

Bargains, Games, and Relative Gains:

Positional Concerns and International Cooperation

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ABSTRACT: Central to recent debates about international cooperation has been the contention that if states seek relative gains, cooperation becomes more difficult. To help revive and redirect the debate, we provide a general treatment of the relative-gains argument in the simplest possible formal terms. The analysis enables us to make two arguments which challenge starkly pessimistic conclusions and define when and how relative-gains concerns affect outcomes. First, if states bargain over the terms of agreement, all positional concerns will be reflected in the bargained outcome and cooperation should remain possible. In the Nash-bargaining model, mutual concern for positionality makes the outcome more symmetric while differential concerns result in agreements biased so as to appease the more positionally concerned state. Second, employing basic game theory, we show that 2x2 games will transform into deadlock as concern for positionality increases only where three necessary conditions on the payoff structure of the original game are satisfied. Hence, while the relative-gains problem can affect cooperation in international relations, it does so only under specific conditions and in specific ways which can be identified theoretically and researched empirically.

KEYWORDS: International Relations, Relative Gains, International Cooperation, Nash Bargaining, Game Theory

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Disagreement over the possibility of cooperation has been a salient aspect of the ongoing debates in the field of international relations. Many scholars have argued that the condition of international anarchy makes cooperation between states rare, temporary, and of little consequence (Carr, 1939; Morgenthau, 1948; Waltz, 1979; Gilpin, 1981). For such authors, anarchy implies that states are pre-occupied with a concern for security, they compete for power, and thus are strongly inclined toward conflict even when common interests exist. More optimistic claims have been made recently by a different group of analysts (Stein, 1982; Axelrod, 1984; Lipson, 1984; Keohane, 1984; Axelrod & Keohane, 1985; Taylor, 1987). They argue that, despite anarchy, nations involved in repeated interactions may be drawn to the high rewards available from mutual cooperation. If interactions are expected to go on indefinitely, and if states attach importance to future payoffs, mutual cooperation can be an equilibrium outcome.

Central to the recent debate between these competing views is the contention, made by scholars in the former group, that states are vitally concerned with “relative gains”: that is, states do not worry simply about whether they can gain by cooperation, they worry about who gains most. This concern for relative gains, it is argued, severely limits the capacity of nations to cooperate. Several recent analyses have examined different aspects of this issue (Grieco, 1990; Powell, 1991; Snidal 1991; Keohane, 1993). Our aim in this paper is to provide a new critical treatment of the “relative-gains problem” by exploring simple bargaining theory, an avenue so far ignored, and by examining simple 2x2 game transformations in a more general manner than has heretofore been attempted. In so doing, we hope to help revive and redirect the debate over relative gains by focusing more attention on exactly when and how positional concerns affect outcomes.

To date, formal analyses of the relative-gains problem have relied mainly upon applications

of game theory. In these applications, the payoffs are typically fixed, implying in effect that they are non-negotiable. Since cooperation is generally based on negotiated agreements, we extend the analysis of relative gains to bargaining processes. We show formally that states will often be able to reach agreements through bargaining which mitigate the problem of relative gains by distributing cooperative gains more symmetrically. Employing the Nash bargaining solution, we show that variation in concerns for relative gains should have predictable consequences for the shape of negotiated agreements.

Next, since explicit bargaining (and renegotiation of old agreements) may not always be possible, we analyze the effects of relative gains in non-cooperative game situations. To date, such analyses have focused mainly on the standard Prisoner's Dilemma game and have adopted very specific and restrictive assumptions about payoffs. Considering instead all possible permutations of payoffs in 2x2 games, we derive necessary conditions for game payoff-structures to be transformed by concerns for relative gains. We conclude that, while the relative-gains problem can hinder cooperation in certain international situations, its impact will depend critically upon the exact matrix of payoffs facing the states involved.

Our results suggest that we should regard with skepticism any sweeping claims that the relative-gains problem presents a universally overwhelming obstacle to international cooperation. They also have several implications — sketched in the penultimate section of the paper — for the conduct of empirical work on this problem since they outline the specific conditions under which, and the specific ways in which, positional concerns affect outcomes.

The Relative-Gains Problem

In an anarchical international system, rational states which value their survival as independent entities will be concerned with their military and economic position *relative* to others. This focus on

relative goals may hinder international cooperation when gains are unbalanced. As Kenneth Waltz writes:

When faced with the possibility of cooperating for mutual gains, states that feel insecure must ask how the gain will be divided. They are compelled to ask not ‘Will both of us gain?’ but ‘Who will gain more?’ If an expected gain is to be divided, say, in the ratio of two to one, one state may use its disproportionate gain to implement a policy intended to damage or destroy the other (Waltz, 1979:105).

Joseph Grieco defines this as the “relative-gains problem” for cooperation:

a state will decline to join, will leave, or will sharply limit its commitment to a cooperative arrangement if it believes that partners are achieving, or are likely to achieve, disproportionate gains as a result of their endeavor (Grieco, 1988b:603).¹

It is essential that we recognize the *instrumentality* of relative gains in this argument. Duncan Snidal has observed that Waltz “...is implicitly describing a trade-off between short-term absolute gains (*i.e.*, immediate payoffs from cooperation) and long-term absolute gains (*i.e.*, security over the long haul)” (1991:704). While it is the relevance of relative gains for a state’s future security that is typically emphasized, such gains are also instrumental for non-security goals to the degree that they affect the state’s long-term bargaining power in relations with friends and foes alike.²

To help distill this argument, we first restate it in a general form: relative gains or losses translate into changes in *power*, and changes in power affect future *security* as well as the ability to achieve future non-security gains from bargaining. Now the argument can be seen to hinge crucially upon the meaning of, and the links between, power and security. The proper definition of the concept of power remains a matter of controversy among international relations theorists. One of the principal issues of debate is the extent to which basic power resources, such as military and economic capabilities, accurately map the relative abilities of states’ to affect one another (Baldwin, 1979; Keohane, 1986; Waltz, 1986). We prefer not to plunge into the debate surrounding the link between capabilities and power in this paper; rather, we would like to focus more critically on the second part of the argument that links power to security. To do so, we will assume for simplicity that

power is defined in terms of a state's relative capabilities. A state's *security* is defined in terms of the threat that a foreign attack will destroy it.

Now we can differentiate between an extreme and a weaker form of the relative-gains argument, distinguishable by the assumed links between power and security in each. Making this distinction is crucial for judging the impact of relative-gains concerns. In the extreme claim, changes in power are assumed to result in proportional changes in security. The result is that states, while interested in avoiding relative losses, should be just as interested in winning relative gains that unambiguously increase their security. This interpretation is consistent with traditional realism's principle of "the concept of interest defined in terms of power" (Morgenthau, 1948:5). Although Grieco denies making a power-seeking argument (Grieco, 1990:44-5), it is implied in his utility function for states:

$$u = v - k(w - v) \quad (1)$$

where v is the state's own payoff, w is the payoff to its partner in cooperation, and k is a positive coefficient of sensitivity to relative gains and losses (Grieco, 1988b:608). According to this function, the state derives negative utility from a relative loss ($w - v > 0$), but it also derives positive utility equal in magnitude from a relative gain ($w - v < 0$).

This extreme argument is problematic because power-seeking can carry large security costs. This is the well known "security dilemma" in international relations. The pursuit of power will not enhance a state's security when it inspires other states to enter an arms race and raises the likelihood of preemptive military actions (Jervis, 1978). The classic example, documented by Thucydides (*ca.* 400 BC/1951), is the Lacedaemonian military response to the growing power of Athens.

It thus seems necessary to posit a weaker form of the relative-gains argument, one in which the link between power and security is more circumspect. The only claim made in this case is that

states are averse to relative losses, they do not necessarily pursue relative gains. This is consistent with more recent statements made by Waltz, and with Grieco's hypothesis that states practice "defensive positionality" (Waltz, 1986:334; Grieco, 1990:44-5). In this view, as stated by Grieco, "positionalism is typically more defensive than offensive" (1990:45). An appropriate representation of a utility function for such a state would be:

$$u = v - k(w - v) \text{ if } w - v > 0 \quad (2a)$$

$$u = v + f(v,w) \text{ if } w - v < 0 \quad (2b)$$

where k now indicates sensitivity to relative losses only, and $f(v,w)$ is a functional form which describes the effect of increased relative advantage on security. In particular, in order to reflect the defensive-positionality hypothesis, $df/d(v-w)$ must be less than 1 so that relative gains produce less utility than equal relative losses produce disutility.

In both the extreme and weak cases, under certain conditions to be examined below, the concern for future security expressed in terms of relative gains can be shown to make cooperation less likely. The most pessimistic results, of course, follow from the extreme form of the argument. We would argue that "defensive positionality" is more reasonable and its effects on cooperation are demonstrably less severe. The reasoning is obvious: the less cause states have to pursue relative gains for security purposes, the less conflicting are their interests, and the more likely is cooperation.

In most of the analysis that follows we will apply the simple Grieco utility function given in (1) above, since it takes a specific mathematical form. In doing so, we are, in effect, analyzing the "worst-case scenario" embodied in the extreme form of the argument in which concern for relative gains will have the greatest negative impact on the likelihood of cooperation. Showing how this negative impact is mitigated and qualified even in the worst case is particularly instructive. At various points we compare these worst-case results with those that derive from the more plausible,

weaker form of the argument.

Negotiated Agreements and Relative Gains: A General Solution

We begin with the argument that agreements are bargained, implicitly or explicitly, and therefore that all concerns about relative gains will be manifest in the bargaining process that sets the terms of those agreements. We proceed to a formal, general analysis of the impact of relative-gains concerns on bargained agreements. In this analysis, we employ a simplified representation of the negotiation process known as the Nash bargaining model.^{3,4} This model is particularly useful for generating predictions about the nature of negotiated outcomes when nothing is known about the exact protocols that govern the particular bargaining game; it is therefore especially appropriate to the present exercise of deriving general, *a priori* conclusions about the impact of positionality. This section proves the general results; the following section provides a simple, graphical example which helps illustrate some of the important features of those general results.

Consider the problem of dividing total payoffs y_0 between two countries; denote the absolute payoff to each nation as v_1 and v_2 . Also, assume that if no agreement is reached the status quo prevails which has payoffs T_1 and T_2 . The important assumptions of the Nash bargaining model are (1) that states will only agree to outcomes which are better than the status quo (*i.e.*, those where $u_1(v_1, v_2) \geq u_1(T_1, T_2)$ and $u_2(v_1, v_2) \geq u_2(T_1, T_2)$) and (2) that nothing is wasted (*i.e.*, the outcome is on the Pareto frontier so that there is no (v_1, v_2) such that $v_1 + v_2 \leq y_0$ and $u_1(v_1, v_2) > u_1^*$ and $u_2(v_1, v_2) > u_2^*$ where u_i^* is utility at the Nash solution).⁵ The solution to this Nash bargaining problem is given by:

$$(3) \quad \text{Max}_{v_1, v_2} [u_1(v_1, v_2) \& u_1(?_1, ?_2)]^a [u_2(v_1, v_2) \& u_2(?_1, ?_2)]^b$$

$$\text{s.t.}$$

$$u_1(v_1, v_2) \geq u_1(?_1, ?_2)$$

$$u_2(v_1, v_2) \geq u_2(?_1, ?_2)$$

where u_1 and u_2 are the utility functions of the two nations, T_1 and T_2 are their *status quo* payoffs, and a and β are their respective bargaining powers.⁶

Since, under Nash conditions, there will be no waste of potential gains (*i.e.*, the solution will be Pareto optimal), we can rewrite v_2 under the agreement as $y_0 - v_1$. Also, since only relative bargaining power matters, we can normalize so that $a + \beta = 1$. Now, we employ the utility function suggested by Grieco as our functional form for $u_i(v_1, v_2)$ so that problem (3) can be rewritten as below. Here, k_1 and k_2 are weights put on relative gains and losses in each state's utility function.

$$(4) \quad \text{Max}_{v_1} A^a B^{1-a}$$

$$\text{where } A = (1 + 2k_1)v_1 + k_1 y_0 + (1 - k_1)z_1 + k_1 z_2$$

$$B = (1 - k_2)y_0 + (1 + 2k_2)v_1 + (1 - k_2)z_2 + k_2 z_1$$

The solution is found by setting the derivative of the expression in (4) with respect to v_1 equal to zero and checking that the second derivative is negative (it is).⁷ Let us express that solution two ways. First, the solution may be stated as:

$$(5) \quad \frac{a(1 + 2k_1)}{(1 + a)(1 + 2k_2)} = \frac{u_1(v_1, v_2) + u_1(z_1, z_2)}{u_2(v_1, v_2) + u_2(z_1, z_2)}$$

This is the first interesting result. Recall that $u_i(v_i, v_j) - u_i(T_i, T_j)$ is the utility gain state i makes over its *status quo* and that a and $(1 - a)$ are the relative bargaining strengths of states 1 and 2. It is a standard result in bargaining theory that the ratio of the utility gains (from the *status quo* to the agreement) made by the parties is equal to the ratio of their bargaining powers with the more powerful of course getting more. We see here that this is amended slightly when relative gains are considered because *the concern for relative gains is itself a source of bargaining strength*. That is, the effective bargaining strength for state i is a , its raw bargaining power, times $(1 + 2k_i)$ which latter increases with state i 's weight on relative gains.⁸

It may appear from this statement that as concern for relative gains increases a state's bargaining power it tends to make agreement more difficult. In fact, quite the opposite is true. What equation (5) shows is that, controlling for raw bargaining power, utility gains are distributed in proportion to the states' concerns about relative gains. Thus, the result of bargaining is precisely to ease positional sensibilities. To see this more clearly let us express the solution another way.

