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Honors Thesis

EFFECTIVENESS OF DIFFERENT REGIME TYPES IN PRESERVING COMMON
RESOURCES: EVIDENCE FROM A LAB EXPERIMENT

by
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Submitted to Brigham Young University in partial fulfillment of graduation requirements for
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ABSTRACT

EFFECTIVENESS OF DIFFERENT REGIME TYPES IN PRESERVING COMMON RESOURCES: EVIDENCE FROM A LAB EXPERIMENT

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This experiment is based on a game-theoretic problem that has troubled the field of political economy since people first started grazing cows in pastures: how can economies best solve collective action problems? This experiment looks at one aspect of this question—types of governance. Are different styles of government (democracies, dictatorships, etc) more or less likely to prevent a common-pool resource (as these goods are called by Elinor Ostrom) from being depleted? Or is the style of governance irrelevant to the question of whether a CPR (common-pool resource) is sustained?

The problem of CPRs (common pool resources) is much the same as this game. If everyone cooperates with the plan (that is, takes only their fair share), then the collective payout would be far greater than if any one person had defected from the plan. For example, everyone can graze on the pasture for a long time if no one consumes faster than the pasture can grow back. However, if one person defects from the plan, then that person can walk away with all of the CPR, leaving nothing for the other players unless the other players also defect.

I will experiment using a democratic society, dictatorship, and a control group with no leadership. I will then take note of which groups were able to preserve the common pool resource until the end of the game. I hypothesize that the control group will be the most effective at preserving the common pool resource.

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Table of Contents

Title.....	i
Abstract.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Tables and Figures.....	v
I. Introduction.....	1
II. Literature Review.....	1
III. Theory.....	2
i. Representative Democracy.....	4
ii. Autocracy.....	4
iii. Direct Democracy.....	5
iv. Culturalism.....	5
v. Behavioralism.....	7
IV. Experiment.....	9
i. Method.....	9
ii. Control Group.....	10
iii. Treatment 1 (Democracy).....	11
iv. Treatment 2 (Autocracy).....	11
v. Hypothesis.....	12
vi. Rejection Region.....	12
V. Results.....	12
i. Limitations.....	16

ii. Policy Implications16

iii. Observations and Avenues for Further Research.....17

VI. Conclusion17

Works Cited18

LIST OF FIGURES

FIGURE 1: Payoff Structure for Prisoner's Dilemma Game.....	3
FIGURE 2: Variance Models 1-4.....	13
FIGURE 3: Leadership Models 1-3	13
FIGURE 4: Rounds Models 1-2.....	15
FIGURE 5: Level Model	15

Introduction:

This theoretical analysis and experimental design explore a game theoretic problem that has captivated political economy scholars since people first started grazing cows in pastures: how can economies best solve collective action problems? This experiment looks at one aspect of this question—types of governance. Are different regime types (democracies, autocracies, etc.) more or less likely to prevent a common-pool resource (CPR) from being depleted? Or is the regime type irrelevant to the question of whether a CPR is sustained?

Literature Review:

Much work has been done on the question of how to share what Elinor Ostrom referred to as “common pool resources”. Ostrom’s work brought a rational, game theoretic method to the problem, and her work has been followed by that of hundreds of scholars.

Ostrom’s work, outlined in her book, *Governing the Commons* (1990), focused on how differently structured institutions made it more or less likely for a group of people to cooperate in preserving a CPR such as a fishing lake or forest. Ostrom focused on small communities, analyzing a wide variety of institutions. She also discussed the costs and benefits of private ownership versus state control of the resource as conservation methods. Ostrom suggested that neither method was a permanent solution to the problem.

In addition, Ostrom, along with others (Anderies, Cardenas, Ensminger, etc.) participated in laboratory and field experiments about common-pool resource problems. Ostrom focused on the ways that different institutional structures affected the outcome of a CPR scenario. In her experiments she found evidence that participants will engage in self-governance, even in the absence of institutional pressure. In another experiment, Ostrom showed the importance of communication in the success of a CPR scenario. However, in a criticism of current experimental methods, Anderies referred to models like Ostrom’s as “stick figures” that needed to be “fleshed out”. He called for experiments that studied institutional arrangements using dynamic models that account for characteristics of the participants and microsituational variables. In my experiment, characteristics of the participants are accounted for by random selection, but a further exploration of characteristics and microsituational variables in the full experiment may yield interesting results.

In addition to laboratory experiments, there is a strong trend in the literature towards field experiments, where game theoretic models are tested with truly representative subjects in an existing marketplace. These experiments have been done in Colombia, Tanzania, and many other developing countries (Cardenas, 2000; Castillo, 2005). The results from these experiments are mixed, some supporting prevailing theory and lab experiments, and others refuting it. All this suggests that there are many unseen variables at play in these scenarios. As such, a lab experiment can be useful for isolating the effect of one specific variable, trading a bit of external validity for clear causal links.

