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Cantankerous Cooperation: Democracies, Authoritarian Regimes, and the Prisoner's Dilemma

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One of the most important debates in the field of international relations is over the effect of regime type on militarized conflict. This debate, however, has rarely extended to how regime type influences other aspects of foreign policy. Using a computer simulated intergroup prisoner's dilemma, we investigate whether democratic decisionmaking groups are more cooperative than authoritarian decisionmaking groups. We argue that differences between cooperation tendencies of groups can be explained by the structure of the decision process. Repeated simulations show that democracies tend to be more consistent in their decisions in comparison to authoritarian groups. Implications for international relations theory and policy are discussed.

KEYWORDS *computer simulation, prisoner's dilemma, international relations, cooperation, conflict, democratic peace theory*

One of the most actively debated propositions in international relations theory is that democracies do not fight each other. The so-called democratic peace theory has been discussed, debated, and refined, and continues to occupy a prominent place in the international relations literature (Ray, 1988; Russett, 1993; Maoz and Russett, 1993; Owen, 1994; Hermann and Kegley,

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1996; Starr, 1997; Chan, 1997; O'Neal, Russett, and Berbaum, 2003). Empirically, the findings that buttress the democratic peace have been quite robust. Yet, it has been argued that a strong theory that adequately explains the absence of war between democracies is lacking (Gowa, 1999; Rosato, 2003). Furthermore, it remains in question if this absence of declared war leads to less conflictual relations between democracies. There have been attempts to extend the scope of democratic peace beyond the question of declared war (Fordham and Walker, 2005), but it still remains to be established if democracies are more cooperative in their foreign relations.

Using a computer simulation of a common collective action problem, this paper investigates whether the structure of decisionmaking affects the propensity to cooperate. Simulated agents are imbedded within democratic and authoritarian decisionmaking structures and are then placed in an iterated prisoner's dilemma to determine whether a significant difference exists in their level of cooperation given differing structures. The ultimate goal is to illuminate the link between regime type and the propensity toward cooperative behavior. Based on the outcome of the study, several implications emerge for understanding the behavior of states. These include evidence suggesting that there are significant differences between democracies and authoritarian regimes in their patterns of cooperation vis-à-vis their opponents.

WHAT EXPLAINS THE DEMOCRATIC PEACE?

Observed differences in the foreign policies of democracies and authoritarian states are usually explained as either normative or structural properties of the states. In the case of the democratic peace these normative and structural factors are thought to contribute to democracies avoiding war with other democracies. The literature on democratic peace generally argues that democratic dyads are more peaceful due to shared norms of nonviolent conflict resolution and/or structural constraints on the use of power.

Evidence from this research program suggests that while democracies do not go to war with each other, democratic states do appear to be as conflict prone as nondemocracies when paired with nondemocratic regimes.[1] Maoz and Russett (1993) explored the two possible reasons for this scenario by outlining the logic of normative and structural explanations of democratic peace. Normative explanations have roots in Kantian thought. Political conflicts can be resolved through peaceful means. Democratic systems foster competition between political factions. Democracies remain stable in spite of internal

[1] This distinction is commonly expressed as two alternate hypotheses of democratic peace. The dyadic hypothesis deals with the lack of declared war between two democracies. The monadic hypothesis, which has garnered much less support, suggests that democracies are always less war prone than other regime types.

contestation in larger part because of norms of compromise (Smith, 1996). The two basic assumptions that underlie this normative model include:

1. *States, to the extent possible, externalize the norms of behavior that are developed within and characterize their domestic political processes and institutions.*
2. *The anarchic nature of international politics implies that a clash between democratic and nondemocractic norms is dominated by the latter, rather than the former* (Maoz and Russett, 1993, 624 italics in the original).

According to the normative argument, democratic regimes attempt to externalize their internal norms of nonviolent conflict management and compromise; however, the nondemocratic norms of the anarchic international system can thwart this externalization. Political competition in nondemocracies tends to be more contentious and often produces clear winners and losers. These conflicts often become violent in part because nondemocratic systems tend toward winner-take-all outcomes (Maoz and Russett, 1993).

Alternate explanations for democratic peace have been advanced by numerous scholars focusing on the structure of democracies as the causal factor. Democratic leaders are held to account for unsuccessful or costly wars (Bueno de Mesquita et al., 1999; Reiter and Stam, 2002). Another explanation is that democracies are generally pluralist societies and leaders may be constrained by segments of the population that are opposed to war (Russett, 1990). Finally, scholars have argued that democratic institutions require a level of transparency that reduces misperception regarding intentions and capabilities (Bueno de Mesquita and Lalman, 1992; Crawford, 1994; Fearon, 1994; Starr, 1997). Because a state can never be sure of another's intentions, transparency is important in helping states to discern the hawkish or dovish nature of an opponent (Starr, 1997). Typically, an authoritarian regime is better able to cloak its decisionmaking process from an opponent, which can lead to a greater likelihood of misperception. In addition, it is easier to vilify an opponent where little public information is available than to attempt the same strategy against a transparent democratic society. Public willingness to go to war then will be decreased by the knowledge of the other's society (Starr, 1997).

An important assumption underlying the structural model is that political leaders must mobilize domestic support for their policies from groups that legitimate the actions of the government (Maoz and Russett, 1993). In other words, war can only occur when the legislature, the public, key interest groups, and the members of the bureaucracy are sufficiently convinced that war is the appropriate policy. Consequently, in democratic systems there are multiple groups and institutions that must be brought on board for policies, be they peaceful or warlike, to be executed.

