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FAIRNESS, JUSTICE AND AN INDIVIDUAL BASIS FOR PUBLIC POLICY

By

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FAIRNESS, JUSTICE AND AN INDIVIDUAL BASIS FOR PUBLIC POLICY

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Prior models of the policy process have examined how human characteristics can affect policy decision-making in such a way that it leads to aggregate effects on policy outcomes as a whole. I develop a model of the policy process which suggests that emotions related to fair and unfair experiences in the same policy domain are utilized by decision-makers as policy criteria. In the lab, I empirically tested this, and find that emotions and experience related to fairness do influence the policy decision to move away from the status quo alternative. Based upon this result, I simulated the evolution of a society of agents engaged in decision-making using similar criteria. The simulation suggests that incentives have an important role in leading to cooperation and social success. The external validity of the simulation also implies that it can act as a platform for future evolutionary policy experimentation.

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Fairness as an Individual Basis for Public Policy

Dissertation Chapter 1

Introduction

Individuals, primarily those among the elite, are often engaged in making policy evaluations and judgments. However, many models of the policy process have the system itself as their focus. This dissertation attempts to contribute a model of the policy process which is rooted in the individual. The model provides a new explanation for how we arrive at public policy based upon modern neurological and biological research on human decisions.

The core idea of democracy is that the law and other institutional expressions of public policy reflect the preferences of the population. In many models of government and other forms of collective action, the individual has been assumed to be making decisions by cognitively choosing those alternatives which reflect their preferences. Recent research has begun to change our understanding of the nature of individual preferences and decision-making. This research has found that some preferences are influenced by physiological, heritable, and unexpected environmental factors creating a base or disposition within the individual for the expression of the preference (Alford, Funk and Hibbing 2005; Oxley *et al* 2008; Smith *et al* 2009). In addition, research on human limitations in decision-making and information processing indicate that the purely rational actor is not an accurate model for individual behavior (Kahneman and Tversky 1979; Simon 1995; Jones 2001; Taber 2003; Camerer *et al* 2005). Scholars of public policy have developed models of the policy process which reflect boundedly rational decision-makers acting in a complex context (Kingdon 1984; Baumgartner and Jones

1993; Sabatier and Jenkins-Smith 1999; Jones and Baumgartner 2005), but they do not account for an evolution of partially predisposed preferences expressed as a phenotype nor do they explicitly model *how* rationality is bounded when making policy decisions.

If preferences on matters of governance are influenced in part by heritable traits, then how is the policy process affected by the evolution of these traits? This key question is restated as being whether communities of individuals with similar predispositions, experiences and decision-making tendencies lead to common preferences for particular public policies and then to an adoption of public policy that reflects those preferences.

The model of the policy process that I present in this dissertation is one which accounts for evolutionary change in traits relevant to governance institutions and individual compliance with the policies of these institutions. The model is based on the idea that individuals have partly heritable predispositions about fairness and justice, and that these predispositions influence some decision-makers' policy decisions. In addition, the preponderance of these predispositions about fairness and justice create an environment that even purely self-interested decision-makers could not ignore in a democracy without risking their own position.

In order to establish the basis for the model, a few key issues need to be addressed. First, an individual predisposition for fairness and justice should be identified. Do human beings have inherent predispositions that shape policy evaluations? Second, there must be an aggregation mechanism to move from individual preferences to public policy that accounts for the partial heritability of preferences. Something must bridge the micro-macro divide with regard to the derivation of public policy.

I will use evidence on human information processing and emotional responses in decision-making during the Ultimatum game as an example of a partly predisposed norm of fairness, and demonstrate that this norm provides criteria for evaluating public policies. Evidence for the partial heritability of the second player's evaluation in Ultimatum is already provided in the literature (Wallace *et al* 2007). Therefore, the key question is whether this norm provides criteria for evaluating public policies.

Further, do the emotions elicited by being treated fairly and unfairly also translate into desires for third parties to be treated fairly by others in society? If so, then a link can be made between emotions related to fairness and preferences for policies designed to assure justice. The prevalence of these policy criteria in society then may lead to an important impact on the policy process and policy outcomes.

The Literature and Key Questions

Two general categories of questions comprise the study of public policy (Lasswell 1951; Mead 1985). First, what should be done by the state? These questions are answered with what is known as policy analysis. Second, why do certain policy outcomes arise from the policy process? It is this second general area of study in which I wish to contribute. In order to understand why policy outcomes arise in government, several models have been developed that explain the policy process.

Models of the Public Policy Process

Three models of the policy process are currently in vogue in the policy community: the Multiple Streams model (Kingdon 1984), the Punctuated Equilibrium model (Baumgartner and Jones 1993), and the Advocacy Coalition Framework (Sabatier

and Jenkins-Smith 1999). These standard models are more complementary with each other than they are competing in explaining the policy process (John 2003).

Kingdon's Multiple Streams model explains the policy process as a series of queues or streams that comprise problems, policies and politics (Kingdon 1984, 19). A policy change occurs when the streams are aligned and an entrepreneur takes advantage of the opportunity. This happens when (1) social indicators indicate a problem, (2) there is a policy solution for that problem, and (3) the public mood and interest groups are amenable to that solution. Under these conditions, policy change can occur because a window will open for that policy change to occur. Change happens when a policy entrepreneur takes advantage of the open window.

The Punctuated Equilibrium model describes a process of policy change in which there are variable speeds at which policy change occurs (Baumgartner and Jones 1993). According to the model, policy normally changes incrementally. However sometimes, Baumgartner and Jones state, "Waves of popular enthusiasm surrounding a given issue provide the circumstances for policymakers to create new institutions to support their programs." (1993, 83) These sudden and dramatic changes are the result of a positive feedback process.

Like the Punctuated Equilibrium model, the Advocacy Coalition Framework (ACF) also is a system where feedback plays a role in outcomes (Sabatier and Jenkins-Smith 1999). The policy subsystem responds to the social indicators, constraints and resources and events external to the policy subsystem. As a result of its own process, the policy subsystem affects these events, indicators and resources. The subsystem itself is a competition among coalitions favoring particular policy outputs.

These three standard models of the policy process share some similar qualities. The models primarily account for individual action in a boundedly rational way. This means that the models assume that individual decision-makers in each model are making decisions rationally / cognitively but with emotions, habit, or other factors keeping decisions from being purely rational. The models do not explicitly assume partly innate preferences as a form of human cognitive limitation or the implications for the policy process that flow from such an assumption. The primary purpose of these models is to describe features of the policy process as a system. This is certainly to their credit as models of the policy process as a system are needed. However, to some degree, individual decision-making that is reflexive or predisposed gets short shrift in these models.

The Disproportionate Information Processing Model

Bryan Jones and Frank Baumgartner (2005a; 2005b) recently have presented a methodologically individual model of the policy process based upon the perspectives of both individual decision-making and organizational decision-making. In the model, decision-making is roughly modeled into four stages for both individuals and organizations (themselves comprised of individuals) (2005a, 33-37). The individual actor is attributed to be boundedly rational with several different bounds presented as leading to effects on policy outcomes. In particular, Jones and Baumgartner focus on the limited attention of individuals and how it can lead to (among other things) punctuated equilibria. This is a particularly insightful model because it recognizes that particular aspects of human nature (as defined by the relevant physical systems underpinning our neurology) can lead to aggregate effects on public policy.

It is not Jones and Baumgartner's focus on the limited attention span of human beings that is of interest to me, though. Rather, I wish to point out that emotion is another trait affecting human decision-making and thus, it is likely to affect the policy process. Jones and Baumgartner do briefly discuss emotion and its effect on policy decisions. They frame emotion as one mechanism for decision-makers to make "mistakes" (2005a, 16). This perspective on human emotion is consistent with the ideas of bounded rationality; that human beings are limited in their cognitive processing. There are, however, other views on emotions' effect on decision-making. In particular, Marcus, Neuman and MacKuen (2000) view emotion as providing useful information for the decision-maker¹. In other words, the perspective is not that individuals are being drawn away from rationality, but rather that certain emotions indicate to us the need to depart from decision-making done habitually (Marcus, Neuman and MacKuen 2000, 127). This is consistent with research in neuroscience which demonstrates that emotions precede and guide cognition (summarized in Marcus 2003, 197).

Evolution and the Policy Process

The evolutionary forces of adaptation and selection have the ability to influence policy decision-making through influence on neurological systems utilized for policy decisions. However, policy is a process involving many individuals. The four models of the policy process previously described illustrate the institutional organization inherent in the policy process. While referring to these models, Peter John states, "Because some writers on public policy use evolutionary ideas in their arguments, it may be possible to argue that the next logical step is to develop the theory more fully, which would be

¹ For an excellent review on emotion in politics, see Marcus (2003).

similar to other areas of the social sciences that have developed evolutionary thinking, such as economics, game theory, economic geography, social theory, and evolutionary psychology.” (John 2003, 491) John’s assertion is that the unit of evolutionary change through selection is ideas or memes (2003, 493). He suggests that memetic selection occurs when the best ideas are tried and evaluated, and that only the ones that work are replicated. I believe that this evolution of technology does affect public policy outcomes (Ayres 1978 [1944]; Hayden 2006), but it may not be telling the whole story.

What John does not address is that it may not be only that the policy ideas are evolving socially through technological trial and error, but also that the heritable predispositions underlying beliefs and preferences on matters of governance are evolving as part of human evolution. If these beliefs or preferences are partly predisposed to particular outcomes because of cognitive biases arising in human neurology, then the physical evolution of human beings may be affecting individual policy judgments, and thus also the policy process in a democracy in a profound way.

One obvious objection to this notion is that the policy process is occurring much, much faster than human evolution could. However, recent research in epigenetics and other genetic research is changing our understanding of the speed of genetic change (for interesting reviews see Robinson *et al* (2008) and Zimmer (2008)). More important, though, is that it is not genotypes that are selected for in evolution, but rather phenotypes (Futuyma 2005, 251; Haidt 2007b).

Phenotypic expression of human behavior may arise from both social transmission of knowledge from parent to child *and* from particular genes being expressed (Plomin *et al* 2001). An example is when a group teaches its young people to

use hygiene. Those who use hygienic techniques are likely to reduce the prevalence of disease allowing more of the population using the techniques to live until reproductive age. The use of the technology itself becomes a phenotypic expression that changes the proportion of the population that adopts it. This is because some technologies have the ability to provide fitness benefits to those communities that adopt them. Jonathan Haidt makes the case well, “Phenotypes (e.g., cooperator or defector) can now be modeled as joint products of genes, cultural learning, and culturally altered payoff matrices. When culture is included, the old consensus must be reexamined. The time frame shrinks from millennia to years (or less) as groups find culturally innovative ways to police themselves, to increase their phenotypic homogeneity, to lower the costs of prosocial action, and to increase the size of the pie they then share.” (Haidt 2007b, 597)

This opens the possibility that both technological change *and* genotypic change could be selected for if they both affect the proportion of phenotypes in the next generation. Both a very fast change (technological) and slower change (genotypic) affects the proportion of phenotypes in succeeding generations, and public policy can be affected by both.

It is not my intention to minimize the influence of the environment, though. The traits of species normally adapt (both technologically and physically) to the fitness landscape provided by whatever environment is present at a given time (Nowak 2006). This means that the phenotypes (or traits) which have higher levels of fitness will be adopted by a species². The policies of the society act as an important component of that environment. For example, the political environment and public policy directly influence

² This assumes that the fitness landscape has a single positive maximum value. Traits which are neutral with regard to fecundity would not have a single positive maximum value.

the distribution of resources in a society. Some people with particular traits may be favored as a result of the distribution of resources established by public policy. These differences may have an impact on the fecundity of people with these particular traits.

These two mechanisms, technological evolution and biological evolution, both have the potential to impact the preponderance of traits in the human population. Do they for public policy? To answer this, a deeper investigation is required.

Individual Preferences and Decision-Making

The most likely candidate for an effect on public policy from evolutionary forces is with policy decision-making and policy preferences. Regardless of whether it is the elite or the mass public, individual policy judgments play a central role in the policy process. All three standard models of the policy process have individual actors who play critical roles in policy change (Kingdon 1984; Baumgartner and Jones 1993; Sabatier and Jenkins-Smith 1999). In addition, the Disproportionate Information Model is a methodologically individual model based upon individual traits. In all of the models, individual influence comes from a wide variety of actors, including policy entrepreneurs, policy brokers and the president.

Nuanced models of human decision-making have been developed that better reflect empirical measurements of behavior than rational choice does. For example, Dayan and Seymour (2009) have recently described a model of human decision-making where different “controllers” within the brain are engaged in choosing among options. They describe three different types of controllers for making decisions (177). In another example, Lau describes a more realistic model of decision-making heuristics where human beings engage in “semiautomatic rule following” (2003, 48). Policy models based

upon only cognitive calculations, such as rational choice, are missing out on a second and third mechanism of decision-making based in (1) our habits, and (2) our evolutionary heritage. Models based upon boundedly rational models of the individual are missing out on how our reflexive predispositions may be affecting systemic outcomes.

While the standard policy process models assume a boundedly rational individual, they do not model an evolution of predisposed values. The most detailed explanation of the boundedly rational / evolutionary individual in the policy process comes from Bryan Jones (2001). Jones' work is a detailed description of the cognitive nature of the individual when making policy decisions.