Equation (5) revealed that negotiated settlements will lead to *utility* gains in proportion to the state's augmented relative bargaining power. What can be said about the absolute payoffs, v_1 and v_2 ? The solution to the Nash bargaining problem given in equation (5) can also be written as:

$$(6) \quad v_1 = \frac{a}{1+2k_2} [(1+k_2)Y_0 + k_2v_1 + (1+k_2)v_2] + \frac{1+a}{1+2k_1} [k_1v_2 + k_1Y_0 + (1+k_1)v_1]$$

Writing the solution in this way clarifies the manner in which one's own concern about relative gains adds to one's relative bargaining power. The first half of this expression ($(a/(1+2k_2))[\dots]$) reflects the impact of state 1's total bargaining power on its own payoff and the second half reflects the effect of state 2's total bargaining power. Notice that the raw bargaining power of state 1, *i.e.* a , is divided by $(1+2k_2)$ to obtain its augmented bargaining power, $a/(1+2k_2)$. Thus, state 2's concern for relative gains serves to mitigate the raw bargaining power of state 1, and, analogously, state 1's relative-gains concerns mitigate state 2's raw bargaining power. It is perhaps most precise, then, to say that concern for relative gains limits the degree to which one's opponent can utilize its raw bargaining power and still expect to obtain an agreement. We begin to see, now, how relative-gains concerns actually operate in bargaining to mitigate discrepancies in payoffs. This formulation of the solution also allows us to take several derivatives which are still more instructive in this light.

$$(7) \quad \frac{dv_1}{da} = \left(\frac{1-k_2}{1-2k_2} + \frac{k_1}{1-2k_1} \right) (y_0 + T_2) - \left(\frac{k_2}{1-2k_2} + \frac{1-k_1}{1-2k_1} \right) T_1 > 0$$

$$(8) \quad \frac{dv_1}{dk_1} = \frac{(1-a)(y_0 + T_1 + T_2)}{(1-2k_1)^2} > 0$$

$$(9) \quad \frac{dv_1}{dk_2} = - \frac{a(y_0 + T_1 + T_2)}{(1-2k_2)^2} < 0$$

$$(10) \quad 1 > \frac{dv_1}{dy_0} = a \frac{1-k_2}{1-2k_2} + (1-a) \frac{k_1}{1-2k_1} > 0$$

In signing these derivatives, we assume that $y_0 > T_1 + T_2$; *i.e.*, we assume that the agreement provides some gains over the sum of the *status quo* payoffs (else why even negotiate it?). The signs of the derivatives accord with our developing intuition about relative gains and bargaining. Either increased bargaining power or increased concern for relative gains for state *i*, gives it a greater payoff, and, symmetrically, increased bargaining power or relative-gains concern for the other state lower state *i*'s absolute payoff. Also, as long as *a* is neither 0 nor 1 (*i.e.* state 1 is neither absolutely without power nor all-powerful) and k_i is neither 0 nor infinity (*i.e.* state *i* cares at least something about but not only about relative gains), increases in the size of the pie being distributed (y_0) increase both states' absolute gain (obviously less than one for one).

There are several ways to observe the "squeezing" property relative-gains concerns have on bargained outcomes. The first is simply to note that the $d(v_1)/d(k_1)$ is positive and $d(v_1)/d(k_2)$ is negative. This implies that state 1 gets more (less) absolutely the more state 1 (state 2) cares about relative gains. Thus, if a state is more concerned than its bargaining opponent about positionality, the negotiated agreement will reflect that concern.

When both states care about relative gains to the same degree (*i.e.* $k_1 = k_2$), an increase in that concern lowers state 1's payoff if $a > 1/2$ and raises it if $a < 1/2$.⁹ That is, if absent relative-gains concerns state 1 would have received more than half the gains (due to having more raw bargaining power),

increasing both states' relative-gains concerns the same amount lowers state 1's absolute payoff. If on the other hand, state 1 would have received less than half, increasing both states' relative-gains concerns raises state 1's absolute payoff. Thus, as argued, relative-gains concerns work to diminish the disparities that emerge from bargained agreements. Concern for relative gains, then, expresses itself in bargaining solutions precisely so as to mitigate the relative losses states worry about. Stated yet another way, controlling for relative bargaining power, gains from an agreement are distributed in proportion to the concern each state has for relative gains.¹⁰

Finally, one cross derivative is also considerably enlightening in this regard. Notice that

$$(11) \quad \frac{d^2v_1}{dadk_i} + \frac{y_0 \alpha_1 \alpha_2}{(1 - k_i)^2} < 0$$

Verbally, the degree to which state 1 can use its raw bargaining power to obtain higher absolute payoffs (dv_1/da) is diminished by increasing concerns for relative gains on the part of either state ($d(dv_1/da)/dk_i < 0$). Once again, this implies some "squeezing" as powerful states cannot wantonly employ their power to maximize absolute gains and still expect an agreement if their opponent cares about relative losses. This property may help explain the inability of hegemonic states to fully press their power advantage to appropriate all rents from organizing the global economy.

All of this analysis was conducted in the worst-case scenario in which relative gains and losses are equally weighted. If on the other hand, the weaker form of the positionality hypothesis is true, relative gains are less valued than relative losses are dreaded. It is straightforward to see how this change matters. Suppose we begin with the strong form of the positionality argument. Assume that state 1 has twice as much raw bargaining power and is just as concerned about positionality as state 2 (*e.g.*, $a=2/3$ and $k_1=k_2=1$) and that status quo payoffs are nil (*i.e.*, $T_1=T_2=0$). Then, state 1 gets $(5/9)(y_0)$ in the equilibrium agreement and makes relative gains (state 2 gets the remainder). Now

suppose instead that the weak form of the positionality hypothesis holds and nothing else has changed; let the old agreement stand as a proposed agreement. As state 1 is to make relative gains while state 2 makes relative losses under this proposal, k_1 will have to be adjusted downward relative to k_2 in the ensuing bargain to reflect the weak-form hypothesis. Suppose, for example, under the weak-form hypothesis k_2 still equals 1 and k_1 now equals .5. Under these conditions, state 1 gets $(19/36)(y_0)$ and state 2 gets the remainder in the new equilibrium agreement. So, as argued, the relative gains made by state 1 are even lower under the weak form. In order to obtain an agreement, state 1 refrains from using all of its raw bargaining power to appease state 2's sensibilities about relative losses.

We conclude therefore that concern for relative gains will make itself felt in bargaining over agreements in such a way that the resulting agreement offends positional sensibilities least. This is true *a fortiori* of the weak form of the positionality hypothesis. These results are illustrated graphically for a specific, simplified example in the following section.

Negotiated Agreements and Relative Gains: An Illustrative Example

Here we consider the illustrative case of division of a total gain of y_0 between two identical (in the sense that their raw bargaining powers and status quo utilities are both nil) states into payoffs v_1 and v_2 respectively [see Figure 1]. The reader should keep in mind throughout this section that by equalizing raw bargaining powers and status quo payoffs in this example, we have isolated relative-gains concerns as the only source of differences in payoffs. We do so only for illustrative clarity, our general conclusions having already been derived above.

[FIGURE 1 ABOUT HERE]

The Nash solution without concern for positionality is an equal division of y_0 (at N, with $v_1 = v_2 = y_0/2$) since the states are otherwise equal in every salient respect. Notice that movements away

from the 45 degree line indicate relative gains to one of the states and relative losses to the other. We have come to expect that high mutual concern for relative gains will have a mitigating effect on payoff disparities: squeezing outcomes around the line of symmetry. To see this in this example, assume the Grieco utility functions:

$$u_1 = v_1 - k_1 (v_2 - v_1)$$

$$u_2 = v_2 - k_2 (v_1 - v_2)$$

where $k_1, k_2 \geq 0$ are the weights attached to relative gains, and v_1 and v_2 are the negotiated payoffs to states 1 and 2 respectively.

We know that, for an agreement to work, the cooperative payoffs must at least exceed the status quo payoffs ($u_1^* \geq 0$) and $u_2^* \geq 0$). It is a simple matter to derive the minimum cooperative payoffs that would be accepted by each state when k_1 and k_2 and y_0 take on different values.¹¹ When $k_1=k_2=0.5$ the range of acceptable agreements is shown by the line AB in Figure 1. When $k_1=k_2=1$, the only acceptable agreements are those along CD. Clearly, the higher the concern for relative gains the more narrow is the range of possible cooperative agreements, but cooperation is never ruled out. For each state, as concern for relative gains approaches infinity, the minimum acceptable payoff to cooperation approaches $1/2y_0$.¹²

This conclusion is the same for both strong and weak forms of the relative-gains argument. States will generally be able to reach agreements through bargaining which mitigate the problem of relative gains by making the distribution of cooperative gains more symmetrical. A consequence of this “squeezing” effect of bargaining on payoff disparities, as Duncan Snidal has suggested, is that, by limiting the range of available outcomes, relative-gains concerns may in fact reduce the difficulty of negotiating agreements (Snidal:703).

Grieco has a somewhat different interpretation. He does suggest that states will seek

“balanced” collaborative agreements, agreeing with Morgenthau that “state balancing of joint gains is a universal characteristic of the diplomacy of cooperation” (Grieco, 1990:47) He emphasizes the important role played by side payments in this regard, and the way institutions can facilitate such payments along with periodic reviews and renegotiations of agreements that help balance outcomes (p. 234). But Grieco is pessimistic about the capacity for successful bargaining along these lines and his reasoning is unclear.

According to Grieco, “saying that relative-gains problems do not inhibit cooperation because states *can* ameliorate them through reforms or side payments is equivalent to saying that cheating problems do not inhibit cooperation because states *can* resolve them by establishing verification and sanctioning arrangements. Both assertions are true *in principle*” (Grieco, 1993:731). Equating the difficulty in making side payments with that of verification and sanctioning arrangements in this way is considerably misleading. The marginal cost of an extra bargaining session aimed at balancing an agreement cannot compare to the large fixed and variable costs involved in creating international monitoring and sanctioning capabilities which often raise fundamental questions of sovereignty. Thus, even if Grieco’s pessimism regarding the feasibility of the latter is warranted, his pessimism regarding the former is questionable.

Failure to balance a mutually beneficial agreement cannot be a preferred outcome for either player unless bargaining costs exceed the cooperative gains at stake. Furthermore, where significant agreements are at issue in a highly institutionalized international setting, the costs of bargaining are highly unlikely to exceed the benefits of an agreement. A more plausible claim is that failure to balance is an unintended consequence of the “lumpy” or indivisible nature of some cooperative gains.¹³ Fearon (1995,1997) has made this same point when discussing the reasons a breakdown may occur in negotiations to avoid war and divide disputed territory between states. Balancing can

breakdown if it is difficult to divide gains along multiple lines, including the set of potential side-payments in linked issue areas. This problem is likely to vary, of course, depending on the existence of institutional mechanisms that facilitate issue-linkage.¹⁴

Actual negotiations over cooperative agreements contain many such balancing clauses. First Italy, and later Portugal, Spain, and Greece, for example, have demanded structural-fund allocation to offset relative losses expected from the 1992 project of the European Community. We discuss the problem in more detail below, and with reference to specific examples, in the section dealing with empirical evidence.

As noted above, the strong and weak forms of the relative-gains argument do have different implications for the likely success of such balancing in the negotiation process. In the Grieco utility function we have used above, any marginal change in a state's cooperative payoff is valued the same ($du_1/dv_1 = 1+k_1$) regardless of whether v_2-v_1 is positive or negative. If we accept "defensive positionality", on the other hand, marginal changes in v_1 will be valued less when states are making relative gains than when they are making relative losses. In this case, states will be more likely to make concessions from bargaining positions that favor them in relative terms than they will be under power-seeking conditions, since the marginal utility losses are smaller. The implication of this view is that relative losers have greater incentive to push for balancing adjustments than relative gainers have to resist, making convergence to more symmetric agreements and, therefore, cooperation more likely.

It should be noted, of course, that our simple complete-information model conveniently side-steps the problems that arise with incomplete information. As Fearon (1995) has shown, bargaining may break down when actors have incentives for strategically misrepresenting their preferences. States may reject an acceptable deal in hopes of convincing others that the deal was actually

unacceptable and that more concessions are required if an agreement is to be made. However, such informational problems, if they exist, will plague negotiations even in the absence of any concerns about positionality. Phrased differently, whether states can overcome such informational barriers or not, there is little reason to imagine that positional concerns will exacerbate them.

While concern for relative gains can never rule out cooperation when bargaining is possible, it can alter the shape of negotiated agreements. If we assume that negotiations generally approximate to the Nash model, we can illustrate the way differential concerns for relative gains might affect the bargaining result. Assuming again for simplicity that bargaining strengths are equal ($a=(1-a)=.5$) and status quo payoffs are zero, the solution is found by maximizing $[v_1-k_1(v_2-v_1)][v_2-k_2(v_1-v_2)]$. Solving this yields a clear relationship between the weights states attach to relative gains and the bargaining solution. To illustrate this, consider the example of a negotiation over the division of y_0 , with the ratio of $k_1:k_2$ varying from 1:10 to 10:1 [see Figure 2].

[FIGURE 2 ABOUT HERE]

If state 1 cares more about relative gains than state 2 ($k_1/k_2 > 1$), bargaining outcomes will favor state 1 (*i.e.*, $v_1 - v_2 > 0$). The converse is also true. As noted above, the Nash solution, *ceteris paribus*, will favor the state which is *relatively* more concerned about positional gains. For example, if the case can be made that the United States has become more concerned about relative gains than Japan in their dealings in the post Cold War era, this should have affected the terms of their recent agreements forcing Japan to cede some of its relative gains (or suffer larger relative losses) so as to ensure agreement.

Notice, though, that in this example, relative gains and losses are fairly small as a percentage of the total to be divided (less than 2%) within the range over which one state cares up to twice as much about positionality as the other (*i.e.*, between $k_1/k_2 = .5$ and $k_1/k_2 = 2$). Recall that in this example,

the levels of positionality concerns are the only differences between the states. It is astonishing, then, that even when one state is only half as concerned about relative gains as the other, payoffs are still divided nearly equally (around 51%-49%). Compare this with the more standard Nash solution without positionality concerns when one state is twice as powerful as the other. Under the latter conditions, the payoffs are twice as high for the more powerful state than for the weaker. Our interpretation of this finding is that the bargaining power conferred by a concern for positionality can do relatively little to produce relative gains unless the other state is considerably less concerned about relative losses. Figure 2 shows that starting from parity otherwise in bargaining, a state needs to be 10 times as concerned about positionality as its opponent before it can manage even a 15% relative gain. Conversely, even being a mere 1/10th as concerned about positionality requires the concession of only a 15% relative loss. This suggests that identifying the impact relative-gains concerns have on negotiated outcomes in any empirical context is likely to be quite difficult (we return to this point in the section on the empirical implications of our findings).