Maoz and Russett concluded that both explanations help account for the democratic peace. Their findings for the normative model were more conclusive, which led to their conclusion that "Both political constraints and democratic norms provide reasonably good explanations of why democracies don't fight each other . . . [but] the normative model may be a better overall account of the democratic-peace phenomenon than the structural model" (Maoz and Russett, 1993, p. 636). The implications of the various mechanisms by which democratic structures produce the democratic peace remain largely under explored. It is unclear if these structures and processes manifest themselves in additional ways. Conceivably, mechanisms that avert warfare between democracies might lead in a more general way to less contentious everyday interactions between democracies.

It is also important to note that while the empirical findings of the democratic peace have been robust, the theory has also accumulated an equally robust set of criticism. Scholars have critiqued the methodological techniques used to produce the empirical findings (Spiro, 1994). Others have taken issue with the imputation of peace among democracies during the Cold War to the presence of democracy. The covariance of shared alliance membership, nuclear restraints, and bipolarity with democracy during this period all detract from the empirical foundations (Farber and Gowa, 1997; Gartzke, 1998). Finally, attempts have been made to systematically undermine and discredit the causal mechanisms proposed by advocates of a democratic peace phenomenon (Layne, 1994; Rosato, 2003). The rebuttals to these critiques have been intense (Russett, 1995; Kinsella, 2005; Slantchev et al., 2005).

This ongoing debate only deepens the need for scholars to look for innovative ways to think about and evaluate the democratic peace phenomenon. In the following sections we outline how structural factors of democracies and authoritarian regimes, might translate into different political outcomes as states seek to overcome the challenges of the anarchic international system. We argue that regime structure plays an important role in the type of policies states select given the constraints on cooperation stemming from anarchy.

INTERNATIONAL RELATIONS, COLLECTIVE ACTION, AND THE PRISONER'S DILEMMA

The basic challenges faced by states in the international system are problems of collective action in an anarchic environment, which can be captured in the prisoner's dilemma (PD) game (Stein, 1980, p. 79). Robert Jervis (1976, 1978) has used the PD to illustrate the security dilemma. States would be better off if everyone possessed fewer arms, but all states know that they would be worse off if they did not militarize, while others did. The result is that anarchy drives states to pursue their own security at the expense of their neighbors' security. The PD has been used by others to understand the provision of global economic infrastructure (Conybeare, 1984; Lake, 1993) and to study the emergence of cooperation between states (Axelrod, 1984).

The PD is a useful tool for representing the international system because it captures both the temptation for states to cheat at the expense of their neighbors and the fact that mutual defection results in a less than optimal outcome. The PD is a competitive interaction where the dominant strategy for both players is to not cooperate, even though the Pareto optimal outcome is for both to cooperate.[2] John Conybeare (1984) expands on how this situation operates in his observation that when a player chooses to cooperate "a nonexcludable opportunity is created for as many other players as exist to exploit the actor who cooperates" (p. 7). All players have an incentive to not cooperate so as to avoid exploitation, but the end result is for all players to be worse off than they would have been if all had chosen to cooperate. Deviation from the defect-defect equilibrium is difficult because any move to unilaterally cooperate will lead to an even worse situation for the participant that changes course.

Although cooperation may be preferred by most actors in the international system most of the time and is in the best interests of the group as a whole, conflictual interactions and defections still regularly occur. All too often, individuals pursue strategies that are in their own interest, but may decrease group welfare (Frolich and Oppenheimer, 1996). Yet, the literature on neoliberal institutions has largely shown that the challenges imposed by the prisoner's dilemma are not insurmountable (Axelrod and Keohane, 1985).

Studies using an iterated prisoner's dilemma (IPD) have shown that over time reciprocity, or a Tit-for-Tat strategy, can produce cooperation (Axelrod, 1984; Macy, 1991). In contrast, in one-shot prisoner's dilemmas it is more likely for participants to defect. When the two parties have repeated interactions the possibility of cooperation is increased due to the concern for future rounds or what is termed the "shadow of the future" (Axelrod, 1984). Experimental research has also demonstrated that cooperation can be enhanced through communication between players (Majeski and Fricks, 1995).[3]

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2 A Pareto optimal outcome exists when no alternative makes every player at least as well off and at least one player strictly better off. In a PD either player can improve on the Pareto outcome, but only at the expense of the other player.

3 While the literature on cooperation under the constraints of the prisoner's dilemma is quite extensive there have been several critiques, suggesting that cooperation may face obstacles other than the temptation to cheat. Defection by an individual or group can result from fear or greed. Fear is the motivation when the group is concerned that the opposition will defect. When greed is the motivation, the group will defect to gain an advantage over the other participant. Communication can help reduce fear but may not affect the greed motivation (Majeski and Fricks, 1995). Perhaps the most aggressive critique of neoliberal conceptions of cooperation resulting from iterated interaction came from Mearsheimer (1994). Mearsheimer points out that cooperation only makes sense if states are interested in absolute gains. Realism, he argues, rejects this assumption in favor of relative gains. Thus, Mearsheimer sees cooperation as much more difficult to achieve and sustain.

Although the theoretical literature is replete with examples of problems of collective action (Samuelson, 1954; Hardin, 1968; Jervis, 1976; Sandler, 2002; Kaminski, 2001), experiments testing the theory are limited (Marwell and Ames, 1979). Early PD experiments focused primarily on individuals, but recent focus has shifted to the study of groups (Insko et al., 1993; Insko et al., 1994; Majeski and Fricks, 1995). Yet, even with this new focus on groups, the role of the decisionmaking structures on the behavior of groups in a prisoner's dilemma has not been investigated. Understanding the structure of decisions within groups may help explain cooperation patterns in the group PD.