The area of the literature which concerns this paper most directly deals with the effect of institutions on the CPR problem. As mentioned above, Ostrom’s extensive work on this subject goes against the economic theory promoting

private or state ownership, claiming that self-governance will exist among people with no higher authority. Rodriguez-Sickert, et al. showed the effectiveness of low fines in policing people's behaviors, and how the absence of these fines led to an increase and then decrease in cooperation. And in a case study in Nepal, Iversen, et al. found that institutional weakness was to blame for elite capture of goods and maldistribution of common resources in the area of Terai. These experiments and studies lead right into my work, which takes the question of institutions and focuses it on comparative political regimes.

One aspect of the CPR problem that was not sufficiently addressed by Ostrom or other scholars was the issue of large-scale political institutions. While specific village- or city-level institutions were analyzed as case studies, the question of how regime type (democratic versus autocratic) could affect a CPR scenario received only a passing mention. In this paper, I would like to address the question more in depth.

The current literature on this topic has said a great deal about certain institutions that have preserved common-pool resources and others that have not. The problem is that often these solutions are tailored to a specific region or political environment. This makes it very difficult to transfer the discovered solutions to resources in other places. This project instead looks at very general political institutions, with the goal of understanding which of these institutions, when applied generally, is most likely to lead to conservation of a common-pool resource.

I will first review the theoretical background of the CPR problem. Then, I will address how two different regime types (representative democracy and autocracy) can affect the outcome of a CPR scenario when compared to a community with no central authority, like the kind Ostrom writes about (hereafter referred to as "direct democracy" or "control"). Finally, I will put forth my design and the results of an experiment which tests the effect of different regime types on the CPR problem. A key piece of literature which outlines experimental designs for testing people's behavior in CPR games is *Rules, Games, & Common-Pool Resources* by Elinor Ostrom, Roy Gardner, and James Walker. In this book, the ideas from *Governing the Commons* are tested in the lab as well as studied in the field. This book helped to give me a viable experimental framework for testing subjects' behavior in CPR games. I used Ostrom's laboratory framework to set up the environment for my experiment, and then replaced Ostrom's experiment with my own design to capture the independent variable of regime type.

Theory:

The problem of how to ensure that people cooperate to conserve a publicly accessible resource is as old as civilization. It is summed up nicely in a classical game theoretic model named "The Prisoner's Dilemma". In this game, two criminals are put in separate rooms and given the option of informing on their partner or staying quiet. If both give information to the police, then both go to prison for 10 years. If only one gives up information while the other stays quiet, the one who confessed gets off without any jail time, while his partner must serve 15 years. If both criminals stay quiet, then they both receive a 2-year sentence. The payoff structure is shown below, with the numbers reflecting years served, so that higher numbers are less desirable.

Player 2

		Don't Talk	Talk
Player 1	Don't Talk	2 2	0 15
	Talk	15 0	10 10

The problem of CPRs is a specialized case of the Prisoner's Dilemma. If everyone cooperates (that is, takes only their fair share), then the collective payout will be far greater than if any one person had defected (taken more than their fair share). For example, if everyone grazes their share, then the pasture can regrow and will be a sustainable resource for generations. However, if one person defects, then that person can deplete the pasture faster than the pasture can recover, leaving nothing for the other players. In this case, the only way for any player to maximize their access to the resource is to also defect, taking as much of the resource as possible for themselves before it is completely destroyed. Thus, in the Prisoner's Dilemma, everyone has an incentive to defect.

Remember that in the Prisoner's Dilemma, the criminals are kept in separate rooms. One does not know what the other is doing, and so must infer it based on the criminal's knowledge of the payoff structure. In the classical payoff structure described above, the rational position is to expect your partner to defect. Thus, in order to avoid the 15-year sentence, you will also defect, and you will both serve 10 years. The only equilibrium solution to the game is for both players to defect, even though this results in a payoff that is not optimal for either. Each would have preferred to get the 2-year sentence, but, because of rational expectations and incentives, each receives the 10-year sentence.

In a CPR scenario, no one person knows what the others intend to do with the CPR. If everyone cooperates, then everyone can enjoy the resource for a long time. However, there is an incentive to cheat—graze more than your share, fish more than your share, or harvest more than your share—because if you are the only one that cheats, you can have nearly all of the resource to yourself. The CPR problem is that everyone in the community understands this, so everyone would rationally choose to cheat so that they can at least get a piece of the resource before it is gone.

This is the problem that economists and political scientists have been trying to solve. How can you change the incentives so that it is in the best interest of the people to cooperate with each other and the preserve the CPR? Many economic and political institutions have tried to solve this problem, with varying levels of success. I will now examine how differences in regime types can lead to differences in how well a CPR is preserved. Following, I will examine how two lenses of comparative politics – behavioral and cultural theories, respectively – alter the predictions of this model.