Our discussion of bargaining processes indicates that negotiation should lead to more symmetrical distributions of cooperative gains, thereby mollifying concerns about positionality *ex post*. Still, equalizing cooperative payoffs by explicit international negotiations may not always be possible for a variety of reasons. How might such differences in payoffs (i.e. non-zero relative gains) affect the possibility of cooperation once the terms of such cooperation are fixed? To help answer this question in the most general terms, we turn now to simple 2x2 game theory.

Game Transformations and Relative Gains: A Single-State Perspective

In this section we will focus on the structure of 2x2 games that model the choice problems of states when deciding whether or not to cooperate for mutual gain. The first important insight is that including a weighted concern for relative gains in the utility functions of the states transforms

game structures. However, to date there have been no fully general analyses of such transformations. Grieco (1988b; 1990:40-44) analyzed the transformation of a particular prisoner's dilemma game to a game of deadlock. We extend the analysis here by beginning with a game of pure coincidence and showing how it may be transformed into prisoner's dilemma and eventually into deadlock. In doing so, we derive the necessary conditions for any structure of payoffs to become Prisoners' Dilemma and Deadlock as positional concerns increase, illuminating an implicit assumption in Grieco's analysis. Snidal (1991) has performed a similar analysis, but he begins from a symmetric form game, leading him to the misleading conclusion that relative gains turns every other game into Prisoners' Dilemma. In particular, his game conversions do not end with deadlock because he assumes that there is no difference in the gains to mutual cooperation (or mutual defection). We explain the source of this important limitation below.¹⁵

We begin our analysis with a game of pure coincidence of interests (PC) where there are no obstacles to cooperation, and alter it by introducing Grieco's utility function.¹⁶ We analyze the transformations beginning with PC because starting with the most cooperation-inducing structure allows the impact of relative gains on the possibility of cooperation the greatest range to exhibit itself. We show that, depending on the level of concern for relative gains, the PC game may be transformed into "prisoners' dilemma" (PD), where cooperation is less likely, and ultimately into "deadlock" (DL), where cooperation is blocked completely.¹⁷ To simplify exposition, we focus first on transformations from the perspective of state 1; a more complete two-state analysis follows in the next section.

Consider, then, a game of pure coincidence of interests.¹⁸

		State 2	
		<i>Cooperate</i>	<i>Defect</i>
State 1	<i>Cooperate</i>	r_1, r_2	s_1, t_2
	<i>Defect</i>	t_1, s_2	p_1, p_2

where $r_1 > t_1 > s_1 > p_1$

Altering the payoffs using Grieco's utility function we derive the amended game:

		State 2	
		<i>Cooperate</i>	<i>Defect</i>
State 1	<i>Cooperate</i>	$r_1 - k_1(r_2 - r_1), r_2 - k_2(r_1 - r_2)$	$s_1 - k_1(t_2 - s_1), t_2 - k_2(s_1 - t_2)$
	<i>Defect</i>	$t_1 - k_1(s_2 - t_1), s_2 - k_2(t_1 - s_2)$	$p_1 - k_1(p_2 - p_1), p_2 - k_2(p_1 - p_2)$

Now, given that PC is characterized by $r > t > s > p$, PD by $t > r > p > s$, and DL by $t > p > r > s$, we can define the corresponding critical inequalities for the amended game:

$$\text{PC: } r_1 - k_1(r_2 - r_1) > t_1 - k_1(s_2 - t_1) > s_1 - k_1(t_2 - s_1) > p_1 - k_1(p_2 - p_1) \quad (12)$$

$$\text{PD: } t_1 - k_1(s_2 - t_1) > r_1 - k_1(r_2 - r_1) > p_1 - k_1(p_2 - p_1) > s_1 - k_1(t_2 - s_1) \quad (13)$$

$$\text{DL: } t_1 - k_1(s_2 - t_1) > p_1 - k_1(p_2 - p_1) > r_1 - k_1(r_2 - r_1) > s_1 - k_1(t_2 - s_1) \quad (14)$$

We notice first that the transition from PC to PD requires the first two and the last two terms of inequality (12) to switch, and the transition from PD to DL further requires the resulting inner pair in (13) to switch. That is, the transition from PC to PD requires that unilateral defection become preferable to mutual cooperation and that mutual defection become preferable to unilateral cooperation. The transition from PD to DL, which latter makes cooperation impossible, further requires that mutual defection become preferable to mutual cooperation. It can be shown that in order for PC to go through PD and into DL not only must concerns for relative gains (*i.e.*, k_i) be sufficiently high, but payoffs must be ordered in a specific way so that:¹⁹

$$r_1 - r_2 < t_1 - s_2 \quad (15)$$

$$p_1 - p_2 > s_1 - t_2 \quad (16)$$

$$r_1 - r_2 < p_1 - p_2 \quad (17)$$

Stating these conditions in terms of relative gains for state 1: (15) the relative gain from mutual cooperation must be less than the relative gain from unilateral defection; (16) the relative gain from mutual defection must exceed the relative gain from unilateral cooperation; and (17) the relative gain from mutual cooperation must be less than the relative gain from mutual defection. If any of these conditions are violated, the game may never become DL for state 1 regardless of the level of k_1 (relative-gains concerns). In Grieco's analysis, there is an implicit assumption that condition (17) is satisfied. Starting from an original game of PD, as he does, he is correct to assume (implicitly) that conditions (15) and (16) hold. Condition (17), however, is not assured.²⁰ In Snidal's treatment, for example, inequality (17) does not hold (because $r_1 - r_2 = p_1 - p_2 = 0$), implying that mutual defection is never preferred to mutual cooperation, which in turn implies that positionality concerns can only increase the temptation to unilateral defection and reduce the sucker payoff to unilateral cooperation. Thus, his conclusion that all games become PD as positionality concerns escalate holds only in games with symmetric payoffs to symmetric behavior.

These conditions are by no means assured and are not obvious from previous considerations of the relative-gains problem. They tell us that *the nature and extent of that problem are crucially dependent upon the exact structure of payoff values in the underlying choice situation*. We can readily imagine situations in which the conditions would not hold. In the case of cooperation to reduce tariff protection, for example, a state may actually secure a greater relative gain over other states by cooperating rather than by defecting unilaterally (a violation of (15): $r_1 - r_2 > t_1 - s_2$). Since small, open countries profit most significantly from economic specialization, they are likely to achieve greater relative gains in mutual cooperation for tariff reduction than they could by unilateral defection. If so, regardless of how concerned such states are about positionality, they would never view the game of trade liberalization as one of deadlock. Perhaps this is why recent rounds of GATT

negotiations have arguably been hampered more by rows between large countries than between them and smaller countries.

Alternatively, consider cooperation for arms control. If states all defect and engage in an arms race, a state's position compared to other states may be worse than if it unilaterally limited its arms build-up (a violation of (16): $p_1 - p_2 > s_1 - t_2$). This may occur if the state would lose the arms race and ruin itself economically in the process, while by opting out of the arms spiral it could at least preserve its economic strength relative to other states. This may explain the wide-spread (every state but the "nuclear club") unilateral cooperation in the nuclear arms race.

This arms control example can be extended. A state's position relative to other states might be better when cooperation is achieved and arms are limited than when it participates in an arms race (a violation of (17): $r_1 - r_2 < p_1 - p_2$). With an arms agreement the state may be able to maintain a military balance along with relatively better economic performance, while an arms race could lead to economic ruin without sufficient military advantage to compensate. For the state considering tariff reductions, alternatively, it may be so well endowed with scarce resources that when tariffs are lowered by cooperation its position compared to others would be far better than when all tariffs remain high and less trade occurs.

To illustrate the transformations for which we have given the general analysis above, consider a specific numerical example in which the three critical conditions happen to be satisfied. For payoffs--in the order r_i, t_i, s_i, p_i --of (6,4,3,2) and (8,5,4,3) for states 1 and 2 respectively, as k_1 rises state 1's preferences are transformed (Case #1) [see Figure 3].

[FIGURE 3 ABOUT HERE]

Preferences change from PC to PD and finally to DL form. Cooperation will eventually break down if k_1 is high enough (exactly how high it must be depends on the exact payoff values as given in

endnote 18).²¹

There are, in fact, 75 different ways the values t_2-s_1 , s_2-t_1 , p_2-p_1 , and r_2-r_1 can be ordered. There are also 75 different payoff orderings for the original, unamended game. Therefore, theoretically, there could be as many as 5625 different transformation paths! Instead of enumerating them, we will consider two further cases of particular interest.

First, consider the circumstance in which none of the three above conditions is met, and specifically that $p_2-p_1 > t_2-s_1 > s_1-t_2 > r_2-r_1$. A numerical example might have payoffs (4,3,2,1) and (4.1,3.7,3.3,3.0) for states 1 and 2 respectively (Case #2) [see Figure 4]. In this case not only is the ordering of payoffs in the original game PC, but the ordering of relative gains for state 1 is the same. (Of course, this has implications for state 2's view of the game as we explore in the next section.)

[FIGURE 4 ABOUT HERE]

In this case, the game does not transform at all for state 1. For any positive level of k_1 , the game will remain PC. Under these conditions, then, state 1's concern for relative gains has no effect on the structure of the game at all; it remains PC for state 1 regardless of its level of relative-gains concern.

Now consider the case in which the first two conditions are satisfied ($r_2-r_1 > s_2-t_1$ and $p_2-p_1 < t_2-s_1$), but the third necessary condition (i.e., that r_2-r_1 exceed p_2-p_1) is violated. Using the payoffs (6,4,3,1) and (8,6,4,3) for states 1 and 2 respectively, we see the following transformations (Case #3) [see Figure 5].

[FIGURE 5 ABOUT HERE]

The game is transformed from PC to “chicken” and then to PD, but it never reaches DL. Thus, cooperation is always possible provided the states place enough importance on future outcomes (see the Appendix for a discussion of the iterated PD game with concern for relative gains).

For the transition to deadlock to occur from any original, unamended game, the condition $r_1 -$

$r_2 < p_1 - p_2$ must hold regardless of the level of k_1 and however other payoffs are ordered. That is, *the relative gain from mutual cooperation must be less than the relative gain from mutual defection*; otherwise, cooperation will always remain possible even if it becomes progressively more difficult to achieve. Note that this is a strict inequality; thus, even if the relative gains and losses are equal in mutual cooperation and mutual defection cases, cooperation is always possible whatever the degree of relative-gains concerns. (Snidal's results were reached precisely because this strict inequality did not hold; relative gains in mutual cooperation and mutual defection were both zero.) This is an important *necessary* condition to check in any analysis of underlying choice problems faced by states considering cooperation.

It is also important to note that conditions (15-17) cannot possibly hold for both states if both view their opponent's gains exactly the way the opponent does. That is, provided that a payoff of r_1 is seen as a gain of r_1 for state 1 both when state 1 calculates its own utility and when state 2 calculates its own utility, then it is a mathematical impossibility for condition 17 to hold for both states if the relative gains from mutual cooperation and mutual defection are non-zero. Therefore, it will always be the case that at least one state will not view the game as deadlock regardless of how high its concerns about relative gains are. The converse is not true; it is not necessarily the case that one state must view the game as deadlock if its k_1 is high enough since, if the original game was not PD so that conditions (15) and/or (16) may have been violated. All of this is because under these conditions a relative gain for state 1 is by definition a relative loss for state 2. This suggests that we should not be satisfied with the single-state analysis provided here, but should have a look at how games transform from both states' perspectives as positionality concerns increase. We do so in the following section.

Two-State Game Transformations

In the preceding section, for initial pedagogical simplicity, we considered game transformations only from the perspective of state 1, as its concern for relative gains (k_1) increased. The conclusions drawn about the likelihood of cooperative game outcomes depended on the assumption that state 2's preferences were unchanged (in PC form).

Here we provide a more complete view of the three numerical examples used above. The diagrams that follow show the original preference transformations for state 1 (these are the same as in figures 1-3), the transformations for state 2 were k_2 to increase, and the full-game transformations were k_1 and k_2 to increase *in lock step*. The full-game transformations presented are therefore to be regarded as the outcomes if both states' concerns for relative gains were to increase from zero at the same rate. This lock-step increase in relative-gains concern is by no means logically necessary. Generally, the k_i 's may be at different levels and may move in different directions at different rates. In fact, the weak form of the positionality hypothesis would imply that frequently the changes in k_i are in opposite directions, depending on who is making relative gains and who is making relative losses from any proposed agreement. The full-game transformations given at the bottom of figures 6-8, therefore, are included just to provide illustrations of a specific example: namely, the case where k_1 and k_2 are equal and increase (left-to-right) or decrease (right-to-left) at the same rate. Actual game outcomes will depend upon the exact k_i 's at any given time.

For example, in Case #1 as described above, state 2's preferences only transform to assurance as k_2 increases, and cooperative outcomes can be achieved however high k_2 is as long as k_1 is low enough for state 1's preferences remain PC or PD. The preferences of state 2 transform only to assurance in this case because only the second of the three payoff conditions necessary for transformation to DL ($p_1 - p_2 > s_1 - t_2$) is satisfied. Here the lock-step outcomes become a form of "easy PD" in which state 1 has PD preferences while state 2 has only assurance preferences that make the

cooperative outcome more likely. These outcomes become “effective DL” once state 1's preferences reach DL since this will ensure state 1's defection and state 2 must defect as well to avoid the least preferred “sucker” payoff [see Figure 6].

[FIGURE 6 ABOUT HERE]

In Case #2, all the payoff conditions necessary for transformation to DL are satisfied for state 2 and its preferences transform to PD, to DL, and even to an “extreme DL” ordering in which it prefers mutual defection to unilateral defection. Cooperative game outcomes can be expected only for low levels of k_2 , but k_1 can be any size since state 1's preferences remain PC. The lock-step game outcomes transform to an “easy PD” in which state 1 has PC preferences which make mutual cooperation most likely, and finally to “unilateral defection” in which state 2 will defect while state 1 will continue to cooperate because mutual defection is its least preferred outcome [see Figure 7].