Structural explanations for democratic peace suggest that the institutional configurations of states have ramifications for how they interact in an anarchic environment. Do democracies play the prisoner's dilemma differently than authoritarian regimes? This is a missing link in our understanding of how democratic and authoritarian regimes approach and respond to the basic problems of the anarchic system.[4] Our next task is to demonstrate how we conceptualize regime type and how best to model the decisionmaking process of these two types of regimes.

CONCEPTUALIZING REGIME TYPES AND MODELING GROUP DECISIONS

The two regime types that are most common in the world system today are democratic and authoritarian. Totalitarian, fascist, and aristocratic regimes have all been a part of the historical landscape, but they do not occupy a prominent position in the present system. A widely accepted definition of democracy remains elusive (Schmitter and Karl, 1996), yet Robert Dahl's definition is a minimalist starting point that has been widely used. Dahl claims that, "a key characteristic of a democracy is the continued responsiveness of the government to the preferences of the citizens, considered as political equals" (Dahl, 1971, p. 1). Judging by the thick debates in the literature, democracy likely entails a great deal more (Mueller, 1992; Huntington, 1991, Dahl, 1971). For the purpose of this study, the critical component to model is the behavior of elites in a democratic state. Therefore, giving each agent a vote allows for a model of foreign policy decisionmaking in a representative democracy. This

[4] This project focuses primarily on the structural aspects of decisionmaking. There is a broad and varied literature on decisionmaking that draws from Social Psychology (Jervis, 1976; Snyder, 1984;), Organization Theory (Janis, 1972; Halperin, 1974; Allison, 1971) and economic modeling and formal theory (Bueno de Mesquita and Lalman, 1992; Powell, 1988). While these approaches have made significant contributions to our understanding of foreign policy, they go far afield from the central focus of this paper: the impact of structure on decisionmaking. For useful introduction to decision theory from a structural perspective, see Margaret G. Hermann's (2001) "How Decision Units Shape Foreign Policy: A Theoretical Framework."

process is characterized by elite bargaining. Although leaders in democratic systems are ultimately accountable to a state's citizenry, foreign policy decisions still remain largely the domain of elites and of elite bargaining. These elites have different goals and constituencies, but for simplicity the interaction of elites can be studied rather than the interaction of constituencies. To model this process of elite bargaining, we have allowed for each agent in a decision-making group to have a unique personal experience and thus a distinctive propensity to cooperate.[5] Together these agents form a democratic decision-making group that makes choices based upon majority rule.

While the majority rule is likely not appropriate for authoritarian regimes, it would be naive to assert that authoritarian regimes are run by fully autonomous heads of state. Juan Linz (1975) offers one of the most accepted definitions of an authoritarian regime:

> Authoritarian regimes are political systems with limited, not responsible political pluralism; without elaborate and guiding ideology but with distinctive mentalities; without intensive or extensive political mobilization, except some points in their development; and in which a leader or occasionally a small group exercises power within formally ill-defined limits but actually quite predictable ones.[6]

With this definition as a frame, we model authoritarian structures by including a decisionmaking elite that has some limited influence over the leader. The leader maintains the ability to make decisions independent of other elites but does take into consideration the positions of the other elites. The exact mechanism determining the leader's decisionmaking is explained further in the modeling section.

This process of representing group choice has at least one imbedded assumption. The agents in this simulation have perfect information regarding both the potential payoffs and the outcomes. Although this is nearly impossible to achieve in the real world, it is assumed that the process in which decisions are made is more important for this study than the perceptions held by individual agents.

A STOCHASTIC INTERGROUP PRISONER'S DILEMMA MODEL

The promise of the prisoner's dilemma construction is that it has allowed various disciplines ranging from biology to political science to research

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5 This process of elite bargaining can be thought of in terms of Graham Allison's (1971) model III explanation for foreign policy decisions. Model III posits that foreign policy is the outcome of political bargaining by elites. Each relevant official has different goals and interests, and the ultimate decision is arrived at through a complex negotiating process.

6 Juan Linz, "An Authoritarian Regime: Spain," Allardt and Rokkan, eds., *Mass Politics: Studies in Political Sociology*, pp. 251–283.

using a common framework (Axelrod, 1997). In international relations, the iterated prisoner's dilemma (IPD) is used to model state behavior in a self-help system. Our research reflects and builds on this approach. The IPD is used to model state interaction in a system characterized by a collective action problem. The main adaptation and contribution of our model is the representation of states as groups of agents. This emulates the two-level nature of international interaction by allowing for foreign policy strategies chosen by states to be determined by domestic structures. In the modeling of the domestic level, each state has five agents. These agents make decisions about cooperation or defection according to a democratic or authoritarian decision rule. Our principle concern is whether groups that utilize a democratic decisionmaking rule are more or less cooperative than groups that use an authoritarian decisionmaking rule.