Representative Democracy:

Democratically elected representatives are given power by a popular vote of the people. In most political systems, the representatives keep this power by securing reelection by another popular vote. The assumption of this system is that facing reelection will drive a leader to provide public goods and engage in other activities that are beneficial for the population. Within Bueno de Mesquita et al.'s framework, an incumbent representative can be challenged by a candidate who can provide more public goods for the "selectorate", or winning coalition needed to stay in power. This challenge drives the incumbent to provide enough public goods to maintain that winning coalition for him or herself (Mesquita et al. 2005).

Then, according to selectorate theory, we would see that the CPR would be preserved by the incumbent representative in order to keep providing public goods to the selectorate. The incumbent would do what was necessary to ensure that the CPR survived for as long as he or she was running for reelection. We can thus assume that, in theory, the CPR would survive under a representative democracy. However, there are alternative scenarios to consider. One such scenario is when a candidate runs up against term limits, and thus cannot be reelected. This may cause both decreased incentive for the current leader to preserve the CPR, and, as the people suspect the leader of skimming, a devaluation of the people's future payoffs. This would raise the people's incentive to take more than their individual shares and deplete the CPR.

How would this system play out in a small, rural community, like the kind that often faces CPR problems? If this community had a democratically elected mayor and a pasture for grazing that needed to be managed, the most efficient way for someone to secure election would be to present themselves as the best possible manager of the public good. If this person later failed to provide this public good by failing to preserve the CPR, then that person would face the prospect of not being reelected.

Autocracy:

In an autocratic government, one person rules by fiat. The leader is not beholden to public opinion or a rule of law that governs his or her decisions. Rather, the leader maintains power by maintaining the loyalty of the citizenry to the point that citizens do not revolt and oust him or her from office.

Autocracies are propped up by economic or security payouts to the population, as well as military force. The money for these payouts, as well as the money to fund the strong military presence, will often come from a CPR (oil, diamonds, etc.). The leader who pays off the people by sharing from the CPR stays in power, and so gets to continue his or her own theft of the CPR. If the leader can, in addition, maintain a coalition that will help prevent access to the CPR except that authorized by the ruler, then the ruler's exploitation can continue without interference from others.

In this case, we would have a private ownership scenario, with the dictator being the *de facto* private owner of the CPR. This is one way that economic theory allows for the solution of a CPR problem (Ostrom, 1990). Since the dictator is the private owner, he or she has a vested interest in preserving the CPR for the future. As long as this private

ownership is maintained by the ruler's absolute power, the CPR will also be maintained. It is in this way that an autocracy can preserve a CPR.

Direct Democracy:

The case of a direct democracy may at first appear trivial. After all, it is simply a gathering of people with no central governing body trying to administrate a CPR by majority rule. It is more the absence of a regime than a regime itself, which is why I use it as the control group for my experiment. However, this political structure highlights a very important aspect of the CPR problem – repeated interactions.

Recalling the Prisoner's Dilemma game, note that a key aspect of the game is that the two players do not intend on ever playing the game with each other again, that is, the game only lasts for one round. The CPR problem, however, is an infinite-horizon game, with the number of rounds equal to some unknown value between one and infinity. If the players of the game are not criminals, but members of the same village or community, then these players must choose their actions by taking into account their next n rounds of play with the same players, where n is an unknown value, expected to be long term. In this scenario, a decision to defect from the *status quo* leads to a punishment in the next round or rounds, while cooperating leads to continued availability of the CPR. As long as the future benefits of cooperation are given more weight than the one-time immediate payout for defecting, then everyone would have an incentive to cooperate. The equation for this equilibrium looks like this:

$$\pi^d - \pi^* < (\pi^* - \pi^N) \left(\frac{\delta}{1 + \delta} \right)$$

where π^d refers to the payoff to the person from defection, π^* refers to the payoff to the person from cooperating to preserve the resource, π^N refers to the payoff to the player in the strict Nash equilibrium that serves as the punishment path after the player's defection, and δ refers to the discount factor, or how much value a player gives to payoffs in the future compared to current payoffs. δ must be a number between 0 and 1. In order for a player to be incentivized to choose the future payoffs of cooperation over the current payoff of defection, the δ must be high, which is interpreted as the player valuing future payoffs as almost equal to current payoffs. The other ways to make the above equation true are for the defecting payoff to be low, or for the difference in payoffs between cooperation and the punishment path to be high. By this equation, we can see how in direct democracy it is possible for a CPR to be preserved because of the repeated interactions that the players have with each other.

How do the lenses of cultural and behavioral theories change these simple models? Let us examine each in turn.

Culturalism:

The theory of culturalism is that political actors will change their preferences to better match the culture in which they live, even if the behavior encouraged by the culture is irrational. A cultural perspective often explains gender or race discrimination, blind

deference to a deified authority figure, or adherence to various religious tenets. By proposing deviation from strictly rational behavior, the cultural perspective changes the predicted outcome for a CPR situation under each of the three types of government I have mentioned.

Culturalism and Representative Democracy:

Under rational choice theory, the citizens will behave in the interest of the public good and choose those leaders who would best preserve the CPR, so that the citizens can reap the benefits of the CPR. The election of these leaders is what results in the best payout in the long run. However, culturalism has a different perspective about how elections will play out.

