Risk Aversion in International Relations Theory

Barry O'Neill

Center for International Security and Cooperation, Stanford University

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Abstract: When international relations writers use the idea of risk aversion, they either leave it undefined or cite the economics conception, that the decision-maker has a concave utility function for the goal. However, concavity is meaningless for the typical decision in the international context where the goal is not an objectively measurable quantity like money. This paper gives two definitions of risk aversion that are "non-metric" in the sense that they do not require such a quantity. The first, *comparative risk aversion*, specifies the relative degree of aversion but does not separate risk-averters from risk-seekers in an absolute sense. A second concept, *multiattribute risk aversion*, is absolute and not a matter of degree. The theory implies significant revisions of some international relations work including historical case studies using prospect theory. Applied to Fearon's categorization of rationalist explanations for war, it indicates further sources of war.

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Attitude to risk – a taste for it or an aversion to it – is an attractive way to explain decisionmaking since it links the strategic and the psychological conceptions of choice. It portrays leaders as calculating goal-seekers while allowing them to have different personal decision-making styles. One can call Khrushchev risk-acceptant and Brezhnev risk-averse without implying that either was more rational than the other. Beyond its theoretical connections, risk attitude is important on its face because an overly daring action can start a war, as can an overly cautious one.

Risk aversion and acceptance have been concerns of research on international decision-making, both in non-formal work and in applications of prospect and utility theory.[1] This paper argues that almost all the uses have a severe problem. When we label someone as risk-averse we are comparing the person to a standard of risk neutrality. However, international applications either do not have a standard or they cite the economics definition, and, while the latter is quite clear, it can be applied only when the goal of the decision involves money or some other measurable commodity. The economics definition states that a risk-neutral person is indifferent between playing a gamble and receiving the gamble's average face value for sure, but international goals almost never have a reasonable way to calculate "average face value." They include elements that are not measurable with respect to an external quantity or they involve multiple scales, so that risk neutrality, acceptance or aversion are undefined. If IR theories involving risk attitude are meaningless to start with, then the international behaviors adduced to support them cannot establish their validity and deductions from them do not really follow.

This paper proposes two conceptions of risk aversion that avoid this problem – it shows how to define the idea non-metrically. The definitions preserve some past conclusions about IR phenomena, but not others. The first section describes why an attribution of risk aversion needs a standard of risk neutrality and why the economics definition needs a quantity that is measurable on at least an interval scale. Although very few international relations writers have identified the problem, many have met its consequences and tried to circumvent them, and the second section shows why their attempts have generally been unsuccessful.

The third section defines non-metric risk aversion in a comparative sense, the definition being comparative in that it ranks decision-makers by degree of aversion but does not label them as risk-averse or risk-acceptant relative to a zeropoint. Many writers who cite the economics definition seem to have had the essence of this definition in mind as it fits much of their discussions. For example, IR analyses tend to treat risk attitude as a character trait, i.e., as determined by the decision-maker's personality rather than the particular decision being faced. By the economics definition, however, even for a given decision the party's risk attitude can change depending on arbitrary aspects of how the decision is stated. Risk attitude in that sense is not determined by personality. The comparative definition given here allows risk to be seen as a personality characteristic, and empirical evidence suggests that it produces comparisons among people that are stable within fairly wide spheres of their decision-making.

The fourth section defines non-metric risk aversion in an absolute sense. The concept requires that the goal have multiple features and so is termed multiattribute risk aversion. Just as the economics definition provides a basis for prospect theory, this definition fits into an existing theory of choice, the associative theory of joint receipts (Luce, 2000). This approach is somewhat analogous to prospect theory, has empirical support, and suggests some interesting hypotheses about international decisions.

The fifth section applies the definitions to three previous analyses in international relations: applications of prospect theory to leaders' changes of policy, Morgan and Palmer's "two-good" theory of international actions (1997, 1998a,b), and Fearon's categorization of rationalist explanations for war (1995). Each should be modified in certain ways in light of these arguments about risk aversion.

THE STANDARD THEORY'S REQUIREMENT OF AN INTERVAL SCALE

Both prospect theory and utility theory applications use the microeconomic definition of risk attitudes, but utility theory's version is simpler and is the one presented here. The idea, suggested by de Finetti (1952) and developed by Arrow (1964) and Pratt (1964), is to define a **risk-neutral** person as one who is indifferent between playing a gamble or receiving its expected face value as a certainty. The person is indifferent, for example, between playing a 50/50 gamble for $0 or $200 versus receiving $100 for sure. (Since we assume that more money is preferred, the risk-neutral individual would choose the gamble if the sure payment were below $100 and choose the sure payment if it were higher.) Alternatively, someone who prefers the gamble over its face value is *risk-acceptant* or *risk-seeking,* and choosing the face value means that the party is *risk-averse*.

The definition involves the gamble's face value in a crucial way. If it said without qualification that a risk-averse person prefers a sure thing over a gamble, it would be empty, since almost anyone would make the sure choice if its winning payoff were set high enough.

The definitions of risk attitude have implications for the shape of the decision maker's utility function for the commodity: for risk aversion it must be concave, and for risk acceptance, convex. A *concave* function is one that bulges upwards, or more exactly, one whose graph lies above the straight line segment connecting any two points.[2] Assuming the commodity is a desirable one, like money, the utility increases, but given risk aversion it increases at a decreasing rate. Figure 1 shows why a concave utility function is associated with choosing the sure $100 over the gamble – on the vertical axis, the certainty's utility, u($100), lies above the gamble's expected utility, which is the 50/50 weighted average of u($0) and u($200), and the former lies above the latter just because of the upward bulge between the loss and win utilities. If the utility function sagged there, i.e., if it were convex, the person would choose the gamble and be labeled a risk-seeker.[3, 4]

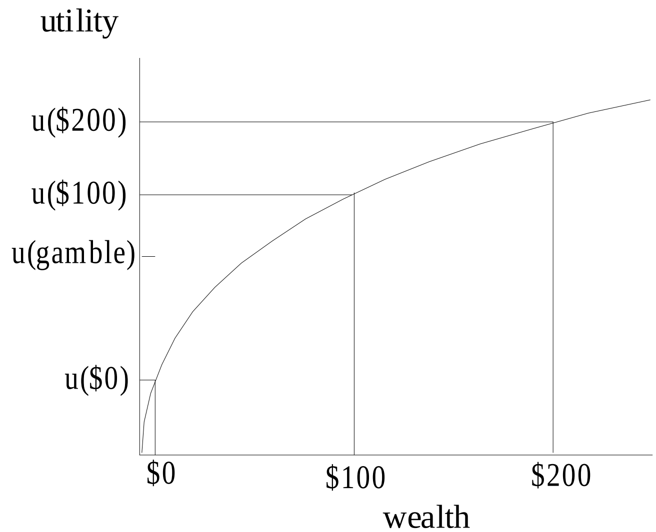

Figure 1. Risk aversion by the economics definition.

One can apply the definition to any goal that allows a calculation of expected values (separate from expected utilities) -- bushels of wheat produced, soldiers' lives saved by a military tactic, the literacy rate achieved in a population, or the global temperature rise averted through a treaty on the ozone layer. To calculate expected values the goal must be an interval scale or stronger, and it is worthwhile to consider some basics of measurement theory to see what this means and when it holds. A *measurement scale* is an assignment of numbers to a set of empirical events such that certain arithmetical relations among the numbers mirror certain empirical relations among the events. If the numbers measure lengths, for example, one object's number having the greater-than relationship to another's number corresponds to the empirical relationship that, with the objects are laid side by side the first object extends past the second. This distinction -- between arithmetical relations among numbers on the one hand and observable relations among world events on the other – seems pedantic, but it is important. Unless there is some empirical relationship that mirrors the addition operations used for the expected values used in risk attitude, that calculation will be meaningless.