The computer simulation developed for this project builds on Macy's (1991) work on stochastic learning models and the prisoner's dilemma. Macy's stochastic model has been adapted by other researchers to address issues ranging from voter turnout (Kanazawa, 1998) to collective action (Oliver, 1993). Macy's stochastic IPD operates using agents with unique predispositions toward cooperation. These predispositions affect but do not determine the behavior of agents in any given round of play. Agents are able to assess what strategies work by adjusting their predispositions according to the success or failure of a particular strategy.[7]

The model employed here involves two phases. Phase I of the model replicates Macy's work almost identically (with a minor change reflecting a different payoff matrix). Phase II takes the same concept of learning based on past successes and integrates it into a group-based prisoner's dilemma. The model is based on the concept that each agent has a personal cooperation tendency. This natural tendency can be reinforced and enhanced or it can deteriorate depending on the success or failure an agent has interacting with its environment. This is meant to mirror the trust-building process that occurs in everyday human interactions. The agent cooperation tendency can range from 0 to 1. An agent with a cooperation tendency of 1 will cooperate 100 percent of the time while an agent with a tendency of 0 will never cooperate.

To make a decision (cooperate or defect), an agent compares its personal cooperation tendency with a randomly generated number ranging from 0 to 1. If the cooperation tendency is greater than or equal to the random number, then the agent will choose to cooperate; otherwise it will defect. Because human behavior is not entirely predictable, relying on a random number adds an element of realism to the cooperation tendency. The cooperation tendency does, however, provide a sense of what is probable.

[7] Again the decisionmaking literature has tackled this notion of learning from a wide range of perspectives. For a summary of the learning literature see Jack S. Levy's (1994) "Learning and Foreign Policy: Sweeping a Conceptual Minefield."

The importance of this randomness will be discussed in light of alternate methods of simulating agent choice in the next section.

Once agents have selected their strategies, they are awarded according to the outcome of the round and the payoff matrix. Each agent then determines if it is satisfied with the outcome of the round. This deviation from Macy's model is merely a superficial one, which compensates for the different payoff matrix employed in this experiment (See Table 1).[8]

Macy is able to designate positive numbers as "successes" and negative numbers as "failures." To devise a similar set of results given a different matrix requires that agents be able to look at any payoff matrix and determine what will be a successful strategy given the available rewards.[9] Agents analyze matrixes by adding up the possible payoffs from each of the four outcomes (0 for Macy and 12 for Young/Urlacher). This number is then divided by 4 to set the minimum success threshold (Macy is 0 and Young/Urlacher is 3). This represents the "average" return. Beating the average is then considered a success while falling short is deemed a failure. The average return is then subtracted from the reward each agent receives. This yields a positive or negative number that reflects the magnitude by which the reward beat or missed the average. This magnitude is a critical part of the learning process.

Agents learn by assessing the strategy chosen, the success or failure of the strategy, and the magnitude of that success or failure. An agent's cooperation tendency is adjusted to reflect these various factors. For example, an agent that cooperates and receives a reward of 4 will determine that cooperation is a successful strategy, and the agent's cooperation tendency will be adjusted so that the agent will cooperate more in the future. This is accomplished by adjusting the agent's cooperation tendency upward. Similarly, an agent that cooperates but receives a 1, which is less than the average payoff, will have its cooperation tendency lowered given that cooperation is not working. This process is a simplification of the Bush-Mosteller binary choice learning mechanism.[10]

TABLE 1 A Comparison of Agent Payoff Matrices for Macy and Young/Urlacher Experiments

	Macy		Young/Urlacher	
	C	D	C	D
C	1, 1	−2, 2	4, 4	1, 5
D	2, −2	−1, −1	5, 1	2, 2

8 The payoff matrix we used is the same as the one used by Majeski and Fricks (1995).

9 Macy argues that a payoff matrix can be reduced to two elements: magnitude and severity. Mathematically the matrix employed here is identical to Macy's. Both yield a severity of 2 and a magnitude of 1 (Macy, 1991, pp. 817–818).

10 This adaptation of the Bush-Mosteller mechanism deviates from Macy's additional model; however, the general concept of re enforcement of success and erosion as a result of failure is consistent.

As with the Bush-Mosteller learning mechanism, the magnitude of the reinforcement provided by the learning mechanism varies according to the degree of success or failure. As the distance between the average from the payoff matrix and the reward increases, the impact on agent learning also increases. Thus, greater levels of success will result in greater levels of reinforcement. While the Bush-Mosteller learning mechanism alters the rate of learning so that it asymptotically approaches the extremes of 0 and 1 and is greatest at .5, the learning mechanism employed is a simplification that remains static across the spectrum of cooperation tendencies. The level of learning that was set for this model is +.042 for a CC outcome, ±.083 for a CD or DC outcome, and a −.042 for a DD outcome.[11] This reinforcement is provided as long as it does not exceed the upper and lower bounds of 1 and 0. This prevents agents from developing patterns of cooperation that cannot ever be broken.[12] In short, this restriction preserves the ability for random events to impact agents even long after stable equilibriums have been achieved.

It should be noted that in Macy's stochastic learning model and in our adaptation some degree of cooperation is built into the underlying assumptions. The only strategy that allows both agents to be satisfied and to have a stable strategy is for both to cooperate. Mutual cooperation reinforces the behaviors in both that lead to success. If one agent cooperates and the other defects, both agents will adjust their strategies accordingly (cooperating less). The agent that cooperated will reduce its cooperation tendency because cooperation was met with exploitation. In contrast, the agent that defected will reduce its cooperation tendency because defection appears to be a successful strategy. The result is a race to the bottom with cycles of CD and DC that eventually erode into DD. In this situation neither agent is able to find a long-term strategy of success. The result is an oscillation between defection and cooperation as agents realize that a defect-defect strategy is not succeeding. Yet, before the agents are able to break into patterns of cooperation, one will defect sending the whole system crashing back into defection (see Figure 1).

