeating, particularly because many critics have misunderstood the reasoning behind the indicator. The similarity of alliance portfolios is not presented as if the degree of similarity is a leader's utility for this or that outcome. Rather, the pattern of alliance commitments is assumed to be highly correlated with the leader's foreign policy preferences. Although the limitations

1. Recent research on trade and other forms of economic interaction raises serious questions about the time-honored belief that trade enhances cooperation (Gasiorowski and Polachek 1982; Pollins 1988; Sayrs 1990); similarities in alliance portfolios, such as are used here, have proved to be useful tools for assessing the risks of alliances and the behavior of their members (Altfeld and Bueno de Mesquita 1979; Iusi-Scarborough and Bueno de Mesquita 1988; Conybeare 1990).

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of alliance patterns are important, that the patterns represent foreign policy orientations hardly seems controversial. Within months of the emerging rapprochement between the United States and the Soviet Union, for instance, both nations codified their new relationship in a treaty of nonaggression. Similarly, the Camp David accords, an alliance of nonaggression, codified the new relationship between Israel, Egypt, and the United States. To be sure, important differences in national policies remain in each case, reflected by a comprehensive view of the patterns of alliance commitments. Thus, the indicator shows the United States and the Soviet Union drawing closer together, likewise Egypt and Israel, but it also reflects enduring differences in interests.

For some purposes, better data than the pattern of alliance commitments are available for approximating the utility leaders attach to alternative foreign policy outcomes. In chapter 7 we use money market discount rates to assess expectations of shifts in the value of the international status quo. However, such data are not available and readily comparable for a long time span across a comprehensive set of nations. Such breadth and scope are essential for evaluating the systematic implications of our theory. The case-by-case construction of indicators of utility on an issue-by-issue basis, as in Bueno de Mesquita, Newman, and Rabushka 1985, is useful when trying to understand this or that issue. But it is not useful when examining broad sweeps of history. There is a great danger of contamination in constructing ex post indicators that are situation specific—the danger of tailoring the indicators to the known results. The danger does not exist with the alliance correlation indicator used here because it is applied in an identical way to each and every case. What is more, it avoids the use of hindsight, relying as it does on information that was readily available to the relevant decision makers at the time. Rather than using ex post knowledge, it uses a tiny fraction of the information presumably available to the decision makers when they made their strategic choices.

The initial building block for our indicator of utilities, then, is the Kendall Tau_b correlation of alliance portfolios. Alliances are ranked according to the implied reduction in the autonomy of a decision maker in choosing policy. Defense pacts are treated as the most costly of alliances because they require one nation to promise to wage war in defense of another nation in the event of an attack. Defense pacts are followed in presumed costliness by nonaggression or neutrality pacts, in which a nation agrees not to aid anyone who attacks the ally.

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Ententes require merely that if attacked, the signatories consult with one another before deciding on a course of action. A signatory does not promise to join its attacked ally or not to attack it once it has been attacked. The least commitment of all occurs when no alliance exists, in which case no promise of any sort has been made.

We are not so naive as to believe that just because nations have entered into a mutual alliance, they necessarily honor the agreement in the contingent event. As Alan Sabrosky (1985) has observed, bilateral agreements are not honored all too often. Yet Michael Altfeld and Bueno de Mesquita (1979) and Chae Han Kim (1991) have shown that when commitments are honored or broken is highly predictable if the researcher looks beyond the bilateral agreement to the overall portfolio of commitments with other nations. When the pattern of alliance commitments is weighted by the ally's capability of influencing the outcome of a contingent dispute, then the predictive accuracy is near or above 90 percent (Altfeld and Bueno de Mesquita 1979), depending on the particular set of cases being evaluated. Our application of the correlation of alliance commitments is used, then, to evaluate the similarity in foreign policy commitments under the presumption that a similarity or difference reflects shared preferences among the states in question. The revelation of shared foreign policy preferences embodied in alliance portfolios is further assumed to reflect the magnitude of unresolved issues between the relevant states. As noted earlier, we assume that the larger these unresolved issues are, the larger are the demands between states.

The Kendall Tau_b correlation of the shared pattern of commitments for each pair of states is denoted as K_j^i. The outcome nation i desires is initially reflected by $K_i^i = 1.0$, the correlation of i's portfolio with itself. The utility of i's (or j's) demand is assessed in terms of the worth of marginally changing j's (or i's) goal to be in compliance with i's (or j's) goal. If i and j have identical alliance portfolios, so that the correlation coefficient between their alliance patterns is 1.0, we set K_j^i equal to 0.999 to reflect the possibility that no matter how alike the revealed preferences of two actors, they can always be still more alike.