Generally only some of the arithmetical relations in a measurement scale have an empirical meaning. With calendar years, for example, it is empirically significant that the number 1936 is greater than 1919, since that arithmetical inequality duplicates the temporal order of the corresponding years. The difference between the numbers representing the years is significant. However, it is not empirically significant that 1936 is a perfect square and 1919 is not, or that the ratio 1936/1919 is greater than 1815/1810.[5] Measurement scales are classified by the kinds of relationships among their numbers that have empirical meaning. In an **ordinal scale,** comparisons of greater than, equal to, or less than have meaning. In an **interval scale,** meaning is attached to greater than, equal to or less than, both between numbers and between differences of pairs of numbers, i.e., intervals are comparable as well as absolute values. For the scale of time, the equality of the differences 1990 - 1980 and 1980 - 1970 corresponds to the fact that a clock timer started at the initial years would reach the same value at the end of both decades. The scale of amount of money also qualifies as an interval scale since the equality of differences $3 - $2 and $6 - $5 has an empirical interpretation. Adding a dollar bill to $2 brings it up to $3, and the same action brings $5 to $6. The establishment of the equality of intervals for money involves appending the same object to two others. The appending operation is termed *concatenation*.[6]

Interval comparisons are common in physics but harder to find in the social sciences. In the context of measuring the power of nations, for example, what meaning can one attach to the claim that state A's power exceeds B's by the same amount as C's exceeds D's? There seems to be no way to concatenate or compare intervals in any other way, no clear way to join A's power with B's to systematically get a power that is the sum of the individual values.[7] In the case of IQ scales, interval comparisons are also uninterpretable. Can one really interpret a jump from 130 to 140 points as equivalent to one from 60 to 70? Are three people with IQ 100 together equally as able as two with 150? IQ scores might claim the ordinal-scale property if someone with a higher IQ is really smarter about life outside the test, but they do not qualify as interval scales.

The criterion of meaningfulness can be applied to the scales underlying risk aversion. The standard definition requires that utility increments be shrinking *for equal increases* in the desired commodity. This condition involves a comparison of intervals on the scale for the commodity, so the commodity must be measurable as an interval scale or stronger. There is no requirement that it be money -- risk attitudes have been attributed to the percent of work force unemployed, the number of lives lost in an epidemic (Quattrone and Tversky, 1988), deaths in election violence (Kowert and Hermann, 1997), and other such goals. Risk aversion can be applied because these scales allow comparisons of differences -- an increase from 4% to 7% in unemployment is the same as 10% to 13% in that the same number of additional people are out of work. But for international decisions over a bundle of objectives, some with interval scales and some without, there is no way to mark off equal increments and decide whether the decider's utility function is concave.

Risk aversion in prospect theory

According to prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), the decision-maker compares the possible outcomes with some reference point and decides on the basis of changes from this mental status quo. The reference point often depends on factors that a typical utility theory application would call irrelevant, such as how the decision is framed in the chooser's mind. A "value," which is prospect theory's analogue for an outcome's utility, is attached to each degree of change from the reference point, such as gaining $5 or losing $10. Further postulates are that the loss side of the value function is steeper than its gain side ("loss aversion") and that sensitivity to losses or gains is marginally decreasing with the amount lost or gained. These imply that the value function is S-shaped -- the decision maker is risk-averse for gains above the reference point and risk-seeking for losses below it.[8]

Prospect theory is meant to be descriptive rather than prescriptive, and it explains several phenomena observed in experiments and in life. On the other hand, it is less specific than utility theory in that it lacks a good account of how someone sets the reference point, and it does not predict well for decisions that mix gains and losses (Chechile and Cooke, 1997). Researchers also seem to have avoided the question of whether the value function is independent of the absolute level of goods held – if it is not, that would call for a theory that is a hybrid with utility theory.

Prospect theory is often presented as a psychological alternative to the rationalism of utility theory, but it brings more economic baggage concerning the shape of the value function over an interval scale. Its requirement of an interval-scale goal presents a greater problem for its application to international decisions. Prospect theory's uses have been more empirically-based than utility theory's, and the deeper researchers have analyzed historical cases, the more they have been criticized on conceptual grounds and the more ambivalence has arisen about the applicability of the theory (e.g., Boettcher, 1995; Jervis, 1992; Levy, 1992b, 1997a; Shafir, 1992; Stein, 1992). The reservations have been stated as involving the practical issue of finding leaders' decision parameters, but this misidentifies the problem. Levy, who has been a strong proponent of prospect theory, has stressed the difficulty of getting accurate measurements of leaders' mental constructions of the decision and their utilities for the outcomes. Laboratory experiments gave subjects simple, explicit and structured decisions, he notes, but these are unlike those faced by national leaders. He recognizes the absence of interval scales in the international setting, but sees the reason as a lack of experimental control (Levy, 1997a:99). Boettcher argues that prospect theory's problem is acquiring full data, since, for one thing, foreign policy leaders do not specify their probabilities. His recommendation is to estimate the numerical probabilities from their verbal expressions, such as "possible" and "likely." However, one could know all the utilities and probabilities precisely and still not be able to test prospect theory's claims about risk attitude. Without an interval scale for the goal, risk attitude is simply not defined.

RESPONSES TO THE SCALE PROBLEM

International applications of risk aversion have seldom recognized the scale difficulty but they have had to deal with its consequences, and this section describes some of these attempts. Most of their answers were not successful, and those that are valid work only in restricted contexts. The section's purpose is to motivate the non-metric definitions to come.

A common approach is to describe an historical case involving a leader choosing between two courses, one with a predictable outcome and the other with an uncertain one. The argument involves *interpreting the sure choice as showing risk aversion and the risky choice as risk acceptance*. Risk acceptance was attributed to Britain and France in their intervention in Suez (Richardson, 1992), and to Eisenhower in his deception about the U-2 overflight (McDermott, 1998); a cautious decision was the United States staying out of Suez (McDermott, 1998). Assigning a risk attitude requires a standard, as noted earlier, and here it is the rejected course of action. If the decision maker had chosen the other road, that would show the opposite risk attitude.

It might seem obvious that opting for the uncertainty shows risk acceptance and vice versa, but utility theory and prospect theory do not support this idea. As Boettcher points out, they state that the course with the higher expected utility (or in prospect theory, the higher weighted value) will be chosen, whether the decision maker is averse or acceptant to risk. For a risk averter this may be the uncertain course and for a risk seeker it may be the certainty – the determining factor is the expected utility or in prospect theory the weighted value. The misunderstanding is shown by a simple question that trips up students on examinations. Assume a risk-averse person has two options, a sure outcome with utility 100, or a 50/50 gamble with expected utility 100. Which will be chosen? One wants to say that a risk averter will prefer the sure thing, but since the domain is utilities rather than payoffs, the correct answer is indifference. A safe choice signals someone's risk attitude only when the alternatives can be equated for their expectations on a separate interval scale.

This association of risk acceptance with the riskier choice appears in Bueno de Mesquita's revised expected utility theory of war (1985) and its development by Morrow (1987). The idea is that a risk-averse state is one that chooses policies that reduce others' incentives to attack it. The authors define a state's "insecurity measure" as the sum of the expected utilities that the other states would derive from starting a war against that state, given the latter's policy choice. The insecurity measure corresponds roughly to the danger of war that the state accepts by adopting its chosen policy, and the state's risk aversion is defined as the proximity of its insecurity measure to the minimum possible value, normalized by the difference between the maximum and the minimum. However, calling this risk aversion is is an odd use of language. A state's choice may lie near the minimum simply because of its good luck that its chosen policy is desirable on grounds other than a low likelihood of being attacked. One cannot interpret the choice as risk attitude, understood either by the economics definition or by common usage, and if the measure correlates with other variables, as this literature has indicated, this finding may not be properly understood.

A related approach involves *interpreting a spectacular failure as a symptom of risk acceptance.* The prospect theory literature often links an action's failure to the decision-maker's risk acceptance. That is, most of the decisions they cite as risk-acceptant are ones that were later regretted. Kennedy's invasion in the Bay of Pigs is analyzed as risk-acceptant but not his blockade during the Cuban Missile Crisis. By definition a risky action often fails, but, as argued before, its selection does not imply the decision-maker is risk-acceptant. Gambles can sometimes succeed but then the analyst is ready to interpret the leader as sensibly willing to act when the chance is worth taking. If attributions of risk attitude require a standard, here it is hindsight.