[FIGURE 7 ABOUT HERE]

In Case #3, only the first two payoff conditions for transformation to DL are satisfied for state 2, so that its preferences transform to assurance and then PD as k_2 rises. Here mutual cooperation will remain a possible outcome for any combination of k_2 and k_1 since the “worst” preference ordering for each state is PD. Whether mutual cooperation can be achieved, of course, will depend upon the discount factors of each state (see appendix). The lock-step game outcomes transform to “easy assurance” in which state 1 still has PC preferences, to “tough assurance” once state 1 has chicken preferences which incline it more to defection, and finally to PD [see Figure 8].

[FIGURE 8 ABOUT HERE]

This analysis of game transformations has proven that *there is no general (pessimistic or optimistic) implication regarding the impact of relative-gains concerns on the possibility of cooperation*. It is neither the case that all prisoners' dilemma games become deadlock nor that all

2x2 games become prisoners' dilemma as relative-gains concerns increase.

Implications for Empirical Studies of Cooperation

The results produced in the bargaining and game-theoretic analyses above have several implications for any rigorous approach to the empirical study of international cooperation. To illustrate each point, we have found it useful to refer back to Grieco's ground-breaking analysis of the Tokyo Round negotiations covering non-tariff barriers to trade — the most intensive empirical investigation of the relative-gains problem yet attempted (Grieco, 1990). In summary, Grieco argued that the original code agreements produced absolute gains for each participant, but produced very different patterns of relative gains and losses between the two key players, the European Community and the United States:²²

- a. Customs Valuation: the EC made relative gains as the US had to make greater adjustments to its practices (specifically, it had to terminate the American Selling Price system).
- b. Anti-Dumping: the EC made relative gains since it was more often the target of anti-dumping actions than was the US and so benefitted from greater code-mandated protection.
- c. Countervailing Measures: the EC made relative gains since again it was more often the target of such actions.
- d. Technical Barriers: the US made relative gains since it relied more on non-government standards agencies that were not covered in the agreement and so provided less additional transparency than the EC.
- e. Government Procurement: the US made relative gains since foreign suppliers had a lower share of government contracts in the EC and public-owned enterprises represented a greater proportion of government contracts in the EC.²³

Grieco argued that, consistent with his view that relative-gains concerns are the key to international cooperation, the EC cooperated on the first three codes but not on the last two.

With these findings in mind, we can assess what it is that our bargaining model and game transformations tell us about the kind of evidence that can shed light on the problem of relative gains. There are at least four key implications of our analysis for the assessment of empirical

evidence on relative gains.

(1) *Balancing failures should not be mysteries.* Consider, first, our demonstration that mutual concern for relative gains squeezes bargaining outcomes toward symmetry. In our model, negotiated cooperation will be broken down by relative gains only if balancing fails. On this point, Grieco has argued that, while states do “recraft agreements and provide side payments in order to address relative-gains concerns ... the available scholarship suggests that effective reforms and side payments are sometimes provided but sometimes are not” (1993:731). A key question thus becomes why such payments are not provided when significant mutual gains are at stake. If relative-gains concerns provide such a powerful incentive for balancing, there must be a good reason why the balancing stops short. Herein lies a good test for the plausibility of any analysis of relative-gains concerns and negotiated cooperation. If such concerns are important, and balancing fails, there should be observable, independent reasons for that failure. If there are no constraints on the consideration of side payments and concessions are readily available for an advantaged state to make, cooperation should proceed. If it does not proceed, perhaps the situation has been misinterpreted.

The credibility of Grieco’s argument that relative-gains concerns blocked cooperation in the Tokyo Round NTB negotiations rests on the implicit assumption that concessions were unavailable. Consider his crucial cases of failure: the Technical Barriers and Government Procurement codes. Assuming, as he does, that the EC faced relative losses in both areas, and that significant mutual gains were at stake, the critical question is why the US did not make concessions to balance the outcome. The US is characterized, after all, as a “defensive positionalist” not interested in making relative gains, just concerned about relative losses. The costs of additional bargaining on these codes were negligible given that the general Tokyo Round framework was already in place and issue-linkage was commonplace. The US could have offered to extend coverage of the Technical Barriers

agreement to all, or some, private testing agencies.²⁴ Similarly, the US could have made many concessions in the area of Government Procurement, perhaps agreeing to limit the extent to which the code would be extended to cover public enterprises.²⁵

(2) *Bargaining power can provide clues.* As Keohane has pointed out, bargaining conflict based on concern for relative gains is not empirically distinguishable from bargaining aimed at maximizing absolute gains (Keohane, 1993:279-80). When states complain about an imbalance in an agreement they are pushing both for more absolutely and relatively. They may also be making a point about fairness. How can we distinguish bargaining that is inspired by positional concerns? Formally modeling the bargaining process yields a real dividend here by directing our attention to the links between outcomes on the one hand, and differences in bargaining power and differences in concern for relative gains on the other.

Our results suggest that good test cases would be those in which bargaining power is unevenly distributed among the states negotiating a cooperative agreement. Such cases allow the analyst to judge whether the powerful are constrained in making agreements that favor them by the positional concerns of the less powerful. If bargaining outcomes do not square well with bargaining power, there is a *prima facie* justification for making a claim about the role of positional concerns. This justification would be consistent with the argument, advanced by Grieco in his initial formulation of the relative-gains problem, that the level of states' concerns about relative gains is likely to vary in line with levels of power. Specifically, very powerful states which feel secure in their position are less sensitive to relative gains than "middle-range states" which both "fear the strong and aspire to their status" (Grieco, 1990:46).²⁶

The NTB cases are not very helpful as examples in this regard, since the bargaining power of the EC and US was presumably rather equal.²⁷ Cooperation among EC member states may provide

better examples of the types of cases we have in mind here. Germany, for instance, clearly the most powerful member of the current exchange-rate system, has nevertheless accepted the move toward monetary union and stands ready to partially cede control over its sacrosanct monetary policy (Pauly 1991). That is, while under the current system, its partners are *de facto* required to adjust their policies allowing Germany to maintain its strong anti-inflationary stance relatively unhindered; under the proposed EMU its partners would have considerably more influence on the EC's and therefore Germany's monetary policy. Of course, Germany may be linking cooperation on EMU to broader foreign and economic policy concerns, yet it is very difficult to make a case that Germany will make gains relative to others that match its significant power advantage. Another illustrative case is the issue of EC enlargement. The original member states accepted new entrants when certainly some entrants (particularly Spain, Portugal, and Greece) were making large relative gains over existing members through admittance. The notion that weaker states are more concerned about relative gains than stronger states and, therefore, that the latter are more willing to make concessions to achieve a mutually beneficial (in absolute terms) agreement has a foothold in such cases and warrants investigation.

To further illustrate our point here, consider Stephen Krasner's study of international cooperation in the field of global communications (Krasner 1991). He finds that cooperative agreements on allocating the electromagnetic spectrum, and on regulating radio and television broadcasting, telecommunications, and remote sensing have perfectly reflected the relative power capabilities of the actors involved. The regimes established in these areas, he concludes, have changed in line with changes in the distribution of power (a variable largely determined by technology and market size). Krasner suggests that this power-based view is consistent with a relative-gains interpretation; in "life on the Pareto frontier", after all, all gains are relative gains (p.

365). It is ironic then that our results suggest that Krasner's study would have provided real support for the relative-gains view if in fact he had found that bargaining power was not so determining. That is, evidence for the importance of relative-gains concerns would be clearer if less powerful states, with more reason to value relative gains, had instead constrained more powerful states.

(3) *Cardinal measures for payoffs are required.* Turning now to our analysis of game transformations, perhaps the most daunting implication for empirical research is that establishing a simple preference ordering of outcomes for each state is not sufficient when analyzing the relative-gains problem. In the absence of relative-gains concerns, just establishing the preference orderings of actors (either PC, PD or DL, for instance) is often enough to enable one to predict behavior and outcomes. Our results show that, when relative-gains concerns enter, the analyst's task becomes qualitatively much more difficult. One now requires a cardinal scale for evaluating payoffs to different states that permits comparisons of the size of gaps in the payoffs received with a range of alternative outcomes.²⁸

Grieco's study of the Tokyo Round NTB codes does not directly confront this core analytic issue. Grieco does note before describing his findings that "the extent and economic consequences of non-tariff barriers in the international trading system are still largely undocumented. Moreover, the economic effects of the different Tokyo Round NTB codes are difficult to estimate and thus to compare" (Grieco, 1990:158). He is able to determine which parties make relative gains under mutual cooperation; *i.e.* he is able to sign the gaps in payoffs. Unfortunately, this is insufficient to determine the structure of the relative-gains-augmented game. To be determinate we need to know more about the size of gaps in payoffs. This is because relative-gains concerns can only transform games and thereby affect outcomes if gaps in payoffs satisfy the specific conditions we have identified above and positional concerns are high enough. These conditions are the subject of our

next implication for empirical work.

(4) *Conditions for transformations should be checked.* Any analysis that aims to test for the effects of relative-gains concerns on cooperation must first establish the basic game form in terms of absolute payoffs and the outcome it implies, then show that gaps in gains and positionality concerns are both large enough to alter the game and hence the outcome. The second part of this procedure requires at a minimum checking that the conditions required for game transformations are satisfied. We have shown that a transformation from PC to PD requires that $r_1 - r_2 < t_1 - s_2$ and $p_1 - p_2 > s_1 - t_2$. The transformation from PD into DL requires that $r_1 - r_2 < p_1 - p_2$. These conditions are necessary and, coupled with adequately high positionality concerns (k_i 's), sufficient for game transformation.

In the analysis of the NTB codes, not only are these conditions not assured, but the original form of the games is left in doubt. Grieco takes some pains to demonstrate that there were absolute gains to the EC from each code agreement, yet this finding is compatible with several game forms, including both PC and PD. A strict application of neoclassical economic theory would imply that, since the liberalization of trade was at stake in each issue area, the appropriate specification for all original games was PC. To make a case that the games were less conducive to cooperation in their original form, one would have to introduce elements of strategic trade theory or optimal tariff theory (neither of which seem applicable here), or to drop the core assumption of unitary states so that an analysis of domestic politics and policy-making is deemed necessary.²⁹ Furthermore, to make the case that relative-gains concerns lay behind the EC's uncooperative behavior on the Technical Barriers and Government Procurement agreements, the analyst would need to show at least that our three conditions hold.

If we take our economic theory seriously, the welfare gains from removing barriers to trade created by technical standards and government-purchasing policies may well have been large enough

to imply a violation of the first two conditions. That is, such gains may be large enough that defecting unilaterally would actually harm the EC's position more than mutual cooperation under the terms of the agreements (violating the first condition that $r_1 - r_2 < t_1 - s_2$). Conversely, had the EC liberalized unilaterally, it would do better relative to the US than it would under mutual defection (violating the second condition that $p_1 - p_2 > s_1 - t_2$). In other words, Grieco argued, in effect, that $r_1 - r_2$ was negative and that $p_1 - p_2$ was positive, but, even if we accept these claims, it remains to be shown that $t_1 - s_2$ was not more negative and/or $s_1 - t_2$ more positive.

Checking that the third condition is satisfied requires a clear specification of the probable effects of mutual cooperation and mutual defection. While Grieco indicates that the EC would be relatively disadvantaged by a change from its status quo before the Technical Barriers and Government Procurement agreements to a future in which it abided by them, he does not investigate the EC's relative position in a future in which the agreements failed to be reached. Given, for instance, that the US and Japan had already started negotiating bilateral deals on technical standards, it is by no means obvious that the EC would have done better relatively in a future without an agreement on the Technical Barriers code.

Conclusion

We conclude that while positional concerns can be an obstacle to cooperation, conclusions about the magnitude of the problem they represent for cooperation (or even whether they represent a problem at all) must rest upon specific parameters of the bargaining and game-strategic environment at hand.

First, we distinguished between an extreme and weaker form of the relative-gains argument, the former implying that states value relative gains and losses equally and the latter implying that states attach less value to relative gains than they do to relative losses. We argued that the latter is

more defensible and, in fact, is more in the spirit in which the relative-gains argument is proposed.

Our analysis of negotiation processes suggested that bargaining should mitigate the problem of relative gains by distributing cooperative benefits precisely so as to minimize that problem. All positionality concerns will be evident in the bargaining, mutually high concern, for example, squeezing the outcome around symmetry. Therefore, as long as bargaining costs are not prohibitive, relative-gains concerns should not rule out cooperation. This holds for both the extreme and weaker statements of the “problem” and holds *a fortiori* in the latter as cooperation is more likely if the weaker claim is correct. We also showed a corollary that negotiated agreements will be tilted in favor of those who are relatively more concerned about positionality, introducing a new hypothesis which deserves empirical exploration.

Finally, we have examined how any structure of game payoffs are transformed by concerns for relative gains. We were able to derive three necessary conditions on the payoffs for the transformation of 2x2 games into Deadlock with rising relative-gains concerns. This analysis also revealed a plethora of possible game-transformations, in which any hindrance to cooperative equilibria introduced by relative-gains concerns depends critically upon the size of the differences in payoffs and the levels of concern for relative gains.

Thus, while the relative-gains problem can hinder cooperation in certain international situations, its impact will depend upon a number of factors which require careful analysis. We have identified these factors and sketched what one must show to argue that positionality is an important source of difficulty for international cooperation. In particular, we must be able to specify with some precision the structure of payoffs in the underlying choice situations, and the level of concerns for relative gains for each actor, if statements about the impact of relative gains are to make sense. We will have to measure (at least approximately) not merely to order the raw payoffs and the relative

gains for the states in each of the possible outcomes.

Our conviction, therefore, is that the debate over relative gains would benefit most at this point by a renewed focus upon empirical tests and the associated problems of evidence. The results of our simple but general bargaining and game-theoretic analyses provide some useful guidance for approaching this task.

Appendix: The Iterated Prisoner's Dilemma Game

How do concerns for relative gains interact with discount factors to affect the likelihood of mutual cooperation as an outcome of repeated prisoner's dilemma games? A logical extension of the 2x2 game analysis provided in the text is an analysis of the relationship between the weight attached to relative gains, k_i , and the minimum discount factor required for cooperation, Axelrod's w (1984). The higher the discount factor that is required, the more severe is the "dilemma", and the less likely it is that cooperation is the equilibrium outcome.

