Ice, Water, and Steam:
Threshold Effects and Getting the Institutions Right

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There is now a widespread scholarly consensus that the "right" institutions are necessary for a country to generate beneficial economic outcomes. For example, many scholars emphasize that the right institutions are required for economic growth and development (Knack and Keefer 1995; Acemoglu, Johnson, and Robinson 2001; Rodrik, Subramanian, and Trebbi 2002), while others suggest that the right institutions are needed for policy stability (Tsebelis 2000), for the protection of investors from capricious government (North and Weingast 1989), for economic change (North 1990, 2005), for increasing levels of trust (Keefer and Knack 1997), or for reducing the costs of contract enforcement (La Porta et. al. 1998; Acemoglu and Johnson 2005). With all of this focus on the benefits that stem from "getting the institutions right," has come not only many policy recommendations for how countries can achieve the right institutions (World Development Report 1997), but also a cottage industry devoted to the measurement of institutional quality and to the study of how institutions of varying levels of "rightness" effect particular outcomes of interest (Knack and Keefer 1995; Tsebelis 2000; Henisz 2000; Freedom in the World 2005; Doing Business: Protecting Investors 2006).

Although the literatures on institutional quality and economic outcomes have made many important contributions, we emphasize that they suffer from three important shortcomings. First, in much of the aforementioned literature, it is not clear what, exactly, the right institutions are supposed to do. Indeed, scholars' many different conceptions of what constitutes a "right" institution and a beneficial economic outcome suggest that there is an ambiguity about *which* institutions have to be right and about *what* the effects of having the right institutions are likely to be.

Second, despite placing great emphasis on the connection between institutions and economic outcomes, there is often little theory of how, exactly, institutions affect outcomes. And, to the extent that there is a theory linking institutions to economic outcomes, this theory often assumes that the relationship between institutions and outcomes is simply linear (i.e. that a one unit change in the institutions will yield a one unit change in a particular outcome of interest).[2] Third, given that it is 1) unclear as to what, exactly, the right institutions are supposed to do and 2) ambiguous as to what the appropriate functional relationship between institutions and economic outcomes is, it seems that efforts to measure institutional quality or institutional "rightness" may be putting the cart before the horse. Stated differently, before we attempt to

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[2] There are some models that include something very close to a threshold effect (for instance, Acemoglu and Johnson 2005 and Zak et. al. 2003); however, their empirical analyses typically neglect the logic of their models and estimate linear relationships between the independent variables and the dependent variable.

measure institutional rightness, we should first have a theory of how it is that the right institutions induce particular outcomes.

In this paper, we improve upon each of these shortcomings by introducing a threshold model of how institutions affect various outcomes. Specifically, we suggest that, contrary to much of the existing literature, the relationship between institutions and outcomes is characterized by threshold effects. That is, just as ice only becomes water once a temperature greater than 0 degrees Celsius is reached and just as water only becomes steam once a temperature greater than 100 degrees Celsius is reached, so too do institutions' effects on outcomes depend upon whether or not a certain threshold has been crossed. More concretely, we argue that below a certain level of institutional quality, even large improvements in institutions might not produce significant improvements in the outcome of interest; however, once a certain threshold of institutional quality is reached, then we may observe large improvements in outcomes. What such threshold effects imply for scholars who seek to "get the institutions right," of course, is that achieving improved outcomes may require more than simply a one unit improvement in the institutions. Rather, the "rightness" of a particular institution will depend upon whether or not a threshold has been crossed, and this may mean that we do not observe improved outcomes until we implement very large institutional improvements.

In order to provide empirical support for our alternative approach to the effect of institutions, we survey the results of several different laboratory experiments, all of which examine the effects that institutions have on various outcomes and all of which demonstrate that the relationship between institutions and outcomes is characterized by threshold effects. Although laboratory experiments necessarily involve a tradeoff between internal and external validity (Trochim 2001), they are in many ways ideally suited for the study of how institutions induce particular outcomes (for further discussion of this point, see Capra et al. 2004). Indeed, laboratory experiments allow scholars to observe the relationship between institutions and outcomes more precisely than is often possible when we are limited to the combination of institutions and outcomes that exist in the real world. And, what these controlled environments demonstrate time and time again is that the appropriate functional relationship between institutions and economic outcomes is one that is nonlinear and, more specifically, involves threshold effects.

This paper proceeds as follows. In section 1, we survey the results of several laboratory experiments that reinforce our argument that the relationship between institutions and economic growth is nonlinear and is characterized by threshold effects. In section 2, we discuss the policy and academic implications of our nonlinear model, and we also introduce a new way of thinking about the impact of institutional changes. In section 3, we conclude.

1. Experimental Studies of Institutions and their Effects on Outcomes

Although it is difficult to determine the functional relationship between institutions and outcomes, data from many laboratory experiments indicate that the relationship between various institutions and outcomes is nonlinear, and more specifically involves threshold effects. Although laboratory experiments necessarily lack the complexities of real-world interactions, it is precisely this artificial aspect that makes them useful for analyzing the relationship between institutions and outcomes. Indeed, unlike the study of real world institutions (where researchers must make due with the institutions that exist and the institutional changes that take place in the context of their particular study), laboratory experiments provide scholars with a controlled

setting in which they can implement a wide variety of institutional changes and then observe their effects without the many confounding variables that exist in the real world.

Specifically, in an experimental setting, the researcher is free to tinker with institutions—be they voting rules (Guarnaschelli, McKelvey, and Palfrey 2000; Koc 1988), methods of communication (Capra et al. 2004; McCubbins and Rodriguez 2006), penalties for lying (Lupia and McCubbins 1998; Boudreau 2006), forms of verification (Lupia and McCubbins 1998; Boudreau 2006), contract enforcement (Andreoni 2005, Ostrom et al 1992), or the provision of information (Weller 2006; Kuklinski et al. 2001)—and then observe the effects that gradual changes in one or more of these institutions have on various outcomes of interest. In this way, laboratory experiments enable scholars to observe 1) the consequences of small institutional changes, 2) the interactions among different institutions, and 3) the functional relationship between institutional changes and the outcomes that they induce.