Another common notion involves *suggesting that there are correct utilities for a decision* compared to which the state is being either too safe or risky. Levy (1992a:93) offers an international implication of prospect theory, that after suffering losses in territory, reputation or domestic support, leaders will tend to take "excessive risks" to recover them. He adds that “excessive” is defined “with respect to predictions based on expected value." This idea of taking “excessive” risks implies that there is some way apart from leaders’ utilities to combine the goals he lists into an expected value, an objectively right measure of true national interest, but how to do this is not specified. Jervis (1992) presents a prospect theory interpretation of crisis instability and suggests that because decisions are being made among losses, a leader will tend to order a pre-emptive strike "[i]n cases in which the standard expected utility model would predict the actor to cut his losses." However, there is no standard utility model for what the leader should do. Many strategic analyses of war have estimated weapons destroyed or lives lost, but these quantities are only part of the factors influencing the choice of a nation on the brink of war. Utilities reflect what a decision maker does; they do not prescribe what one ought to do, and there is no right set of utilities apart from the nation’s behavior.

Another technique involves *applying the economics definition of risk attitude based on an equal spacing of the outcomes along the x-axis,* such as Bueno de Mesquita's original expected utility theory of war. In his explanatory graph, adapted in Figure 2, the possible outcomes, which are peace, winning the war, or losing it, are placed at equal intervals along the x-axis. The utility function is defined at only three points, but if the middle value lies above the line joining the other two, it is concave by the definition and the leader is termed risk-averse. The problem is the arbitrariness of the equal spacing. It is not clear what an equally spaced x-axis means as a measurement scale -- there is no empirical sense in which the interval between the status quo and losing a war is “equal to” the interval between winning and the status quo, but defining some kind of objective equality is crucial, since if one expanded one of the two intervals the risk attitude might switch. In the many-outcome version where risk attitude is determined by the median value (Morrow, 1994), the problem can be shown by splitting one of the outcomes into several. In Figure 2, one could divide losing into "losing badly," "losing" and "losing mildly." This would change the identity of the median outcome to "losing mildly." The latter has a lower utility than the original median and the attributed risk attitude might change from averse to acceptant. This consequence is unsatisfactory, since a party's risk attitude should not depend on the analyst's grouping or splitting of outcomes.

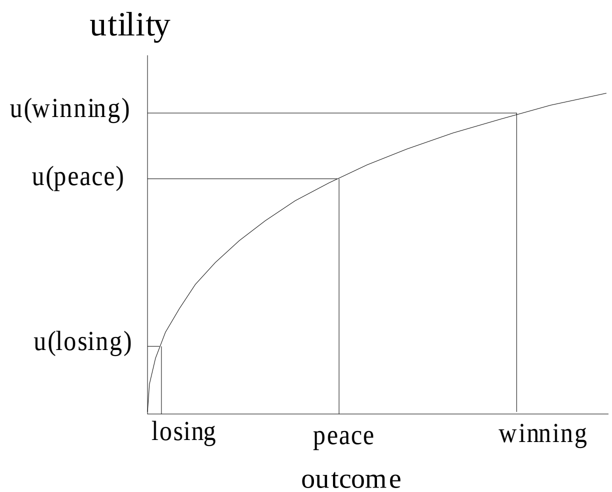

Figure 2. Risk aversion in the *War Trap.*

Another approach involves introducing a policy space where each leader has an ideal point and preferences that decrease with the distance from the ideal. Risk aversion is introduced by *postulating that each country's utility is a concave function of the distance from the ideal* (e.g., Morrow, 1986). These models do not violate the principles espoused here. Although they do not include an explicit definition of an interval-scale measure of distance in the space, it can be shown that their assumption of single-peaked preferences in effect determines one, when many decision makers with different ideal points are included (Coombs, 1950). The models cannot be criticized on meaningfulness grounds, but they apply only when there is a policy space with preferences determined by ideal points and distance.

Other models *introduce an interval-scale variable over which utilities are to be concave, but one* *that is not in fact the goal*. The consequent definitions of risk attitude do not have some of the basic properties one would expect from the concept. In this category is Morrow's discussion (1996) of a dominant state's choice to accommodate or wage war when it is confronted by a rising challenger. In the model a state enjoys a level of benefit from its world position and this level varies continuously as time passes. Integrating this instantaneous inflow gives the total utility over a period of time. If a state's utility function is such that a constant situation yields an integrated utility increment that decrease concavely with the time the situation is experienced, the state is termed risk-averse. Thus the x-axis of the utility function, time, is an interval scale. The difficulty of the model is subtle: its use of integration in treating the stream of benefits conflicts with the reasonable properties of risk aversion. Standard risk aversion means that the utility of two benefits received simultaneously is less than the sum of their individual utilities, e.g., that the utility of getting $1 twice (that is, u($2)), is less than twice that of gaining $1 (less than 2u($1)). If the utility of two benefits is subadditive when they are simultaneous, it is hard to see how they could jump to the sum of the individual values when one of the gains is delayed momentarily. However this is what integrating instantaneous utility over time implies,[9] and it is not clear how a model with this element can represent risk aversion.

Another study in this category is by Huth, Bennett and Gelpi (1992) relating system uncertainty to war. They define a state as risk-averse if it tends to avoid choices with unclear probabilities in favor of those with specified probability values, like a coin with a known rate of coming up heads. A decision-maker has an unclear probability if he or she possesses a wide probability distribution over the true probability value, so risk-averse states are those that prefer low variance in their distributions over the probability of the important event. This definition of risk aversion is parallel to the normal one, but makes the x-axis probability, a variable that satisfies the criterion of an interval scale. The question, however, is validity: someone might dislike choices that are relatively safe and have less well-specified probabilities, but be drawn to 50/50 gambles because their probabilities are clear. It would be odd to call this risk-aversion since a 50/50 gamble can be highly risky. The concept the authors define is often called "ambiguity aversion," and it is theoretically and even empirically different: Kuchen (1997) lists several experimental studies that found no correlation between subjects' degrees of risk and ambiguity aversion.

In summary, responses to the scale problem have usually involved either constructing an interval scale in some way, or suggesting that the decision already includes one, or specifying risk aversion as holding over distance in a space, or using a scale that is not the decision-maker's real objective. They are not successful or are applicable on very limited domains.

COMPARATIVE RISK ATTITUDE, A NON-METRIC DEFINITION

The next sections deal with the problem by defining risk aversion without an interval scale. The first definition is a comparative concept. Its basic idea had appeared in the literature of convex functions but it was presented most fully by Yaari (1969; see also Kihlstrom and Mirman, 1974). Assume two decision makers are facing the decisions that are "the same," in the sense that their sets of riskless outcomes can be matched pairwise in a reasonable way. Perhaps the two are in a conflict and each is considering either compromising or holding fast for a possible win or loss. Then one party's win outcome could be matched with the other's win outcome, compromise with compromise, and loss with loss. Applied to Richardson's and McDermott's example of the Suez Crisis, a successful British intervention would correspond to a successful American one, and so on. To compare their risk attitudes we put B's utility values for the outcomes on the x-axis and plot A's utilities vertically. If the decisions are in fact similar the curve will increase since an outcome that is more desirable for one party will be more desirable for the other. If the points lie on a straight line the individuals have *equal comparative risk attitude*; if they form a one-to-one and increasing concave function then B is *comparatively more risk-averse* than A; a one-to-one increasing convex function means that B is *comparatively more risk-acceptant* than A; any other shape means that their risk attitudes are not comparable.[10] This approach is parallel to the economics definition; the interval scale on the x-axis is not money but the other party's utilities. Instead of absolute statements about one person's risk attitude it produces a comparison of risk attitudes.