Jones's description is an intriguing one. He points out that we are bound to both our social and biological heritage (2001, 15). He suggests that our biological influences are of two different types: procedural and substantive. In Jones' model, biological influences of the procedural type are those which affect the processes by which we make decisions (2001, 15). Substantive influences are, "those conscious and nonconscious behaviors that affect the content of decisions directly." (2001, 16)

One of the procedural influences of biology that Jones and others point out is that human cognition, at least for the purposes of making political evaluations, has two aspects for every political evaluation made: the cognitive consideration of the concept and the emotion attached to the concept (Jones 2001, 100-102; Taber 2003; Lodge and Taber 2005). This is a dual process model of human information processing. When a concept is brought from long-term memory into short term memory, both the idea of the concept and the feelings about the concept are present to affect judgment and decision-making. As we evaluate policy, for example, we have the feelings that we have

associated with that policy in our conscious mind at the same time. In this way, emotions associated with reflexive responses to information from the environment can affect policy decisions.

Information Processing Propensities and the Ultimatum Game

Policy criteria are necessary for evaluating public policy alternatives and deciding amongst them (Anderson 1979). Values play an important role in acting as the criteria for deciding which criteria will be utilized for the actual policy decision (Lindblom 1959; Hayden 1995; Hayden 2006). In other words, values are the meta-criteria for the policy criteria used for a decision. In Rokeach's terms, lower order values provide criteria for higher order values which are influential in decision-making (1973). One form of policy criteria that is often relevant to policy decisions is justice or its analogue, fairness (Rawls 1971, 2002).

Some suggest that feelings of fairness are handled both cognitively and emotionally (as in the dual process model) (van Winden 2007; Cory 2003). They claim that fairness is a result of a dynamic balance between the empathetic range, based upon affective feelings, and the egoistic range, based upon the self interested, cognitive processing of the brain (Cory 2003).

The economic game known as Ultimatum is an interesting example of some features related to human information processing and policy decision-making. First, the Ultimatum game has been found to invoke both cognitive and emotional centers of the brain (Sanfey *et al* 2003). Second, the Ultimatum game entails a norm of fairness that is inconsistent with the traditional rational view of the individual (Lopomo and Ok 2001; Spitzer *et al* 2007). Third, there is evidence for the partial heritability of some of the

decisions in the game (Wallace *et al* 2007). Finally, the Ultimatum game involves a decision on the social allocation of resources where one individual makes a decision that directly affects the allocation to another.

The Ultimatum Game is a split of an amount of money between two players. The first player chooses how to divide the money, and then the second player gets to decide whether to accept or reject the offer. If the first player makes a “fair” offer, then the second player will often accept and they each get to keep their allotment. If the first player makes an “unfair” offer to the second player, then the second player sometimes feels that they are being treated unfairly and rejects the offer. In that case, neither player gets anything. This is unusual because rational choice theory (and thus traditional game theory) would predict that the second player should accept any positive offer from the first player.

Prior research has established that the threshold between what is considered fair and unfair among those in Western industrialized nations falls somewhere around 20% or 30% of the total amount being split (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006). Thus, if the first player offers an even split (approximately 50%), then this is considered to be a fair distribution. Many players acting as the first player offer an even split. If the first player offers 10% of the amount split, then it is generally considered an unfair offer and there is a reasonably high chance that the second player will reject the offer, though not always. For the most part, this ratio between fair and unfair offers holds up cross-culturally, although there are some exceptions (Henrich *et al* 2001). Additionally, the response from the second player has been found to be substantially

heritable with 42% of the variance explained by additive genetic effects in an ACE twin study (A=42%, C=0% and E=58%) (Wallace *et al* 2007).

Using functional magnetic resonance imaging (fMRI), Sanfey *et al* (2003) found that unfair offers in the Ultimatum Game caused activity in the anterior insula (emotion) and dorsolateral prefrontal cortex (cognition) areas of the brain. Further, Knoch *et al* (2006) found that low frequency transcranial magnetic stimulation (TMS) of the right dorsolateral prefrontal cortex would cause individuals receiving unfair offers to reject the offer less frequently, but to still feel as if the offer were unfair. In other words, the victims of unfair offers were engaging their cognitive and emotional parts of the brain, but when the magnetic stimulation disrupted their cognitive abilities, they were unable to act on their emotional response to the unfair offer.

If both emotion and cognition are active when receiving unfair offers, then how does the brain resolve potentially incongruent signals of wanting to receive a positive monetary outcome and feeling insulted by an unfair offer? It is possible that willpower provides a guide based upon learned social rules. Bechara (2005) has suggested a model for the use of social rules that incorporates the dual process model. Bechara's idea is that decisions on whether to give in to an addiction are made as a result of both the "impulsive" amygdala and the "reflective" prefrontal cortex. Bechara suggests that there is a neural system for willpower where the reflective system knows the social rules and is able to resist the impulsive system. He states that decision making is dependent upon the regulation of homeostasis, emotion and feeling. (Bechara 2005, 1458). A later empirical study was consistent with Bechara's theory, and found that decision making in the face of risk was dependent upon emotions generated by the ventromedial prefrontal cortex

(Weller *et al* 2007). Its results also suggest that decision making on potential losses may be occurring in different brain regions than those for potential gains, similar in nature to prospect theory (Weller *et al* 2007, 963; Kahneman and Tversky 1979).

The social context certainly plays a role in decision-making as well. What social rules might apply in the case of fairness and the Ultimatum game? First, there is an expectation of sharing that is taught in many societies. Second, greed or gluttony are often considered socially unacceptable in high degrees. These are likely in mind for both the first player and the second player at the time of the decision, and players' decisions are expected to be judged based upon these social norms. For the first player, there are competing interests between maximizing the personal outcome, following the sharing norm, and avoiding the appearance of greed. When the second player receives the unfair offer, it is considered socially acceptable to punish someone who violates the sharing and greed norms.

Individuals playing Ultimatum know and expect that people will play fairly according to social norms regarding the sharing or equal division of resources (at least in Western societies). When people don't share, sometimes the response to the unfair offer is an emotional rejection of an otherwise positive individual outcome. Other times, they control the dishonor felt from an unfair offer and accept the low, but positive personal outcome. Thus, they may act impulsively or they may act reflectively primarily depending upon some exogenous context or frame. In sum, social rules about fairness seem to be processed both cognitively and affectively with self interest motives attempting to constrain the impulsive emotional reaction to the violation of the social norm.

From a policy perspective, this research creates an interesting distinction between policies formulated to influence compliance (individual decision-making and action) by appealing to an individual's desire to gain and an individual's desire to avoid loss (Weller *et al* 2007; Kahneman and Tversky 1979). Many public policies take the form of incentives or disincentives, and these are likely processed differently in the brain by the targets of the policy (Spitzer 2007; Gächter *et al* 2008).

It should be noted that impulse restraint is only one of several abilities involved in policy compliance. Compliance requires several different abilities including the presentation and enforcement of incentives and disincentives. Other abilities include establishing norms, learning established norms, perceiving the reward or punishment, acting in compliance, and acting to punish others in noncompliance. Incentives or disincentives leading to individuals acting in compliance are important, but they are only one part of the story of policy compliance.

Overall, the Ultimatum game reflects many of the characteristics of policy decision-making. Decision-making in Ultimatum concerns the social allocation of resources. Social norms play an important role in both policy decisions and decisions in Ultimatum. Further, Ultimatum evokes intense emotional reactions related to the unfairness of the information (acting as a stimulus) presented to the second player. In order for this form of emotional decision-making to have an impact on public policy, though, it is necessary to determine whether personal emotional experiences affect social decision-making and not just personal decision-making.

Four perspectives on policy

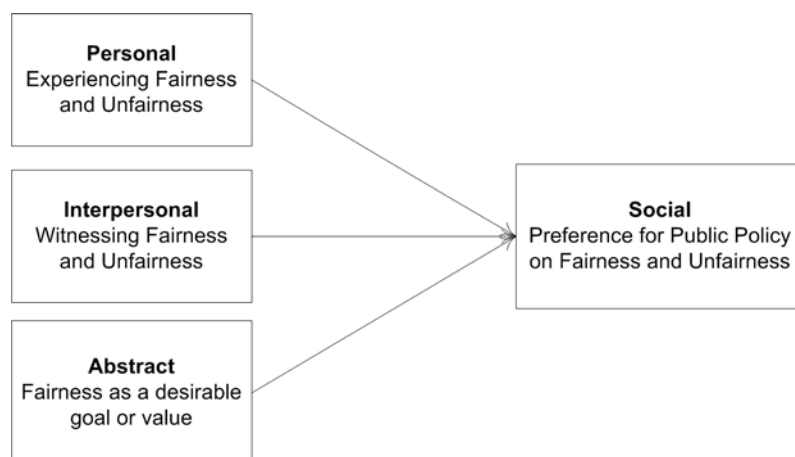
Do individual experiences in the domain of the policy lead us to have different attitudes toward public policies? Does the experience of receiving a speeding ticket alter my attitudes towards traffic laws? While seemingly common sense, this is currently an open question. For example, consider the difference between someone who is pro-choice in their social attitudes, but would never consider having an abortion. Another example might be the person who is wealthy, but who favors a progressive tax system.

Other scholars have considered this possibility. For example, Marx *et al* (2007) theorize that personal emotional experience in the climate change policy domain affects individual attitudes about climate change. They cite a study (Leiserowitz 2004) that found that the emotional experience of watching the film, *The Day After Tomorrow* (Emmerich and Gordon 2004), has an impact on the policy attitudes of movie-watchers as compared to non-watchers. However, as Coleridge stated, people engaged in fictional works are willing to suspend their disbelief (Coleridge 1817). Is the effect the same when the experience is personal?

This means that there are potentially four perspectives when it comes to public policy. These four are demonstrated in Figure 1.1. The first perspective is personal. The key factor is whether a situation is unfair to the individual. For example, having your car broken into and your property stolen leads to feelings of being violated. The second perspective is interpersonal and empathetic. We can witness people who are treated unfairly and feel for them. Perhaps we know someone whose unemployment benefits have just run out even though we are still employed. The third perspective is abstract. It is the idea that fairness is an abstract value or goal and is desirable on its own. The fourth

perspective is social and normative. It is the attitude each person has toward various public policies. What policies do they favor for society? What rules or laws would they implement if given direct power? In the prior examples, the policies might involve increasing punishment for those who engage in property crime, and increasing benefits for those who are unemployed. Given these four perspectives, it is currently unclear as to how they may relate to each other, and how they relate to each other offers a potential path to bridging the micro-macro gap in explaining public policy processes. The leap to be made is not only from the personal to the social perspective, but from feeling or witnessing the experience of being treated unfairly to wanting to establish norms or laws enforcing or encouraging fairness.

Figure 1.1 – Do preferences for public policy come from experiencing or witnessing fairness?



From a psychological perspective, one potential link between the personal or interpersonal perspective and the social perspective comes from simulation, the shared representation mechanism, and empathy (Decety and Grèzes 2006; de Waal 2008). Simulation occurs when a person imagines another's situation and feels the same way. Feelings elicited by fictional works such as crying during a film are simulations arising

from a shared representation (Decety and Grèzes 2006). Individuals know that the characters and situations are false, but they are able to share the perspective of the character and they feel as if they are real. Empathy is feeling an emotional state of another and identifying and adopting the emotional state of the other (de Waal 2008). These feelings can lead to altruistic action on the part of the person experiencing empathy. Behaviors such as consolation are also the result of empathy (de Waal 2008).

The link to the social perspective and public policy is made when a person who has felt, through experience or by witness, the feeling of an unjust action caused by a third party and then suggests that others should not have that experience (Cory 2003). This type of planning for the future based upon past events is related to the human ability to abstract reality (Liberman and Trope 2008). People can abstractly form plans for the normative structure of society based upon their prior emotional experiences.

The prototypical modern example is John Walsh of *America's Most Wanted* (America's Most Wanted 2009). Mr. Walsh's story is that his child was abducted and murdered in 1981. Since then, he has endeavored to assist others in his situation, including working towards the passage of The Adam Walsh Child Protection and Safety Act of 2006 (America's Most Wanted 2009; White House Office of the Press Secretary 2006). For Walsh, the perspective of the victim of crime is psychologically close in nature. For some of the American founders, the psychological perspective of the criminal was close because of their treatment by the British, and their policies as evidenced in the Declaration of Independence (United States Congress 1776) and the Bill of Rights in the U.S. Constitution (United States of America 1787). The policies in these documents reflected a desire for individuals accused of crimes to be reasonably protected from state

power. In other words, it was easy for Walsh and the American founders to hold the social policy positions that they have because they had emotional experience relating to those perspectives.

If government is designed for assuring justice, then public policy's roots may lie in our feelings of fairness associated with justice. Rawls (1971; 2002) substantially utilized fairness as a form of policy criteria for the social contract. Thus, the Ultimatum game's exposition of fairness norms may be quite an effective tool at examining the micro-basis for government policy. Fairness and justice are unlikely to be the only form of policy criteria, though. Other bases for moral judgment that involve emotion include harm / care, in-group loyalty, authority / respect, and purity / sanctity (Haidt and Graham 2007). Justice / fairness is considered to be one that is consistent across many individuals regardless of ideology, however (Haidt and Graham 2007). Part of the effort of this dissertation is to ascertain the relationship between these four perspectives. Do personal or witnessed emotional responses involving unfairness affect attitudes and decisions regarding social policy when contrasted to that provided by the abstract expression of fairness as a goal?