That said, we certainly acknowledge that laboratory experiments always involve a tradeoff between internal validity and external validity (Trochim 2001). While the many advantages described above enable scholars to draw internally valid causal inferences from their experimental data, these very same advantages make laboratory experiments much weaker in external validity. However, given that real world data provide, at best, a partial answer to the question of how institutions effect outcomes, we now draw upon the experimental literature that sheds light on our questions and suggests that the relationship between institutions and outcomes may be nonlinear and involve significant threshold effects.

Example 1: Institutional Change and Citizen Competence
One of the many outcomes of interest to both political scientists and development experts is citizen competence. While several scholars emphasize that institutions provide citizens with heuristics and cues that guide their political decisions (Popkin 1991; Lupia 1994; Lupia and McCubbins 1998; Sniderman, Brody, and Tetlock 1991; Druckman 2001), many others lament citizens' lack of basic knowledge about their government and the representatives that they elect (Delli Carpini and Keeter 1991, 1993, 1996; Converse 1975; Campbell et al. 1960; Bartels 1996; Neuman 1986). Based upon this latter body of literature, many scholars have questioned whether democracy can possibly work, given that citizens seem to lack the sophistication required for the decisions they must make.

In order to assess whether and under what conditions institutions can substitute for citizens' lack of sophistication, Boudreau (2006) conducted experiments (extending Lupia and McCubbins's 1998 experimental design) that analyze the conditions under which even unsophisticated individuals can learn from the statements of a knowledgeable speaker and improve social welfare. In the experiment, subjects are asked to answer math problems about which they are uncertain, but before they mark their answer, they have an opportunity to learn from another subject (dubbed "the speaker") who knows the correct answer to the math problem (i.e. the experimenter reveals the correct answer to him or her at the beginning of each trial) and who then makes a statement to the other subjects about the correct answer. Following the knowledgeable speaker's statement, the subjects then have 60 seconds to choose an answer to the math problem.

The key to this experimental design is twofold. First, both the speaker and the subjects know that the speaker can make any statement that he or she wishes; that is, the speaker can lie about the correct answer to the math problem or tell the truth. Second, both the speaker and the subjects know that the speaker is subject to one of two institutional conditions: namely, a threat

of verification or a penalty for lying. Specifically, in the verification condition, both the speaker and the subjects know that the experimenter will verify the speaker's statement with some probability (i.e. there is either a 100%, 90%, 70%, 50%, or 30% chance of verification) to make sure that it reveals the correct answer to the math problem. Similarly, in the penalties for lying condition, subjects know that the speaker will suffer a penalty (of either $15, $5, or $1) if the speaker lies about the correct answer to the math problem.

What the results of these experiments reveal is that the relationship between the gradual institutional changes that are imposed in the experiment and the outcome of interest (i.e. social welfare) is clearly nonlinear and may involve threshold effects. Specifically, the results in Figure 1 show that although there is an increase in social welfare when the 30% chance of verification is raised to 50%, 70%, 90%, or 100%, this increase in no way follows a linear trend. To see this, consider the results for the 30%, 50%, and 70% chance of verification conditions. In these three conditions, the probability of verification is gradually increased by 20%, but each 20% increase in the probability of verification does not lead to a linear increase in social welfare.

Figure 1. The Effects that Reducing the Chance of Verification has on Social Welfare
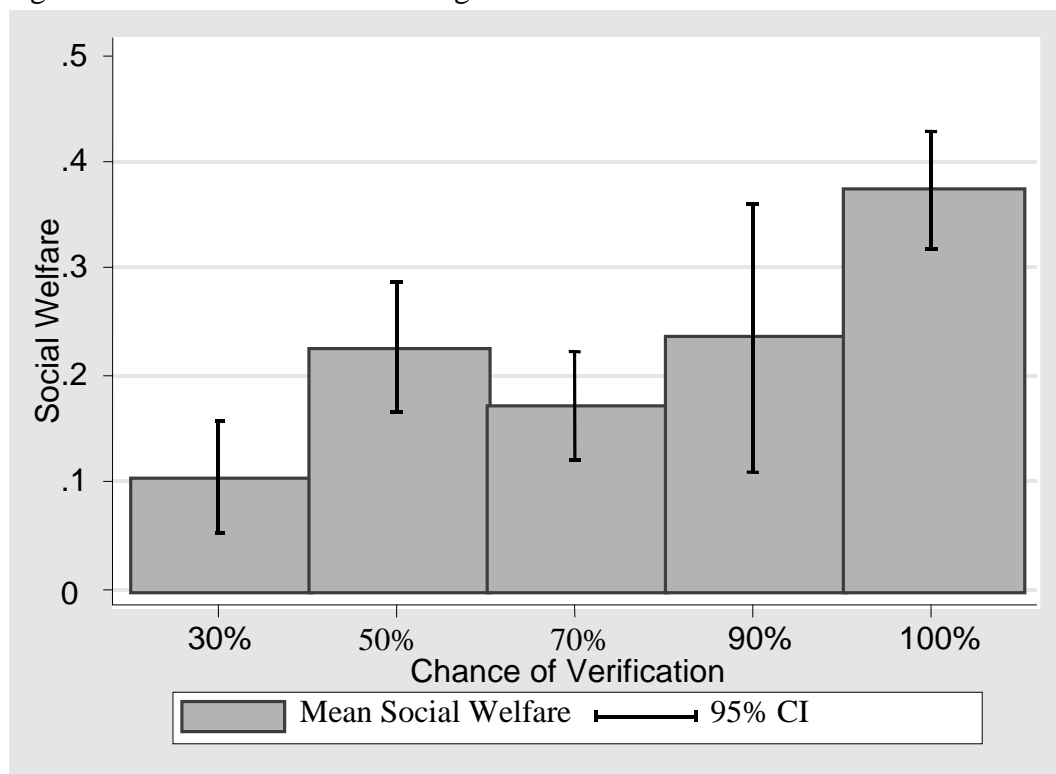
We observe a similar nonlinear relationship between institutions and social welfare when the penalty for lying that the speaker faces is increased from $1 to $5 and then to $15, as shown in Figure 2. Specifically, when the speaker faces a $1 penalty for lying, subjects earn, on average, only $0.17 per problem. Contrary to what we might expect, when that $1 penalty for lying is increased to $5, we do not observe a significant increase in social welfare; that is, in the $5 penalty for lying condition, subjects earn, on average, only $0.15 per problem. However, when that $5 penalty is further increased by 2/3 (i.e. to $15), we do observe an increase in social welfare. Indeed, subjects in the $15 penalty for lying condition earn, on average, $0.41 per

problem, which is significantly larger than the $0.15 that subjects earn in the $5 penalty for lying condition and the $0.17 that subjects earn in the $1 penalty for lying condition. In this way, these results also suggest that the relationship between institutional changes and outcomes involves threshold effects. Indeed, the results for the penalty for lying condition suggest that until a certain threshold (which exists somewhere between a $15 penalty and a $5 penalty) is crossed, then we should not expect this institution to improve social welfare.