Under culturalism, the deciding factor of a person's vote is not necessarily what individually benefits him or her the most (rational choice), but what vote was the most socially acceptable. This culture, in the form of so-called "popular opinion", that builds up around specific candidates will motivate voters to judge candidates on standards not necessarily related to how well the candidate would preserve the CPR. For example, it's possible a community's culture places a high value on having men in office. Then, the community will be more likely to put a man in office, even if the candidate who is most likely to preserve the CPR is a woman. It is also possible that a community's culture values fiscal independence over high government spending. Then, the community is likely to elect a candidate who will preserve the CPR.

The cultural values, which are products of social norms and values, have no assurance of lining up with rational choice values. Thus, the possibility of a democratic government preserving a common pool resource depends greatly on what qualities the culture values. If the culture values qualities in a candidate that will make them likely to preserve the CPR, then the CPR will most likely be preserved. If, however, the culture values qualities not at all correlated with preservation of the CPR, then it is highly unlikely that the CPR will be preserved, as the leaders elected would not make choices which best preserve the CPR. In this model, what a society values is directly connected to their future prosperity.

Culturalism and Autocracy:

In the autocratic model under rational choice, the fiat leader has a type of private ownership over the CPR. No one takes from the CPR without the leader's permission, and no one takes more than the leader allows. Under rational choice, this is a successful system, since it is in the leader's best interest to preserve the CPR so that he or she can continue to take from it. How would a cultural perspective change this situation?

In a rational choice model, the leader has incentive to know exactly how much CPR he or she can distribute and to whom. The leader knows how much he or she can give out, and only gives out that amount. However, a cultural perspective suggests that cultural pressures, if not from the people then perhaps among other leaders, can cause the leader to behave irrationally. If, for example, there is a cultural celebration and the leader is pressured to give out more CPR than dictated by the model, this cultural influence can distort the CPR, causing the leader to use more now and take more from the people later.

On the other side, if a cultural holiday includes some type of fasting, it could pressure the leader to let the CPR lay fallow. Although neither of these would necessarily lead to the depletion of the CPR, neither would be considered optimal behavior.

Cultural pressures, then, can cause a leader to act irrationally in his or her distribution of the CPR. Cultural pressures may cause the leader to deplete the CPR to satisfy cultural norms. Thus, the cultural perspective breaks the certainty of a rational choice perspective that an autocrat/private owner would perfectly preserve the CPR.

Culturalism and Direct Democracy:

Finally, we look at the direct democracy model from a cultural perspective. From a rational choice perspective, repeated interactions give every player an incentive to cooperate, since they will get a better payout this way than if they defect and are punished by the group. This way, everybody cooperates, and the CPR is preserved.

It is possible that the cultural perspective would arrive at the same conclusion in the direct democracy model. Where the rational choice perspective says people obey the rules because it is in their best interest, the cultural perspective would say that people are reacting to cultural norms. Since everyone in the society is equally benefitted or harmed by the preservation of the CPR, it follows that the culture will favor an even, rational approach to the CPR.

Of course, this may not be the case. It is also possible that cultural norms of the society favor an uneven distribution of the CPR, even to the point of depleting the resource. This may be in order to give more of the resource to the poor, the sick, mothers, children, or even to sacrifice a part of the CPR in some kind of religious ceremony. In short, it is impossible to know how the cultural perspective would affect a direct democracy model.

Behavioralism:

We will now look at how a behavioral perspective changes the results of the three models listed here. The behavioral perspective, in a sense, is the opposite of the rational choice perspective. While rational choice says that human beings are rational, calculating creatures, the behavioral perspective allows for behavior that cannot be rationally explained. I will now examine how a behavioral perspective affects the outcomes I predict from the three models of government.

Behavioralism and Representative Democracy:

As with all three perspectives, I focus on the voting behavior of the players as the main variable controlling the outcome. Under rational choice, the voters' behavior is based purely on which candidate is most likely to preserve the CPR. In the cultural perspective, voters' choice may be determined by other cultural values that cause the voters to not elect the candidate that is most likely to preserve the CPR. From a behavioral perspective, there are two possible outcomes to the election.

First, we look at voters on an individual level. Each one has a rational choice of candidate. However, the behavioral perspective says that an individual voter can choose

to vote irrationally. This can happen for many different reasons—the voter could be experiencing loss aversion which causes him or her to miscalculate incentives, or confirmation bias, making him or her overconfident in the decision to vote for a particular candidate. There are many different ways that behavioral tendencies manifest themselves.

What is important is that if this irrationality is present on an individual rather than a collective level, than it will be accounted for by the law of averages. In this way, a few people acting irrationally will not be enough to wash out the other rationally behaving voters. Therefore, the rational, optimal candidate is still elected, and the CPR is preserved.