This can be seen in real world negotiations, such as in the Israeli–Palestinian conflict or Northern Ireland, where even minor stumbling blocks

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[11] These learning levels were set from the payoff matrix by reflecting the magnitude of difference from the average return and dividing by the total possible payoff for both players. This is one of several possible ways that the learning mechanism can be structured. Our Belief is that the implications of learning mechanisms has been largely under explored, and we choose to rely upon a parsimonious approach that would imbed fewer assumptions into the model while preserving its functionality. It is important to note that the sign in front of these percentages does not correspond to how they will be used. For example a −.042 from a DD scenario will be subtracted resulting in a cooperation tendency increase of .042. A DC strategy will result in the .084 being subtracted from the cooperation tendency.

[12] If both agents have cooperation tendencies above 1, then a random number generator that ranges from 0 to 1 will never allow for either to defect. Because this strategy is reinforcing, cooperation scores could grow indefinitely while never changing the possibility of defection (which would forever be 0).

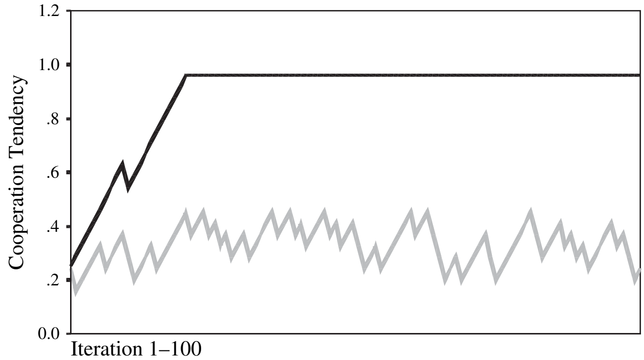

FIGURE 1 This graph represents the histories of two different pairs of agents. Both pairs started out with cooperation tendencies of .25. Pair 1 (black line) cooperated in the first couple of iterations and managed to build a successful CC strategy. Pair 2 (gray line) failed to build the necessary trust to sustain a CC strategy and became trapped in an uncooperative scenario.

can destroy a limited willingness of both parties to cooperate in response to a hurting stalemate. After such a collapse, the parties involved often require a period of time before each side will acknowledge that the only viable strategy is to once again work toward cooperation.

Macy noted a similar pattern in his model and suggested that the key to success was early cooperation (Macy, 1991, pp. 818–820). If agents are able to break into cycles of cooperation initially, they can avoid the disastrous defection-induced crashes. Once caught in the defection trap the only way out is for an unusual string of random numbers that allow for a long streak of mutual cooperation. This can push the agents over the threshold of defections and into a cooperative world.

The stochastic learning model was selected over several other possibilities for two critical reasons. The first reason is that it captures the nuances of a complex system.[13] Secondly, this approach is relatively parsimonious from a programming perspective. While we will not explain in excessive detail the specifics of alternative models, it is useful to note the general advantages of a stochastic model.

In an early study utilizing the prisoner's dilemma and computer programming in international relations, Robert Axelrod hosted two round-robin

[13] Evolutionary learning would have provided similar insights into the nuances of the system; however, we choose to avoid evolutionary approaches for the following reason: Evolutionary models generally operate on the principle that each agent has a slightly different strategy. At the end of a single round or at the end of a set number of rounds those agents that have been successful are allowed to reproduce (the next generation will contain more agents using successful strategies) while unsuccessful strategies will "die out." While this will likely produce results similar to a stochastic learning model, there is a lack of continuity between agents over time. Individual agents do not learn but are replaced by agents that have significantly different strategies. This becomes problematic in comparing how groups negotiate because groups do not mutate and are not replaced in the manner implied by evolutionary models.

tournaments for programmed strategies. The most successful strategy to come out of Axelrod's tournaments was "Tit for Tat" (TFT). TFT functions by cooperating on the first round, and then uses the strategy employed by its opponent in the previous round. It looks at recent behavior of its opponent to make future decisions. The result of this strategy is immediate feedback to an opponent that defection is not a strategy that will work over the long term. By quickly putting the fruits of DC or CD out of reach, it forces agents to seek a CC strategy, which TFT is willing to accommodate. While this simple strategy is amazingly successful in playing against a wide variety of strategies, it is less than useful as a means of getting at the systemic cooperation dynamics produced by different structures. One thousand TFT agents facing each other will always cooperate all the time. When past behavior determines future outcomes, agent choices are path dependent and completely predictable. For this reason TFT and other historically grounded (backward looking) variations are not employed. Macy outlined how the stochastic model avoids the sort of deterministic outcomes that result from a backward looking strategy.

> The [Stochastic Learning] model is not deterministic. Stochastic search introduces an element of uncertainty or "noise" that captures the idiosyncrasies of human behavior. . . . The model assumes only that the actors have a tendency to cooperate that is reinforced by the payoffs. They remain free to do the unexpected so long as their whims are randomly distributed (Macy, 1991, p. 811).

This unpredictability makes each agent somewhat unique and provides an opportunity to assess the impact of structure on decisionmaking in a way that a path dependant strategy would not.

STOCHASTIC GROUP DECISIONMAKING

Phase II integrates the stochastic decisionmaking and the learning processes with group decisionmaking rules. Agents aggregate their individual decisions through either democratic or authoritarian decisionmaking processes. Although the prisoner's dilemma game is played by groups, the learning process is applied to individuals.