The correlation of alliance portfolios does not capture important differences across countries that relate to the propensity of this or that leader to take risks. Therefore, the correlations, by themselves, are not our indicator of utility for alternative outcomes, although they are sufficient to provide the implied ordering of preferences across prospective outcomes. The propensity to take risks is an intrinsic part of any utility function as it gives curvature to that function. Risk-aversive

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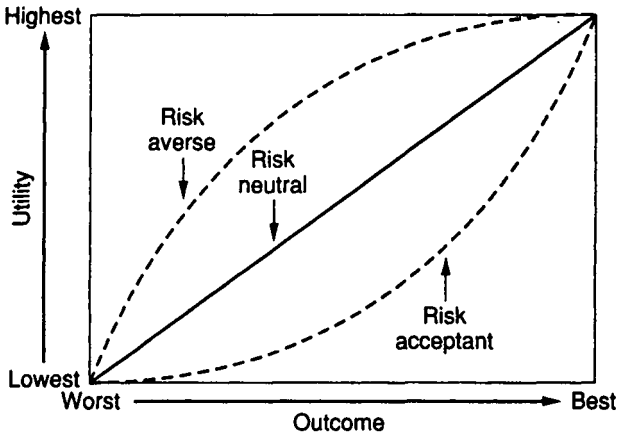

A1.1: Prototypical shapes for utility functions.

decision makers, for instance, have utility functions that are concave from the origin, indicating that the difference in value between, say, a worst-case outcome and an intermediate outcome is greater than the difference between the same intermediate outcome and a better outcome. That is, the utility for outcomes increases at a decreasing rate as outcomes are more and more preferred. For risk takers, in contrast, utility functions bend upward from the origin, with utilities increasing at an increasing rate as outcomes are more and more preferred. Figure A1.1 depicts prototypical utility functions for risk-averse, risk-acceptant, and risk-neutral decision makers.

For our second building block, we take the measure of risk-taking propensities delineated in Bueno de Mesquita 1985 and denoted as r^i here. James Morrow has shown that this measure is generally robust and consistent with conventional economic treatments of risk. He also shows that it suffers from two prospective sources of bias: "Bueno de Mesquita's risk indicator should recover a nation's risk attitude from its alliance decisions . . . except for those cases where the status quo is unusually close to victory or defeat"; the limitations of the measure "point up a higher random error . . . than was originally thought" (1987, 436–37). That random error tends to suppress rather than inflate goodness-of-fit indicators, thereby introducing a conservative bias into our analyses.

The measure is predicated on the assumption that the policies that actors reveal themselves as preferring represent an inherent trade-off between what they really want and what they believe is politically pragmatic. Pragmatism is defined in terms of maximizing a nation's

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security (or minimizing its vulnerability to attack). In that sense, the measure is a close approximation of the extent to which nations pursue enhanced security as their primary goal. It goes beyond the assumption that security is all that national leaders pursue by treating choices as the reflection of varying degrees of willingness to risk some security in order to seek particular objectives. National leaders establish objectives that combine the quest for security and the search for ways to achieve outcomes that reflect their ideals and values. David Lalman and David Newman (1990) show that alliance formation is frequently motivated by a quest for security, and Altfeld (1984), Bruce Berkowitz (1983), Altfeld and Won Paik (1986), John Conybeare (1990), and Morrow (1991a) provide increasingly sophisticated theories of the trade-offs between the maximization of national security and national autonomy. Each of their results is generally consistent with the logic underlying the measure of risk-taking propensities used here. Risk-averse leaders adopt policies (reflected by patterns of alliances) that minimize their vulnerability, presumably at the expense of some of their autonomous objectives. Risk-acceptant decision makers eschew more security in exchange for more idealistic—perhaps ideological or domestically motivated—preferences.

The indicator of risk-taking propensities that we use is highly correlated with independent indicators of exposure to risk. Risk-averse leaders, for instance, initiate significantly fewer wars that they ultimately lose than do risk-acceptant decision makers, according to the indicator used here (Bueno de Mesquita 1985). Conybeare (1990) has also demonstrated that the risk indicator provides a reliable means of estimating the propensity to engage in risky patterns of behavior in terms of the returns in security of alternative alliances.