In the repeated prisoner's dilemma, it can be shown that the discount factor for each state must be no less than the larger of two values (Axelrod, 1984:208) for mutual cooperation to be a Nash equilibrium. This condition can be restated for state 1 using the payoffs in our amended game above. State 1's discount factor, w , must satisfy the following inequalities (the conditions for state 2's discount factor are symmetric):

$$\text{and, } w_1 \geq \frac{[t_1 - r_1 + k_1(t_1 - s_2 + r_2 - r_1)]}{[t_1 - p_1 + k_1(t_1 - s_2 + p_2 - p_1)]} \quad (\text{A1})$$

$$w_1 \geq \frac{[t_1 - r_1 + k_1(t_1 - s_2 + r_2 - r_1)]}{[r_1 - s_1 + k_1(t_2 - s_1 - r_2 + r_1)]} \quad (\text{A2})$$

From these inequalities it is clear that the impact of relative-gains concerns on the likelihood of cooperation depends upon the size and direction of gaps in payoffs. The expressions for dw_1/dk_1 can be obtained, but defy (at least our) intuitive interpretation:

$$\text{from (A1), and } \frac{dw_1}{dk_1} = \frac{(t_1 - s_2 + r_2 - r_1)[t_1 - p_1 + k_1(t_1 - s_2 + p_2 - p_1)] - (t_1 - s_2 + p_2 - p_1)[t_1 - r_1 + k_1(t_1 - s_2 + r_2 - r_1)]}{[t_1 - p_1 + k_1(t_1 - s_2 + p_2 - p_1)]^2}$$

$$\text{from (A2). } \frac{dw_1}{dk_1} = \frac{(t_1 - s_2 + r_2 - r_1)[r_1 - s_1 + k_1(t_2 - s_1 - r_2 + r_1)] - (r_1 - s_1 - r_2 + r_1)[t_1 - r_1 + k_1(t_1 - s_2 + r_2 - r_1)]}{[r_1 - s_1 + k_1(t_2 - s_1 - r_2 + r_1)]^2}$$

By simplifying, we can show that the relationship dw_1/dk_1 is positive if:

$$r_1(p_2 - s_2) + t_1(r_2 - p_2) - p_1(r_2 - s_2) > 0$$

and

$$r_1(t_2-s_2) - t_1(t_2-r_2) - s_1(r_2-s_2) > 0$$

Since these conditions are not assured, *increases in a state's level of concern about relative gains do not necessarily coincide with increases in the minimum discount rate necessary for cooperation.*

To illustrate this point we use two numerical examples. In example (a), we alter the standard PD game to incorporate relative gains, and use the payoffs (in the order t_i, r_i, p_i, s_i) of (4,3,2,1) and (4.1,3.1,2.1,1.1) for states 1 and 2 respectively. That is, state 2 gets slightly more than state 1 in each of the four possible outcomes. In this example, dw_1/dk_1 is positive, and increases in positionality concerns do coincide with increases in the minimum necessary discount rate. In example (b), we use the payoffs (4,3,2,1.9) and (4,2,1.9,0.9). That is, state 2 suffers more from being the sucker than state 1 and gets slightly less in the mutual defection case. In this case, increases in state 1's concern for relative gains actually lower the minimum discount rate required for cooperation to be an equilibrium [see Figure 9].

[FIGURE 9 ABOUT HERE]

Once again, the conclusion is that relative-gains concerns have ambiguous impact on the possibility of cooperation. As we have shown in the text, we need considerable information about the exact payoff matrix to say more.

Figure 1: Nash Bargaining and Concern for Relative Gains
 Squeezing of Minimum Acceptable Payoffs by Positional Concerns

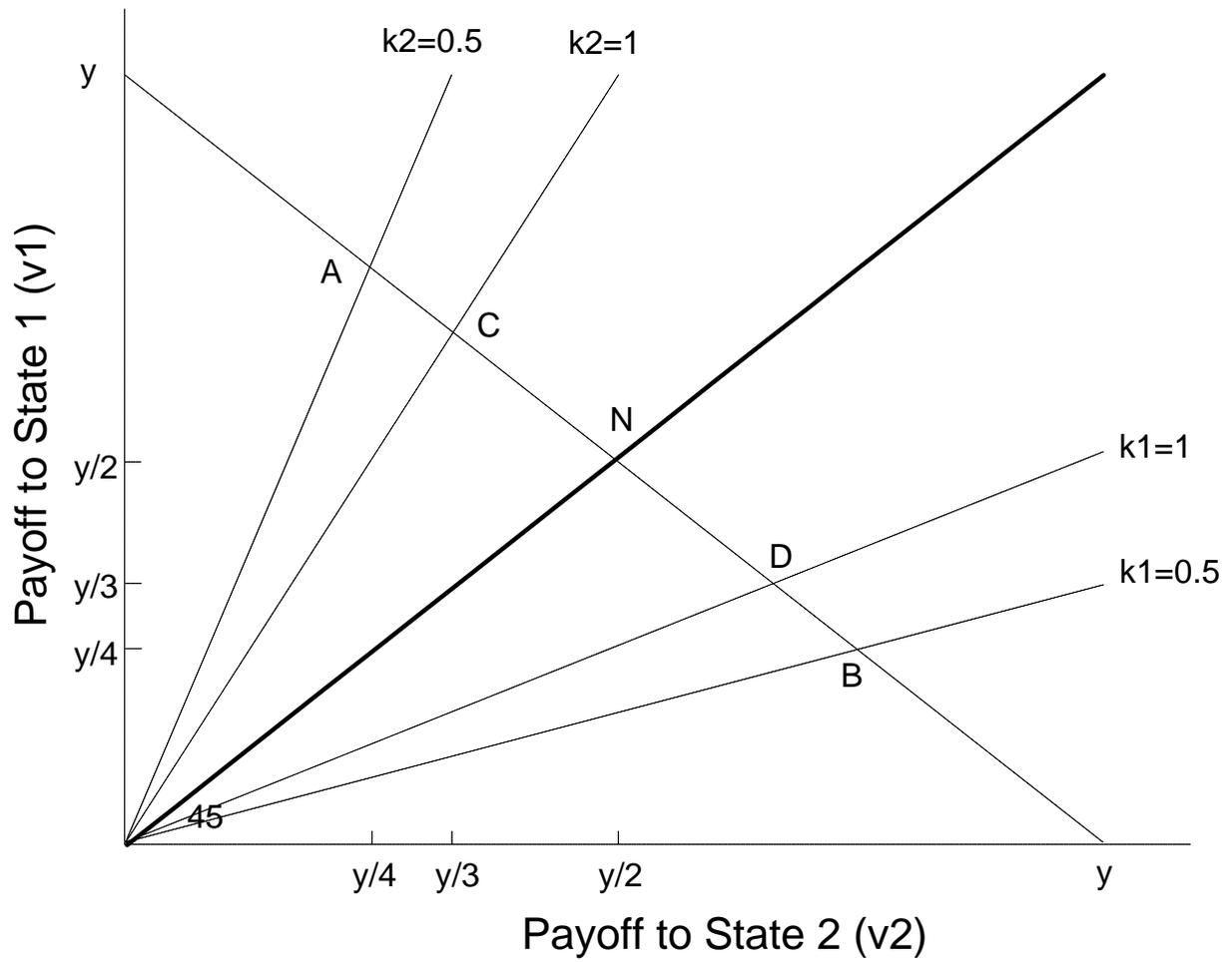


Figure 2: Bargaining Solutions & Differences in Concern for Relative Gains
Relative Gains for State 1 as a Function of the Ratio of Positional Concerns