The democratic decision process generates a random number for each agent and compares this number to the agent's cooperation tendency. This process is repeated for each agent and the number of agents in the group who choose to cooperate is tallied. A majority "vote" results in a cooperation strategy for the round. A minority supporting cooperation means defection.

The authoritarian decision process functions under a weighted average regime. The first agent in the group is designated the "president." In a perfect authoritarian system the decision of the group would entirely be dependent upon the president's cooperation tendency. Perfect authoritarian systems, however, are abstractions that do not reflect the role of the other elites in the decisionmaking processes. Authoritarian leaders are always constrained to some degree by other elites competing for influence. To integrate elite bargaining into the leader's decision requires a significant abstraction of a relatively intangible process. For the purposes of this model, Elite Impact (EI) is reduced to a percentage of impact. This is calculated using the following formula.

$$\frac{[CT_1 * (100 - EI)] + \left[\frac{EI * \sum_{i=2}^{N} CT_i}{N - 1} \right]}{100}$$

CT_i represents an agent's individual cooperation tendency while EI stands for the amount of impact the elite have on the leader's choice (0 to 100). The leader is the first agent with CT_1. The elite includes agents 2 through N. This formula generates a group cooperation tendency that is weighted by the relative importance of the leader and the elite. It is this group tendency that is then compared with a random number to determine cooperation or defection strategies.

The learning mechanism is applied to each individual in response not to the individual's choice but to the group's choice. Thus, an agent that voted to cooperate in a group of agents who all wanted to defect will have its cooperation tendency adjusted in response to the strategy selected by the group. This adjustment occurs according not to the single agent's choice to cooperate but in response to the success or failure of the group's attempt to defect.

PROPOSITIONS

In keeping with structural explanations of democratic peace, we would expect that foreign policy decisions in democracies are constrained by domestic interest groups, public opinion, and formal political actors. By contrast, authoritarian leaders face fewer pressures on the domestic level. These factors may exist in authoritarian regimes but the saliency of these factors in determining policy outcomes is arguably less than in democratic states (Bueno de Mesquita et al., 1999). Therefore, our first proposition relates to the ability of regimes to change policy given the constraints that they face at the domestic level.

> *Proposition 1: Authoritarian regimes are more capable of making unexpected shifts from their initial level of cooperation since they face fewer restraints.*

This proposition also implies that democracies are more stable in their policies. As was noted earlier, the only stable equilibrium in the stochastic PD is mutual cooperation. Thus, we argue that democracies will be better able to sustain this equilibrium because they have more restraints on the policy process that make a change in course less likely. For this reason, we expect that relations between democracies should be more cooperative.

> *Proposition 2: Democracies are more cooperative with each other than with authoritarian regimes.*

Given normative and structural causal stories that attempt to account for democratic peace, we would expect the least cooperative arrangement to be between two authoritarian regimes. The lack of constraining domestic factors allows for either authoritarian actor to break from a cooperative equilibrium strategy with relative ease. Consequently, we would expect dyads that involve a democracy to be better able to preserve a stable cooperative equilibrium, and dyads that involve two authoritarian regimes should be the least cooperative.

> *Proposition 3: Authoritarian regime dyads are the least cooperative combination.*

From these three propositions, it is expected that significant differences exist in the level of cooperation among the three types of dyads—democratic–democratic (D–D), democratic–authoritarian (D–A), and authoritarian–authoritarian (A–A).

MODEL AND RESULTS

To explore this proposed set of propositions, we use data collected from our simulations of intergroup PD. Ordinary Least Squares regression (OLS) is then used to establish whether differences in cooperation levels are systematic. The dependent variable, cooperation rate, is a number between 0 and 1 that reflects the number of decisions to cooperate made over the course of 1000 iterations divided by 1000. Because it is the sum of the number of cooperative decisions divided by the total number of trials, this number can be expressed as a proportion.[14]

The primary component that was altered during the simulations was the dyad type (DD, AA, and DA/AD). By creating a series of dummy variables to represent the different dyad types, we were able to use dyad type as an explanatory factor to evaluate the propensity of groups to cooperate. Because the statistical analysis is run using simulated data there is little need for the kind of control variables commonly used in the development of

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[14] Multiplying the proportion by 100 then yields a percentage.

TABLE 2 Parameter Estimates from Simulation

	Unstandardized Coefficients		
Cooperation Rate	B	Std. Error	T-score
Constant (Mixed)	0.461	0.012	37.711***
Dem vs Dem	0.295	0.021	13.925***
Auth vs Auth	−0.130	0.021	−6.157***
R^2 = .290		N = 800 (DD = 200; AA = 200; DA = 200; AD = 200)	

***Indicates significant at $p < .001$ level.

regression models. Given that the data analyzed in this project was generated using a stochastic process that we manipulated in only one way, we are confident that the inclusion of just two dummy variables provides us with a fully specified model.[15] The general equation for this model is as follows:

$$\text{Cooperation Rate} = \text{Constant (Dem vs. Auth)} + \text{Dem vs. Dem} + \text{Auth vs. Auth}$$

When coefficients are estimated the final model is as follows:

$$\text{Y} = .461 + .295\ D_{\text{Dem vs. Dem}} + -.130\ D_{\text{Auth. vs. Auth}}$$

In this model the constant term represents the level of cooperation that is predicted for the category that is not included. In this case, the constant represents the cooperation level of DA and AD dyads. Given the coefficients, in a mixed scenario we would expect that over time a democratic and authoritarian dyad will exhibit cooperation approximately 46.1% of the time. Democratic regimes when facing each other, however, can be expected to cooperate an additional 29.5% or approximately 75.6%. In other words, democratic regimes cooperate 29.5% more when facing other democratic regimes than when they face authoritarian regimes. Authoritarian regimes seem to be the least prone toward cooperation. Authoritarian regimes facing each other will attempt to cooperate 33.1% of the time. Table 3 shows the percentage likelihood of cooperation for the three groups.