Of course, it is very unlikely that the population does not experience collective irrationality. When a candidate is able to sway the public using irrational arguments that target human behavioral tendencies, then he or she may be able to steal the election, even if he or she is not the candidate most likely to preserve the CPR. In this situation, the behavioral perspective leads to a very different outcome than the rational choice perspective.

Behavioralism and Autocracy:

How would a behavioral perspective change the outlook of the autocratic model? We know that in the rational choice model the autocrat preserves the CPR because he or she is the sole proprietor, and is therefore not concerned with anyone else depleting the resource. In the cultural model, depending on the cultural norms, the autocrat may or may not preserve the CPR, as living up to existing cultural norms is more important than behaving rationally.

In the behavioral perspective, we look at the individual or group level irrationalities that may affect decisions. One case of this would be a mass irrationality of the other players. This could take the form of a mob mentality that causes them to think that the autocrat has been stealing from them and does not deserve the CPR. In response, they make the irrational move to storm the CPR and try to take it back, in the process destroying it. This is one fairly negative example of a behavioral perspective prediction of the autocratic model.

Another possibility is that the autocrat behaves irrationally. This irrationality could come in the form of short-sightedness, causing the autocrat to deplete the CPR too quickly. An extreme form of this short-sightedness is that the autocrat greatly discounts his future earnings from the CPR, making it more attractive to him or her to take all of the CPR now. Either of these irrational strategies would result in the depletion of the CPR, when a rational, optimal strategy could have preserved it. As with the democratic model, in the autocratic model, a behavioral perspective is much more pessimistic about the preservation of the CPR.

Behavioralism and Direct Democracy:

The behavioral perspective states that the various players in the direct democracy model can behave irrationally. This means that they can either decide to take too little or too much from the CPR. They may decide to take too little because they miscalculate the

replenishment rate, or maybe because they miscalculate the cost of harvesting the resource compared to the benefit of an extra unit of the resource. On the other hand, they may decide to take too much because they overvalue the current payoff and undervalue the future punishment. Even if the structure is set up to perfectly allow for rational behavior, the behavioral perspective states that human beings can often miscalculate incentives to arrive at an irrational conclusion.

Which side will the player(s) err on? Will they tend towards taking less than the optimal amount? Or will they act on poor calculations of punishment-reward and take too much? Will these effects even out when spread across the population? These are the questions that make it difficult to ascertain what effect human behavioral tendencies will have on the direct democracy game. While the CPR could be preserved, it is also possible that suboptimal behavior by some players could deplete it.

Experiment:

While the distinct theories of behavioralism and culturalism are ambiguous in their application to the problem of CPRs, an experiment which randomly assigns regime type to a certain population may give a surer result. Absent the ability to randomly assign regime types on a large scale, a laboratory experiment is opted for, leading to a less nuanced but more controlled environment. I recognize that this discussion can and should have a sequel in which natural experiments are found and examined. These natural experiments are an avenue for further research that can either corroborate or refute the findings of this laboratory experiment.

Method:

This experimental design is in large part borrowed from Ostrom, Gardner and Walker in their book *Rules, Games and Common-Pool Resources*. While the treatments used in this experiment are different from theirs, the general setup is the same.

I randomly selected groups of five participants from a pool of volunteers. I then put the groups into separate rooms, and each group was assigned to one of two treatments or to be a control group. The two treatments were a representative democratic system and an autocratic system (discussed more at length later in this paper).

Each player was told that they were starting out with \$5. In addition, a pool of money containing \$16 was available to the group. The participants were told that the researcher would come in at regular intervals to ask how much money was to be taken out of the pool and given to the participants that round. It was explained clearly to the participants that they would walk away with whatever money they requested out of the pool. If the participants asked for more than was in the pool, the remaining money would be given proportionally according to their requests.

In order to remove the incentive to take more money just prior to the last round, the number of rounds was also randomized, and the participants were not told how long the game would last. This preventative measure had limited effectiveness – more details on this, as well as proposals for more effective preventative measures to be used in the full experiment, will be discussed towards the end of the paper.

The participants were also informed that the pool of money would replenish based on how much money was left in the pool. For this experiment caps were set at \$16, \$11, \$7, \$4, and \$2. Once the money supply dropped below a cap, it would only replenish up to that cap for the next round. If the pool dropped below \$2, it would stop replenishing altogether. In this way, players faced tighter and tighter restrictions as they decided to take greater amounts of money from the pool. These rules were made clear to the participants, and the numbers for the different caps were written on a whiteboard plainly visible throughout the game. Finally, the participants were told the rules of their particular treatment. Participants were allowed to ask clarifying questions, but they were never told the duration of their game or the fact that other groups were playing under different rules. This discussion prior to the experiment is a way to control for the variable of information, which is important in game-theory, but was not the variable of interest in this particular experiment. I will now describe the conditions of the control and the two treatments.

Control Group:

Each round, each player was asked out to fill out a sheet of paper indicating how much money they would like to take out of the pool for themselves. By default, this amount was kept private between the player and the researcher, but there was no rule preventing the players from sharing their amounts with each other, and there was no penalty for a player that is able to see another player's amount without the other player's knowledge. In this way, commitment devices and strategy were both permitted as means for players to reach a more profitable outcome.