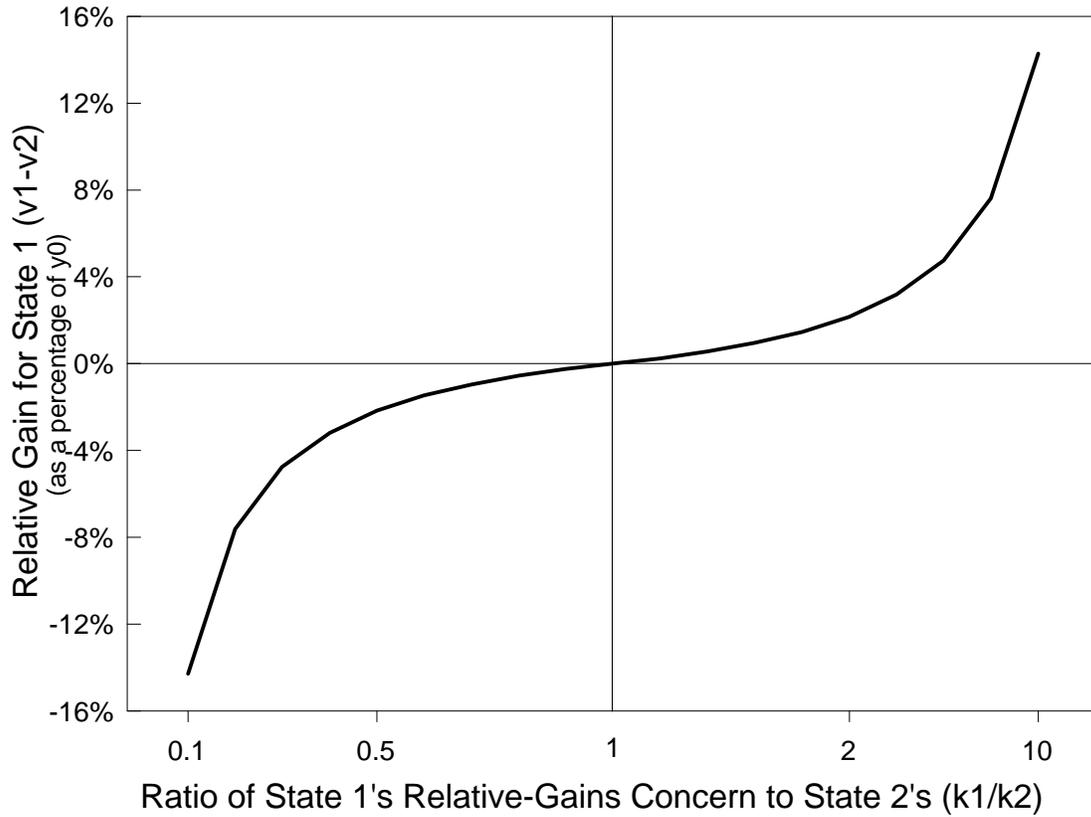


Figure 3: Preference Transformations for State 1: Case #1

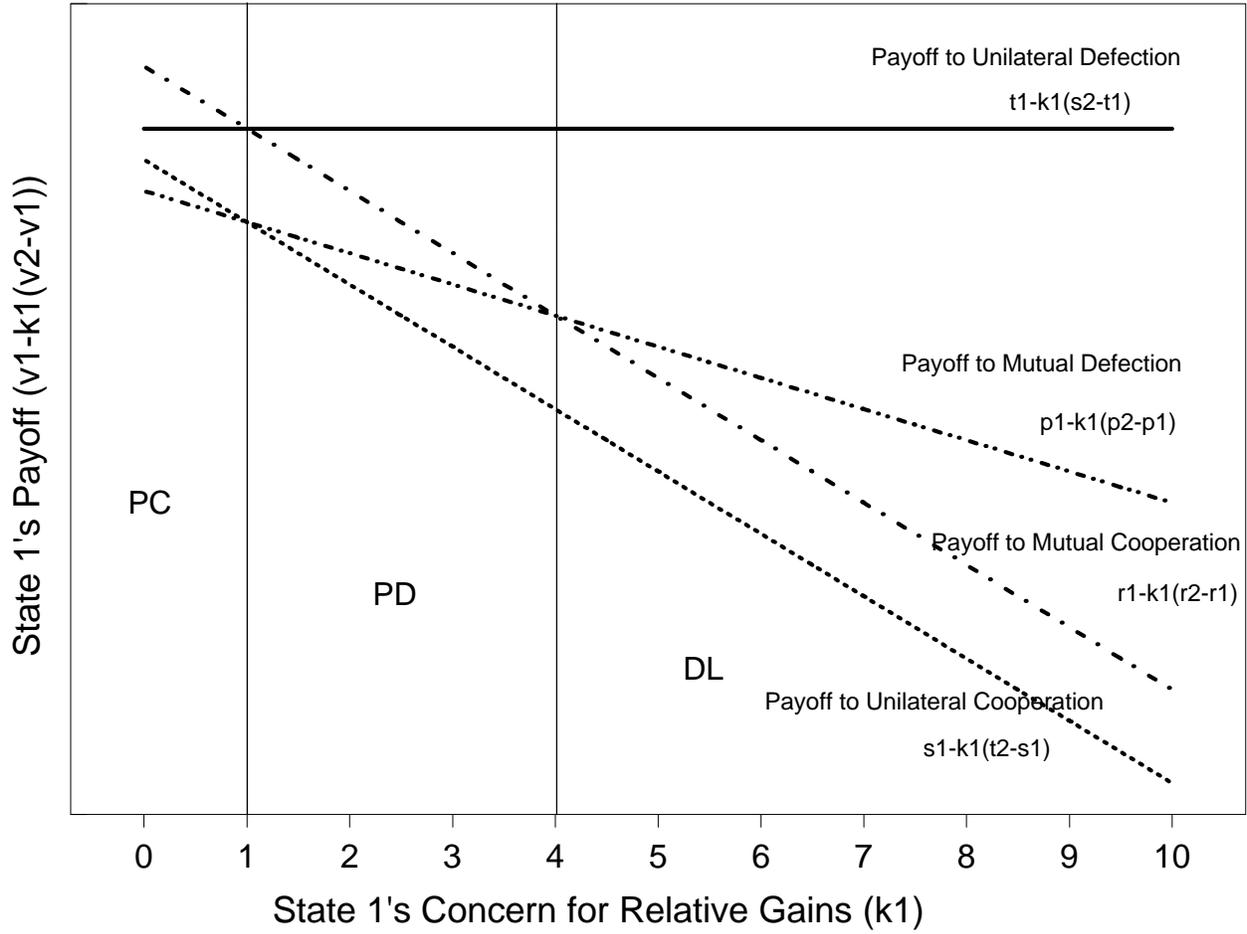


Figure 4: Preference Transformations for State 1: Case #2

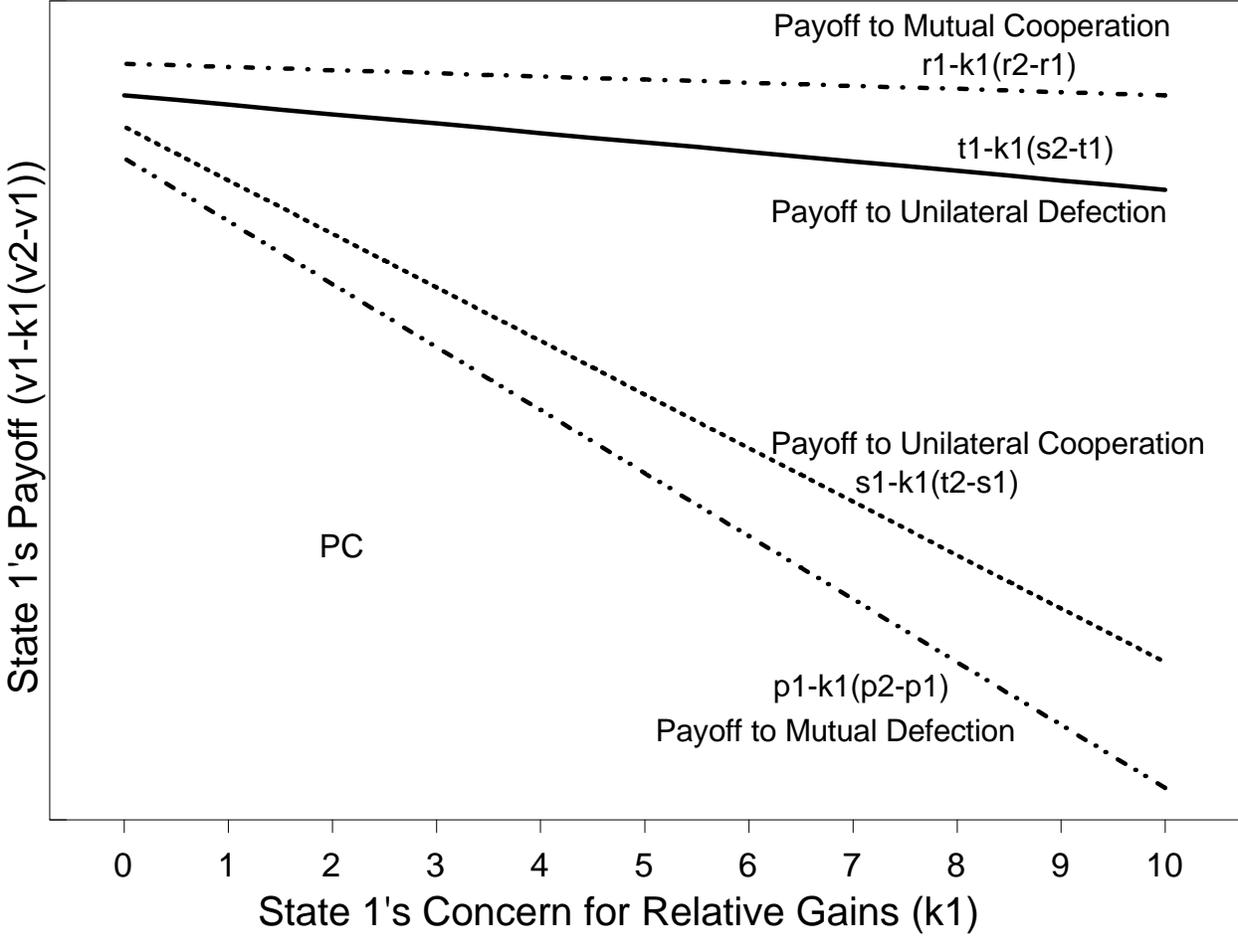


Figure 5: Preference Transformations for State 1: Case #3

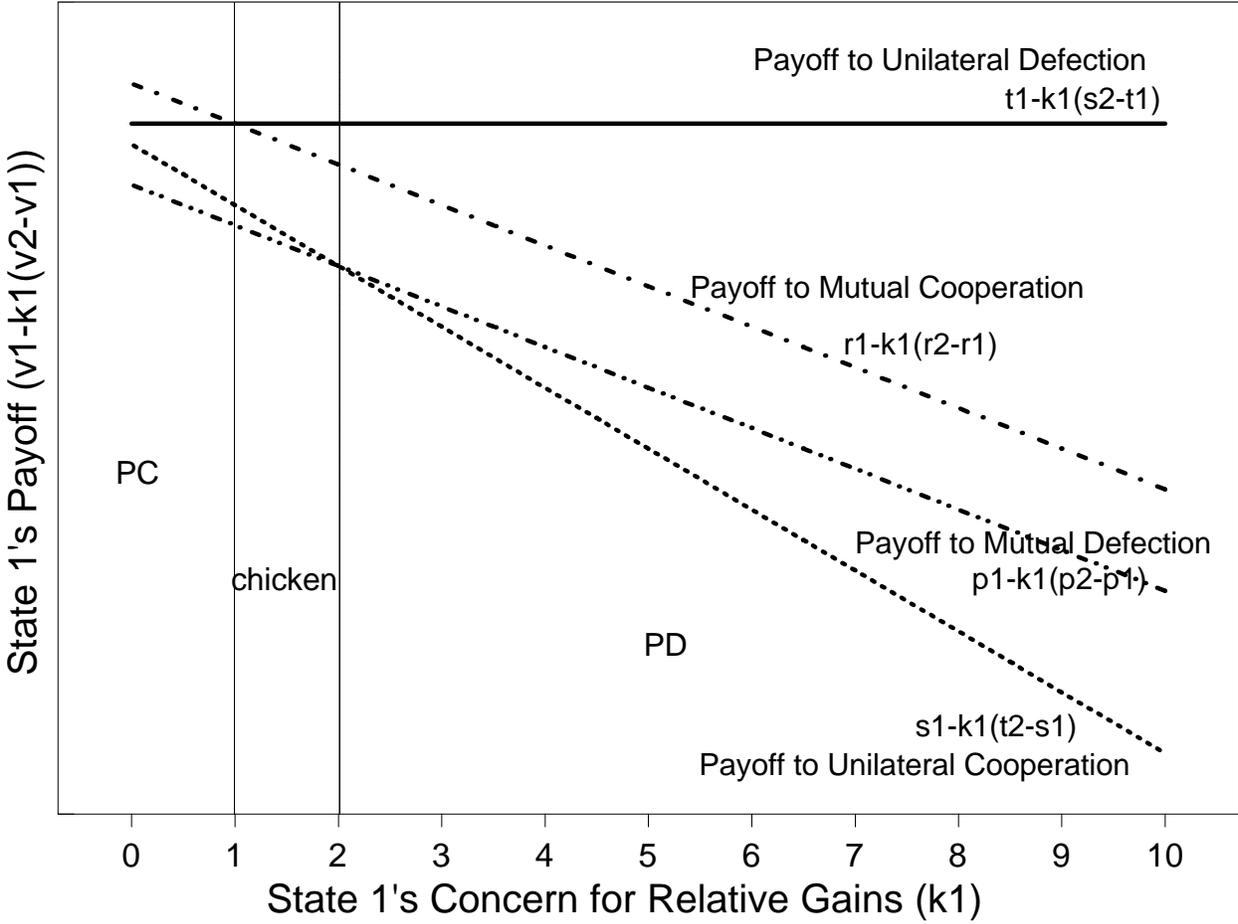


Figure 6: Lock-Step Complete Game, Case #1

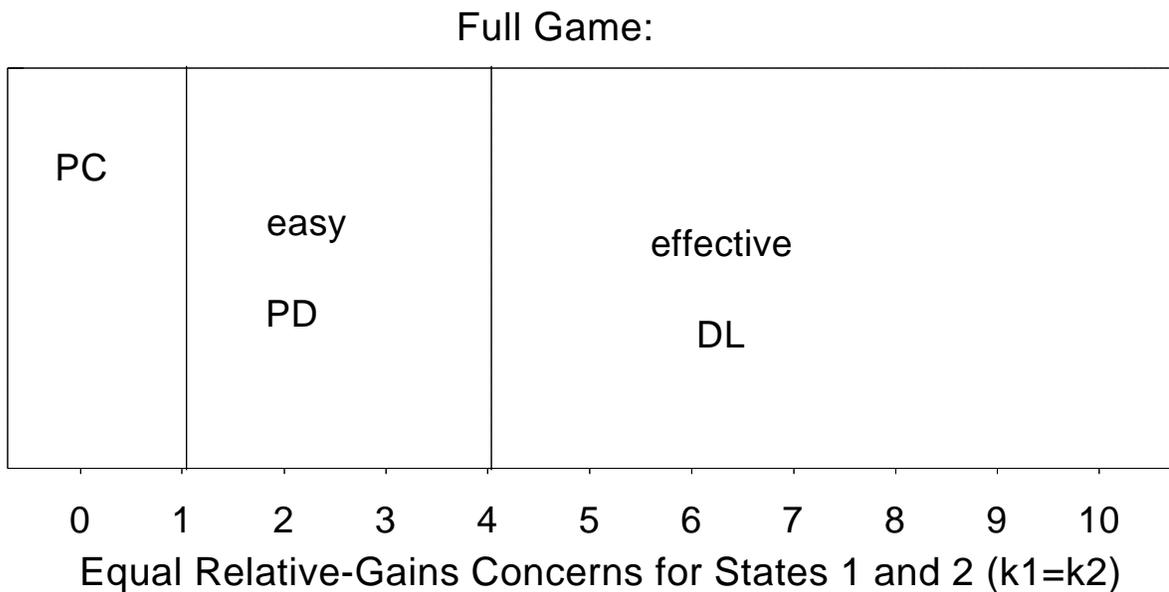
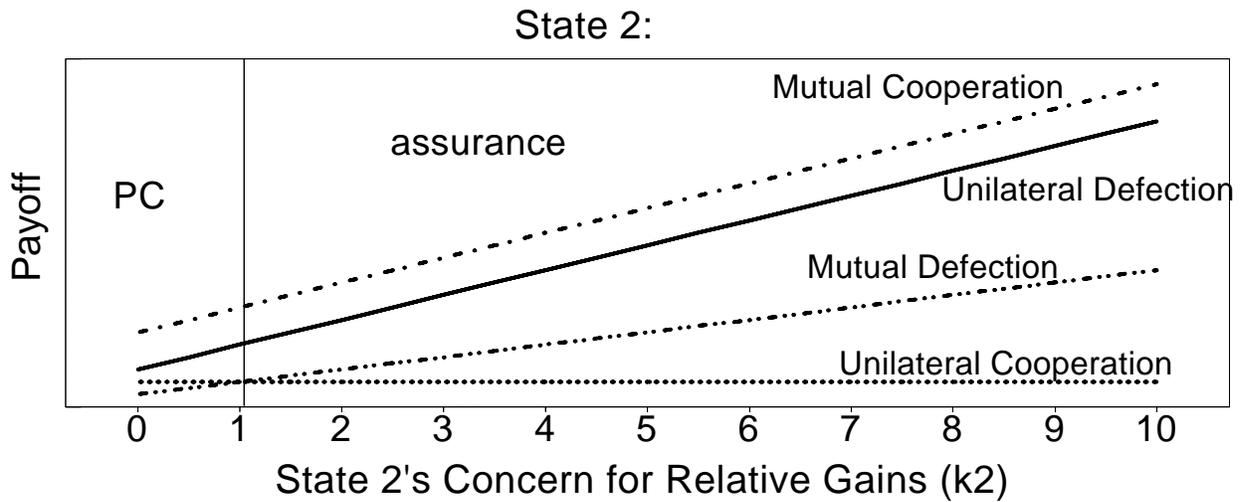
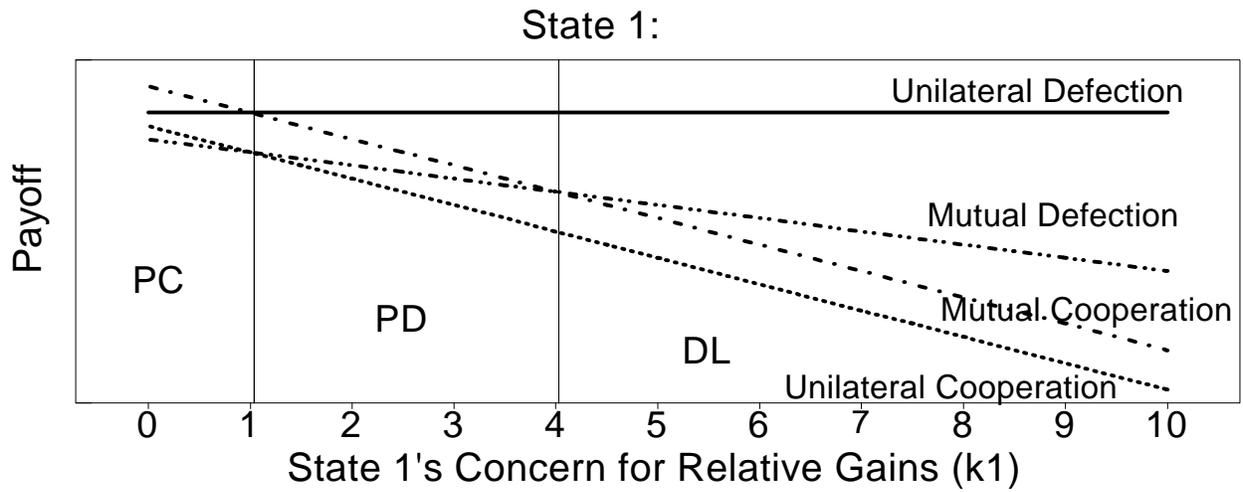