The Aggregation Problem

Even if emotion arising from personal experience or witnessing others' experiences does drive policy, then there is still the aggregation problem. How do individual expressions of fairness criteria become public policy? The obvious answers to this question are embedded in the models of the public policy process discussed earlier (Kingdon 1984; Baumgartner and Jones 1993; Sabatier and Jenkins-Smith 1999; Jones and Baumgartner 2005). Individual actors play important roles in each of the models,

and as human beings, they are likely making decisions with both cognitive and affective influences. In addition, all four models account for normative influence emerging from social groups, whether they are elite or from the public at large. In the Advocacy Coalition Framework, both “fundamental socio-cultural values”, “policy beliefs”, and public opinion play roles in the various policy subsystems (Sabatier and Jenkins-Smith 1999, 149). Policy communities, interests, and the national mood play important roles in the punctuated equilibrium description of the process as well (Baumgartner and Jones 1993). In the garbage can model, policy communities and the national mood play important roles (Kingdon 1984). In the Disproportionate Information Processing Model, individual attention limitations play the critical role in leading to punctuations (Jones and Baumgartner 2005). In all of these models public policy emerges at least in part from normative criteria present in different groups of people.

Nonetheless, the connection between emotional response and public policy is not direct in the standard models. If our decisions can be rooted in cognitive, habitual or reflexive control under different contexts, and the standard policy models account for, at best, two of the three types of decision-making in human beings, then there is a need for an additional model about how public policy is aggregated.

Therefore, part of this effort will be to propose an additional model of the policy process from the perspective of individual predisposed attitudes that act as a form of policy evaluation criteria. The model is not one where individuals engage in rational, utility-based decisions. Rather, the model will attempt to account for recent knowledge regarding human cognition and decision-making, and public policy will emerge from heritable individual preferences. This model is not meant to supplant descriptions of the

process made by the standard models for public policy. Rather, it will hopefully provide another perspective that may help illuminate the policy process: a micro-model of individual decision-making that results in macro-effects on policy outcomes.

The Premises of the Basic Model

If emotional responses to unfairness have an impact on policy decisions, and the emotional response to unfairness leads to an impulsive and reflexive decision, then evolutionary processes could be affecting the criteria for policy decisions. The predisposed response could come in the form of a trait for being sensitive to unfair situations. If many people in a democracy, or one certain person in an autocracy, were more sensitive to such unfair situations, then policy outcomes would be affected.

The general idea is that many public policy outcomes are the result of the ubiquity of criteria among many human beings for evaluating the fairness of a public policy. If the criteria or their underlying values are partly heritable, then ubiquity would be the expected result of a stable evolutionary environment as those values or criteria which provide higher average levels of fitness would become more numerous in the population. These criteria common to many would then be employed contextually in different decisions made by decision-makers in the policy process. If a decision is made according to criteria common to many in society, then its perceived legitimacy is substantiated.

The basic model can be elaborated with five premises. They are as follows:

1. Public policies are typically comprised of individual incentives and disincentives that affect individual action.

2. Regardless of whether they are the elites or members of the mass public, individuals making policy decisions have evaluation criteria and attitudes towards these public policies.
3. Experiencing and Witnessing Unfair Action
 - a. Individual experience with unfair action in the domain of a particular policy will affect the individual's evaluation criteria for that policy domain, and thus their attitudes and decisions.
 - b. Witnessing unfair action in the domain of a particular policy will affect the individual's evaluation criteria for that policy domain, and thus their attitudes and decisions.
4. The criteria for what is fair and unfair among human beings are ubiquitous and partly heritable as a result of similar neurology, similar values, and common socialization.
5. If many human beings share common criteria for what is fair and unfair in a democracy, then this should affect policy outcomes for the mass society because of the political influence associated with a set of mass social beliefs.

Assessing this fifth statement is the basic premise of the research that I present in this dissertation. In other words, common values and common decision-making tendencies affect the policy process, particularly as both pertain to fairness as a human value.

The Research Questions

Some of the premises of the basic model are supported by prior research. For example, it is not controversial to assume that public policies are comprised of incentives and disincentives to individual action (premise 1) (Lowi 1972). It is also not controversial to assume that decision-makers will have evaluation criteria for public policies (premise 2) and that their attitudes and decisions will be based upon their evaluation criteria (Anderson 1979; Jones 2001; Simon 1997). There are several questions related to premise numbers 3a / 3b, 4 and 5 that deserve greater attention, however.

The research questions that the literature points towards, and those that I seek to address in this dissertation, are as follows:

1. Is the likelihood of expressing a preference for policies enforcing fairness (social perspective) increased by recent experience with unfairness (personal perspective) in the same policy domain? (premise 3a)
2. Is the likelihood of expressing a preference for policies enforcing fairness (social perspective) affected by recently witnessing a situation encompassing unfairness (interpersonal perspective) in the same policy domain? (premise 3b)
3. Do human beings share a common set of evaluation criteria for policies involving fairness? (premise 4)
4. If preferences on matters of governance are influenced in part by heritable traits, then how is the public policy process affected by the evolution of these traits? (premise 5)

- a. What type of compliance policy (incentives, disincentives, or a mix) is more likely to lead to long term cooperation and compliance in the proposed model? (premise 5)
- b. What type of compliance policy (incentives, disincentives, or a mix) is more likely to lead to long term successful social outcomes in the proposed model? (premise 5)
- c. Do predisposed evaluation criteria for public policies affect policy outcomes as compared to the absence of predispositions? (premise 5)

Overview of the Dissertation

The dissertation will consist of two phases. The first phase will entail a survey and collection of physiological responses to unfair situations. Participants in the survey will be broken into three groups. One group will experience unfair offers in the Ultimatum game directly, and then be asked about their policy preferences regarding play in the game (research questions 1 & 3). The second group will witness others experiencing unfair offers in the Ultimatum game, and then be asked about their policy preferences regarding play in the game (research questions 2 & 3). The third group will be asked about their policy preferences based upon a description of the game (without experiencing or witnessing unfair offers). The third group will act as both a control and as a test for the abstract perspective on policy. Chapter 3 of the dissertation will report the results of the empirical phase of the study, and will address research questions 1, 2, and 3.

The second phase of the research will involve a simulation of the evolution of traits related to fairness. In it, agents will play Ultimatum in order to earn resources

necessary for survival and reproduction. Those who earn the most will be considered to have the greatest fitness levels and therefore will have greater fecundity. This greater fecundity creates the necessary conditions for the evolution of the agents' traits. The environment will consist of different government policies regarding play in Ultimatum that the group of agents themselves will be able to determine over the course of the simulation. To accomplish this, agents will have traits that express a preference for public policies related to play in the Ultimatum game. Both incentives for playing fairly and disincentives for unfair play will be modeled to represent policy alternatives available to enforce fair play in different variants of the model. These model variants will be used to consider the impact of different policy institutions (e.g. those with incentives, disincentives, or both). In addition, in one variant of the simulation, agents will have some heritable predisposed traits. In another variant, these traits will not be predisposed. The results of the simulation runs with predispositions and without predispositions will be compared. Ultimately, this simulation should provide some evidence for how heritable traits might affect public policy outcomes, at least in a simulated environment. Chapter 2 of this dissertation will provide a detailed description of the theoretical model. Chapter 4 will address the results of the simulation regarding research questions 4a, 4b, and 4c. Finally, Chapter 5 will synthesize the empirical and theoretical results and suggest further avenues for research.

Conclusion

Understanding the nature of justice, and its analogue fairness, is one of the key pursuits of the field of Political Science. Emotions regarding fairness have their roots in certain physiological and neurological foundations. If reflexive emotional responses

regarding fairness are affecting individual policy decisions, and they are heritable, then there should be an evolutionary effect on public policy outcomes for policies related to fairness. Therefore, in this dissertation I propose an additional model of the policy process which accounts for these potential evolutionary effects on public policy.

An Evolutionary Model of the Policy Process

Chapter 2

Introduction

The five step basic theoretical model of the policy process presented in the first chapter is exactly that: basic. The basic model provides the tenets of an evolutionary model of the policy process. This chapter will provide a full description of the proposed theoretical model of the policy process. It is this theoretical model which will be implemented as an agent-based model with a full description of the implemented model and the results presented in chapter 4.

Heritability and the Policy Process

I suspect that two types of evolutionary processes may have an impact on policy decision-making and thus policy outcomes. The first is the result of public policies being a form of technology. The evolution of technology has been described as a Lamarckian type of evolution where tools, skills and knowledge are passed (in part) from one generation to the next and where technologies that are useful are kept and those deemed less useful are abandoned (Ayres 1978 [1944]; Dawkins 2006 [1976]; John 2003). This technological evolution applies to public policy as society “learns” the best policies for the current natural, social and political environment (Hecl 1974; Hall 1993; Freeman 2006). Public policy fits the definition of technology when seen as an instrument for meeting the goals of the government (Dewey 1988 [1927]). In this type of evolutionary process, policies can be replaced by those policies which are believed to better serve the needs of the government or the public in a democracy. One definition of biological evolution is that it is a change in the proportion of a population with a particular trait and consists of four processes: replication, selection, mutation and random genetic drift

(Futuyma 2005; Nowak 2006). Using this definition applied to public policy, policies can be seen to be replicated, selected, and mutated through the processes of policy diffusion, policy analysis and policy design respectively¹. In fact, one aim of the study of policy analysis and policy design is to try to evaluate which policies are technically superior at meeting the goals of government. In other words, policy analysis itself is partly about delineating between two or more policies and deciding which maximizes fitness within the natural, social and political environment. In policy (and economic) terms, maximizing fitness is finding which of the policy alternatives is more efficient. This is an evolutionary process, albeit different in detail from biological evolution.

The technological evolution of public policy is sometimes confounded by and confused with the political debates over values. Much of the political debate concerning policy is not over whether one policy is better than another at meeting a commonly-held goal. Rather, political disputes are frequently about which values should be set as the principle goals of government (Anderson 1979; Mooney 2001). For example, if one policy is good at meeting Goal A and another is good at meeting Goal B, then the political debate is about which goal to meet, A or B. The technological aspect of policy is determining whether a third policy is better than the first policy at meeting goal A. This comparison is analogous to the idea of the “policy sciences” of Lasswell (1951). Of course, this delineation between the technical aspect and values aspect of public policy is abstract and never clear in practice² (Lindblom 1959). Nonetheless, public policy has a technological aspect and it evolves like other technology through a process that selects policies that are fit within the policy environment.

¹ I am not certain that there is a reasonable analogue between random genetic drift and public policy.

² In other words, Lindblom was accurate in describing public policy decision-making as “muddling through” (Lindblom 1959)

The second type of evolutionary process that may affect policy decision-making is biological evolution. Biological evolution can have an effect on public policy outcomes by affecting the way in which policy decisions are made by individuals. Human decision-making can be affected by biological evolution in a couple ways. First, human beings are endowed from birth with some specific needs, and these needs are expressed as values. Second, decisions are affected by decision-making biases rooted in human neurology. Both human values and human neurology are partly heritable.

An extreme example of a heritable effect on decision-making is that human beings value certain things like food and potable water. In this example, the value for the individual arises from the avoidance of the feelings of hunger and thirst and these values are heritable. People who experience the state of hunger in response to a lack of food have children who experience hunger in response to a lack of food. It is this relationship between the physical need (food) and the emotion related to it (hunger) that leads to the effect on decisions.

Values related to morality seem to work similarly to the needs for food and water, and these values are frequently utilized for policy evaluations. Haidt and Joseph (2004) describe morality as having five foundations: 1) Harm / Care, 2) Fairness / Reciprocity, 3) In-group / Loyalty, 4) Authority / Respect and 5) Purity / Sanctity. Their implication is that these bases for morality are intuitive and that the intuition expresses itself affectively. Following Haidt and Joseph (2004), Haidt and Graham state, "Each system is akin to a kind of taste bud, producing affective reactions of liking or disliking when certain patterns are perceived in the social world." (2007, 104) They also suggest that human beings have a neurological preparedness to learn norms and beliefs related to

these moral foundations (Haidt and Graham 2007, 106). In other words, norms that are rooted in these five systems of morality are more likely to be accepted by people because of the neurology utilized for judgment. To summarize, policy judgments have an emotional component that can be affected by the evolution of neurological systems involved in decision-making. These emotions provide a basis that norms and laws can be judged against (Alford and Hibbing 2004b; Haidt and Graham 2007).

This argument does not discount the role that the environment plays in distinguishing between moral and immoral behavior. Rather, norms distinguishing morality from immorality that fit with the current human neurological traits are more likely to be accepted than those which are at odds with those traits. Political socialization of norms consistent with these values will be more readily accepted than for norms inconsistent with these values. The presence or absence of that socialization is a critical factor in the norms as they are adopted in practice. Further, the population may have a wide variety of traits. For example, Haidt and Graham (2007) point out that political liberals and conservatives are receptive to different systems of morality. In policy terms, those policies which have greater legitimacy will be those consistent with the moral foundations of judgment for a particular population.

Others have established a physical basis for political values and beliefs. Amodio *et al* (2007) found that ideology was related to “individual differences in the functioning of a general mechanism related to cognitive control and self regulation.” (2007, 1247). Hatemi *et al* (2009) found that genetics account for approximately 40% of the variance in explaining political and social attitudes (2009, 23). Greene *et al* (2001) found that brain regions associated with emotion were involved in moral-personal judgments and that

these differed from the brain regions activated by non-moral judgments. The point is that values of human beings are at least partly heritable, and these values are those utilized by individuals when judging (at least some) public policies. Policy criteria consistent with these heritable traits are more likely to be utilized than policy criteria inconsistent with these traits.