Figure 2. The Effects that Reducing the Penalty for Lying has on Social Welfare
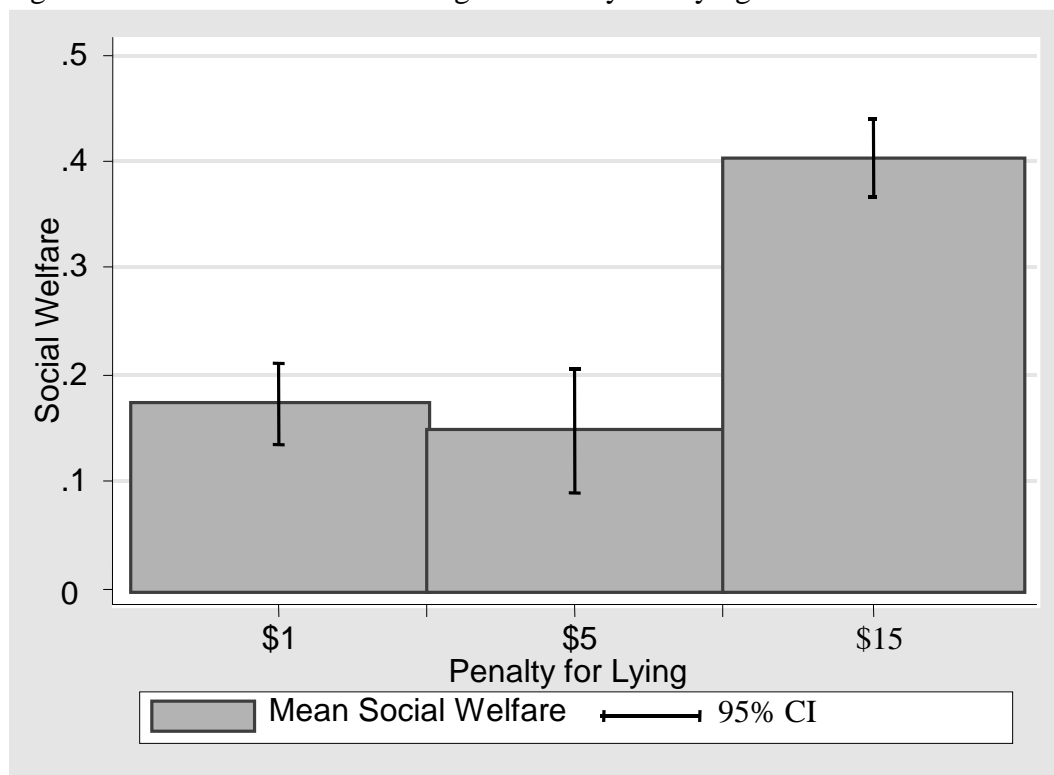
Example 2: Institutional Change and Economic Markets
        Yet another issue of interest to political scientists and development experts is the question of how institutions affect economic growth and development. Although many scholars have offered both institutional and non-institutional explanations for the different levels of economic development that we observe in countries around the world (North 1990, Haber 2000, Sachs and Warner 1995, Knack and Keefer 1995, Acemoglu et al. 2001, Sachs 2003, Glaeser et al 2004, Barro 1997, Hall and Jones 1999), their explanations are necessarily limited by the real world data on which they rely. Indeed, existing, real world data do not allow us to assess which one (if any) of scholars' explanations best accounts for the disparities in economic growth and development that we observe (see Capra et al. 2004 for further discussion).
        Given the difficulties associated with studying economic growth using real world data, Capra et al. (2004) conduct an experimental study of how various institutions affect economic markets. Specifically, in their experiments, these scholars set up a simple economy in which subjects produce output and then must decide how much of their output to consume and how much to invest. After subjects make their consumption and investment decisions, these decisions

are then aggregated to determine a group payoff, which is a function of the total amount of investment.

In this experimental economy, there exist two equilibria. The first, which the authors dub the "rich country equilibrium," occurs when subjects invest enough money to surpass a certain threshold and earn a group payoff that gives them higher consumption and higher utility. In the second equilibrium, dubbed the "poverty trap equilibrium," subjects do not invest enough money to surpass the threshold, and they, therefore, do not earn as much money as subjects who reach the "rich country equilibrium." In the absence of any other institutions, Capra et al. (2004) find that subjects routinely converge to the poverty trap equilibrium, invest an inefficiently low level of resources, and do not earn as much money as possible.

In an effort to analyze the conditions under which investment (and, by extension, economic markets) can be improved, Capra et al. (2004) introduce three different institutions to the experimental setting. The first institution is analogous to "freedom of expression" in that it allows subjects to engage in pre-play communication about their investment and consumption decisions. Ideally, players in this setting will announce their intent to invest a large portion of their resources, which should then induce others to invest and bring about greater earnings than in the control setting. The second institution is analogous to a democratic voting process in that two subjects (who are selected at random) propose investment and consumption schedules for the other participants in the experiment. Their two proposals are then simultaneously voted on, and the proposal that is chosen by the majority is enacted. The third institution is simply a combination of the first two. That is, players are allowed to communicate, and following their communication, two players are randomly selected to propose a consumption and investment schedule, and the proposal with the most votes is implemented.

As the results of Capra et al.'s (2004) experiments reveal, the interaction of the two different institutions that they impose creates substantial nonlinearities in the outcome of interest. Stated differently, their results demonstrate that the addition of one institution at a time does little to improve outcomes, but once their two institutions are combined, we observe large improvements in outcomes. Specifically, when the "freedom of expression" condition is introduced, it enables only some (not all) of the experimental economies to overcome the poverty trap equilibrium, and the same is true when the "democratic voting" condition is introduced by itself. Further, in both of these institutional conditions, the experimenters observe large amounts of variance in outcomes, which suggests that neither one of these institutions, by itself, is sufficient to improve economic performance consistently.