After delivering the initial rule summary and answering questions, the researcher left the room without asking the participants for a request for money. In each round that followed, when the researcher entered, he passed out the sheets of paper, and then collected them. He then tallied the amounts and informed the group how much money was *collectively* removed from the pool (not how much was taken by each individual). If the pool was at a level where it could replenish, the researcher "replenished" the pool to the appropriate amount based on the aforementioned rules. This final amount was written on a whiteboard, and the players were told that they had that much money to withdraw from in the next round. Finally, the researcher either told the group that the game was over, or that he would be back next round.

In each of the groups, roughly ten minutes passed between each round. Neither the treatments nor the control had any rules about what could and could not be done during these rounds, except that the participants were not allowed to interact in any way with the other groups that were playing at the same time in other classrooms. What happened during this break was meant to simulate the society that develops in a village or community surrounding a common pool resource, and so it was left as unstructured as possible.

In the control group, there were no leaders, no elections, and no formal sanctions established. There was no rule against the group coming up with their own rules, but the experiment proceeded in the same way regardless – each person was given the opportunity each round to withdraw from the pool, and that money was theirs to walk

away with. As this amount was a nontrivial sum, there was incentive for the players to maximize their winnings.

Treatment 1 (Democracy):

In this group, players were told the same rules as the control group, with one key difference. The participants would not be able to decide for themselves how much money would be given to them from the pool. Rather, the group elected a leader from among its five members, and this leader had exclusive power over the amounts of money given to each participant. The leader stayed in power for two consecutive rounds, after which another election was held. No term limits were imposed, so it was possible for the same person to be elected leader every two rounds for the duration of the game. If a new leader was elected, that leader had the power starting that same round to give money to players (as well as to themselves). There were no restrictions given on campaigning or vote-buying, neither were the participants encouraged or discouraged to participate in any such activities. All of these rules were explained to the participants at the beginning of the game.

As with the control group, the participants were given about ten minutes between the initial instructions and the first request for money, in this case preceded by an election. The election was done by secret ballot (unless the group had decided to vote using a more transparent method). The votes were collected by the researcher, tallied, and the group was told who won the election along with the number of votes for and against that person.

The leader was then given a sheet where he or she wrote down the amount to be given to each player and to him or herself. These amounts could be different for each player and for the leader, enabling the leader to dole out specific punishments or rewards as he or she saw fit. The researcher received the sheet, and then privately informed each participant of the amount he or she had received via a secret note (again, there were no rules against the leader or players sharing their amounts if they wished to). Finally, the researcher told the group how much money had been taken from the pool, how much was left in the pool after it replenished, whether there would be another round, and whether or not there would be an election in the next round.

Treatment 2 (Autocracy):

The rules of this group were different from those of the democratic treatment in that the leader who decided the payments was not elected. Rather, each participant was asked at the beginning how much of their initial \$5 they were willing to pay to be made the dictator. The participants were told that this dictator would remain in power for the duration of the game unless the other participants paid a total of \$10 to replace him or her with another participant. The money paid to become dictator and the money paid to remove one would all be taken from the participants' final totals.

After these rules were explained, the researcher left the room. When he returned, he first took everyone's bid for becoming the dictator. He then announced the winning bid and gave the winner a sheet where the leader wrote down his or her payment, as well as the payment to everyone else for that round. There were no ties in bids during this

experiment, but if there had been, they would have been broken by a second bid only between those two participants. If no one had bid, then everyone would be asked to bid again until a leader was chosen.

In every round following, each person besides the leader was asked to write down, privately (unless the group had decided otherwise), how much he or she was willing to pay to replace the current dictator with another player. If the total was equal to or greater than \$10, the leader would be removed and replaced by the desired (majority vote) leader of those who contributed to the “coup”. The researcher announced only whether or not the amount to replace the leader was reached, and then announced the payment totals and pool amounts as described in the other treatments.

Hypothesis:

I hypothesize that the democratic treatment will be the most effective at evenly distributing the resource and in preserving it. This will be measured by the variance in the total amounts received by participants. I expect that variance in the democratic treatment will be smaller than in the autocratic or control conditions. I also expect that the democratic treatment will have the greatest percentage of groups that do not deplete the common pool resource.

Rejection Region:

The significance level at which I will reject the null hypothesis that a governance treatment does not affect the preservation of common pool resources is $P=.05$, or 5%.

Results:

In analyzing this data, I focused on how the group did collectively as well as the participants individually. I ran several regressions where the variable concerned was regressed on dummy variables for the democratic and autocratic treatment. To avoid multicollinearity, the control treatment was defined as a 0 value for both the democratic and autocratic dummy variables.