With the basic building blocks—K_j^i and r^i—now described, we can begin to assemble them into the relevant variables.[2]

$$U^A(\Delta_A) = 2 - 4\left[\frac{2 - (1 - K_B^{\hat{A}})}{4}\right]^{r^A}. \tag{A1.1}$$

$$U^A(\Delta_B) = 2 - 4\left[\frac{2 - (K_B^{\hat{A}} - 1)}{4}\right]^{r^A}. \tag{A1.2}$$

2. The 2's and 4's are simply ratchet operators to preserve scale without taking roots of negative values. Negative root values could otherwise arise in those expressions that assess $U^i(\Delta_j)$. If no marginal change in policy positions is expected, then the expected change in $K_i^j - K_j^j$ is zero, so the calculation of the value of the status quo—which is not expected to change—reduces to 0.5^{r^i}.

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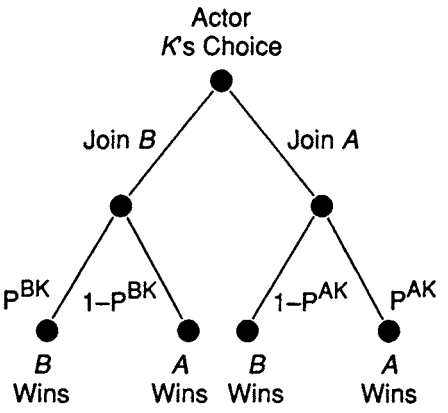

A1.2: Third-party choices to support side *A* or *B*.

$$U^A(SQ) = 2 - 4\left(\frac{2}{4}\right)^{r_A}. \tag{A1.3}$$

$$U^B(\Delta_B) = 2 - 4\left[\frac{2 - (1 - K_A^B)}{4}\right]^{r_B}. \tag{A1.4}$$

$$U^B(\Delta_A) = 2 - 4\left[\frac{2 - (K_A^B - 1)}{4}\right]^{r_B}. \tag{A1.5}$$

$$U^B(SQ) = 2 - 4\left(\frac{2}{4}\right)^{r_B}. \tag{A1.6}$$

The variable STAKES is derived from these indicators. STAKES is operationalized as (A1.1) − (A1.2) for actor *A* and as (A1.4) − (A1.5) for state *B*.

The Probability of Success

We assume that the subjective estimate of the probability of success of actor *A* is a function of its capabilities and the capabilities of its prospective supporters, discounted by the intensity with which it and each of its prospective supporters prefers success by *A* to success by *B*. The precise specification is motivated by a decision-theoretic view of third-party choices to join side *A*, side *B*, or remain neutral during an ongoing dispute. Figure A1.2 depicts the decision problem, and expressions (A1.7) and (A1.8) represent it algebraically.

With *N* as the set of all nations, let *A*, *B*, $K \in N$. Let *K* be any third party to a potential dispute between *A* and *B*, so that *K* is neither *A*

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nor B. In the putative dispute between A and B, there is some probability that A's demand of B will be accomplished and some probability that B will obtain the outcome it desires from A. K attaches some utility to each of these outcomes [$U^K(\Delta_A)$ and $U^K(\Delta_B)$]. If A is successful, then we assume K derives $U^K(\Delta_A)$ from the outcome of A's dispute with B. Likewise, if B succeeds against A, then we assume that K derives a benefit or loss (as the case may be) of $U^K(\Delta_B)$. These utilities apply whether K decides to help A, help B, or remain neutral.

K is capable of influencing the outcome of the dispute between A and B. We assume that in joining A, K cannot decrease A's chances of success and that, likewise, by joining B, K does not diminish B's chances.[3] Let P^{AK} be the probability with which A combined with K defeats B. By combined we mean that K joins the dispute on A's side. Let P^{BK} be the comparable probability of success for B. K's choices, with the associated expected utilities, are

$$P^{AK}[U^K(\Delta_A)] + (1 - P^{AK})[U^K(\Delta_B)] - C_A^K, \tag{A1.7}$$

and

$$P^{BK}[U^K(\Delta_B)] + (1 - P^{BK})[U^K(\Delta_A)] - C_B^K, \tag{A1.8}$$

with C_A^K and C_B^K representing the costs K expects in utilities if it joins side A or B, respectively. Each cost term is assumed to be greater than or equal to zero. If (A1.7) > (A1.8), then K anticipates greater value from joining side A than from joining side B and so is expected to do so. If (A1.7) < (A1.8), then K is expected to join side B. If (A1.7) = (A1.8), then K is indifferent, so we assume that K chooses to remain neutral and avoid any of the costs associated with joining in the dispute.