The second type of heritable effect on decision-making comes from cognitive biases and other neurological influences. Human decision-making is rife with biases from cognitive, rational thought. The most common example of this type of decision-making bias is prospect theory (Kahneman and Tversky 1979), but there are many others (Lau 2003). In addition to biases, Bryan D. Jones (2001) cites other aspects of cognition that can affect decision-making. These include: working or short term memory, calculation ability, knowledge, and retrieval from long term memory (Jones 2001, 64). Of these, knowledge is the only one which does not have the reasonable expectation of a connection to heritability, though there is ongoing debate on the heritability of the others (Blokland *et al* 2008; Levenson and Sweatt 2005; Vinkhuyzen *et al* 2009). In sum, these neurological constructs and their related biases are believed to affect decision-making and it is likely that they are at least partly heritable.

To summarize, two types of evolutionary process likely have an effect on policy decision-making and policy outcomes. These are (1) a technological learning process, and (2) the biological evolution of traits related to human decision-making. Within the realm of biological evolution, decision-making can be affected by the evolution of (a) the neurology providing or affecting human values and (b) decision-making biases.

An Evolutionary Model at the Macro Level

A precise definition of evolution will be useful for explaining the proposed evolutionary model of the policy process. Evolution can be described as the processes of selection and mutation exploring and finding a local maximum of the rate of reproduction (or fitness) within a particular environment for an infinite population (Nowak 2006; Futuyma 2005; Case 2000). This can be represented as finding an optimum across a fitness landscape (Nowak 2006, 30; Eigen and Schuster 1979; Wright 1931). How does this work? To begin, the genotype is the set of genes of an organism. Genes are expressed through phenotypes. Phenotypes are the traits of an organism which confer abilities that may be helpful for living and reproducing. A fitness landscape is the relationship between all the possible genotypes (genomic sequences) and the particular levels of fitness provided in a fixed environmental context for those genotypes. Imagine a bar chart with all possible genotypes on the x-axis and their related fitness levels (rates of reproduction) on the y-axis. This is the fitness landscape. Mutation and selection “explore” the landscape created by the fitness levels of the environment (Nowak 2006, 30). This exploration settles in at a local maximum if two conditions are present. First, there must be at least one genetic sequence which has a greater than neutral fitness level. Second, this genetic sequence must be reachable given the rate of mutation. If the mutation rate is either too high or too low, then adaptation does not occur. A quasi-species is a set of similar genomic sequences related to some phenotype (Nowak 2006, 31). The exploration of the fitness landscape by selection and mutation leads to

adaptation as those quasi-species with the highest fitness levels will become more numerous in the population, *ceteris paribus*³.

How can this be applied to the public policy process? Considering that both the evolution of value predispositions and the evolution of cognitive biases are biological, the application of evolutionary ideas is direct. For the evolution of technology, these concepts provide an analogy. Table 2.1 portrays different elements of the evolutionary effects for the different models. For the predisposition of values, the basic idea is that receptiveness to a particular value (such as fairness) is a heritable phenotype. This expression of this phenotype leads to relatively higher rates of reproduction for those with the genetic code related to the phenotype. Over time, the predisposition to the value can become ubiquitous if it has the maximum average fitness amongst those quasi-species (genotypes) that have code similar enough to be within range of a potential mutation, or those quasi-species already in the population. This means that the adapted trait is not the absolute maximum, but rather a local maximum (Case 2000; Nowak 2006).

³ The *ceteris paribus* qualification is necessary because other factors, such as the error rate, can allow less fit quasi-species to become more numerous in the population (Nowak 2006). The mathematical model described applies for an infinite population. Finite populations are similar with the exception that neutral genetic drift becomes a more important factor in determining the proportion of the population of traits that do not have a positive influence on fitness.

Table 2.1 – Concepts of Biological Evolution as applied to Public Policy

| | Policy Evolution | | |
|---------------------------|--|---|---|
| Biological Concept | Technological | Predisposition to Values | Cognitive Biases |
| <i>Genotype</i> | Policy theory | Genes | Genes |
| <i>Phenotype</i> | The instantiation of a policy | Receptiveness to a particular value | Decision-making biases |
| <i>Quasi-species</i> | The law or rules that implement a policy alternative | Genes encoded for the values phenotype | Genes encoded for the bias phenotype |
| <i>Fitness</i> | Measures or indicators of policy success | Reproduction rate of individuals with the phenotype | Reproduction rate of individuals with the phenotype |
| <i>Sequence Space</i> | All potential policy alternatives | The set of all possible genotypes | The set of all possible genotypes |
| <i>Fitness Landscape</i> | Policy criteria | The set of fitness values for the sequence space | The set of fitness values for the sequence space |
| <i>Selection</i> | Choosing an alternative which adequately meets the policy criteria | Those quasi-species which have the maximum average fitness will be selected | Those quasi-species which have the maximum average fitness will be selected |

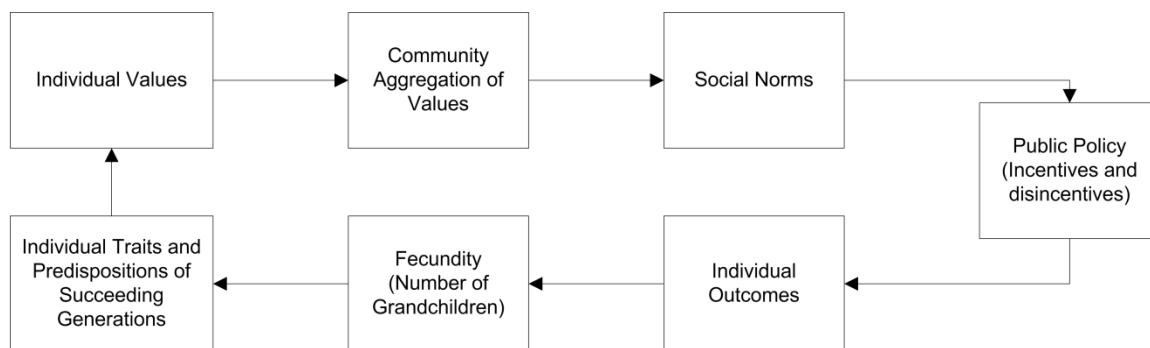
Of course, the domain of public policy has a complicating factor compared to other traits that might affect rates of reproduction in the population. Public policy is normally a social activity⁴. Any impact on policy outcomes that might arise from changes in the value predispositions of the population wind their way through a series of institutional rules and social norms (Commons 1995 [1924]; Ayres 1978 [1944]; Polyani 1944; Ostrom 1992, 1999, 2005; Hayden 2006). This social environment for policy is well described by the elements of the Advocacy Coalition Framework (ACF), Policy Streams, and Social Fabric Matrix approaches to the policy process (Sabatier and Jenkins-Smith 1999; Kingdon 1984; Hayden 2006). The ACF, in particular, is a description of the role of institutional influence on public policy outcomes. Each of the subsystems in the ACF represents different institutions in the policy domain. In fact, Sabatier and Jenkins-Smith address the role of values in the ACF. They consider cultural

⁴ Cases where public policy is not social, such as in a pure autocracy, are unrealistic and thus trivial. Further, even in these cases, the decision-maker is a human being and would be affected by their own predispositions and their own decision-making biases.

values and social structure (as lumped together) to be one of the “relatively stable parameters” (Sabatier and Jenkins-Smith 1999, 149). My intention with this evolutionary model is to let this parameter vary and to fix the institutional environment. Despite holding this factor constant for the purposes of experimentation, an individual’s predisposition to certain values means nothing outside of the context provided by the society and the social institutions within the policy domain.

Evolutionary models are cyclic as one generation establishes the conditions for the succeeding generations. Figure 2.1 graphically demonstrates the macro-level of the proposed evolutionary model of the policy process. In it, public policy is part of a generational cycle involving heritable values, social norms, and an evolving population.

Figure 2.1 – Evolution of Values



As an evolutionary model, the action primarily occurs at the population level. However, the population is a collection of individuals, and individual results do affect the course of the model. This is the basic idea of methodological individualism⁵. A debate continues on the role of groups in evolution. Some theorize that biological evolution utilizes the individual gene (Hamilton 1964) as the unit of analysis. Other biologists believe that multilevel selection is occurring and this imparts an important role for the group (Wilson 1983; Sober and Wilson 1998). My take on this argument is that the

⁵ For an overview on methodological individualism, see Udehn 2001.

benefits of group life can have an effect on the fecundity of a group's members. Thus, social institutions and the rules they establish through the determination of public policy can affect the fecundity of individual members of the society. The model in figure 1 reflects this impact.

Evidence for this effect comes from social behaviors and their heritability. The neurological basis for behaviors such as altruistic punishment and empathy are reasonably well established (de Quervain *et al* 2004; de Waal 2008). While the heritability of altruistic punishment seems to be an open question, there is evidence for the heritability of some forms of empathy (Davis *et al* 1994). The arguments of multilevel selection make sense because those individuals with adapted traits relevant to group life, such as altruistic punishment and empathy, would have advantages in protecting group members, especially the vulnerable young. They would also have advantages in developing technological solutions to problems, and in the overall production of resources⁶. These advantages related to being a member of the group would enhance the fecundity of the members of the group.

This applies further to values themselves. A group that adopts norms and crafts institutions that adhere to values associated with Haidt and Joseph's moral foundations would likely have a higher rate of reproduction than one in which there were no moral foundation (2004). In particular, valuing justice and fairness provides a benefit to the group. If members of a group are treated fairly or impartially by others in that group, then the distribution of resources would be such that survival is enhanced. Rawls' maxim fairness criterion distributes resources in such a way that the greatest number of

⁶ An example that illustrates this point might be the difference in efficiency between individual craftspeople and a production line.

individuals receives a distribution required for survival (1971). This value can thus affect levels of fecundity for individuals within a group.

I do not mean to imply that only groups matter and that individuals are not relevant. The behavior of each individual is relevant to the operation of the proposed model of the policy process and to policy outcomes as illustrated in figure 1. Each individual is participating in society and is a part of the population of phenotypes and genes. Individuals are affected by the policies of society which often provide incentives and disincentives designed to encourage or constrain individual action. These enticements and constraints then affect the fecundity of individuals with particular values which in turn affects the proportion of individuals with particular values in the next generation. The basic idea is that human values affect the state of public policy, and that public policy affects the ability to procreate and successfully raise children. Thus, public policy is part of an evolutionary cycle. The population evolves to the environmental conditions partially created by public policy and public policy is altered by the receptiveness of the population to it.

The Micro Level of the Model

There is a deeper, more micro-level to the model. As discussed in the first chapter, the Ultimatum game is a good example of some methods of human information processing as it pertains to policy decisions. In particular, Ultimatum creates the context wherein the second player is evaluating the fairness of the offer from the first player. The first player often shares the pot, but when the first player makes a low offer, the second player is often motivated by an emotional response to the low offer. The low offer acts as a violation of the social norm regarding sharing. This violation often triggers an emotional response from the second player evaluating the offer. This role for emotions in

the fairness evaluation as evidenced through the Ultimatum game has been well studied (Sanfey *et al* 2003; van 't Wout 2006; Sanfey 2007; Wallace *et al* 2007). The threshold between what is fair and unfair (from a distributive justice perspective) can be measured by the switch that occurs when the emotional response to the norm violation starts to overwhelm other considerations. This threshold indicates the degree to which the individual considers the distribution to be fair. It is likely that there is both a genetic and a normative influence on this threshold level of what is considered fair in Ultimatum (Wallace *et al* 2007). The evidence for a normative influence is established by the differences across cultures⁷ (Henrich *et al* 2001). Though, as Henrich *et al* acknowledges (2001, 77), the ultimate determinants of the emotional cues likely have a basis in genetic predispositions. This makes sense as the cultural norm of what is socially acceptable would likely need to adhere to the intuitive, emotional judgments of the individuals in the society that are established by any individual dispositions to a threshold level.

Emotions provide information to the individual about what should be valued during the course of making a decision (Marcus, Neuman and MacKuen 2000). Marcus, Neuman and MacKuen's model suggests that two systems are operating in order to engage in action: the surveillance system and the dispositional system (2000, 126). The disposition system assesses the success and failure of the routine actions of the individual

⁷ Henrich *et al* (2001) did not account for genetic differences across its samples from different cultures. Genetic difference could explain the differences attributed to social norms. As genetic differences would likely only provide a disposition towards a particular fairness threshold, cultural practices would likely fill in the gap, but need to remain consistent with the genetically predisposed level for the whole population. There is also the difference between the individual and the social that can explain a difference between a genetic disposition to a level and the social norm establishing the level.

and stores this information in procedural memory⁸. The surveillance system signals that something is new or threatening in the individual's environment and is used to raise an emotional alarm. They view most action as habitual until something in the environment invokes some emotion that triggers a novel action as a response.

This theory is useful in partially explaining how emotions can inform decision-making, but it ignores a large category of influence on decisions... Human decisions are guided by goal seeking, habit, *and* pavlovian or reflexive influences (Dayan 2008; Dayan and Seymour 2009). Human beings do not crave water because they develop experience over time informing them that water makes them feel good. Rather, thirst is an emotion experienced when the body senses that it is inadequately hydrated. This value is not stored by the disposition system as a result of experience, but is rather predisposed in human beings (and many other organisms).