First, the individual analysis. This analysis is important because it shows how individuals are directly affected by different regime types. It also shows us the distribution of money within the group between regime types. In this way, we can see whether money is more or less centralized in different regime types, and whether this money is centralized in the leader, in his or her supporters, or in non-supporters. Broadly, this part of the analysis looks at the microeconomic side of the impact of regime types on common pool resources.

As we can see in the table, the average total per participant was significantly less in the autocratic treatment. This finding was significant at the .10, but not quite at the .05 level, so I am unable to reject the null hypothesis. However, the variance in amount paid was not significantly different from the control in either the autocratic or democratic treatment, indicating that the distribution of the resource was similar in each treatment.

As another proxy for distribution, I ran regressions on the highest amount paid to a participant in each group against the dummy values for the regime types. I ran a similar

regression on the lowest amount paid to a participant in each group. Neither of these yielded significant results, reinforcing the notion that resource distribution was not affected by regime type.

	(1) Average Total Per Participant	(2) Variance in Total Per Participant	(3) Highest Total	(4) Lowest Total
Autocracy	0.174 (0.125)	1.023 (17.79)	0.205 (0.677)	0.400 (0.656)
Democracy	0.861 (0.621)	1.97978e+09 (3.44261e+10)	64.50 (212.7)	0.513 (0.842)
<i>N</i>	9	9	9	9

Exponentiated coefficients; Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Arguably the most important difference between the control and the treatments was the presence of a leader, elected or bought. I ran several regressions to analyze how the player that held the leadership position played differently or received a different payout.

In the first model, I regress the amount paid to every player in every round on dummy variables for whether that person was the dictator or the president in that round. The base group is not holding any of these positions, signified by a 0 for both of the dummy variables. In the second model, I regress the total paid to each player at the end of the game on dummy variables signifying whether that player was ever appointed president or dictator during the game (i.e. there could be two presidents in the same group because one was elected after the other). In the third model, I regress the total paid to each player on the number of rounds that that player served as dictator or president. In model 2, we are measuring whether simply being appointed to a leadership role affected the total paid to that player. In model 3, we are measuring whether the effect is correlated with the number of rounds that a player *remains* in power.

	(1) Amount Paid Per Round	(2) Total Paid to Player	(3) tot
Dictator for Round	2.031** (0.526)		
President for Round	0.732 (0.226)		
President (Yes/No)		4.581 (4.007)	
Dictator		0.610	

(Yes/No)			(0.889)
President (Number of Rounds)			1.870 (0.732)
Dictator (Number of Rounds)			0.914 (0.250)
<hr/> <i>N</i>	285	45	45

Exponentiated coefficients; Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results from these models seem contradictory. In model 1, we find our only result which is significant at the .01 level. At this level, dictators were paid more than those who held no office, with a coefficient of .708. However, in model 2, presidents are paid more at a .10 significance level with a coefficient of 1.52, and in model 3, presidents are paid more at a level that is almost significant at the .10 level, with a coefficient of .626. What could account for this disparity?

One reason may be that there is an outlier in the president treatment, where one participant left with \$26, which was far larger than any other participant (the next largest being \$15). This amount might have been enough to account for the results in models 2 and 3. However, the one-time largest withdrawal of \$16 was not as removed from the trend of withdrawals, preventing it from skewing the data taken at the player-round level. The notion that being a dictator may result in higher pay is an interesting one that deserves further investigation. It is possible that this discrepancy comes from the fact that the dictator requests more money in order to recoup his or her cost to become leader. However, given the small amounts generally paid for leadership, I believe that this does not account for the whole difference.

Next, we look at the aggregate data and indicators for each group. This constitutes the macroeconomic analysis of the difference between regime types when dealing with a CPR. These data include the number of rounds the group played before the resource was depleted (if the group ended before they were told to end by the researcher), the total money paid out to the group, and how much the group depleted the resource, as measured by the cap level that the group ended on.

To determine whether the regime type affected how quickly the resource was depleted, I ran a regression of rounds played on the treatment dummy variables. Since the number of rounds was randomized, when the game ended depended in large part on how well the group preserved the resource, or was a reflection of how the group discounted the future winnings they could get by continuing to play compared to the amount they would leave on the table by not cashing out before the game was ended (the limitations inherent in this game design, and suggestions to remedy it in the full-scale experiment, are discussed in the limitations section of this article). The results of this regression are insignificant, so we cannot infer a connection between regime type and number of rounds played.

As another measurement of the length of time played, I regress the number of rounds played expressed as a percentage of the number of rounds that that group was assigned on the dummy variables. The advantage of this method of measurement is that it captures those groups whose time ended when the researcher announced it, as compared to those who ended the game early by depleting the resource. Using this measurement also gives insignificant results, supporting the previous finding.

	(1) Rounds Played	(2) Rounds as a Percentage
Autocracy	0.264 (0.296)	0.862 (0.131)
Democracy	1.396 (1.566)	1.104 (0.169)
<i>N</i>	9	9

Exponentiated coefficients; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In order to establish the depletion of the resource, I ran a regression of the cap level that each group reached on the dummy treatment variables. This regression was meaningless, as every group besides one completely depleted this resource. I believe that this is a flaw in the game design where the game did not effectively simulate an infinite horizon game. Later in this paper I will suggest solutions to this for the full-scale experiment.