Why should this be called comparative risk aversion? The reason lies in the definition's consequences. For a certain decision situation, identify the set of riskless outcomes facing the two parties, and from these construct all possible gambles. Each party has a preference ranking over the set comprising the riskless outcomes and all these gambles. The definition of risk aversion involves a pairwise matching of the riskless outcomes between the parties, and consequently a matching of the gambles. If we choose one of individual A's riskless outcomes, c, there will be a set of gambles that A will accept in place of c, called A's *acceptance set for* c. Letting c' be the outcome of B's that is matched with c, B's acceptance set for c' can be defined in a similar way. Yaari (1969) showed that if, for every corresponding pair of sure outcomes c and c', A's acceptance set lies in B's set, then B is equally or more risk-seeking than A by the definition. That is, if B would trade the given sure thing for all the gambles that A would (and perhaps some more), then B is at least as risk-seeking.

Applying the idea to the example in Figure 3, we might stipulate that B's utilities for the three riskless outcomes -- losing a war, staying at peace, and winning a war -- are 1, 6 and 11, and are on the horizontal axis, while A, on the vertical axis, has utilities 3, 7 and 9. The larger set including constructed gambles would have prospects of winning or losing the war with all possible probabilities, plus more complicated three-outcome gambles that gave some weight to peace. Simple calculations indicate that relative to peace, state B would take any gamble with a probability of winning greater than ½ [= (6 - 1)/(11 - 1)], and A would insist on a probability of winning of 2/3 [= (7 - 3)/(9 - 3).] Thus any gamble over war that A would accept, B would also. It is easy to show this is also true for other sure things and for all three-outcome gambles, so that B is equally or more risk-seeking.

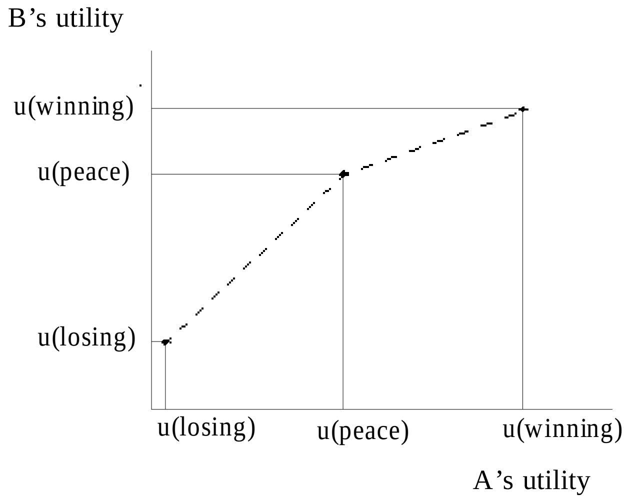

Figure 3. B is comparatively more risk-averse than A.

The two criteria -- concavity of the party's utility function and nesting of the acceptance sets -- are equivalent ways to define the comparative concept. Each has its advantages: concavity gives a practical test, and the idea of nested acceptance sets fits our intuition of risk aversion. The latter definition has the merit that it defines the concept without assuming utility theory.

Comparative risk aversion is defined with respect to a certain matching based on an isomorphism of the two parties' outcomes. The definition is congenial to prospect theory studies that compare the same decision of an individual before and after some change of mental frame, to infer a change in risk attitude within an individual. Farnham looked at President Roosevelt's reversal on intervention in the Munich Crisis, and Berejekian (1997) used the approach for the European Community's change to accepting the Montreal Protocol for the protection of the ozone layer. One of McDermott's cases, discussed later, involves President Carter's shift to allow the Shah of Iran to enter the United States. However, this definition requires at least a change in their conclusions: the implication is not that the leader became risk-averse or acceptant in prospect theory's absolute sense, only that the leader became *comparatively* more or less risk-averse.

Comparative risk aversion as a personality trait

International relations writers often regard risk attitude as a feature of a leader's personality that is stable across situations. This subsection argues that the economics definition has the concept depend largely on the situation that the individual is facing, even on arbitrary aspects of how the decision is stated, so it cannot be seen as a personality trait. However comparative risk aversion as defined here seems to be a matter of personality.

The economics conception makes invariance across contexts impossible in principle, since the same decision can sometimes be described in different ways, with risk attitude reversing according to the description chosen. Suppose that someone is interested in earning money to buy land, and the person values property according to the utility function $u(p) = p^{4/5}$ where p is the acreage. Suppose that land can be purchased according to the function $L(x) = x^{3/2}$ where x indicates dollars. Since the goal of earning money is to buy land the functions u(p) and L(x) imply that the utility of money is $v(x) = u[L(x)]^{4/5} = x^{6/5}$. Since u(p) is concave the individual shows risk aversion for land, but the convexity of v(x) implies risk acceptance for money. If the person has to make a risky investment decision whose goal is to earn more the money, the decision problem could have its outcomes specified by money earned or by the land that the person will buy. Risk attitude would depend on how the decision is stated, so it cannot be intrinsic to the person.

In contrast, empirical research suggests that risk attitude in the comparative sense is stable for a given person across a significant range of contexts. It can then be seen as a personality trait. The concern of researchers has been whether more risk-acceptant individuals are more prone to crime, automobile accidents, teenage pregnancy, drug abuse, or bad business decisions. Kagan and Wallach (1964) asked college students to give advice on gambles facing an imaginary third party. Subjects stated the minimum probability they would require for a successful outcome before they would recommend that the person take a chance. Karen could become a doctor and be sure of riches, or go to music school with a chance to do what she really loves. What critical probability of success in music should she require before choosing that career? MacCrimmon and Wehrung (1986) presented business executives with memos from a hypothetical boss calling for a recommendation in a problem situation. The researchers included questions about subjects' actual behaviors: How much insurance do you have? Have you ever left a job without having a new one to step into? They also gave them choices among money gambles. Shapira (1995) and Kowert and Hermann (1997) report further studies. These questions fit the comparative definition rather than the economics one. There is no separate interval scale on Karen's happiness as a musician. When subjects state their critical probabilities they are giving their acceptance sets.

The researchers report an association between risk propensity and traits like openness, sensation-seeking, impulsiveness, age, and position in a company – attributes of the person rather than the situation. Risk acceptance is not invariant across all contexts, but it might be so across a considerable range, and indeed other authors, reviewed by MacCrimmon and Wehrung, have concluded that regular patterns of risk propensity emerge if risky situations are clustered by type. Two people may reverse in their comparative risk acceptance when they move from physical to emotional or to monetary danger, but they show a consistent ranking within a context. Results like these suggest that comparative risk aversion is a trait of the decision-maker.

It makes sense that the economic notion should vary with the decision's context more than the comparative notion. Money, the typical commodity, is usually just a means to an end and its relationship to the end may vary with the situation. If a bus ticket costs $25, one's utility for money will jump up at that value. Someone who needs to go home will show risk acceptance by taking some numerically unfavorable gambles, but it is misleading to call this an "attitude" since it is induced primarily by the situation. The comparative notion by its definition asks about different individuals' choices *in the same situation.* With context held constant it must depend on the decision-maker.

RISK ATTITUDE IN AN ABSOLUTE SENSE, A NON-METRIC DEFINITION

For many international relations theories, for example Fearon's work described below, the comparative conception is inappropriate. This section defines absolute risk attitude, in a concept termed *multiattribute risk attitude* because it requires that the outcomes involve features on two or more dimensions. Risk aversion will mean a disposition to feel satisfied with doing well on one dimension or the other, rather than wanting to go for high values on both.

Two prizes that you prefer to the status quo are a sports car and a speedboat, and you must choose between the following gambles:

With probability ½ receive both the car and boat; with probability ½ receive neither.

or

With probability ½ both receive only the car; with probability ½ receive only the boat.