The choice problem for nation K can be rewritten by simply rearranging the terms in (A1.7) and (A1.8):

$$(P^{AK} + P^{BK} - 1)[U^K(\Delta_A) - U^K(\Delta_B)] \gtreqless C_A^K - C_B^K. \tag{A1.9}$$

Expression (A1.9) helps clarify some important features of (A1.7) and (A1.8). Because we have assumed that P^{AK} and P^{BK} are each at least as large as A's or B's prospects of success without K's assistance, $(P^{AK} + P^{BK} - 1) \geq 0$. As the expected costs for joining one side

3. In this context, A or B can be thought of as an individual state or as the coalition of states on a given side in a dispute, so K can calculate its expected utility from alternative strategies by taking the evolution of the dispute into account. For an interesting treatment of this feature of K's calculations, see C. H. Kim 1991.

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approach being equal to the anticipated costs for joining the other side, the side joined, if any, is determined by the sign of $U^K(\Delta_A) - U^K(\Delta_B)$, for K behaves sincerely in choosing sides so long as the cost differential is not large enough to alter its calculations. With the assumption that the differential is not expected to be too large, we apply a modification of Jeffrey Banks's (1990) monotonicity result to (A1.9), as suggested in Bueno de Mesquita and Lalman 1986; Lalman 1985, 1988. We assume that the level of effort made by K is an increasing function of the absolute magnitude of (A1.9). In other words, the greater the intensity of preference or the greater the contribution K makes to the probability of the outcome, the more resources K is prepared to commit to the dispute.

Now we add an operational conceptualization of probability as the gambling odds based on the distribution of capabilities. Let Λ^i equal the resources, or capabilities, of nation i. We estimate Λ^i using the composite capabilities score developed by the Correlates of War Project and widely used in the assessment of national power. We operationalize the two probability terms in (A1.9) as $P^{AK} = (\Lambda^A + \Lambda^K)/(\Lambda^A + \Lambda^B + \Lambda^K)$, and $P^{BK} = (\Lambda^B + \Lambda^K)/(\Lambda^A + \Lambda^B + \Lambda^K)$, so that, with a little algebraic manipulation, it is evident that the probability component of (A1.9) reduces to $\Lambda^K/(\Lambda^A + \Lambda^B + \Lambda^K)$.

As we have stated, we assume that K's level of effort is an increasing function of (A1.9). But we are interested here in estimating P^A or P^B, A's and B's subjective estimates of their respective probabilities of success. If A and B assume that K's level of effort on their behalf or on behalf of their adversary is an increasing function of A1.9, then A and B must make a subjective judgment not only about the capabilities of each third-party K but also about the intensity of preference that K has for A's or B's desired outcome. We denote A's estimate of K's intensity of preference for the outcome A wants compared to the outcome B wants as follows:[4]

$$^AU^K(\Delta_A) - {}^AU^K(\Delta_B) = \frac{(K_A^K - K_B^K)}{2} e^{R^A(K_A^K - K_B^K)}.$$

With the various conditions just stipulated in place, we offer the following operational view of (A1.9):

4. Division by two is to avoid counting capabilities twice. Recall that $-1 \leq$ Kendall's $\text{Tau}_b \leq 1$. The term r^A, used in earlier expressions, is a transformed variant of R^A. The details of the transformation and the reasoning behind it are spelled out in Bueno de Mesquita, Newman, and Rabushka 1985.

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Let

$$P^A = \frac{\sum_{K \in \psi}^{N} \Lambda^K[{}^AU^K(\Delta_A) - {}^AU^K(\Delta_B)]}{\sum_{K=1}^{N} \Lambda^K|({}^AU^K(\Delta_A) - {}^AU^K(\Delta_B)|}, \quad \text{(A1.10)}$$

with $\psi \subseteq N$ such that $\forall\, i \in \psi$, ${}^AU^K(\Delta_A) - {}^AU^K(\Delta_B) > 0$.

Expression (A1.10) has a straightforward interpretation. The numerator, derived as an extension of (A1.9), is the sum of the capabilities of all states that prefer *A*'s objectives to *B*'s, discounted by *A*'s estimate of the intensity of their preferences. The denominator is the discounted sum of all capabilities expected to be available in the dispute, whether on the side of nation *A* or nation *B*. Thus, (A1.10) is the proportion of all utilized capabilities that *A* expects to find supporting its goals. The calculation from *B*'s perspective is analogous.