	(1) Level
Autocracy	1.000 (0.544)
Democracy	1.948 (1.060)
<i>N</i>	9

Exponentiated coefficients; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

I was also planning on running a logit regression to see if the regime type affected the probability of a group finishing the game, meaning that they played until the researcher told them to stop. This might yield insights into the discounting of future winnings and the political and economic stability of one regime type over the other, or over the control. However, the sample size prevented me from running this regression,

since the only group that finished the game was a control group. This regression might yield interesting results in the full-scale experiment.

As is, this data would suggest that regime type has little to no effect on the macroeconomic outcomes of a common pool resource problem. The community will receive a similar payout, and the resource will last a similar length of time, whether the community has a democratically elected leader, a dictator, or no leader at all. The impact on microeconomic indicators is also small, except in the case of the dictator, who seems to get more money for him or herself than other players. The president may have a similar outcome, but a strong outlier makes it difficult to conclude. In summation, it would seem based on this data that regime type has virtually no impact on how a CPR problem is handled. Of course, this is only a pilot study, and it suffers from great limitations, suggesting that we see these results as merely signposts of where to go in the full experiment.

Limitations:

First, it must be kept in mind that this is a lab experiment and not a field experiment. Therefore, there are some inherent problems with external validity. For example, even though there are several rounds played, playing this game over only two hours or so is not truly reflective of real-world CPR scenarios.

I also understand that my governance models are, of necessity, very simplistic. These simpler models were adopted so that effects could be seen more clearly, and also so that the test could have the power that comes with a greater number of games. The power of the experiment would have been lesser had the models required more complicated rules that necessitated a greater number of participants.

Perhaps most importantly, the statistical power of this experiment is constrained by the small number of observations (9) that I was able to make at the group level. While in some of the player-round observations we had an n - of more than 200, conclusions about the group or player-group units are without statistical power. With more funding, more games could be run, yielding more powerful results.

As this is a pilot experiment, in addition to increasing the scale I hope to improve the experimental design in the full experiment to address problems found in this study. The most glaring of these is the issue of timing. In an attempt to recruit volunteers, I provided an estimate of how long the experiment would last. In doing so, I inadvertently affected their perception of the game, and disincentivized them from playing as if the game had an infinite horizon. To address this problem, I will either not give a timeframe, or will give a much wider range of possible durations. Also, to further incentivize participants to play the game as if it had an infinite horizon, I will attach a penalty for every round that the group does not play because they depleted the resource. I hope that these adjustments can properly align players incentives to more closely simulate the infinite horizon of a real-world CPR game.

Policy Implications:

What are the policy implications of this research? While these current findings are not conclusive, it is important to consider what changes governments could make to their care for CPRs based on the findings of this and future experiments.

If results show that some form of governance, be it a representative democracy or dictatorship, is most effective at preserving CPRs, then it is in the interest of the citizens of that community to institute that form of government, at least in the administration of the CPR. Then, a government that purports to promote an equal distribution of wealth and responsible resource use would want to set up these kinds of governments in areas where CPRs exist. However, the government would have an incentive to administrate the resource inefficiently for its own benefit. The only way to overcome this is if the political pressure on the government to keep its word and not steal from the people became stronger than the economic benefits of abusing the CPR. This is most likely to happen when the members of CPR communities are aware of their economic losses and are inspired to campaign for change. Of course, effect size is everything -- if the benefits of one form of government over another is small, the gains may not be enough to encourage either the central government or the community members to change the status quo.

It is important to note that it is possible that the null results found in this experiment will hold when the experiment is scaled up. In this case, we would conclude that governments and bureaucrats should look for solutions to the CPR problem other than the accountability of leaders to the members of the community. Instead, the answer perhaps lays more with the economic structure of the resource, such as a private owner or a rental structure. As political structures do not preclude economic ones, these questions should be the subject of further study and experimentation.

Observations/Avenues for Further Research:

Certain questions not directly addressed in this analysis would nevertheless be valuable additions to the full experimental design, or to further research. These would be studies of the transition of power, and whether the groups conform to the selectorate theory of Bueno de Mesquita, or distribute power and resources according to another framework. Are votes truly bought? Is the dictator kept in check by his subjects? Does the leader take full advantage of their position to accrue private wealth? All of these would yield valuable insights into the mechanisms by which the CPR problem is solved, or not, under different regime types.

Conclusion:

In conclusion, this pilot experiment, while not very powerful statistically, showed how a similar experiment on a larger scale would work, and what adjustments would need to be made in order to find more applicable results. It did suggest that the dictator may be able to gain greater pay, but otherwise was inconclusive. It is also possible that neither a democratically elected leader or a dictator significantly affects the outcome of a common pool resource problem, but a larger scale experiment would be required to confirm that conclusion.

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