A first instinct might be to judge whether you like the car or boat better. However, your probability of receiving each item will be the same whichever gamble you choose. Since your choice does not change your prospect of getting either one, your relative preference for the car or boat should not matter. The issue is whether you will take a chance for both or be sure of exactly one. Someone who prefers the gamble for both or nothing is defined as *multiattribute risk acceptant*, and someone who chooses the gamble yielding exactly one item is ***multiattribute risk averse*.** An indifferent person shows ***multiattribute risk neutrality*.**[11] The standard of risk neutrality thus is deciding purely on the likelihoods of the individual items, without attaching further value to getting them individually or jointly. Risk acceptance means going for both at the risk of neither.[12]

Assuming that the individual is maximizing a utility function, the condition for risk-averse behavior is 2 u(nothing) + 2 u(car—boat) < 2 u(car) + 2 u(boat) or simply, u(nothing) + u(car—boat) < u(car) + u(boat), where "x—y" means objects x and y are acquired jointly. This shows the relationship to the economics definition. Let the two objects be dollar bills, $\$1_a$ and $\$1_b$, conceived of as two physical items. Having neither gives u($0), having either one alone gives u($1), and having both gives u($\$1_a$ —$\$1_b$), but since the bills are the same this is simply u($2). Therefore someone is risk-averse by the present definition if u($0) + u($2) < 2u($1). Dividing each side by 2 shows this to be an instance of standard risk aversion, the disposition to choose a sure $1 over a 50/50 gamble for $0 or $2. The intuition is that the standard risk attitude depends on the synergy in mental worth, or lack of it, between amounts of money, and multiattribute risk attitude depends on a like synergy between different objects. The importance of the multiattribute definition is that it applies when the items are non-identical, when they cannot be joined into a single commodity.

Note that the multiattribute risk aversion implies a zero point of risk neutrality, which the comparative does not, but it makes no comparisons between people on the same side of the zero. It is an absolute conception. However with two non-metric definitions of risk attitude the question arises of whether they are compatible. Suppose that one individual shows multiattribute risk aversion and another shows multiattribute risk acceptance. Could it be that the comparative definition implies the reverse judgment, i.e., labels the latter individual as comparatively more risk-seeking than the former? We would not want definitions that led to this and in fact it can be shown that it does not happen. The definitions are compatible in this sense.[13,14]

The definition is stated for two attributes with two levels on each: there is a car and a boat at issue, and the individual gets the car or not and gets the boat or not. It can be generalized to several values on each attribute, such as alternative models of boats or cars, and to three or more dimensions, adding vacations or houses, and so on.[15]

Empirical evidence on multiattribute risk aversion

A body of research relevant to multiattribute risk aversion has developed under the title of *joint receipt* (Thaler, 1985; Luce, 1997; see also Luce, 1995, 1996; Cho, Luce and von Winterfeldt, 1994; Cho and Luce, 1995; Luce and Fishburn, 1991, 1995; Fishburn and Luce, 1995; and Luce, 2000). The literature aims to develop a theory of how we evaluate receiving combinations of items as a function of our values for each item. Would a student rather get 2 B grades, or an A and a C? Would I prefer to have two letters with bad news about grant proposals on the same day or on different days? How about good news? In many contexts we want to hear pieces of bad news together but keep good news separated. When the news is mixed but mostly bad, we tend to want to separate the parts and keep the good news as a "silver lining."[16]

Work on "mental accounting" is related but focuses more on the prior question of whether we first evaluate each item and then combine the evaluations, or combine them and then evaluate the group (Thaler, 1985, 1999; Linville and Fischer, 1991; Read, Loewenstein and Rabin, 1998). Thaler (1999) tells of flying to Switzerland to address a group of executives and staying on a week for a vacation. An unfavorable exchange rate plus Switzerland's usual steep prices made the cost of hotels and meals outrageous, but he was willing to spend the money and enjoy the vacation because of the high fee he had received for the talk. The fee more than balanced the costs so that his "Swiss mental account" stayed in the black and never activated his loss aversion. If the same fee had come from a talk he had given in New York before he left, his vacation spending would have been more frugal, he believes. Risk attitude for joint receipts will deal with the synergies of items evaluated in combination and these synergies will be expected only for choices within the same account.

Most of the joint receipt and mental accounting research involves money and makes essential use of its scale, but Luce and Fishburn's *associative model of joint receipt* (Luce and Fishburn, 1991; Fishburn and Luce, 1995; Luce, 1997, 2000) is free of interval-scale assumptions on the goal and is especially relevant here. For two items both preferred to the status quo the authors present normative arguments and experimental evidence that a decision maker's preferences can be represented by:

$$u(x—y) = u(x) + u(y) - u(x)u(y)/C.$$

Here x and y are not numbers but acquired gains, like going on a trip or meeting a friend. The rule relates the utility for the event x—y, receiving the two items jointly, to the utilities of receiving each singly. It is stipulated that $u(e) = 0$ where e is the status quo of neither item being acquired. Like prospect theory, this approach attaches importance to a reference situation, e, and whether the events are gains or losses with respect to it. The formula above is for two gains, but for two losses (i.e., for $u(x), u(y) < 0$), the u-values follow a rule with a different constant K:

$$u(x—y) = u(x) + u(y) + u(x)u(y)/K.$$

A more complicated rule holds for a decision mixing a gain and a loss.

The parameters C and K can be seen as determining multiattribute risk aversion or acceptance. The definition's criterion for risk aversion is:

$$u(x) + u(y) > u(e) + u(x—y)$$

Assuming the case of two gains and substituting $u(e) = 0$ and Luce's formula for $u(x—y)$ gives $u(x) + u(y) > u(x) + u(y) - u(x)u(y)/C$, or $C > 0$. Risk aversion for two losses means $K < 0$. Prospect theory suggests that subjects might be risk-averse for gains and risk-acceptant for losses, and indeed this is the modal (but not universal) pattern -- about 40-50% of them show both $C > 0$ and $K > 0$ (Luce, personal communication). The difference $K - C$ corresponds to the degree of loss aversion in prospect theory – a loss-averse decision-maker has $K > C$.[17]

The empirical research on joint receipts is still small and the theory tends to be mathematical, but the approach seems promising as a version of prospect theory free from inappropriate interval-scale assumptions.

IMPLICATIONS FOR SOME CURRENT IR THEORIES

Historical case studies using prospect theory

Several authors have applied prospect theory to historical cases. By generating some detailed studies they have made an important contribution and the criticisms here are aimed at taking a further step forward. One theme has been the explanation of leaders' sudden policy switches. McDermott (1998) looked at President Carter's reversal over admitting the Shah of Iran to the United States, and as her arguments for this case are fully laid out, it will be used as an example of the larger group.

The essence of the story is this. In January 1979 the Shah abdicated his rule and left for Egypt. The following month he asked to enter the United States. Iran's revolutionaries had been willing to see him go directly to the United States, but his initial plan to stay near his homeland, as well as some of his public statements, suggested that he was hoping to retake power. President Carter did not want to be seen as providing him with a base to plan his return, and barred him. The Shah proceeded instead to Mexico. The following October Carter learned that the Shah had an urgent medical condition that could be treated best in the United States. He reversed his decision and the Shah entered New York Hospital. The situation entered a crisis in November when students seized the US embassy in Tehran, but these events go beyond our focus, which is explaining Carter's change of mind.

McDermott accounts for Carter's switch by prospect theory. Refusing the Shah was a more cautious choice than admitting him, she states, since the former's success and failure outcomes lay within the range of latter's outcomes. On the negative side, for example, refusing him might have triggered a conflict with the Shah's American friends and could have been seen as disloyalty to an ally, but admitting him risked something worse, violence against Americans in Iran and bad relations with its new government. In February 1979 Carter had high approval ratings and had achieved, or was expecting, several foreign policy successes, over arms control, Panama, China, and a Middle East peace treaty. The hypothesis is that Carter's mental reference point had yet to adjust to these jumps so that the possible outcomes of his decision on the Shah all lay on the positive side of that point. Prospect theory would then predict the risk-averse choice, a refusal, which was the one Carter made. However, by October Carter's fortunes had sunk. He had become vulnerable to Republican attacks and was being challenged by Edward Kennedy within his party. His reference point had yet to adjust downwards and he saw the various outcomes of a decision on the Shah as losses. Now prospect theory would predict the riskier course of admitting the Shah, which is what Carter did.[18] McDermott's book details several other cases, and argues that in contrast to standard utility theory, prospect theory has been validated experimentally and predicts puzzling changes of minds by real leaders.