What, then, is a value? Rokeach describes values as having a hierarchical structure with some values as fundamental (having a low order) and other higher order values being based upon these lower order values (Rokeach 1973). Some values are fundamental and intuitive, such as the values that Haidt and Graham discuss for engaging moral judgments (Haidt and Joseph 2004; Haidt and Graham 2007). These are likely the type of values that have genetic predispositions associated with them. Other values and goals, though, are worked with cognitively. In other words, a person can consciously set a goal that helps guide the actions of the individual. Models of rational choice and economic theories of utility primarily focus on values as preferences (Black 1948; Arrow 1950; Riker 1980). I view these preferences as much higher order values that can be

⁸ Considering that Marcus, Neuman and MacKuen suggest that their theory is complimentary to rational choice (2000, 129), one might suggest that the information stored in procedural memory constitutes a set of preferences.

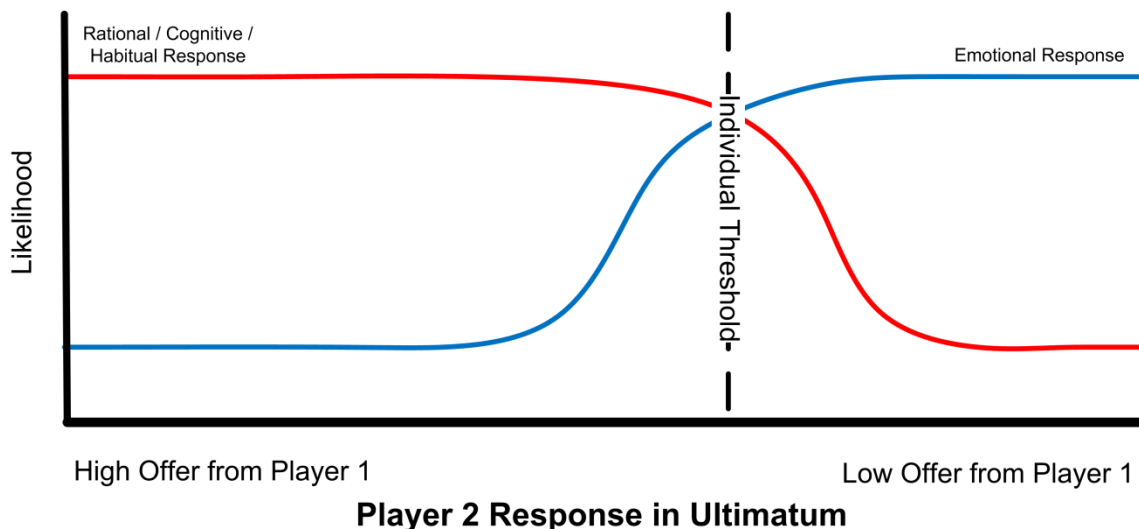
ephemeral like tastes. If conscious consideration can set values, then any potential preference could be set, and this is not consistent with evidence of human reflexive responses. As Rokeach (1973) suggests, it is likely that higher order values need to be consistent with lower order values, and these lower order values are likely beyond conscious control.

How do different values apply to public policy? Values provide the criteria against which public decisions are made (Hayden 1995). When a public decision is being made, it can have as its criteria higher and / or lower order values. Policy alternatives are assessed against whichever criteria are being utilized for a particular decision, regardless of whether the decision-maker is consciously aware of those criteria. A policy alternative is selected which is cognitively and emotionally assessed to be acceptable given the particular criteria. Few studying public policy will argue that policy decisions are consciously and cognitively considered. It is an open question, though, as to the effect emotion has on policy decision-making. I will empirically examine to what degree policy decisions are influenced by emotional responses in chapter 3.

Figures 2.2 and 2.3 demonstrate the micro and macro models graphically. Figure 2.2 demonstrates the model of the individual response as player 2 in Ultimatum. One curve represents the likelihoods of the individual response arising from habit or conscious rational cognition. Another curve represents the likelihood that a passionate emotional response is elicited by the offer. As the offer from the first player gets lower, the likelihood goes up that the violation of the sharing norm will cause player 2 to feel insulted or dishonored and then ultimately decide to reject a positive offer from player 1.

This threshold where rejection begins illustrates the point where a reflexive emotional response begins.

Figure 2.2 – The Individual Threshold Elicited During the Second Player’s Response in Ultimatum



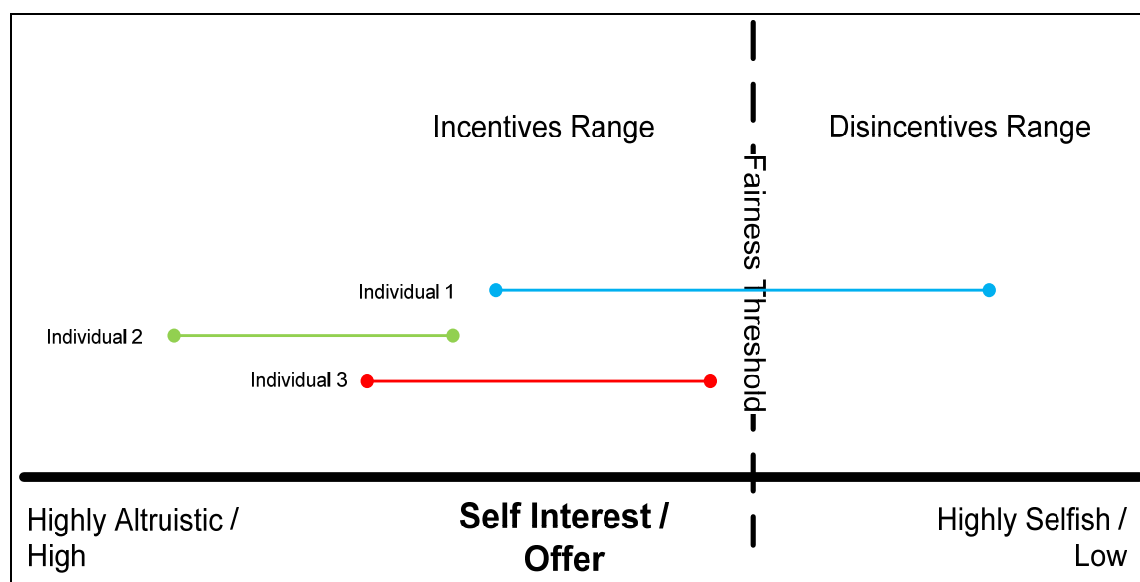
It can be argued that player 2 rationally wishes to pay a cost in order to punish the first player for the violation of the social norm in order to assure future payoffs.

Ostensibly this would occur without emotional influence on the decision. However, the feelings of insult and dishonor are experienced by players when they reject (Pillutla and Murnighan 1996). In addition, Ultimatum play has been found to light up both cognitive and emotional centers of the brain (Sanfey *et al* 2003). Further, altruistic punishment has been associated with activity in the reward systems of the brain (de Quervain *et al* 2004). All of these indicate that a purely conscious and rational calculation when assessing the first player’s offer is not occurring for most individuals.

Figure 2.3 demonstrates a graph similar to Figure 2.2 except that instead of the second player’s response being modeled, three different individuals playing as the first player are modeled. Each of these individuals has a heuristic that guides how selfish of an offer they will make to player 2. The threshold between fair and unfair in figure 2.3 is

the social threshold. It is the criteria for judgment of individual action, and public policy sets whether there will be incentives and disincentives applied as a result of the individual choices. For example, in Figure 2.3, individual 1's heuristic range when acting as player 1 allows player 1 to sometimes violate the social norm as established by the social fairness threshold. If player 1 takes the chance and selfishly exceeds the social fairness threshold, then player 1 will be hit with a disincentive⁹.

Figure 2.3 – The Social Fairness Threshold and Self-Interest Heuristic Ranges of Individuals Acting as the First Player



One link between figures 2.2 and 2.3 is that the social fairness threshold as established by norms and laws can be an aggregation of the individual thresholds. The relationship between the individual thresholds and the social threshold (or between the individual criteria and social criteria) is dependent upon the institutions of government and other less formal social institutions and authorities. The government (or the community) can establish as policy some threshold where action that exceeds the threshold becomes punished or rewarded. Social policy criteria can represent an

⁹ In the model as it is implemented in the simulation, all violations of the social fairness threshold are hit with disincentives. Obviously, in reality, some who violate the criteria provided by norms and laws do so without punishment.

aggregation of the various individual criteria for fairness (or justice) and it is the nature of the government that controls this relationship. In most democratic thought, the criteria establishing the law should be responsive to the expectations of the population. The legitimacy of a policy is at stake when individual criteria and social criteria are out of line with the fairness expectations of the population.

Conclusion

This chapter has presented a theoretical model of the policy process which views public policy as part of a larger ecological system in which the human population evolves. In the next few chapters, this model will be empirically and theoretically explored.

The Influence of the Personal, Interpersonal and Abstract Perspectives on Policy Decisions

Dissertation Chapter 3

What motivates decision-makers to choose policy alternatives that depart from the status quo? Emotion and experience may be factors that influence the decision in favor of policy change. For example, many engage in policy advocacy as a result of tragic personal experiences in their policy domain. There are plenty of anecdotal references to cancer survivors lobbying for additional funding for cancer research, or victims of crime lobbying for stiffer criminal sentences. This type of emotional experience seems to affect their policy choices. Does the emotional experience of being treated unfairly impact a person's policy decisions and attitudes? Does being presented with the story of another person's unfair treatment also impact policy decisions and attitudes? Are individuals consistent in their evaluation of fairness regarding the treatment of others? In this chapter, I will use experimental and survey methods to examine the impact of emotions that are related to fairness on a person's policy attitudes.

Research Questions

The results for the following research questions (previously stated in Chapter 1) will be presented in this chapter:

- Is the likelihood of expressing a preference for policies enforcing fairness (social perspective) increased by recent experience with unfairness (personal perspective) in the same policy domain? (RQ 1 from Chapter 1)

- Is the likelihood of expressing a preference for policies enforcing fairness (social perspective) affected by recently witnessing a situation encompassing unfairness (interpersonal perspective) in the same policy domain? (RQ 2 from Chapter 1)
- Do human beings share a common set of evaluation criteria for policies involving fairness? (RQ 3 from Chapter 1)

Hypotheses

The experience of fair outcomes is not the polar opposite of the experience of unfair outcomes. While the primary goal of this part of the research is to understand the role of unfairness, an understanding of the role of experiencing fair outcomes will make for a good contrast and is of merit in its own right. Therefore, it makes sense to split research questions 1 and 3 into two hypotheses for each question in order to handle both the fair and unfair circumstances. In both cases (research questions 1 and 3), I have included hypotheses expressing my expectations for the fair case and the unfair case.

Hypotheses for Research Question 1

H1a: Recent personal experience with unfair outcomes will increase the likelihood of expressing a preference for policies that enforce fairness when compared to a control.

H1b: Recent personal experience with fair outcomes will NOT increase the likelihood of expressing a preference for policies that enforce fairness when compared to a control.

Intuitively, it makes sense that someone who personally experiences unfair outcomes would wish to change the policies that might, in part, lead to the unfairness of their personal outcome. Anecdotal evidence, such as cancer survivors lobbying for cancer research funding, provides some indication that this may be the case. In addition, some prior research theorizes that policy attitudes can change given presentation of an emotional experience (Leiserowitz 2004; Marx *et al* 2007). In the case of fair outcomes,

they are likely associated with the status quo because of the rational inclination to keep the status quo if it seems to be working.

Hypothesis for Research Question 2

H2: Witnessing a situation where unfairness is experienced by others will increase the likelihood of expressing a preference for policies that enforce fairness when compared to a control.

Empathy for others in a similar circumstance, as well as the shared representation mechanism, suggest that witnessed unfairness should increase the likelihood of preferences for policy change (Decety and Grèzes 2006; de Waal 2008).

Hypotheses for Research Question 3

The third research question concerns whether there is any consistency in the evaluation of fairness. If there is a standard fairness norm that many people subscribe to, then fair situations should be evaluated consistently as fair and unfair offers should be consistently evaluated as unfair. This question, therefore, breaks into two parts. Do participants evaluate fair situations as fair? Do participants evaluate unfair situations as unfair? As will be explained later in the methods section of this chapter, the Ultimatum game will be utilized to create the conditions to test these hypotheses. If there is a social norm and/or an underlying predisposition for fairness in contexts like that presented by the Ultimatum game, then there should be some consistency in the evaluations. If there is no consistency, then it is unlikely that a norm or predisposition is in effect.

H3a: Offers containing an even split between the two parties in Ultimatum will be evaluated by a third party to be fair on average.

H3b: Offers where one player receives greater than 70% of the pot and the other less than 30% of the pot in Ultimatum will be evaluated by a third party to be unfair on average.

Since the sample will come from the U.S., I expect that evaluations of fairness and unfairness while playing the Ultimatum game will be consistent with those of prior literature (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006) where even-split offers are considered fair and offers of 30% or less are considered unfair. This reflects the social norm or predisposition about fair play in the game.

Method

In order to investigate these questions, a survey and experiment was conducted at a large Midwestern university. The experiment was conducted using an R-Comparative Posttest design where a treatment is applied to one group and no treatment to another with random assignment to each group (Mohr 1995, 58).