Figure 7: Lock-Step Complete Game, Case #2

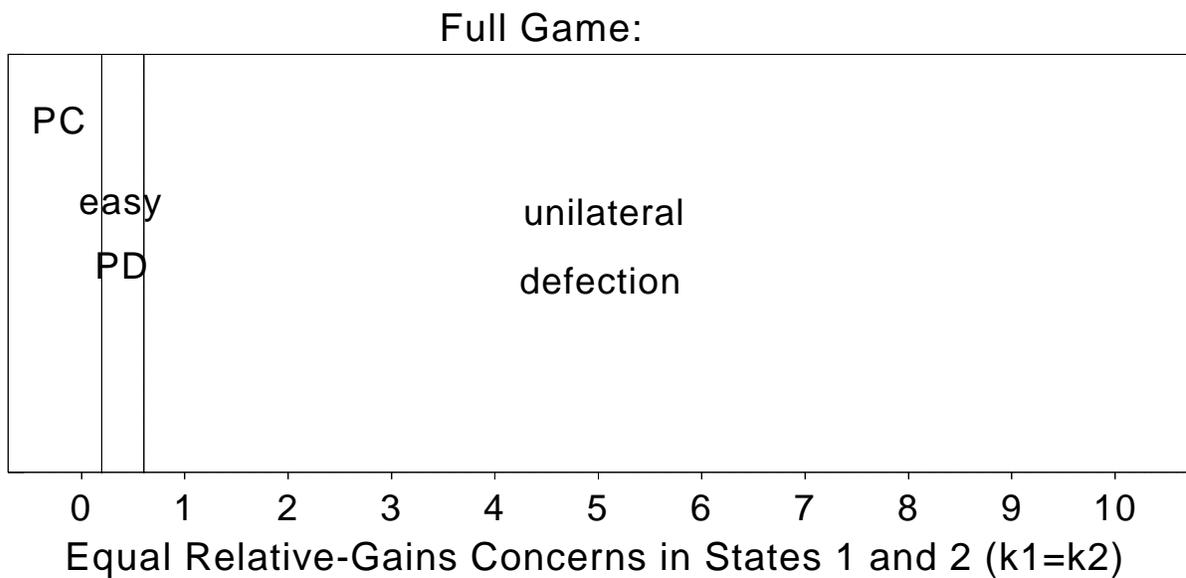
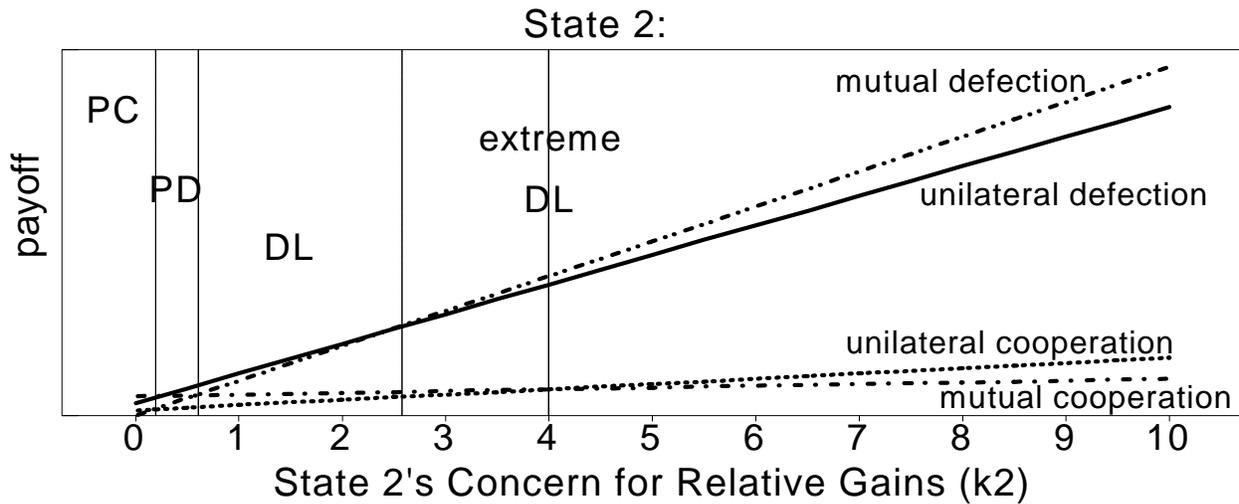
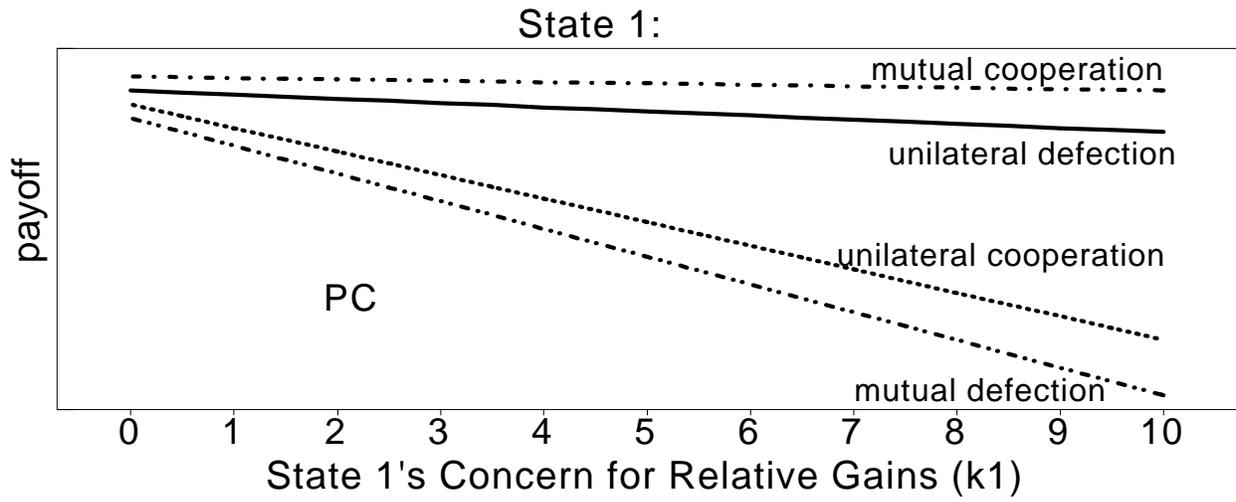


Figure 8: Lock-Step Complete Game, Case #3

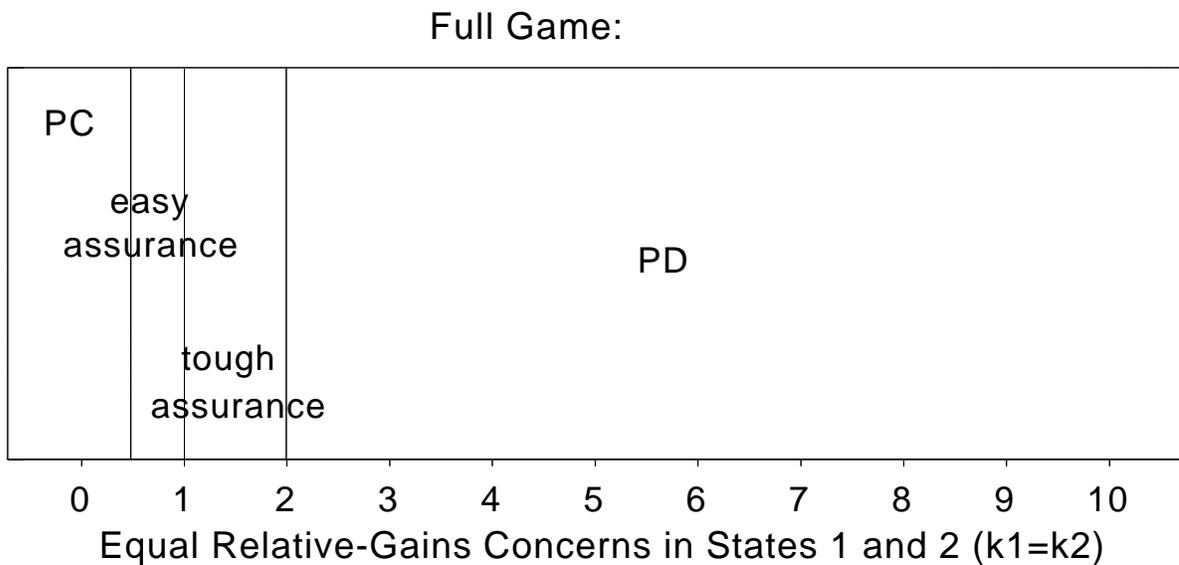
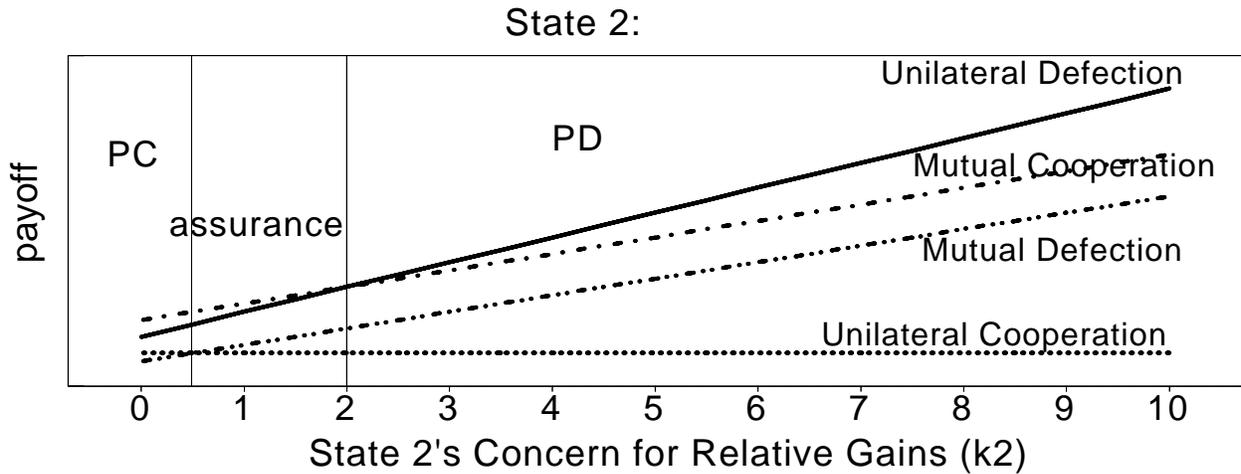
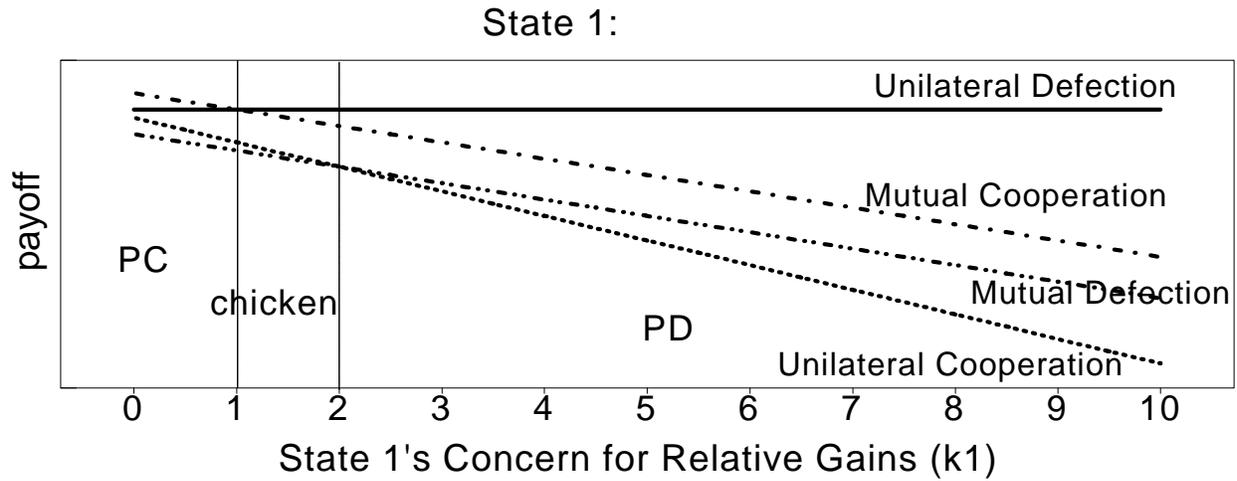
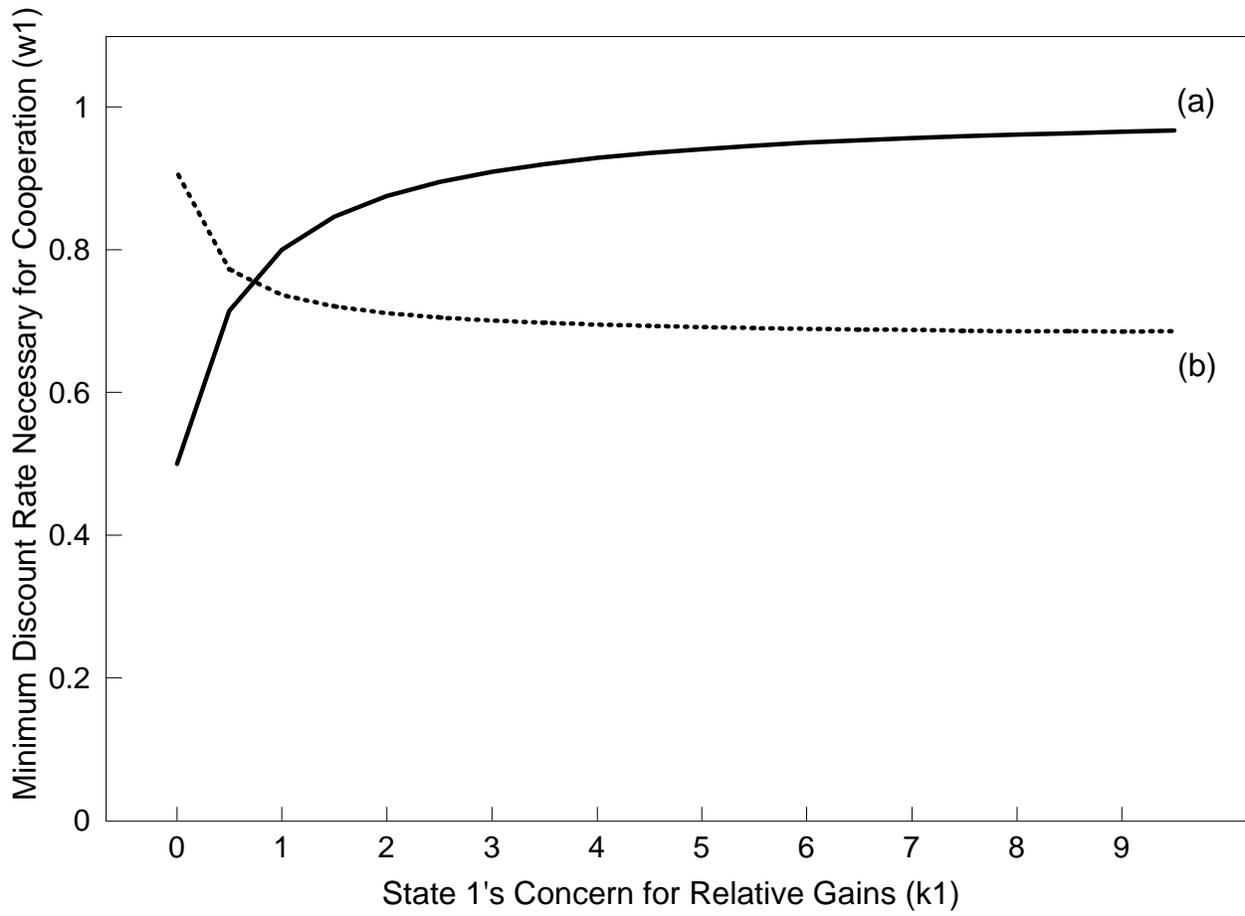


Figure 9: The Minimum Discount Factor for Cooperation and Concern for Relative Gains



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Notes

1. See also Grieco (1988a), Grieco (1990), and Grieco (1993). For other early discussions of how relative gains considerations inhibit cooperation see Jervis (1988) and Gowa (1986).