However, once both the "freedom of expression" and "democratic voting" institutions are imposed together, then the experimenters observe large improvements in outcomes. Specifically, when these two institutions are combined, every single experimental economy is able to surpass the threshold, avoid the poverty trap, and earn a larger amount of money. In this way, Capra et al.'s results suggest that the interaction effects among different institutions may create nonlinear outcomes and threshold effects. Indeed, only when the "right" combination of institutions is adopted do they achieve a large improvement in outcomes.

Example 3: Institutional Interactions and Policy Tradeoffs

Citizens' ability to make tradeoffs among different policy options has long been of concern to scholars of political behavior (Citrin 1979; Ladd 1979; Modigliani and Modigliani 1987; Kuklinski et al. 2001), initiative and referenda reform (Kousser and McCubbins 2005), and economic policy (Cox and McCubbins 2001, Shugart and Haggard 2001). Indeed, many of these

scholars emphasize that making tradeoffs among policy options is a task that pervades the many duties that citizens are expected to carry out—namely, voting for candidates in primaries, voting on initiatives, evaluating different provisions of proposed laws, etc. (for more on this point, see Kuklinski et al. 2001). However, if citizens are unable to choose from different policy options in a consistent, sensible manner, then the health of our democracy is likely to suffer, as politicians will not receive consistent signals about citizens' preferences and inefficient policy outcomes may result.

Given the importance that making tradeoffs has for institutional design, Kuklinski et al. (2001) conducted a survey experiment that was designed to test whether and how various institutions affect citizens' ability to make tradeoffs among different policy options. Specifically, Kuklinski et al. asked citizens to answer a series of survey questions regarding health care reform—an issue that inevitably requires citizens to make tradeoffs. For example, providing health care coverage to all citizens most likely requires an increase in taxes, and requiring employers to pay for their employees' health care most likely means a reduction in the number of jobs that are available (Kuklinski et al. 2001). According to Kuklinski et al. (2001), it is recognizing (and then making) these various tradeoffs that is important for good public policy.

In order to assess the effects that institutions have on citizens' ability to make tradeoffs, Kuklinski et al. (2001) incorporated a series of experimental manipulations into their survey design. Specifically, these scholars assessed whether and how information, motivation, and the combination of these two institutions affect citizens' ability to make tradeoffs. In the information condition, citizens were given either 1) generic information about how making decisions about public policy requires giving one thing up to get something else or 2) more specific information about the exact tradeoff that citizens had to make (for example, citizens were told that "experts say we cannot provide health coverage for everyone and at the same time keep taxes down" p. 421). In the other institutional condition, citizens were given a motivational prompt that encouraged them to take their time and do their best on the questions. In the institutional combination condition, citizens were provided with one of the two types of information and a motivational prompt.
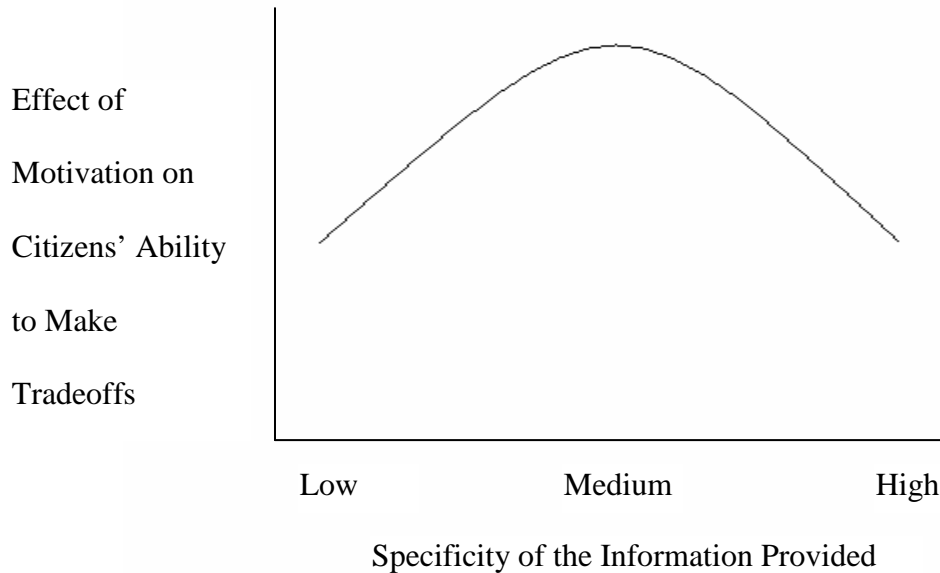
Similar to Capra et al.'s (2004) results, Kuklinski et al. (2001) discovered that the relationship between various institutional arrangements and outcomes is highly nonlinear. Specifically, their results demonstrate the following nonlinear pattern: When citizens answer the survey in the absence of any institutions (i.e. without the informational or motivational prompts), many of them fail to make necessary tradeoffs and ask for more than policymakers can possibly deliver. When general information about the need to make tradeoffs is provided to citizens, they still fail to make tradeoffs among competing policy options. Similarly, when a motivational prompt is introduced, citizens do not make the necessary policy tradeoffs.

However, when general information is provided with a motivational prompt, citizens make tradeoffs and reduce their overall policy demands. Further, when citizens are provided with specific information about the tradeoff that they must make, citizens also make the necessary tradeoffs and reduce their demands. Indeed, the specific information provided in this last condition is so powerful that combining it with a motivational prompt does not improve citizens' decisions. Stated differently, in political environments that provide specific information, citizens can make tradeoffs easily enough that adding a motivational prompt does not have an independent effect on their decisions (Kuklinski et al. 2001).

Taken together, Kuklinski et al.'s (2001) results reveal two important findings. First, they demonstrate that only the "right" combination of institutions induces the desired outcome

(i.e. a reduction in the contradictory demands that citizens place on policymakers). Second, they demonstrate that, in the context of their study, the relationship between various institutional arrangements and outcomes is curvilinear, rather than linear (see Figure 3). For our purposes, these two findings provide substantial support for our argument that the appropriate functional relationship between institutions and outcomes is nonlinear.