A lab setting was selected for the experiment for a variety of reasons. First, it needed to be plausible that the participant could change public policy. In a real policy environment, only those who are elite in one way or another would have the expectation that they could directly influence policy. Second, some participants are required to experience unfair outcomes. The fairness and unfairness of the outcomes can be controlled in the lab in a way that is not possible in the field.

The economic game known as Ultimatum was selected to create fair and unfair experiences. It was also used for assessing the consistency in the evaluation of fair and unfair outcomes. The Ultimatum game is an excellent mechanism to create the conditions of the experiment for a variety of reasons. First, Ultimatum invokes social norms related to fairness. In prior research, most people in the U.S. and other Western industrialized nations accept the social norm where an even split is proposed by the first player, and accepted by the second player (Güth and Tietz 1990; Sanfey *et al* 2003;

Knoch *et al* 2006). This research also indicates that there is a threshold where people start rejecting offers they consider to be unfair. This typically occurs when the offer from the first player is below 20-30% of the total pot. When this occurs, the response is often emotional with individuals who reject feeling insulted and dishonored (Pillutla and Murnighan 1996). In addition, rejection is associated with the activation of both the dorsolateral prefrontal cortex (cognition) and the anterior insula (emotion) regions of the brain (Sanfey *et al* 2003). Further, there seems to be a substantial heritable component to this decision-making (Wallace *et al* 2007). Thus, when the social fairness norm is judged to be violated, there is usually a meaningful emotional response for the second player, and potentially also for those witnessing the interaction.

The second reason Ultimatum is a good choice is that it is a set of rules, or institution, which engages in the social allocation of resources. It has the three main components of any social institution: people engaged in action, rules guiding that action, and beliefs associated with the rules (Neale 1987). When the first and second player are making their decisions, they are allocating for each other and not just themselves. This is similar in nature to policy decision-making where policy decisions are for a community and not just for an individual.

The third reason Ultimatum is a good choice is that its player roles mimic some of the roles of individual experience in the policy process. In particular, the evaluation of offers is not unlike the evaluation of policy proposals. Individuals, both acting as decision-makers and as members of the mass public, evaluate policies according to some form of criteria (Anderson 1979; Hayden 1995). Assuming that the justice or fairness of policies is one of the criteria that people use to evaluate public policy under some

circumstances (Haidt and Graham 2007; Haidt 2007a), then the response from the second player in Ultimatum can act as a proxy for these types of fairness evaluations.

The fourth reason that Ultimatum is a good choice is that it is plausible that participants could directly influence the future play of the game by changing the rules to make the game fairer. If the rules of Ultimatum are analogous to the rules, norms and laws of society, then a change in the rules is analogous to a change in public policy. This allows for the creation of a dependent variable which asks participants if they would like to change the rules of the game. This question is analogous to a policy decision-maker being asked about whether the decision-maker believes that a law should be changed.

The Study

The study was conducted during the summer and fall of 2009. Participation was open to anyone 19 or over, or 18 with parental consent. All participants were paid \$10 for participating in the study. Two methods of recruitment were utilized. Some participants responded as a result of emails sent to students enrolled in some political science courses during 2008-2009. These participants may or may not have received extra credit for their participation in addition to the \$10 participation payment. Other participants were recruited through the Political Science Experimental Participant Pool (PSEPP). The PSEPP compensated students with course credit for participating in addition to the \$10 payment.¹

One hundred and two participants completed the survey and experiment. Those who participated arrived at a lab on campus at a scheduled time. They read the Informed

¹ The study received approval from the University of Nebraska – Lincoln Institutional Review Board (IRB# 2009069957EP). Funding for the participant fees and payment for a proctor came from the Senning Summer Research Fellowship provided by the UNL Department of Political Science. Other support was provided by the University of Nebraska's Presidential Fellowship.

Consent Form, and had any questions answered about the study before agreeing to participate. After agreeing to participate, the participants were seated at a computer station where they had skin conductance sensors attached to the distal phalange of their index and middle fingers of their non-dominant hand. The non-dominant hand was defined as the hand which was not normally used to operate a computer mouse. Thus, for most participants the non-dominant hand was the left hand. A double sided adhesive collar with a 1 cm hole was utilized on each finger to control the amount of contact between the sensors and the fingers. An isotonic gel was utilized to ensure connection between the sensors and the fingers.

Participants were randomly assigned to one of three different groups. Each group received a different version of the survey and experiment. Thirty-four participants completed the survey in each group. A detailed description of the survey for each group is presented in Appendix A.

All participants completed a survey of demographic information and set of questions on empathy. The third segment of the survey was based on the experimental condition. Participants either (1) played the Ultimatum game 10 times (with instructions prior to play), (2) read about two other players playing Ultimatum (with instructions prior to play), or (3) received instructions on how Ultimatum is played. Participants who were in the group who played the game were instructed to imagine that they were playing a game for real stakes, but they were not paid according to the outcome of the game. All participants received the same \$10 fee and some participants received extra credit or course credit for their participation that was not dependent upon their play in the game.

Following the experimental condition, all participants answered questions about changing the rules of the game to make it fairer and how they might like to see the rules of the game changed along with other policy questions regarding the game. Participants then completed a Machiavellianism survey. Finally, participants watched videos of people experiencing unfair outcomes along with neutral videos (such as a screen saver, or a bumble bee flying amongst a bunch of flowers). Following the videos, the participants were unhooked from the physiology equipment, debriefed and paid. A summary of the procedures is presented in Tables 3.1 and 3.2.

Table 3.1 – Description of the segments of the survey for the three conditions

| Order | Played Ultimatum (E1) | Witnessed Ultimatum (E2) | Control (C) |
|-------|---------------------------------------|-------------------------------|-------------------------------|
| 1 | Demographic | Demographic | Demographic |
| 2 | Empathy Scales | Empathy Scales | Empathy Scales |
| 3 | Ultimatum Instructions | Ultimatum Instructions | Ultimatum Instructions |
| 4 | Play Ultimatum as Player 1 (5 trials) | Watch Ultimatum (10 trials) | * |
| 5 | Play Ultimatum as Player 2 (5 trials) | * | * |
| 6 | Policy Questions | Policy Questions | Policy Questions |
| 7 | Machiavellianism Scale | Machiavellianism Scale | Machiavellianism Scale |
| 8 | Unfairness and Neutral Videos | Unfairness and Neutral Videos | Unfairness and Neutral Videos |

Table 3.2 – Description of the offers made to each group in the experimental condition

| Trial | Play Ultimatum (E1) | | Witness Ultimatum (E2) | |
|-------|---------------------|----------------|------------------------|-------------------|
| | Participant Role | Offer / Pot | Player 1 Offer / Pot | Player 2 Response |
| 1 | Player 1 | ?/60 | Offer 30 / 60 | Accept |
| 2 | Player 1 | ?/20 | Offer 15 / 20 | Accept |
| 3 | Player 1 | ?/80 | Offer 20 / 80 | Reject |
| 4 | Player 1 | ?/500 | Offer 50 / 500 | Reject |
| 5 | Player 1 | ?/120 | Offer 108 / 120 | Accept |
| | Switch | | Switch | |
| 6 | Player 2 | Offer 40 / 80 | Offer 60 / 80 | Accept |
| 7 | Player 2 | Offer 5 / 60 | Offer 15 / 60 | Reject |
| 8 | Player 2 | Offer 55 / 120 | Offer 10 / 120 | Reject |
| 9 | Player 2 | Offer 3 / 20 | Offer 10 / 20 | Accept |
| 10 | Player 2 | Offer 40 / 500 | Offer 450 / 500 | Accept |

The Key Dependent Variable

In order to assess the effect of the experimental conditions on preferences for policy change, a series of questions was asked about the fairness of the game that either the participants experienced, witnessed or heard about. The key survey question assessed whether participants believed that the rules of the game should be changed in order to assure that offers from the first player to the second were fair. It was measured as a dichotomous variable; the participant could answer either yes or no. This question immediately followed whichever of the three experimental conditions had been randomly assigned to the participant (playing Ultimatum for group E1, witnessing Ultimatum for group E2, or the instructions for Ultimatum for group C). It assesses whether or not the participant desires policy change for the purposes of making the game fairer. As such, it uses preferences for rule changes in the game as an analogue for preferences for policy change in society. Essentially, the participants are asked if the current policy comprised by the rules of Ultimatum should be changed to assure fairness.

This distinction between the status quo and future policy change is a fundamental one in public policy. Most textbooks on policy analysis invokes that the status quo be utilized as an important alternative to contrast against other potential alternatives (Patton and Sawicki 1986; Quade 1989; Gupta 2001). While the survey question asks for the participants' preferences on policy change, this is the same preference that policy decision-makers would provide in the course of making a decision to engage in policy change. Thus, the question to the participants is between two future states of the world... One is the status quo that they have either directly experienced, indirectly experienced, or not experienced and the other is a future state where the policies of the game have been changed.

Results

The Personal Perspective and Preferences for Policy Change

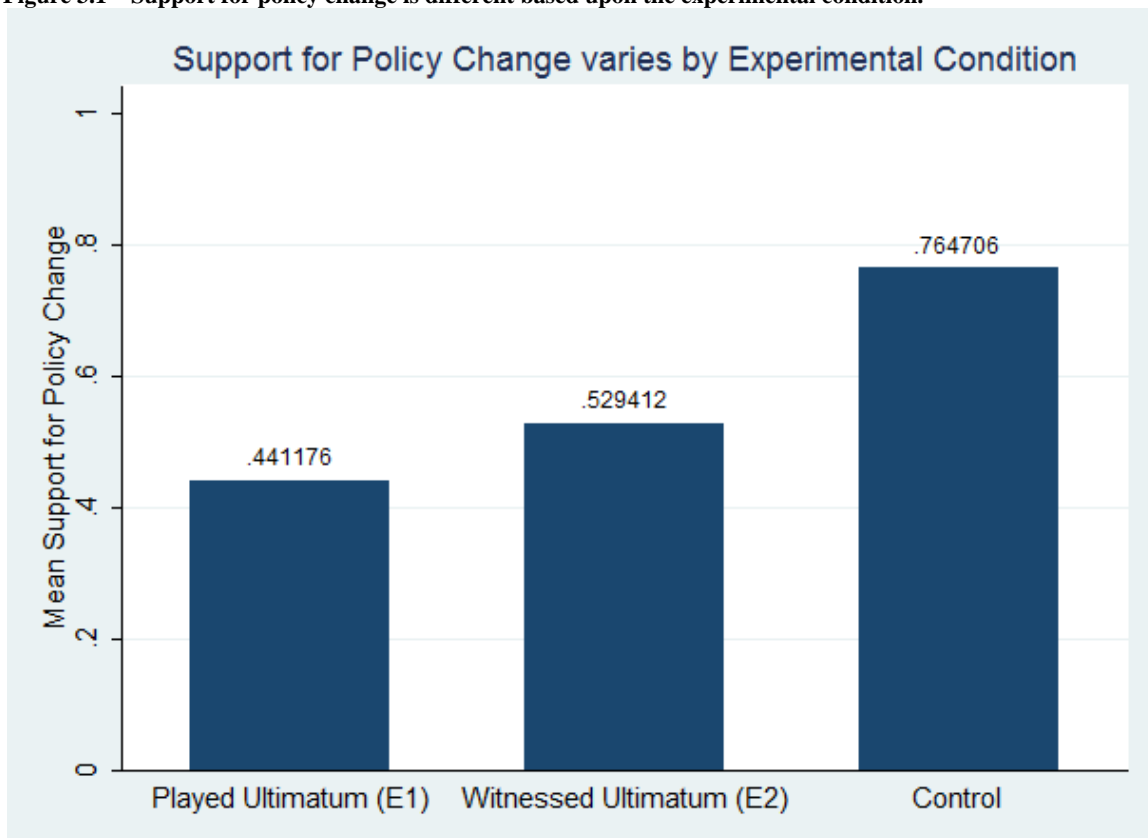
As demonstrated in Table 3.3 and Figure 3.1, the mean support for policy change between the three groups is significantly different for some of the groups, but not others. In particular, the Tukey Honestly Significant Difference (HSD) test indicates that a significant difference exists between the group that played Ultimatum (E1) and the control group (C). It is surprising that those who experienced the game have relatively lower support than those who did not experience the game. This may be because the control group (C) has much higher support for policy change than was expected. While this difference between playing the game and not experiencing the game is interesting, these results are not enough to evaluate the two parts of hypothesis 1 because both the participants who experienced a fair outcome overall and the participants who experienced an unfair outcome overall are lumped together in the Playing group (E1).

Table 3.3 – Differences in Support for Policy Change by Experimental Condition

| ANOVA on Support for Policy Change | n=102 | F = 4.10 | Prob>F = 0.0195 | Adjusted R ² = 0.0578 |
|------------------------------------|--------------------------------|--------------------------------|-----------------|----------------------------------|
| | Mean Support for Policy Change | Mean Support for Policy Change | Difference | Tukey HSD Test |
| Playing (E1) v. Witnessing (E2) | 0.4412 | 0.5294 | 0.0882 | 1.0681 |
| Playing (E1) v. Control (C) | 0.4412 | 0.7647 | 0.3235 | 3.9164* |
| Witnessing (E2) v. Control (C) | 0.5294 | 0.7647 | 0.2353 | 2.8483 |

* <0.05, Studentized Range Critical Value (0.05, 3, 99) = 3.3651
An estimated increase in sample size to 89 from 34 for each group would be required to achieve a 0.05 level of significance for E2 v C.