Three kinds of issues will be raised: whether the events taken as confirming prospect theory really follow from it, whether they distinguish a prospect theory explanation from a utility theory one, and whether the application to Carter's reversal is vulnerable to the arguments raised here about risk attitude. To separate the first two questions from the last, we postpone the issue of an interval-scale goal. For the purpose of the discussion we assume that one applies, that Carter wanted simply to maximize his vote total in the next election.

On the first question of prospect theory's predictions, for the theory to imply a cautious choice in February one must claim that the two courses were equal in their expected values of votes. Lacking this condition it is possible that February's Carter was in fact risk-acceptant in votes but chose to refuse the Shah because that course had a high vote expectation. Similarly in October he may have been risk-averse but was again responding to expectations. The fact that the outcomes of one course are nested within those of the other does not mean the former is less risky, since the probabilities associated with the outcomes may differ. The "riskiness" of a course of action depends on the probabilities as well as the values (for one definition, see Machina and Pratt, 1997.)

A prospect theory advocate might counter that perhaps one cannot prove that Carter moved across the zero point into risk acceptance but his reversal indicates at least that he became *more* risk-acceptant, and this change is consistent with prospect theory. However it cannot be inferred that he became more risk-acceptant, since the gambles of February and October had different decision parameters. While both involved barring or accepting the Shah, their consequences for Carter's goals changed with the news of the Shah's illness. With his life at stake, the new situation was more than a change of mental frame and made Carter's reversal explainable within utility theory.

The second difficulty for these applications is distinguishing prospect theory from utility theory. Even if one could establish that the decision parameters stayed the same, i.e., that the gains, losses and likelihoods associated with each course were constant, utility theory might still apply. Between February and October, Carter saw his welfare fall. Utility functions with quite reasonable shapes can produce the following phenomenon: the decision-maker may choose the sure thing over the gamble, then as wealth decreases the individual switches to the gamble, and even goes back to the sure thing as wealth declines further (Bell, 1988).[19] Prospect theory's message is that individuals switch their choices based on nothing more than their mental framing of the decision, so distinguishing it from utility theory usually requires a difference of framing alone while level of welfare is held constant, a condition that does not obtain here.

These points set aside the question of an external interval scale, but the final issue is that Carter's decisions had none. He was not moving up and down on an x-axis of wealth or expected votes or any other single interval measure. The risk attitude concepts appearing in prospect theory have no referent.

Carter's dilemmas fit into a joint receipt and mental accounting frameworks, however, and allow the application of multiattribute risk aversion. He had multiple goals -- domestic approval, peace in the Middle East, humanitarian treatment of an individual, etc., and he faced the outcomes in combinations. If he conceived his decision on the Shah as one on national security it would interact with other outcomes in the same area, but if he saw it as a humanitarian question it would interact with another group of issues. If his decisions followed the model laid out in the joint receipt research, a change of frame might switch his risk attitude and his choice even though the objective consequences of the courses remained the same.

The study of joint receipt generates predictions about another issue that is not usually considered in the IR literature, the timing of a decision that can be faced immediately or put off. One needs the auxiliary assumptions that the outcome is revealed just after the decision is made and that the receipt of two items together in time and or at different times are evaluated respectively as u(x—y) and u(x) + u(y), i.e., as time passes the decision-maker opens a new account. One hypothesis is that for decisions yielding likely gains, the individual will prefer to make them at separate times since u(x) + u(y) is the greater of the two quantities. For a pair of unpleasant or dangerous tasks the party will tend to undertake them together, since u(x—y) is not as low as u(x) + u(y). If bad news arrives and a further distasteful decision has to be faced at some time, the tendency will be to get the second one over with. While the idea that individuals choose their decision times to maximize their total u in this way has been only partially supported by experimental evidence (Thaler and Johnson, 1990; Linville and Fischer, 1991), a good theory of mental accounting and joint receipts might also tell us about leaders' timing.

Although the multiattribute risk approach solves the scale problem of prospect theory, it relies on hypotheses about the decision makers' inner frames, which are hard to establish outside laboratory controls. Also to specify risk attitude directly one needs test gambles with specific parameters – just as the standard theory needs alternatives that are equal in terms of face value, this one needs gambles with probabilities perceived as 50/50. Applying the theory to cases may be possible through indirect methods, but that presents challenges some of which are similar to the problems of prospect theory. An unambiguous advance, however, is the avoidance of the need for an external scale.

Morgan and Palmer's two-good theory of international action

The definition of multiattribute risk aversion requires that the outcomes be valued on two or more dimensions. This often holds in the international context: national security is put as a matter of guns or butter; making an alliance trades off having others' support in one's own conflicts against getting tangled in theirs. Farnham describes the Munich crisis as Roosevelt's dilemma between preserving peace as an international goal and facing domestic attitudes of isolationism. Morgan and Palmer (1997, 1998a,b) have generalized the tradeoff between dimensions in their "two-good" theory of foreign policy decisions. The goals are "preservaction" and "proaction," defined respectively as maintaining one's security and promoting one's positive goals. The last paper gives an explicit utility function to the decision maker: $u(Q_1, Q_2) = Q_1^a Q_2^b$ for positive amounts Q_1 and Q_2, where exponents a and b are positive. Applying the definition of multiattribute risk attitude one chooses any pair of lower and higher levels on each dimension (corresponding to not having or having the car or boat) – say $Q_1 < Q_1'$ and $Q_2 < Q_2'$ – and compares $u(Q_1, Q_2) + u(Q_1', Q_2')$ with $u(Q_1', Q_2) + u(Q_1, Q_2')$. If the latter is greater, the chooser is risk-averse. Since this test uses only the relative positions of Q-values on each dimension, risk attitude is invariant for any way of measuring the two quantities that is monotonic with the originals, so the two scales need not be interval. Substituting Morgan and Palmer's utility function into the condition, $Q_1^a Q_2'^b + Q_1'^a Q_2^b > Q_1^a Q_2^b + Q_1'^a Q_2'^b$ means risk aversion and the reverse inequality means risk acceptance. In fact the risk acceptance inequality holds for all their allowed values of the quantities and exponents.[20] The model's implication that decision makers are always risk-acceptant goes somewhat against the experimental evidence discussed earlier, that C is positive for gains thus indicating multiattribute risk aversion. To be consistent with this empirical tendency another utility function is needed and one candidate is $1 - \exp(-aQ_1 - bQ_2)$ for positive Q_i. Applying the derivative test of footnote 21 gives $- ab \exp(-aQ_1 - bQ_2)$, which is negative, implying multiattribute risk aversion. The present theory thus shows the relation of Morgan and Palmer's approach to risk attitude and allows their model's utility function to be guided by a large body of experimental research.

Fearon's categorization of rationalist explanations of war

Fearon (1995) shows that states in a dispute will always have agreements available that are mutually preferred to fighting, at least under some simple assumptions. Why then do they go to war? He categorizes different ways of modifying the basic assumptions to yield that possibility. His argument uses risk aversion in a central way, one that is open to some objections raised above. Applying the non-metric definitions leads to somewhat different conclusions.

Fearon begins with a model of pre-war negotiations. Two states must choose between the gamble of a war versus a peaceful compromise. In a war one side or the other will get its way fully and the parties hold common probabilities of each side winning. Both know the costs a war would put on each of them and they have a continuum of possibilities for a compromise. He argues that rational leaders are risk-averse and from this proves that for a given probability distribution for the war's outcomes, there always exists some negotiated settlement that gives higher expectations to both than a fight.

The model is not meant to depict the world as it is; it gives a starting point and the next step is to ask how to change it to allow for war. One might construct a non-rationalist model, but staying within the rationalist/neorealist paradigm means dropping one or more of its assumptions, and so including one or more of the following features: (1) inability to credibly commit to a settlement, (2) information held by a side that cannot be convincingly shared with the adversary, (3) indivisibility in the possible compromises that precludes in-between solutions. Negotiations between Japan and the United States failed in 1941, for instance, and Jervis (1988a) suggests that the situation resembled a Prisoner's Dilemma game where neither could credibly promise to respect the other's interests. This interpretation fits Fearon's conclusion, as it involves the impossibility of credibly committing to a deal.