Figure 3. The Curvilinear Relationship between Institutions and Outcomes[3]

Effect of

Motivation on

Citizens' Ability

to Make

Tradeoffs

Low   Medium   High

Specificity of the Information Provided

Example 4: Trust, Investment and Information
        A significant amount of literature has argued that trust is an important determinant of economic exchange (Arrow 1972, Fukuyama 1995, Putnam 1993, Knack and Keefer 1997, Zak and Knack 2001). Trust plays a role in exchange by lowering transaction costs. For instance, if two actors are exchanging goods it is likely impossible to specify all of the relevant aspects of the exchange due to information, monitoring and enforcement costs. The inability to craft a complete contract could lead the two actors to avoid exchange and simply keep their own goods rather than take on the risk inherent in exchange. The lack of exchange has negative consequences for overall social welfare, even if it is in each actor's individual interest because of the level of uncertainty. One possible solution to this incomplete contract problem is for the two players to trust each other to uphold their end of the bargain. If the players can trust, or act as if they trust, each other then the problems that arise from incomplete contracting might be minimized. Knack and Keefer (1997) and Zak and Knack (2001) find evidence that levels of economic development are associated with survey-based measures of trust; however, this does not tell us how trust is created.
        To begin to answer how trust can be created Weller (2006) adopts and modifies the experiment of Berg, Dickhaut and McCabe (1995). In the original experiment two anonymous players are matched together. The first player is given $10 and told that they can pass some, all or none of their $10 to the other player. When money is passed its value triples. The second player receives the tripled value and can choose how much, if any, of it to return. In this set-up

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[3] This Table was adapted from Kuklinski et al. (2001, p. 414).

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Player 1 exhibits trust in sending money to Player 2 and Player 2 exhibits trustworthiness in returning money. Contrary to game theoretic predictions, Player 1's send an average of $5.07 to Player 2 and Player 2 returns an average of $3.50 in Weller's (2006) control condition.[4]

In Weller's (2006) modification of the experiment, subjects play a prisoner's dilemma for five rounds with a different, anonymous partner each time and do not know they will later play the trust game. This precludes the possibility of signaling or reputation development. Players then play the trust game, but before they choose how much to pass to Player 2 they are told how their partner played in the five rounds of the prisoner's dilemma. The information from a prisoner's dilemma is analogous to much information we receive about possible partners in economic exchange. That is, it is not directly relevant to the transaction about to take place, but it is the only information to which actors have access. This might be similar to information about language, culture, customs, and behavioral norms. None of this information is directly relevant to the decision to invest money with another person (which is what the trust game requires), but players may form expectations about the likely behavior of another person based on this information.

The information from the prisoner's dilemma does not affect the subgame perfect equilibrium in the trust game, so we still expect players to keep all of the money and not pass any to Player 2. The results, as shown in Figure 4, are grouped by the number of times out of five the Player 2 defected in the prisoner's dilemma. If the individual defected zero or one time, he is called a cooperator; if he defected 2 or 3 times, he is called neutral; if he defected 4 or 5 times, he is called a defector. The results show that unless Player 1 defected 4 or 5 times in the Prisoner's Dilemma the additional information has no effect on decisions, as we would predict. However, if a subject is matched to an individual who defected more than four times in the prisoner's dilemma there is a dramatic change in Player 1's passing of money. It is only in this condition that Player 1's behavior is statistically different than the control group (p = .01 in a Mann-Whitney ranksum test). Again, this result suggests that there is a threshold effect, in which outcomes are unaffected by the provision of information until some critical point is reached that causes a change in behavior. In this experiment the institution would seem to provide Player 1 with information that leads him to predict Player 2 will be less trustworthy than initially believed.

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[4] These results are close to the findings in the Berg et al (1995) paper in which under the control condition Player 1s send an average of $5.16 and Player 2s return an average of $4.66. The medians of Player 1s and 2s behavior is even closer in the two experiments, the larger difference in the average is mostly because of the range of behavior in the data. There is tremendous variation in actions of subjects in both Berg et al (1995) and Weller (2006)'s experiments. Players 1 send anywhere from $0 to $10 and Player 2's return anywhere from $0 to

Figure 4: Effect of Prisoner's Dilemma on Investment in Trust Game
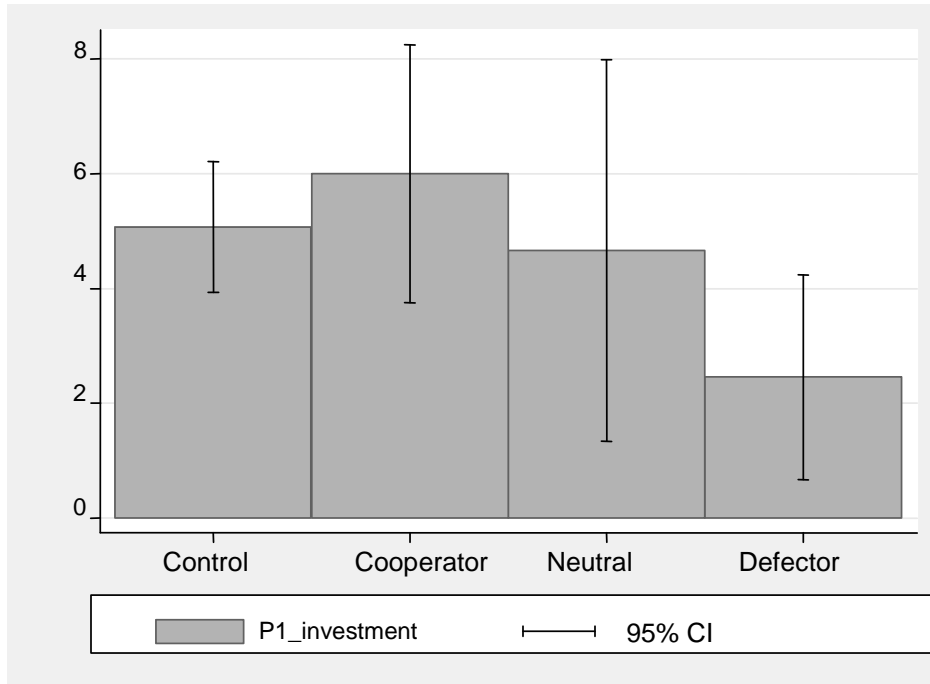
Example 5: Deliberation and Social Welfare