Costs

The coarsest of our indicators are the approximations of the cost variables. We assume for operational purposes that anticipated domestic costs vary directly as an increasing function of each side's subjective estimate of its probability of success (P^A, P^B) and of the value it attaches to the status quo, so that ϕ_i is presumed to be positively correlated with *i*'s evaluation of the status quo. The rationale is that if the status quo is relatively desirable, then the domestic population is more likely to be agitated by policies that threaten to disrupt it. Consequently, the use of force to alter an already-attractive state of affairs is assumed to prompt greater domestic opposition than the use of force in circumstances in which the status quo is unattractive or irksome. Furthermore, we assume that powerful nations face greater opposition to the use of force than do weaker nations, all else being equal. The rationale behind this assumption is that strong nations are in a better position to get what they want through negotiation and to control relations with other states. If they use force, their foreign policy is perceived as a greater failure exactly because they should have had the leverage to manage their relation with a weak adversary more effectively through peaceful means. After all, peaceful negotiation is generally preferred to using force. The domestic cost term for nation *i* is operationalized as $U^i(SQ)P^i$.

The costs in terms of lost life and property are assumed to be an inverse function of relative power. The higher the probability of success, the lower the losses in life and property that we assume are

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expected in the event of violence. Therefore, the loss for the initiator of a war is $\alpha_i(1 - P^i)$, for the target it is $\tau_i(1 - P^i)$, and for a capitulator it is $\gamma_i(1 - P^i)$. Unfortunately, we have not yet devised a way to estimate α, τ, or γ, so we do not distinguish between them. Because we cannot compare the value A (or B) attaches to the outcomes War_A and War_B, we specify only the relevant condition closest to the terminal event of interest if more than one condition must be estimated. If we are estimating the necessary and sufficient conditions for, say, War_A, then any estimate of the expected utility of war is based on War_A and not on War_B. If there is a condition on War_B, then, as we note in the text, that condition remains unestimated.

Clearly, our estimation of expected costs only scrapes the surface of the problem. These very limited approximations may introduce considerable measurement error into our analyses. Assuming that our operational procedures are not systematically biased one way or the other, we expect that, on average, the crudity of our estimation of costs suppresses rather than inflates our results. But we cannot be confident of this claim until better indicators are developed and tested in the future.

Uncertainty

In the game we propose, uncertainty can arise from any number of factors. Leaders may be uncertain about the costs of conflict or the capabilities of their adversaries. They may be uncertain about a foe's preferences for alternative outcomes. They may be uncertain about the beliefs their rivals have about them. We cannot at this time measure each of these and many other prospective sources of uncertainty. We have, however, devised a general indicator that we believe reflects fundamental sources of uncertainty in international relations. How a nation responds to a given circumstance is significantly influenced by its willingness to take risks or its aversion to doing so. We assume that different decision makers respond differently to risks. Furthermore, we assume that a principal source of uncertainty in international politics has to do with how a given nation will respond to risky choices. Therefore, our indicator of uncertainty is the variance in our measure of risk taking on a year-by-year basis.

For each year we calculate the willingness of the leadership of each European nation to take risks. In some years, there is more commonality across leaders in this regard than in other years. When the variance in risk scores is large, we assume that decision makers are not at all certain how any one nation will respond to a risky situation.

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When the variance is small, we assume there is less uncertainty about how any given state will respond to a risky situation. Because of these assumptions, the decision makers in our game are more likely to estimate accurately the utilities that their rivals (or third parties) attach to alternative outcomes in years of low risk variance than they are in years of high risk variance, meaning that in years when risk variance is low, *A*'s estimate of *B*'s ordering, say, and *B*'s actual ordering (in each case, estimated by our methods) are less likely to be reversed.

COMMENTS

With the operational indicators in place, we are able to estimate most of the terms of our theory and to provide empirical assessments for almost all the propositions we deduce from the international interaction game. We again caution the reader, however, to expect no more than the central tendency to be reflected in the empirical results. More than that is extremely difficult to attain with the set of indicators we use. At the same time, we also caution the reader to be wary of measurement approaches that seemingly circumvent such coarseness by using ex post information about how events turned out or by using assessments that are particular to each case. Such approaches run grave risks of nonreproducibility, dependence on the knowledge of outcomes, and selection or interpretation biases. General indicators weaken the overall goodness of fit, but they avoid many other pitfalls that would make the empirical results all but uninterpretable.

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