Our concern about Fearon's result is its premise of an interval-scale goal. He recognized the issue and suggested thinking of it as territory. This is a valid interval scale, measured in square feet, but the assumption greatly reduces the theory's range. Usually there is no such scale and so no reason to expect a negotiated peace or else infer one or more of the three conditions as a requirement for war. The goals in the U.S./Japan example were non-interval-scale and multivariate. Japan feared it would lose its markets and access to raw materials and so become dependent on foreign powers, while the United States wanted to extend its economic power by establishing freedom of trade and investment (Utley, 1985; Barnhart, 1987; Sagan, 1989.) It also wanted to preserve England against the Axis and abhorred the atrocities of the Japanese army in China. Both sides held racist attitudes towards the other. With a multivariate goal, the standard definition cannot assign a risk attitude.

Introducing the non-metric definitions of risk aversion the domain of Fearon's model but raises the question whether its conclusion still holds. Applying multiattribute risk aversion first, a party is defined as risk-averse when for any pair of issues it would prefer an even chance of the better outcome on exactly one issue or the other, to the 50/50 gamble of both or neither. The multiattribute version of Fearon's theorem does not hold, as shown by a numerical example, a certain negotiation situation where two risk-averters have no compromise mutually preferred to the war.[21] However, even though one cannot prove a blanket theorem, in the typical case multiattribute risk aversion promotes peace in that it increases the attractiveness of compromises.

Moving to comparative risk aversion, it can be proved that, fixing the utilities of winning and losing the war, when one of the states becomes more risk-averse than before, the pairs of utilities achievable by a negotiation will include the previous set and more. A closely related result is this: when one state becomes comparatively more risk-averse, the new set of probabilities of winning the war for which some settlement is mutually preferred to war contains the original set and possibly more. Thus comparative risk aversion helps a "rational peace," but does not guarantee it.

Another change should be made in Fearon's argument: to drop the idea that a rational state must be risk-averse. His reasoning involves a "gambler's ruin" argument, that a risk-acceptant state could be presented with a sequence of 50/50 gambles for double or nothing (over territory, for example), and would take each one, even though it knew from the start that it would eventually lose everything. A sign that something is wrong with the argument is its implication that even a risk-averse state would choose self-destruction. As long as its utility function is unbounded above and not below, there is a series of all-or-nothing gambles that it would take, that lead it to eventually losing all.

The position taken here is that risk acceptance is not irrational. It may seem odd for states to knowingly choose destruction, but we must remember that risk attitude may be a local concept, changing when a state's welfare level falls below a certain point. A state might be risk-acceptant for the range of issues arising in a particular pre-war negotiation but turn risk-averse when its existence is jeopardized.

In a discussion of Fearon's theory Gartzke presents another argument that risk acceptance cannot be a cause of war (1999, fn. 20), and it illustrates a central point I would make about risk. If states were risk-acceptant, he states, that would imply "either continual conflict, or risk propensities that change because of exogenous factors that would then really constitute explanations for war." The first possibility is contrary to observation, and he rejects the second since states do not constantly change their nature. However, his argument uses the premise that risk attitude is a trait innate to the decision-maker, an idea I have argued against here. The present approach attributes the on-and-off pattern of conflict to a risk behavior that changes because of the situation that the states are currently facing.

A revision of Fearon's approach would try to identify the kinds of situations that induce risk acceptance and block a negotiated settlement.[22] Hassner (1999) has examined disputes over sacred places, sites that rival religions see as a center of their faith. The same place is often hallowed by two religions because their doctrines are historically related, or because a growing movement tries to dislodge an older one by adopting its important place. Sacred spaces induce risk-acceptance when the concept of sacredness means that only one's own adherents can tread there and only one's own ceremonies can be held there. Neither side is interested in a middle settlement involving shared access, and by either the economics or multiattribute definition they show risk acceptance. They would tend to fight. Matters of ethics also have this character often, as do symbolic issues concerning a group's identity, such as control over the city of

Jerusalem (O’Neill, 1999).

CONCLUSIONS

Some international relations theory is aimed at specific policy questions such as how to implement deterrence or whether larger powers should intervene in ethnic conflicts. Studies of risk aversion have had a different purpose, however: to develop a basic understanding of decision making so that insights from theory and laboratory experiments can be transferred up to states. The enthusiasm for prospect theory comes from the hope that the discipline now has an account of decision making with more empirically validity. The approach has strengthened the connection of international relations and psychology and introduced the orderliness of a coherent theory. The frequently-expressed frustration stems from the aspects of prospect theory that suit economics but not international relations. It is important to recognize the distinctive nature of international decisions and modify the approach accordingly.

The usual way of talking treats risk as an external substance, an entity with a location and a quantity. Risk is “shared” or “transferred”; we “bear” it, or ”manage” it; we “avoid” it or are “attracted” to it as we might be to heavy metal music or anchovies on our pizza. Like the anchovies, we talk of “taste” for risk. It is common to speak of patterns of behavior as if they were substances or objects as when we "acquire" status, "contain" their anger, or "share" our love (Lakoff, 1987). Conceptual metaphors are handy ways of thinking and talking but they can be misleading. Conceiving risk as a substance suggests that choosing a certain course of action will bring the chooser risk and possibly the goal as well, as if these were separate commodities. It makes risk aversion and acceptance appear to be meaningful independent of whether the goal can be measured, just as one’s preference for anchovies would not depend on being able to measure the pizza’s size. Within most formal conceptions, however, risk aversion does not posit a new goal but refers to a pattern of decision behavior when actions are connected probabilistically to a given goal.[23]

The metaphor of a “risk attitude” construes the behavior as innate to the person even though an example above for the regular economics definition showed that it must change according to the decision faced. A purpose of this paper is to show what risk aversion means undistorted by our mode of talking. It develops definitions applicable in broader contexts and so clarifies the general meaning of risk attitude.

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ENDNOTES

1. Non-formal uses of risk-aversion appear in Russett (1980) on Franklin Roosevelt, Huth and Russett (1984) on Hitler and Chamberlain, and Kupchan (1988) on the Soviet Union. Some utility theory applications of risk aversion are by Alsharabati and Kugler (1997), Bennett and Stam (1996), Bueno de Mesquita (1980, 1981, 1985), Fearon (1995), Huth, Gelpi and Bennett (1993), Huth, Bennett and Gelpi (1992), Kilgour and Zagare (1991), Kugler (1987), Kugler and Zagare (1987), Morrow (1985, 1986, 1987, 1994, 1996), Niou and Ordeshook (1990), Powell (1995), Sandler, Tschirhart and Cauley (1983) and Wagner (1991). Some prospect theory applications or discussions are Bauer and Rotte (1997), Berejikian (1997), Blumberg (1998), Boettcher (1995, 1997), Davis (1997), Davis and Arquilla (1991), Derouen (1995), Farnham (1992, 1994, 1997), Gause and Feldman (1998), Hebron and James (1997), Hermann et al. (1997), Huth et al, (1993), Jervis (1988b, 1989, 1992), Kanner (2001), Kanwisher (1989), Knopf (1993), Kowert and Hermann (1997), Lau and Levy (1998), Lebow and Stein (1989), Levy (1987, 1989, 1992a,b, 1996, 1997a,b, 1998, 2000), McDermott (1992, 1998), McInerney (1992), Maoz (1990), Mintz and Geva (1998), Richardson (1992), Stein (1992, 1996), Stein and Welch (1997), Taliaferro (1997a,b), Weber (1991), Weyland (1996), Whyte and Levi (1994) and Zinnes and Muncaster (1997).

2. The definition as stated here requires that intermediate values be strictly greater than the end-points, a concept sometimes termed *strict* concavity. Also, the definition of concavity applies even if the function is defined at only a finite number of points.

3. The concept defined here is “global” risk aversion, where the sure thing is chosen for any zero-expectation gamble at any level of assets. Risk aversion at a specific level of assets for small gambles is called local risk aversion. With a "wavy" utility function, it is possible to be locally risk-averse at one level of assets and locally risk-seeking at another, or to prefer the sure thing over a small fair gamble, but to prefer a large fair gamble over the sure thing.