       For millennia, legal scholars, social scientists, democratic theorists, and others have extolled the virtues of deliberation, arguing that we should incorporate more deliberative practices into our political institutions, as well as those in developing countries. To this end, scholars have argued that electoral processes should be made more deliberative (perhaps through the use of deliberative polling, see Ackerman and Fishkin 2004), while others recommend that deliberative processes be incorporated in legislatures, courts, and agencies (Bessette 1994; Burdett 2000; Granstaff 1999; Mucciaroni and Quirk in press; Abramson 2000; Cuellar 2005). In this way, deliberation is proposed as a major palliative and, for some, even a panacea, for nearly all that is wrong in society—a procedural "cure all" for self-interested decision making (Habermas 1996; Cohen 1997), for an uninformed citizenry (Gastil and Dillard 1999; Fishkin 1991; Fishkin and Luskin 1996), for the oppression of minorities (Petit 2000), for social fragmentation (Gutmann and Thompson 1996), and for low levels of confidence in government (Dryzek 2001), among other ills. As McCubbins and Rodriguez (2006) note, however, in all of this frenzy to cure societal ills through deliberation, scholars have either explicitly or implicitly assumed their own conclusion: that deliberation has social welfare-enhancing effects.

       In order to investigate empirically whether and under what conditions deliberation does in fact have social welfare-enhancing effects, McCubbins and Rodriguez (2006) design a laboratory experiment in which subjects are asked to deliberate about the answers to math problems about which they are uncertain (that is, subjects do not necessarily know the correct answers to the math problems). These math problems are drawn from an SAT II, level two math test, and under various conditions, subjects are asked to make a series of binary choices about them: first, subjects may choose to answer a problem or leave it blank; second, if they decide to answer a problem, then they may choose either answer "a" or answer "b" as the correct answer.

Subjects have 60 seconds to answer each math problem, and they earn $1 for every problem that they answer correctly, they lose $1 for every problem that they answer incorrectly, and they neither earn nor lose money if they choose not to answer the problem. Subjects are also told that they make an additional $10 each if they all choose the correct answer to a math problem (i.e. if even one subject gets a problem wrong or leaves it blank, then they all miss out on the $10 bonus), and this establishes strong common interests among them. Indeed, the experiment is purposefully structured to encourage the subjects to reach a consensus, which is one of the goals that many scholars have attributed to deliberation. McCubbins and Rodriguez consider successful deliberation to have occurred when all subjects choose the correct answer to a math problem.

In groups of various sizes, McCubbins and Rodriguez (2006) allow subjects to deliberate, and thus, the sizes of the groups form the various institutional conditions applied in the experiment. Specifically, they allow subjects in groups of 4, 8, 9, 10, 12 or 15 individuals to exchange information about the math problem on which they are working. So, when solving each math problem, each subject in the group has the chance to pay $2 to make an anonymous statement to the other subjects (i.e. send a signal about whether they recommend answer "a" or answer "b" as the correct answer to a math problem), and each subject can also choose to pay $2 to listen to an aggregation of the signals that the other subjects sent.[5] These $2 costs associated with sending and receiving information are designed to be analogous to real world deliberative settings, where there are inevitably opportunity costs associated with speaking and listening (Lupia 2002, 2005). After deciding whether to pay $2 to send a recommended answer to the other subjects and after deciding whether to pay $2 to receive information about other subjects' recommended answers, subjects then have 60 seconds to choose their final answer to the math problem.

In order to identify whether and under what conditions deliberation improves social welfare, McCubbins and Rodriguez (2006) calculate a straightforward measure of social welfare—namely, the average amount of money that subjects earn per problem in each group size. So, for example, if subjects are deliberating successfully (i.e. coordinating on the correct answers to the math problems), then we should observe higher payoffs per subject (i.e. increasing social welfare), as all of the subjects in the group are earning $1 for solving the problems correctly and earning an additional $10 because all of the other subjects also solved the problems correctly. By contrast, if subjects are unable to deliberate successfully, then a lower amount of social welfare should be generated, as subjects in the group will not earn an additional $10 and some may not earn $1 for solving the problems correctly.

As the results of McCubbins and Rodriguez's (2006) experiments reveal, there are substantial nonlinearities in the amounts of social welfare that subjects earn in the different size groups. Specifically, Figure 5 shows that in groups that consist of 15 or 12 individuals, subjects generate a negative amount of social welfare (that is, they earn, on average, $-0.17 and $-0.03 per problem, respectively). As the group size is decreased to 10 or 9 individuals, then subjects earn, on average, $0.02 and $0.07 per problem, respectively. Note, however, that none of these apparent improvements in social welfare are statistically significant.

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[5] Note that the aggregation of signals that subjects can pay to receive consists of information about the total number of subjects in the room, the number of subjects who chose to recommend answer "a," and the number of subjects who chose to recommend answer "b."

However, when the group size is further decreased to 8 or 4 individuals, then subjects are able to generate significant improvements in social welfare. Specifically, when the group consists of 8 individuals, subjects earn, on average, $0.92 per problem, and when the group consists of only 4 individuals, subjects earn, on average, $1.79 per problem. Both of these amounts of social welfare are significantly larger than the amounts of social welfare that subjects generate in groups that consist of 15, 12, 10, or 9 individuals ($p < 0.01$). Further, the amount of social welfare that subjects generate in a group of 4 individuals is significantly larger than the amount of social welfare that subjects generate in a group of 8 individuals ($p < 0.01$).