2. This may be what Grieco has in mind in a more recent claim that “international anarchy leads states to be concerned about gaps in gains from cooperation not just because they seek security and survival, but also because they value their autonomy and independence” (Grieco, 1993:734).

3. Rubinstein (1982) has shown that Nash Bargaining produces identical solutions to a competitive game of offers and counter-offers (under fairly general assumptions). To the extent, then, that international negotiations can be seen as a game of offers and counter-offers, *it is not valid to argue that Nash Bargaining is inapplicable to international relations as the former is a cooperative-game solution-concept and the latter is a competitive situation.*

4. For a more complete discussion of the Nash model see Harsanyi (1977). We rely upon Binmore (1992:180-191) for our formal treatment of the Nash problem.

A simpler method for analyzing bargaining involves specification of the “core” of the game. The core is the set of payoffs for all players in which no subset of players could improve their share by striking out on their own (Ordeshook, 1986:339-84). While this is useful way of narrowing down the number of feasible outcomes, analysis of the core rarely provides a determinant solution. Another alternative method employs the “Shapley value”, a related bargaining solution-concept which distributes the gains from a cooperative agreement on the basis of each partner’s marginal contribution to the total benefit (Shapley, 1959). We consider this marginal contribution to be part of the raw bargaining power of the state (see endnote 6). For a comparison of the Nash model and the Shapley value see Ordeshook (1986:475-77). While the Shapley value does provide a determinate solution, it relies on complicated calculations that have less intuitive appeal than the Nash model. Since the Nash model limits outcomes to the core of the two-player negotiation, and a state’s bargaining power in the Nash model is likely to be strongly correlated with its marginal contribution to cooperative agreements, our Nash results should not deviate greatly from outcomes derived by the alternative methods.

5. Formally, the Nash model requires two further assumptions: first, if we transform each state’s utility function in a positive linear way, then we transform the outcome of the negotiations in the same way; and second, if the solution when T is a set of feasible outcomes is (u_1^*, u_2^*) , and if we add outcomes to T to form U , then the solution with U defining possible outcomes should be either (u_1^*, u_2^*) or one of the outcomes that has been added.

6. The *status quo* payoffs here should be understood as the payoffs which accrue to each state if no agreement is reached. Therefore, they are not necessarily equal to the payoffs accruing before the potential agreement was mooted. They are the payoffs each state will get in a future where the possibility of this agreement arose but was turned down. The *bargaining powers* of each state should be understood as separate from the *status quo* payoffs. We shall refer to it as *raw bargaining power* by which we mean such characteristics as the marginal value of the state to the agreement (the Shapley Value), the negotiating ability of its representatives in the bargain, reputation, *etc.*

7. The reader following the math will find it easier to interpret the results from maximizing the log of the expression given in (2) than the expression itself. Transforming the expression in this way (with a monotonic increasing function like $\log(x)$) is of course always permissible.

8. This argument seems to imply an incentive for states in an environment of incomplete information about each other’s k to exaggerate their positional concerns (Grieco mentions this possibility in passing, 1990:230). This might lead to a kind of brinkmanship which threatens particular agreements, but so long as there remains a potential agreement range (*i.e.*, the possibility for both states to gain) rational states would restart negotiations. Something like this may well have been at issue in the (in)famous US-EC row over agricultural subsidies in the Uruguay Round of the GATT.

9. This can be seen by adding derivatives 6 and 7 holding $k_1=k_2$.

10. This can be seen by those with a background in public finance as something quite similar to a Ramsey rule. Nash Bargaining with concerns for relative gains allocates “taxes” more to those whose acceptance of the agreement is least sensitive to them and “subsidizes” those whose acceptance is most sensitive. The “taxes” in this context are relative

losses while the “subsidies” are relative gains.

11. The derivation of these results is simple. For state 1 when $k_1=1$, setting the utility function equal to zero and solving yields $v_1 = y_0/3$. When $k_1=0.5$, the solution is $v_1 = y_0/4$. These minimal acceptable payoffs are the same for state 2 when $k_2=1$ and 0.5.

12. For state 1, the minimum acceptable payoff from cooperation is found by setting the utility function equal to zero and solving to yield $v_1 = y_0/2 - v_1/2k_1$. The limit for v_1 as k_1 approaches infinity is thus $y_0/2$.

13. We would like to thank an anonymous reviewer at the Center for International Affairs at Harvard University for making this point.

14. For an argument linking institutions with transaction costs and issue linkage in international relations, see Keohane (1984).

15. Grieco (1993), too, has noted this limitation.

16. Note that perfect coincidence (PC) should generally characterize trade between unitary-state actors. Regarding states as unitary allows us to abstract from domestic, distributional issues involved in trade. While there are counter-arguments (such as optimal tariff and strategic trade theory), neoclassical economics is united around the conclusion that free trade Pareto dominates protection. Rather than debate the issue here, we accept, at least for expositional purposes, the neoclassical result and its concomitant conclusion that (unitary) state actors have the incentive to liberalize trade despite any “opponent’s” obstinacy. Thus, the key to the payoff orderings for PC are that mutual free-trade is preferred to unilateral protection (and to all other outcomes), so there is no incentive not to cooperate. In such a setting, relative-gains concerns are needed to explain any *non-cooperation* in trade matters.

17. The conditions derived for PD or DL to describe the amended game, however, apply to any matrix of absolute payoffs substituted for the initial payoff variables regardless of the whether they take the PC ordering (under some original game-forms, one or more of the conditions may be assured or precluded).

18. The mnemonic device used in labeling our payoffs is r = reward to mutual cooperation, s = sucker’s payoff for unilateral cooperation, t = temptation payoff for unilateral defection, and p = punishment payoff for mutual defection.

19. The three conditions given ensure that the game turns into DL at some level of k_1 , but they do not ensure that DL is the “final” form of the game. For DL to be the final game as k approaches infinity, it is also required that $t_2-s_1 > r_2-r_1$, and $p_2-p_1 > s_2-t_1$, so that the complete (necessary and sufficient) condition is, $t_2-s_1 > r_2-r_1 > p_2-p_1 > s_2-t_1$. This is easy to see since as k_1 goes to infinity only the payoff differences matter. Thus, the given series of inequalities is precisely that given by (15) in the text, ignoring the constants and dividing by $-k_1$ (remembering to reverse the inequalities).

For the switch from PC to PD to occur, then, the relative gains from unilateral defection must be larger than those from mutual cooperation and the relative loss in mutual defection must be less than that of unilateral cooperation. Assuming these conditions are met, we can derive the level of k_1 (the solution for k_2 is symmetric) required for PC to become PD. Both of the following conditions must hold:

$$k_1 > (r_1-t_1)/[(r_2-s_2)-(r_1-t_1)] \text{ (a)}$$

and

$$k_1 > (s_1-p_1)/[(t_2-p_2)-(s_1-p_1)] \text{ (b)}$$

If the original game is PC, the right-hand side of these inequalities may be positive or negative. Now, to move from PD to DL the middle two terms of inequality (14) in the text must switch. In order for this to occur, $k_1[(r_2-p_2)-(r_1-p_1)]$ must exceed r_1-p_1 . Since $r_1 > p_1$ and $k_1 > 0$, this means that r_2-r_1 must be greater than p_2-p_1 . Again assuming the precondition is met, we derive the level of k_1 required to transform PD to DL:

$$k_1 > (r_1-p_1)/[(r_2-p_2)-(r_1-p_1)] \text{ (c)}$$

These inequalities can be used to solve analytically for the k_i ’s at which games change in figures 3-8. Notice that even if the original game is PD, inequality (c) is not assured to hold because the right-hand side under those conditions can still be positive.

20. Grieco derived the condition $k_1 > (r_1 - p_1) / [(p_1 - p_2) - (r_1 - r_2)]$ for the transformation of PD to DL, implicitly assuming that $(p_1 - p_2) > (r_1 - r_2)$. If this does not hold, the direction of the inequality would have to be switched implying the k_1 must be less than a negative number which cannot be true.

21. Notice here that $r_1 - k_1(r_2 - r_1)$ crosses $t_1 - k_1(s_2 - t_1)$ at the level of k_1 at which $s_1 - k_1(t_2 - s_1)$ crosses $p_1 - k_1(p_2 - p_1)$. But this need not be the case. If $t_1 - k_1(s_2 - t_1)$ intersects $r_1 - k_1(r_2 - r_1)$ first, the game becomes “chicken” before it converts to PD. This occurs when

$(r_1 - p_1) / (r_2 - r_1 - (s_2 - t_1)) < (s_1 - p_1) / (t_2 - s_1 - (p_2 - p_1))$. If $p_1 - k_1(p_2 - p_1)$ crosses $s_1 - k_1(t_2 - s_1)$ first, the game becomes “assurance” before it converts to PD. This occurs when $(r_1 - p_1) / (r_2 - r_1 - (s_2 - t_1)) > (s_1 - p_1) / (t_2 - s_1 - (p_2 - p_1))$.

22. The subsidies component of the Subsidies and Countervailing Measures Code is ignored here since in Grieco’s view, while greater transparencies on subsidies would have provided absolute to both players (but relative losses to the EC), greater discipline on agricultural subsidies would have produced an absolute loss for the EC. Non-cooperation was therefore over-determined.

23. Grieco also discusses the EC resistance to demands that VAT charges be included in contract estimates, a step which would have placed many more purchases over the threshold for code coverage. But he does not argue that this was an issue for the EC-US balance, but rather a problem of balancing the costs of the agreement between EC member states with different VAT levels. Notably, though, the U.S. was aggrieved enough to bring the matter before a GATT dispute panel which ruled in its favor in 1984.

24. There is a suggestion that US negotiators may actually have made such offers (Grieco, 1990:185n).

25. The US and EC did eventually reach a compromise on the VAT issue. After the GATT panel ruling in favor of the US, the EC accepted a unilateral reduction of 6.5% (later 13%) in the contract-threshold value (Grieco 1990:187).

26. Our bargaining analysis represents a new way of analyzing the common observation that the small can sometimes exploit the large, an analysis similar to that made in Snidal (1991:720) and in contrast to the standard explanation offered by Olson and Zeckhauser (1966) and Kindleberger (1973).

27. As we suggested in the text above, figure 2 is also relevant to this point. Our bargaining analysis, as indicated in that figure, implies that when states are fairly equal, positionality concerns have to be considerably different between the states for the impact on bargained arrangements to be appreciable.

28. Formally, if only absolute gains matter, we need to rank the payoffs to mutual defection, mutual cooperation, unilateral defection, and unilateral cooperation for each state (p_i, r_i, t_i, s_i) in order to determine the structure of the game. When positionality is relevant, on the other hand, we need to be able to rank $r_i - k_i(r_j - r_i)$, $p_i - k_i(p_j - p_i)$, $t_i - k_i(s_j - t_i)$, and $s_i - k_i(t_j - s_i)$ to make the same determination. That the latter requires a cardinal payoff matrix is obvious.

29. One might read into Grieco an attempt at both. He makes the claim that “the EC believed that the technical standards and government procurement issue areas could play a vital role in refurbishing the industrial sectors of EC member-states...[and] in other words, viewed the two issue areas as having strategic implications for their future as autonomous actors in the world economy” (Grieco 1990: 203). It would be difficult to fit this interpretation under strategic trade theory which shows the welfare-enhancing effects of a *production subsidy* in providing first-mover advantages to firms *in global markets where the efficient scale of production supports only one or few producers*. For a statement of the theory and its narrow applicability see Krugman (1987). In any event, Grieco makes no attempt to verify that the conditions set forth in Krugman actually apply to the industries affected by the agreements. Furthermore, even if the theory applies to these industries, it calls for specific subsidies to production not general trade restrictions in the form of technical standards and government-procurement regulation. The same argument applies to any claim that there were technological (or any other variety of) spill-overs in these industries and therefore that “strategic” trade barriers are preferred to liberalization.

Alternatively or additionally, his references to the beliefs of leaders in this context (p. 203-9) may leave open the possibility of a model based on domestic political concerns yielding policy preferences different from those implied by economic trade theory. Still, the point is that these preferences need to be more explicitly specified so as to determine the original game structure and check the transformation conditions.