Figure 3.1 – Support for policy change is different based upon the experimental condition.



Therefore, the group that played the game was split into three sub-groups. Table 3.4 provides a summary of the characteristics of each of these three sub-groups. One of these sub-groups, the Losing Players (E1.1), lost 227 game points compared to the other player in the game (on average). Another group, the Even Split Players (E1.2), was 4 game points ahead of the other player in the game (on average). The third group, the Profitable Players (E1.3), was 110 game points ahead of the other player (on average). The difference in the mean support for policy change of these three groups is striking.

Table 3.4 – A breakdown of the differences amongst those who played Ultimatum (E1)

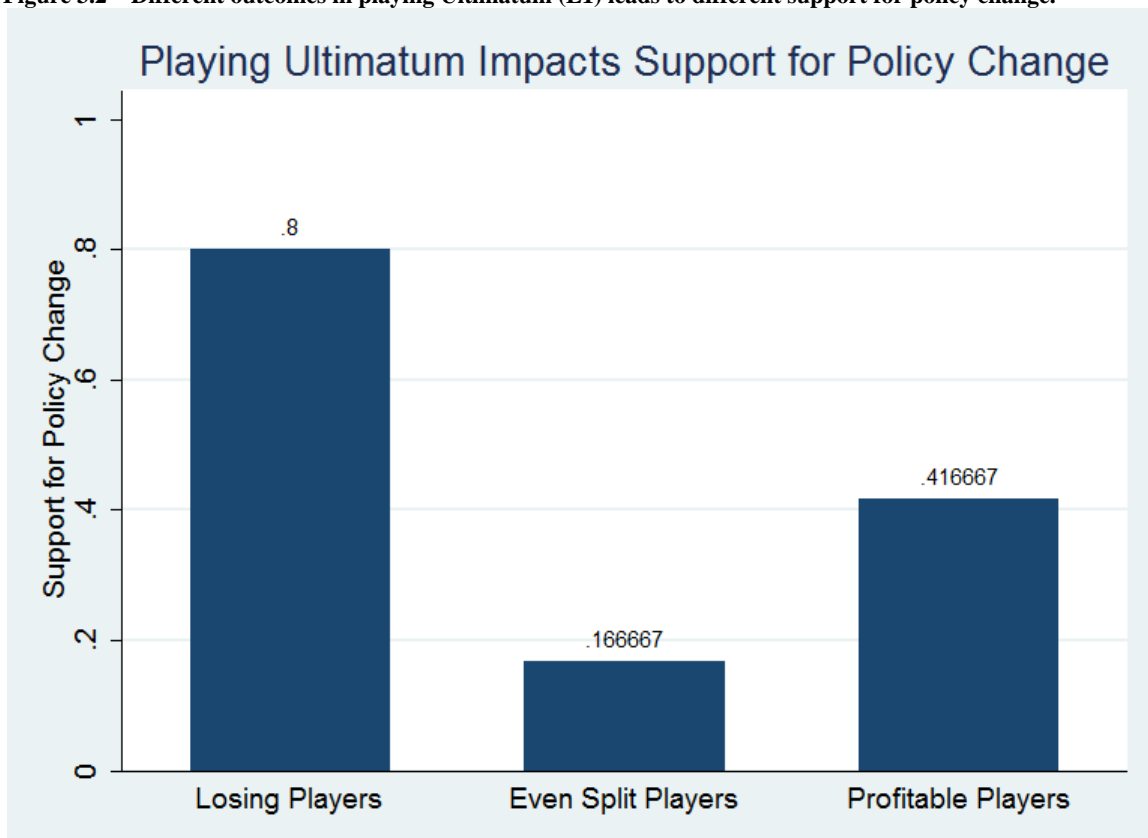
| Mean (s.d.) | <i>Losing Players (E1.1)</i> | <i>Even Split Players (E1.2)</i> | <i>Profitable Players (E1.3)</i> |
|--|----------------------------------|--------------------------------------|--------------------------------------|
| <i>Support for Policy Change</i> | 0.80 (0.42) | 0.17 (0.39) | 0.42 (0.51) |
| <i>Game Points for Self</i> | 485.7 (39.6) | 428.8 (85.7) | 520.2 (85.82) |
| <i>Game Points for Other Player</i> | 713.4 (269.7) | 424.6 (90.1) | 409.8 (76.1) |
| <i>Difference between Self and Other</i> | -227.7 (259.7) | 4.2 (7.9) | 110.3 (70.4) |
| <i>N</i> | 10 | 12 | 12 |

Those who lost (E1.1) were highly supportive of policy change. In fact, their mean of 0.8 is slightly higher than the control group's (C) mean of 0.76. Those who had an even split (E1.2) were very unsupportive of policy change. Their mean support for policy change was 0.17. This difference between those who lost (E1.1) and those who had an even split (E1.2) was significantly different as demonstrated by the ANOVA in Table 5, and is demonstrated graphically in Figure 2. One item to note is that the sample size is relatively low for these three groups (with n's of 10, 12 and 12). Despite this, the Losing (E1.1) and Even Split (E1.2) groups' mean support for policy change was significantly different.

Table 3.5 – Tukey HSD test on ANOVA results comparing differences between groups receiving different outcomes in Ultimatum.

| ANOVA: | n=34 | F = 5.51 | Prob>F = 0.0089 | Adj R ² = 0.2147 |
|--|--------------------------------|--------------------------------|--------------------|--------------------------------|
| | Mean Support for Policy Change | Mean Support for Policy Change | Difference | Tukey HSD Test |
| Losing (E1.1) v. Even Split (E1.2) | 0.800 | 0.1667 | 0.6333 | 4.7564* |
| Losing (E1.1) v. Profitable (E1.3) | 0.800 | 0.4167 | 0.3833 | 2.8789 |
| Even Split (E1.2) v. Profitable (E1.3) | 0.1667 | 0.4167 | 0.2500 | 1.8775 |
| * <0.05, Studentized Range Critical Value (0.05, 3, 31) = 3.4808 An estimated increase in sample size to 32 each from 10 and 12 would be required to achieve significance at 0.05 between the Losing and Profitable groups. | | | | |

Figure 3.2 – Different outcomes in playing Ultimatum (E1) leads to different support for policy change.



This cut on the data allows for assessment of the first two hypotheses.

Hypotheses H1a and H1b compare the Losing Players (unfair treatment, H1a) and the Even Split Players (fair treatment, H1b) against the Control (C). The ANOVA and Tukey HSD results are presented in Table 3.6. Hypothesis H1a asserted that those experiencing unfairness would be more likely to support rule changes than a control group. However, this was not the case. It was not the case because the control group's support for policy change was unexpectedly high at 0.76. In fact, with a mean of 0.8, the Losing Players group (E1.1) was very supportive of policy change when compared to the Even Split Players (E1.2), but not when compared to the control (C). However, the Even Split Players (E1.2) were significantly different from the Control group (C) on their support for policy change. This was not as predicted, so both hypotheses H1a and H1b

must be rejected. Even though these hypotheses are rejected, they still contain interesting results and deserve an explanation.

When considered in the context of a fairness norm violation, the Losing Players and the Even Split Players make sense. Those participants whose experience of the game was to have an even split between themselves and the other player generally thought that the game was fair. They evaluated their experience with the criteria provided by a fairness norm and their emotions, and evaluated that the game did not need improvement. Those who lost overall evaluated their experience against the criteria provided by the fairness norm and their emotions and decided that their experience did not meet the criteria. Thus, they were supportive of policy change.

The Profitable group was not significantly different from any of the others, including the control (as stated in Table 3.6). However, it is interesting that so many in the profitable group were willing to support policy change. While this is purely speculative, it is possible that some in that group assessed themselves against the fairness norm and decided that their experience was not fair. It was not fair because they themselves were the beneficiaries of an unfair set of policies.

None of the outcomes of these groups who played the game is particularly surprising. The only one that was surprising was the control group who did not play the game. So, what's going on with the Control group (C)?

Table 3.6 – Comparison of the mean support for rule changes with group E1 cut according to outcome.

| ANOVA on support for policy change | n = 102 | F = 4.79 | Prob>F = 0.0014 | Adj R ² = 0.1304 |
|------------------------------------|--------------------------------|--------------------------------|-----------------|-----------------------------|
| | Mean Support for Policy Change | Mean Support for Policy Change | Difference | Tukey HSD Test |
| Losing (E1.1) v. Control (C) | 0.8000 | 0.7647 | 0.0353 | 0.2989 |
| Even Split (E1.2) v. Control (C) | 0.1667 | 0.7647 | 0.5980 | 5.0652* |
| Profitable (E1.3) v. Control (C) | 0.4167 | 0.7647 | 0.3480 | 2.9478 |
| Witnessing (E2) v. Control (C) | 0.5294 | 0.7647 | 0.2353 | 1.9929 |

Note: Only comparisons involving the control have been included in the list of Tukey values. All of the groups have been included in the ANOVA.
* <0.05, Studentized Range Critical Value (0.05, 5, 97) = 3.9312

The Abstract Perspective and Preferences for Policy Change

The control group arrives at the policy question with little if any experience with the game. They have instructions on the rules, and an abstract sense of what fairness means. With a mean support for policy change of 0.76, the Control group (C) defied my expectations. I suspected that they would prefer the status quo, and not have a strong preference for policy change. However, on reflection, there may be some clear explanations for why the control group was so supportive of policy change. The first of these explanations is that the participants in the control group sit behind Rawls' veil of ignorance (Rawls 1971). In assessing the fairness of a game that they had only briefly described to them, participants chose to support higher levels of fairness. They did not know ahead of time if they were going to be on the winning end or the losing end, and thus they expressed a desire to see the rules of the institution be fairer. The second explanation is related, but comes from a slightly different perspective. In this explanation, the participants come at the question from the perspective of the wary cooperator (Hibbing and Alford 2004; Smith 2006). Here, the participants warily

approach a game because they are trying to avoid being made into suckers. Once they know that the experience is fair enough, then they can support the current rules of the game. However, without that experience, they would prefer to have the rules changed in order to assure fair outcomes. Both explanations are related because both imply that without experience, people are reluctant to engage in institutions with unfair rules.

The Interpersonal Perspective and Preferences for Policy Change

The group that witnessed Ultimatum (E2) was not significantly different from either of the other groups (in particular the control group (C)) on the issue of supporting policy change. This is enough information to evaluate hypothesis 2. For hypothesis 2, which asserted that witnessing unfairness would increase the likelihood of support for rule changes compared to a control, the null result must be accepted. In addition to being in the wrong direction, there is no significant difference between those who witnessed Ultimatum (E2) and those in the control group who only received instructions on how to play (C).

The question then is, why was there no significant difference between the Interpersonal group (E2) and the control (C)? One explanation may be that there is a sample size problem. The witnessing group mean (E2) was 0.52 and the control group mean (C) was 0.76. This difference of 0.24 is reasonably large. There were 34 participants in each group, and if the sample size were to be increased to 89 in each group, then a significance level of 0.05 could be reached. If the sample size were to be increased, it is uncertain what would happen, though. My guess is that it would stabilize where it is, and not move towards either the high support for policy change level or the low support for policy change level.

Fairness Criteria and Preferences for Policy Change

The group that witnessed Ultimatum (E2) still has a role to play despite the null results for the second hypothesis. Between each trial of the Ultimatum game, each participant who was in the witnessing group (E2) was asked to rate the fairness of the offer from the first player to the second player. Some trials were fair, some trials were unfair, and others were quite generous when evaluated using the standard fairness norms that suggest an even split is fair and an offer of less than 30% is unfair. The trials that were generous were offers from the first player to the second player where the offer was greater than 70%. I label these offers as “altruistic”. The third set of hypotheses (H3a and H3b) seek to assess whether participants adhered to the standard fairness norms when evaluating fair (H3a) and unfair (H3b) trials. Table 3.7 details the offers and categories of the various trials.