Figure 5. The Effects that Group Size has on Social Welfare
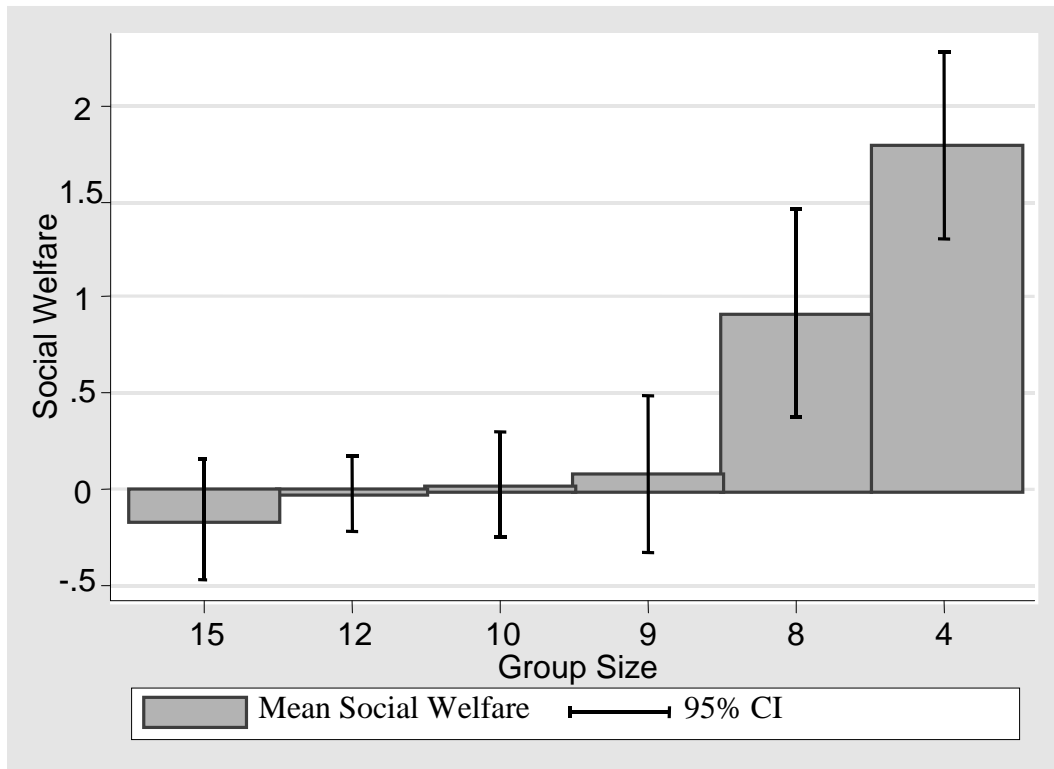
In this way, the experimental results in Figure 5 reinforce the main argument of this paper: that the relationship between institutions and outcomes is nonlinear and is characterized by threshold effects. Specifically, McCubbins and Rodriguez (2006) vary the nature of one particular institution (namely, the size of the deliberative group), and their results demonstrate that only certain institutional variations induce improvements in social welfare and that these improvements in no way follow a linear trend. For example, decreasing the group size from 15 individuals to 12, 10, or 9 individuals does not lead to a significant change in social welfare, while decreasing the group size from 9 individuals to 8 individuals does lead to a significant improvement. And, further reducing the group size from 8 individuals to 4 individuals leads to an even larger improvement in social welfare. In this way, these results demonstrate the existence of a threshold effect, in which social welfare does not increase until a small enough group size is put into place that allows for an improvement in social welfare.

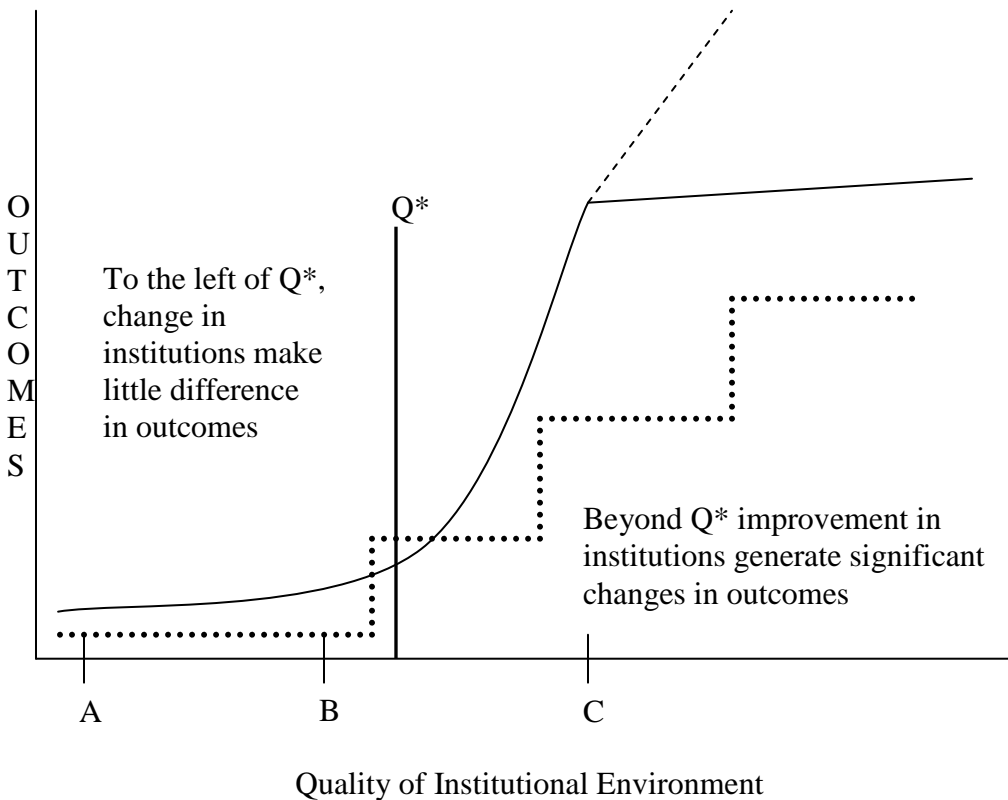## 2. Discussion: The Implications of Threshold Effects

Thus far, we have surveyed the results of laboratory experiments that demonstrate that the relationship between institutions and outcomes is characterized by threshold effects and that, contrary to much of the existing literature, we cannot simply assume that institutions improve outcomes in a linear manner.[6] In this section, we discuss the implications of our argument that the relationship between institutions and outcomes is nonlinear and is likely to contain important threshold effects. Specifically, we argue that there are two important consequences of these findings: 1) a practical implication for policy prescription and analysis, and 2) the need for a new model of the relationship between institutions and economic growth.