Based upon evidence from the regression model, Propositions 2 and 3 are supported. A democracy versus democracy scenario results in the most cooperative combination and an authoritarian vs. authoritarian scenario produces the least cooperative results. To address the first proposition we need

[15] An additional factor was potentially manipulated in this analysis. For this model we began with perfectly neutral agents (.5). While it is possible to begin with agents set to any level of cooperation propensity, previous trials suggest that the results of altering starting levels produce results consistent with expectations i.e. increasing starting level increases total instances of cooperation, and decreasing the starting propensity decreases the overall level of cooperation.

TABLE 3 A Comparison of Cooperation Rates Across Different Regime Dyads

	Auth vs. Auth	Auth vs. Dem	Dem vs. Dem
Cooperation Rate	33.1%	46.1%	75.6%

to take a step back and look at the underlying implications of the second and third propositions. Thus, we must explain why decisionmaking structure has such a strong impact on cooperation levels.

To understand how different regime types behave as the average group cooperation tendency changes, the probability curve for a cooperative decision was calculated for both authoritarian and democratic regimes. This provides a degree of insight into the ability of regimes to make unexpected shifts when agents are very uncooperative, very cooperative, or somewhere in between. Figure 2 illustrates the probabilities of regimes choosing to cooperate for changing cooperation levels among agents.

The probability function for authoritarian regimes follows a straight line with a slope of 1. The cooperation level of the leader weighted by the population is the probability that an authoritarian regime will cooperate. The average cooperation tendency in an authoritarian regime will shift according to the probability of cooperative behavior. The S-curve, which represents a democratic regime with five voting members, has a slope that varies across the cooperation tendency spectrum. Cooperation probabilities for the group are quite different from the actual cooperation levels of the actual agents who vote.[16]

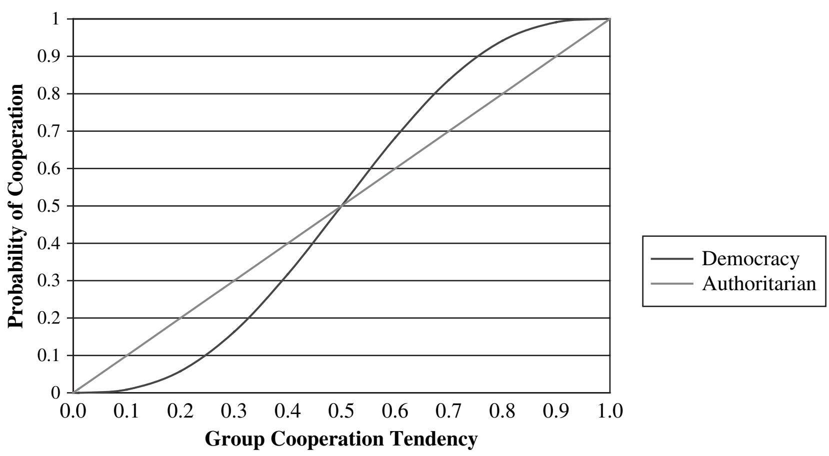

FIGURE 2 Probability of Cooperation at a Given Group Cooperation Tendency.

[16] This probability distribution was calculated by computing the probabilities of all 32 possible combinations that result from 5 agents voting to either cooperate or defect. Of these 32 combinations there are 16 combinations that will produce a cooperative decision. The probability of each of these scenarios was calculated and summed to get the probability of a cooperative decision at a given cooperation tendency.

The implication of these different probability curves is that the decisionmaking structure alters the probability of achieving a cooperative outcome. Democratic and authoritarian regimes may have different levels of cooperative behavior even if they have the same individual propensities toward cooperation. This does not necessarily mean that democracies are more cooperative. Democratic regimes with uncooperative agents (cooperation tendencies between 0 and .33) have a much lower probability of cooperating than authoritarian regimes. At the upper extreme (cooperation tendencies between .66 and 1), however, democratic regimes are more likely to secure a cooperative coalition than their authoritarian counterparts. Because of the decision structure, at the upper and lower extremes democracies are comparatively more stable. With an average cooperation level of .9 authoritarian regimes will cooperate 90% of the time while democracies will cooperate more than 99% of the time.

This probability curves support Proposition 1. At low cooperation tendency levels, authoritarian regimes are more cooperative than democracies but at upper levels they are less cooperative; however, in both situations authoritarian regimes are not as predictable as democracies. Authoritarian regimes are more susceptible to the random events that in stochastic models represent the unexpected decisions or shocks that occur in the real world.

This is particularly important in understanding the centrality of regime structure in foreign policy. At the extremes of the cooperation tendency spectrum, democracies can be expected to act as one might predict. In a cooperative world democracies are less likely to fall from a stable CC situation because a decision to defect would be less probable. Consequently, democracies are better able to sustain a CC equilibrium. In an uncooperative world democracies are less likely to cooperate and thus will deny their opponents the spoils of a CD or DC combination. Democracies and authoritarian regimes still require a fortuitous string of events to move from an uncooperative to cooperative situation; however, once in a cooperative situation, democracies will be more stable.