4. The next step is to define *degree* of risk aversion, the most accepted way being Arrow and Pratt's formula: $r(x) = -u''(x)/u'(x)$. One can then define the riskiness of a gamble (Rothschild and Stiglitz, 1970). The definitions should fit

each other, meaning that the riskiness of a gamble should be the property that risk-averters are averse to – the more risk-averse person pays more to avoid a riskier gamble. The pair of definitions is then called *coherent*. The standard pair is coherent, but so are others (e.g., Landsberger and Meilijson, 1990).

5. "Empirically significant" and "meaningless" have the same meaning here as in formal measurement theory (Coombs, Dawes and Tversky, 1978; Roberts, 1984; Narens, 1985.)

6. In fact it is stronger, a *ratio* scale, in that the ratio of a pair of values has an empirical interpretation.

7. In quantitative IR studies, power is usually measured by a proxy, like a weighted sum of territory, energy use, or GNP. Although these analyses do not usually compare the differences between two pair of index values, they often use statistical methods that effectively do that, in that they depend on interval-scale properties of their index, such as means or Pearson correlations. This is a different problem from the risk aversion literature where no underlying interval scale is usually described.

8. It is also assumed that if the problem admits objective probabilities, the decision maker transforms them according to a certain function. For particular contexts auxiliary hypotheses are added about how people edit the input to set up their decision or how they change their reference point with experience.

9. The problem is seen more clearly in problems where time is finite so that the total utility a sum: $3 \ast^t u(x_t)$, for t = 1, 2, . . . The factor $\ast$ is the discount factor and u is assumed concave to represent risk aversion (e.g., Garfinkel, 1991). Consider two options: (1) a 50% chance of getting $10 daily for four days and a 50% chance of nothing for four days; (2) for each of the four days independently, a 50% chance of $10 and a 50% chance of $0. One would expect a risk-averse person to choose the second, but the summation formula assigns them equal utilities. Solutions to this issue have been discussed by Hindy and Huang (1992), Huang, Hindy and Kreps (1992), Pratt (1992), and others.

10. Note that this definition is appropriately independent of interpersonal comparisons of utilities. When functions f and g are defined on the same domain, f is said to be *concave with respect to* g if and only if fBg^{-1} is concave, so the definition is requiring that one utility function be concave with respect to the other. A connection with the degree of

risk aversion r(x) as defined in footnote 4, is that if B's r(x) is higher than A's for all x, then A will be comparatively more risk-averse than B by this definition, as follows from the discussion of Pratt (1964).

11. de Finetti (1952) alluded to the idea, but it was fully stated by Richard (1975). There has been little theoretical literature on it since, exceptions being Mosler (1984) and Scarsini (1985, 1988, 1991), and it has been applied in very few contexts (e.g., Ingersoll, 1992).

12. Rothschild and Stiglitz's notion of a "mean-preserving spread" (1970) provides another intuition for calling the present definition risk attitude. As a simple example of their idea, suppose we start with a two-outcome money gamble, and generate a second gamble by adding an amount to the winning outcome, and subtracting an amount from the losing outcome, the two values being related so that the expected value of the gamble is held constant. One would certainly call the second gamble riskier than the first. This is analogous to what is happening in the definition. The first gamble is generated from the second by adding and subtracting the boat from corresponding sides, while keeping the "multiattibute mean" (the vector of the expectations of getting each item) constant. (I am indebted to Duncan Luce for this observation.)

13. To show this, let party A's utilities for having nothing, item x, item y, or both, be, respectively, u_0, u_1, u_2, and u_3, and let B's corresponding utilities be v_0, v_1, v_2 and v_3. The utility for nothing is lowest and the utility for both is highest. Assume that A is risk-averse and B is risk-seeking in the sense of the present absolute conception: $u_1 + u_2 > u_0 + u_3$ and $v_1 + v_2 < v_0 + v_3$. To show that B cannot be *comparatively* risk-averse with respect to A, one must show that the points (u_0,v_0), . . . (u_3,v_3) in the u-v plane are not both monotonic and concave. If monotonicity holds, the utilities for the four outcomes must follow the same order: $u_0 < u_1 < u_2 < u_3$ and $v_0 < v_1 < v_2 < v_3$. (Without loss of generality we can assume it is y that is the more valued.) Concavity implies $(v_1 - v_{0-})/(u_1 - u_0) > (v_2 - v_1)/(u_2 - u_1) > (v_3 - v_2)/(u_3 - u_2)$. All numerators and denominators are positive, and the inequality involving B's risk acceptance means that the numerator of the lefthand expression is less than that of the righthand one, while A's risk aversion implies that the righthand denominator is less than that of the lefthand one, so the lefthand expression cannot be greater.

14. The definition is not connected with concavity of the utility functions, either in one or two dimensions, since if both dimensions had interval scales, one could transform them with arbitrary monotonically increasing functions f(x) and g(y) in ways that destroy any concavity while leaving multiattribute risk aversion invariant.

15. An example would be several kinds of goods with various alternatives of each kind, such as different kinds of cars. A still more general form would be a lattice, where higher up in the lattice represents goods that are additional in some objective sense. Risk aversion would require *submodularity:* $u(x) + u(y) \exists u(x\omega y) + u(x\varpi y)$, where $x\omega y$ and $x\varpi y$ are the greatest lower and least upper bounds, respectively, of lattice elements x and y (Birkhoff, 1967). Submodularity in this definition plays the role of concavity in economic risk aversion.

16. On its face the answer would seem to depend fully on the particular commodities considered. If we asked subjects about left shoes and right shoes, we would expect everyone to be "risk-acceptant." We should use reasonable discretion in choosing the context, as one would in applying any theory (Luce, 2000). For example, the regularities around adding weights on each side of a pan balance would disappear if one used objects that evaporated. Likewise the model is not meant to apply to goods with an important objective complementarity.

17. The analogy here is only approximate because Luce's theory states that people will generally not assign equal probability weights to the gambles in the test for multiattribute risk aversion. Typically they assign a higher weight to the preferred outcome, even though its likelihood is declared to be .5. This means that some individuals with positive C's will still make the risk-acceptant choice.

18. This element is common in IR theory but controversial. Thaler and Johnson (1990) interpret prospect theory as stating that after a loss decision makers will often be more risk-averse, and they cite experimental data in their support.

19. In the example, there is, of course, no assumption that the gamble and the sure thing with this property have the same expected value.

20. This can be shown by representing $Q_1'^a$ as $Q_1^a + k_1$ and $Q_2'^b$ as $Q_2^b + k_2$, with positive k_1, k_2, and expanding each

side. The condition for multivariate risk aversion when there are interval scales on the quantities, assuming the utility function is twice differentiable, is $*^2u(Q_1, Q_2)/*Q_1 *Q_2$ # 0 (Richard, 1975). Applying this test here gives the derivative as $abQ_1^{a-1}Q_2^{b-1}$, which is always positive.

21. As a counterexample, assume that states 1 and 2 are negotiating over the values of two variables x and y , [0,1]. State 1 has utility function u(x,y) = x/3 + 2y/3 - xy/10, increasing in x and y, and so wants to maximize both, i.e., set x = y = 1. State 2 has objectives -x and -y and utility v(x,y) = -x/2 + 1/(1 + y) - xy/10, which is decreasing in x and y, and wants x = y = 0. Both negotiators exhibit risk aversion on the issues since $*^2u(x,y)/*x*y$ and $*^2v(x,y)/*(-x)*(-y)$ are negative (note 20 above). If p is the probability of the first player winning a war, and the war has cost .001 to both, then one can calculate that for the approximate range .01 < p < .22, there is pair of values mutually preferred to a fight.

22 See, for example, Axelrod's theory of conflicts of interest (1969).

23. Some theories postulate that decision-makers like gambling for its own sake (e.g., Pope 1996/1997), and these are closer to the risk-as-a-substance metaphor.