First, if the relationship between institutions and economic growth does indeed contain the threshold effects we observe in numerous experiments, then we need to reconsider how we evaluate the impact of institutional reform. For instance, if a country with low institutional quality moves from point A to point B in Figure 6, then our nonlinear model would not predict an increase in economic growth, but a move from point B to point C should lead to a change in economic growth. By contrast, the typical policy advice from the World Bank suggests that every unit change in "institutional rightness," for instance from point A to B to C, should lead to improved outcomes. Therefore, in the absence of a change in economic growth as a country moves from A to B, the World Bank and others might conclude that either institutions do not matter or that the government did not "get the institutions right." However, if we are correct about the existence of thresholds, then the lack of change in economic growth suggests another conclusion: namely, that even if the country is closer to "getting the institutions right," if they have not passed point C in Figure 6, then their institutional improvements will not induce improved outcomes. This suggests perhaps starkly different practical policy recommendations. In the world of threshold effects, the country would need to consider the possibility that they had not yet crossed the threshold and/or that other institutions also must be in place to create a change in economic growth. This makes policy advice and analysis more difficult than if the relationship between institutions and economic growth is linear, but the evidence in this paper suggests that reliance on a linear model will lead us to misunderstand the relationship between institutions and economic growth.

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[6] Across the board, the experiments we surveyed show that there are threshold effects between institutions and outcomes. For example, the experiments of Kuklinski et al. (2001) and Weller (2006) show that information provision can affect behavior, but information does not always change the behavior of experimental subjects. Rather, information has important interaction effects with both the other types of information and with the prior beliefs of individuals. The experimental results of Capra et al. (2004) show that threshold affects can arise from institutional interactions. There results demonstrate that some institutions, when implemented separately, will have little or no effect, but when combined together can dramatically change behavior. Finally, the results of Boudreau (2006) and McCubbins and Rodriguez (2006) show how even a single institution can lead to threshold effects between changes in institutions and outcomes.

Figure 6: Institutional Quality and Outcomes

To the left of Q*,
change in
institutions make
little difference
in outcomes

Q*

Beyond Q* improvement in
institutions generate significant
changes in outcomes

A   B   C

Quality of Institutional Environment

Of course, rejecting a linear model does not tell us what exact functional form is a better model for the relationship between institutions and outcomes. It also is not clear that our results, at this point, can provide us with the information needed to determine the correct functional form. However, they do offer some guidance on at least two fronts. First, the functional form needs to suggest that at low levels of institutional quality there is little change in outcomes from gradual increases in institutional quality. Second, the functional form needs to incorporate the threshold effects we observe in the experiments. We are confident that the functional form needs to account for these two aspects, but the experimental results do not fully inform us about the relationship between institutions and outcomes once we cross an initial threshold.

That said, we can imagine three different functional forms, shown in Figure 6. The functional form displayed by the solid line suggests a phase transition related to passing an institutional threshold. We generally think that there are two possibilities after passing this initial transition. In the first possibility, the returns from improvements in institutions continue beyond the initial threshold. The implication from this model is shown by the dashed line in Figure 6. Another possibility is shown by the solid line in the figure. In this functional form, the returns to improvements in institutions decline after a threshold is passed. This would suggest that there is a big gain from passing some initial threshold, but future improvements may not have much of an effect. An alternative functional form (the dotted line) suggests the existence of multiple thresholds or a step function to describe the effects of institutional change. All three of these forms would seem to match the results from the various experiments we review. However,

none of the experiments allow us to distinguish between these functional forms, and it will take a careful experimental design to determine which of these functional forms is most likely to explain institutions' effects on outcomes.

The other issue raised by all of these experiments is the inability to predict, *a priori*, which institutional forms and combinations will lead to changes in outcomes. This not only suggests that we need to understand better what it means to "get the institutions right," but it also implies that we need to understand better how humans interact with their institutional environment. There have been significant attempts to develop theories of human behavior and decision making (Kahneman and Tversky 1979; Camerer 2003) that incorporate the lessons learned from these experiments. However, none of these theories have been widely accepted. More importantly, most of the theories address behavioral issues such as concerns with equity, fairness, or risk aversion, but do not theorize about how humans perceive and interact with institutions. These experiments primarily raise the issue of how humans interact with their institutional environment and when that environment affects their behavior, an issue that has not seen much theoretical work (North 2005).

At this point we do not have a full answer to how humans perceive and interact with their institutional environment, but the experiments do suggest at least two important conditions. First, institutions must create conditions in which incentives are clear. Second, institutions must make common knowledge the payoffs and strategies of actors. Regarding the first condition, Boudreau (2006) shows that when experimental subjects do not know the incentives of the speaker in the experiments they cannot make decisions to improve their social welfare. It is only with the addition of institutional conditions that clarify the speaker's incentives that listeners are able to improve social welfare. The ability of institutions to clarify the incentives of possible actors in an interaction can make it easier for players to predict the consequences of others' actions. If players cannot predict the likely consequences of their interaction, they may simply choose to avoid interaction, and thereby forego any possible benefits. In the case where individuals are not willing to interact, they will not be able to capture gains from exchange, which will ultimately hinder economic growth. The experiments reviewed here begin to unpack how institutions make incentives clear, but future experimental designs can modify institutional conditions to determine how they affect interaction and social welfare. The ability of institutions to clarify incentives seems necessary for institutions to change individuals' behavior (and, thus, aggregate outcomes), but it is likely not sufficient, nor does it guarantee that an institution will improve social welfare. We leave an explanation of sufficiency and how to increase social welfare for future papers.

3. Conclusion

In this paper we have argued that the literature concerned with "getting the institutions right" has failed to clarify the relationship between institutions and outcomes and has also failed to consider the applicability of the linear model most scholars employ. As we have discussed these shortcomings, we have suggested that we need a different model than the linear one used by most scholars. Indeed, we have argued that the new model must incorporate the threshold effects that we observe in many experiments, and we have also suggested some important aspects of an alternative model. We certainly believe, and the experiments demonstrate, that institutions can have a profound effect on economic growth and other outcomes, but so far we do not fully understand the conditions under which they are likely to do so. We believe that an improved (nonlinear) model for the relationship between institutions and outcomes can help us to understand their effects better.

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