CONCLUSIONS

This project explores how regime type affects state behavior. Using a computational model to simulate the prisoner's dilemma as played by groups, we have demonstrated that democratic regimes may generally be more cooperative. They are most cooperative when playing against each other; however, democracies also tend to cooperate more with authoritarian regimes. An authoritarian regime playing against another authoritarian regime is the least cooperative combination.

On the surface our findings appear to bolster the larger argument for democratic peace; however, there are distinct implications for the democratic peace debate that emerge from this study. First, the structure of the decisionmaking process appears to be very important. Bringing more actors into the decisionmaking process produces increasingly stable policies. Our findings are consistent with Tsebelis (2002). He contends that comparing, for example, presidential systems to parliamentary systems is not as useful as looking at the number of actors in the system that have effective veto over policy decisions. According to Tsebelis, the more veto players in a political system, the more stable policy will be. We would expect that one of the key distinctions between a democracy and an authoritarian regime is the number of veto players being larger in a democracy. Since authoritarian regimes likely have fewer veto players, their policies should tend to be less consistent. Although our model does not ascribe a veto to the agents, the logic is similar. More actors involved in the decision process leads to a smaller range of acceptable policy outcomes.

Next, our research offers a modest rebuttal to the criticism leveled by Farber and Gowa (1997) that the empirical findings of democratic peace can be explained by shared interests that pushed democratic countries into a single alliance structure. Although it has been claimed that fear of the Soviet Union sustained extended cooperation amongst democratic states during the Cold War, what has led to the maintenance of cooperation after the fall of the Soviet empire? Our research suggests that once democracies have established a cooperative equilibrium, regardless of the reason, it will remain more durable than equilibriums between authoritarian states. The continued survival of NATO and the generally cooperative nature of US/EU relations suggest that a cooperative equilibrium has continued to persist even after the Soviet threat collapsed.

To pursue the implications of this project a bit further, a series of diagnostic models should be run to confirm that the observed dynamic holds in a variety of situations. Varying the assumptions underlying the agent learning mechanisms would further strengthen these findings. Also, to further test some of these findings and to address some scholars concerns regarding the use of computer modeling to simulate human behavior, an experiment using human subjects is the logical next step. A laboratory setting with similar structures and payoffs would allow for an interesting test that could provide extra support for this explanation. While this research project is a long way from verifying the democratic peace theory, it does raise some important questions and provides a compelling case that regime structure in conjunction with norms can affect policy outcomes. Norms may be important in the causal story as producing the onset of democratic peace whereas our structural story may provide an explanation for the durability of peaceful relations among democracies.

CONTRIBUTORS

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APPENDIX A

A Comment on Simulated Datasets

The question of determining significance of a sample for a population that does not exist is one of the more challenging issues behind the actual use of this computer model in generating information. The population of our model is literally infinite while the sample size is constrained only by the memory and the processor of the computer running the model. Most of the theory that has been advanced on this topic, however, is based on the work of early modelers and statisticians in the 1960s. The constraints imposed by the limited computing power available in the 1960s make questions of minimum samples for a set level of accuracy a pressing question that has more or less been resolved while becoming increasingly irrelevant.

Geisler (1964) noted that, “Since these [stochastic] models deal with random variables, they are amenable to statistical analysis” (p. 262). While statistical analysis is appropriate, there are three key issues that need to be kept in mind when working with iterated computer simulations. First, the initial starting values assigned will impact the outcome to some extent. In our situation the question becomes how much of what is witnessed is the nuances of the system and how much is the result of the initial agent values. The common solution to this problem leads to the second threat to validity.

To eliminate the initial impact of the starting values requires a large enough number of iterations to escape the gravity of the starting point. The question then becomes how much iteration is enough. Hopefully, natural breaks occur, but lacking a clear natural break modelers can fall back upon a body of work that had developed mathematical ways of estimating the appropriate number of iterations.

This brings us to the third threat to validity: autocorrelation. The data generated by iterated computer models generally has such a high degree of autocorrelation that some strategy must be employed to neutralize the effects in statistical analysis (Fishman, 1966; Naylor et al., 1967). We employed a single strategy to circumnavigate all three of these threats.

Rather than generating a single long iterated series to analyze, we generated 800 series of 1000 iterations. Each of these 800 series was then collapsed into a proportion of cooperation for each of the two groups. This eliminates the problem of autocorrelation because it is no longer a question of how iterations 1–10 impact iterations 11–20. Instead the focus turns to whether a group was able to break into a cooperative cycle, and if so how early did this occur? A high percentage suggests that a group managed to break into a cycle of cooperation. The higher the percentage, the earlier this must have occurred. This avoids the key problem addressed by Fishman (1966) in traditional methods of addressing autocorrelation. "Removing autocorrelation does away with one property of the process with which the investigator should be intimately concerned. . . . He is interested in the average level of activity, deviations from this level, and the length of time these deviations last, once they occur" (1966, p. 526). Collapsing 800 iterations into a proportion preserves much of this information in a way that is both intuitive and relatively easy to manipulate.

Similarly, the problem of determining an appropriate cutoff point is avoided. One thousand iterations provide each group multiple opportunities to break into cycles of cooperation. Data from individual agents suggests that with an infinite number of iterations, agent pairs will eventually find a cooperative equilibrium resulting in dominant cooperation patterns throughout the system. When we are concerned with the probability of different group decisionmaking strategies making the transition into a cooperative equilibrium, setting a fixed number of iterations is an appropriate strategy.