Table 3.7 – Witnessed trials categorized by their type of offer from the first player to the second player

| <i>Trial</i> | <i>Offer from Player 1 to Player 2</i> | <i>Pot</i> | <i>Category</i> |
|--------------|--|------------|-----------------|
| 1 | 30 | 60 | Fair |
| 2 | 15 | 20 | Altruistic |
| 3 | 20 | 80 | Unfair |
| 4 | 50 | 500 | Unfair |
| 5 | 108 | 120 | Altruistic |
| 6 | 60 | 80 | Altruistic |
| 7 | 15 | 60 | Unfair |
| 8 | 10 | 120 | Unfair |
| 9 | 10 | 20 | Fair |
| 10 | 450 | 500 | Altruistic |

As demonstrated in Figure 3.3 and Table 3.8, the mean of the fair trials was assessed to be significantly fairer than the middle value of 3.0. This confirms hypothesis H3a. In addition, the mean of the unfair trials was assessed to be significantly less fair than the middle value of 3.0. This confirms hypothesis H3b. While there was no

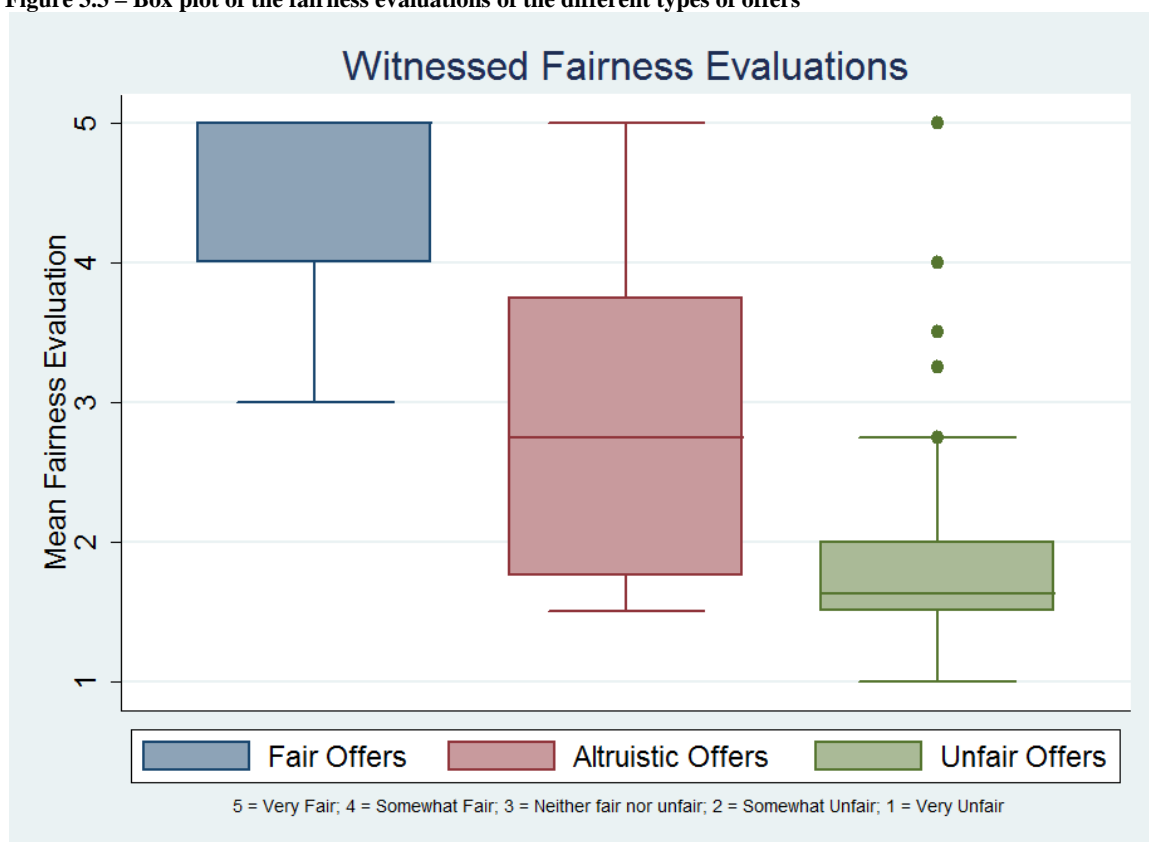
hypothesis for the altruistic trials, the altruistic trials were not significantly less than, greater than or equal to 3.0. Thus, the altruistic trials provide some interesting variation.

Table 3.8 – Mean Fairness Evaluations

| | Mean Fairness Evaluation | t | Ha: Mean<3.0 Pr(T<t) | Ha: Mean=3.0 Pr(T > t) | Ha: Mean>3.0 Pr(T>t) |
|-------------------|--------------------------|--------|-------------------------|-------------------------------|-------------------------|
| Fair Offers | 4.54 | 13.734 | 1.000 | 0.000* | 0.000* |
| Altruistic Offers | 2.93 | -0.329 | 0.372 | 0.745 | 0.628 |
| Unfair Offers | 1.94 | -6.955 | 0.000* | 0.000* | 1.000 |

* < 0.05; 5=Very Fair; 4=Somewhat Fair; 3=Neither Fair nor Unfair; 2=Somewhat Unfair; 1=Very Unfair

Figure 3.3 – Box plot of the fairness evaluations of the different types of offers



Arousal and Policy Criteria

In chapter 1 of this dissertation, the third research question asked whether human beings share a common set of evaluation criteria for the evaluation of public policies involving fairness. As was just demonstrated, there is consistency in the participants' third party evaluations of offers from the first player. However, were those evaluations

emotional? Were participants in a heightened emotional state at the time they made their policy choice?

One indicator of emotion, arousal and attention is electrodermal activity (EDA), also known as skin conductance (Dawson *et al* 2007). The basic idea is that when the sympathetic nervous system is activated due to a heightened emotional state, the eccrine sweat glands respond by producing more sweat. The level of sweat is measurable by passing a constant current through two electrodes attached to the skin and measuring the resistance. When there are higher levels of sweat, the resistance declines (and vice versa). Thus, skin conductance can act as a measure of emotion, arousal and attention as experienced in the sympathetic nervous system. Since the sympathetic nervous system is part of the autonomic nervous system, there is not conscious control of these results.

Participants were measured on their skin conductance levels during many parts of the survey and presentation of video stimuli. Following data collection, these levels were standardized for each individual by setting the mean score for each individual to be zero and the standard deviation to be one. Figure 3.4 presents the standardized skin conductance levels for participants while they were witnessing Ultimatum play (E2).

Several aspects of this data stand out to me. Those who favored policy change were becoming more and more aroused as the trials proceeded. At the same time, those who did not favor policy change were slightly habituating to the environment. Ultimately, both groups converged on a similar level of arousal at the time they made their choice on whether to favor policy change.

Figure 3.4 – Skin Conductance Results while Witnessing Ultimatum Trials

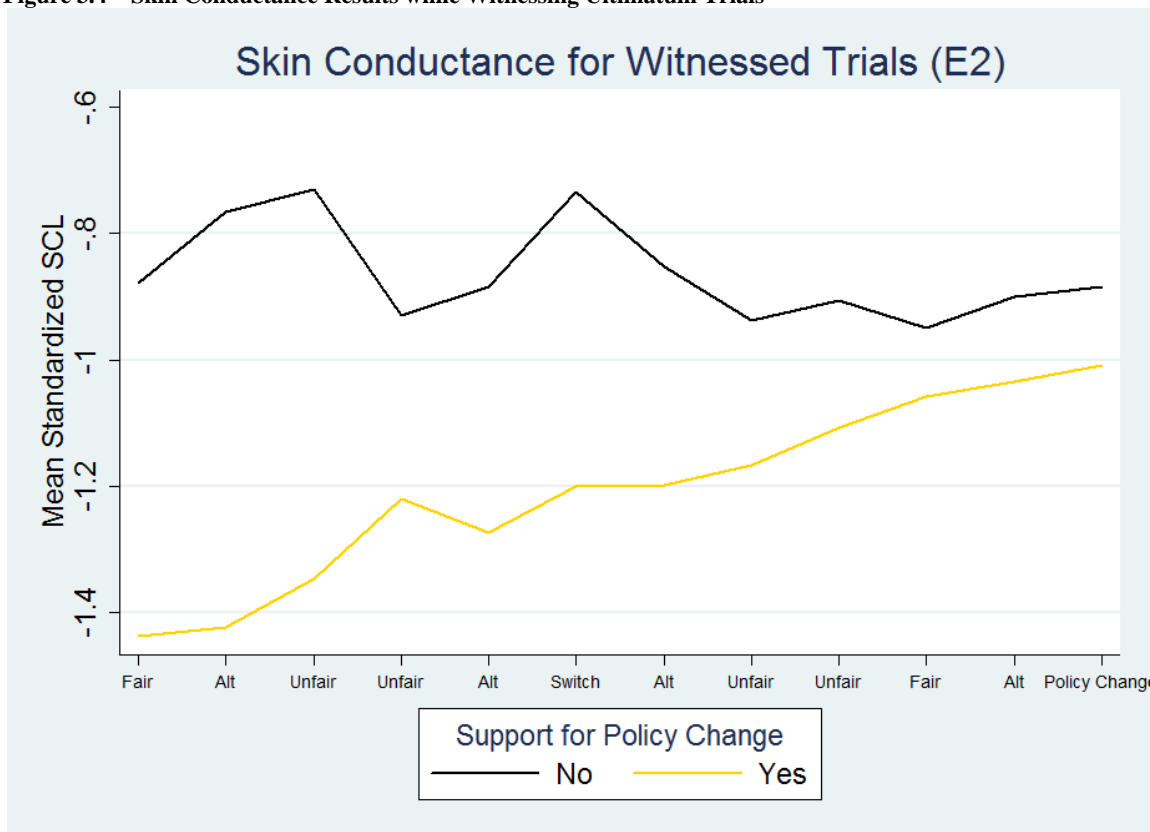


Table 3.9 demonstrates that there was a significant difference between the arousal levels at the initial trial and the policy change question for those who supported policy change. However, those who did not support policy change did not see any significant difference from the beginning trial to the question on policy change. Those who seem to be emotionally aroused or made attentive by witnessing trials also seemed to be willing to support policy change.

Table 3.9 – Changes in Arousal differed by Support for Policy Change for Witnessed Trials (E2)

| Support for Policy Change | n | Mean Standardized SCL - Trial 1 | Mean Standardized SCL - Policy Change | t | Diff != 0 Pr(T > t) |
|---------------------------|----|---------------------------------|---------------------------------------|---------|----------------------------|
| No | 12 | -.8779021 | -.8840018 | -0.0224 | 0.9825 |
| Yes | 18 | -1.438156 | -1.009087 | 1.9948 | 0.0624# |

<0.10

In the case of those who played Ultimatum (E1), the experience was relatively comparable for both those who supported policy change and those who did not (as seen

in Figure 3.5). That is, until the 10th trial where the participants were offered 40 out of 500 game points, an unfair offer on the largest pot of all the trials. While both groups were affected by the large unfair offer, those who supported policy change started at a lower overall level prior to the unfair offer, and ended up at a higher level overall. It should be noted that the increase in arousal among those who supported policy change was only significant in a single-tailed test at the 0.10 level of significance (as demonstrated in Table 3.10). In addition, this group had an n of 14. So, this difference should be somewhat discounted. Nonetheless, it does demonstrate some effect that emotion may have on preference for policy change resulting from experience.

Figure 3.5 – Skin Conductance Results while Playing Ultimatum – Each trial consists of three data points that are above and to the right of the named marker.

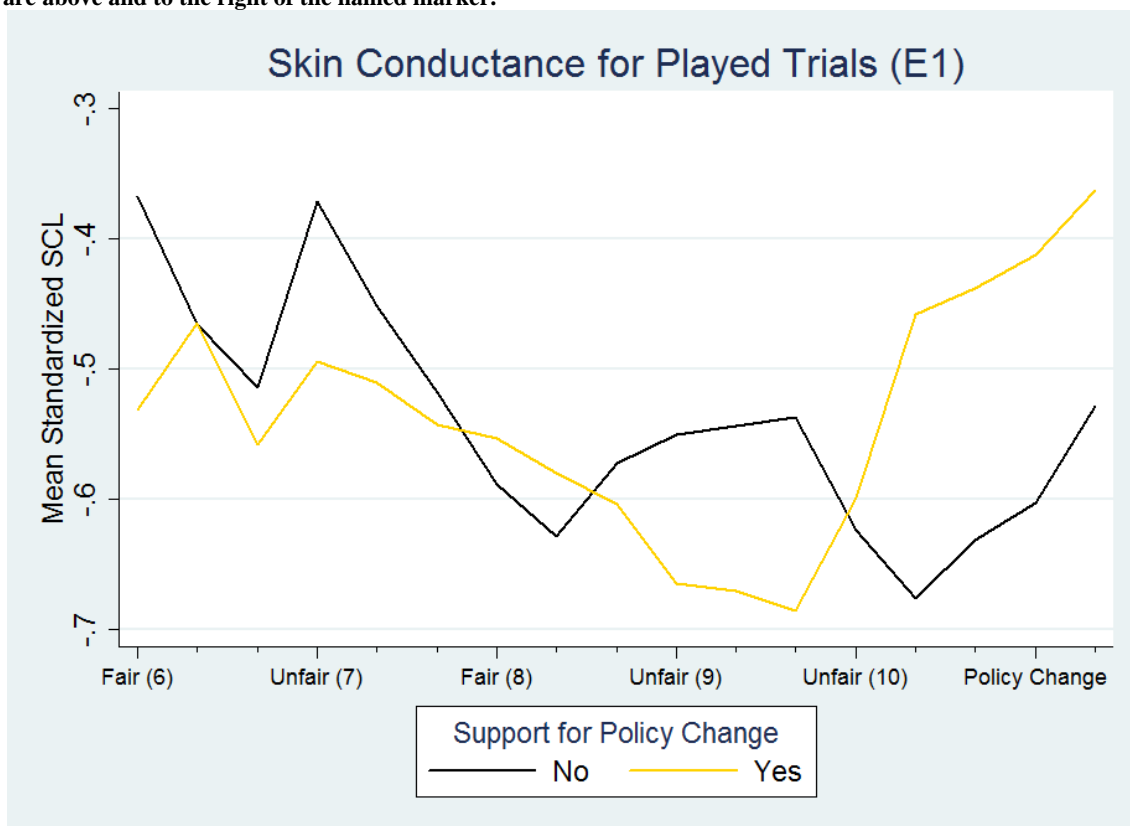


Table 3.10 – Change that occurred between the event before the large unfair trial (10) and during the Policy Change question for those Playing Ultimatum (E1)

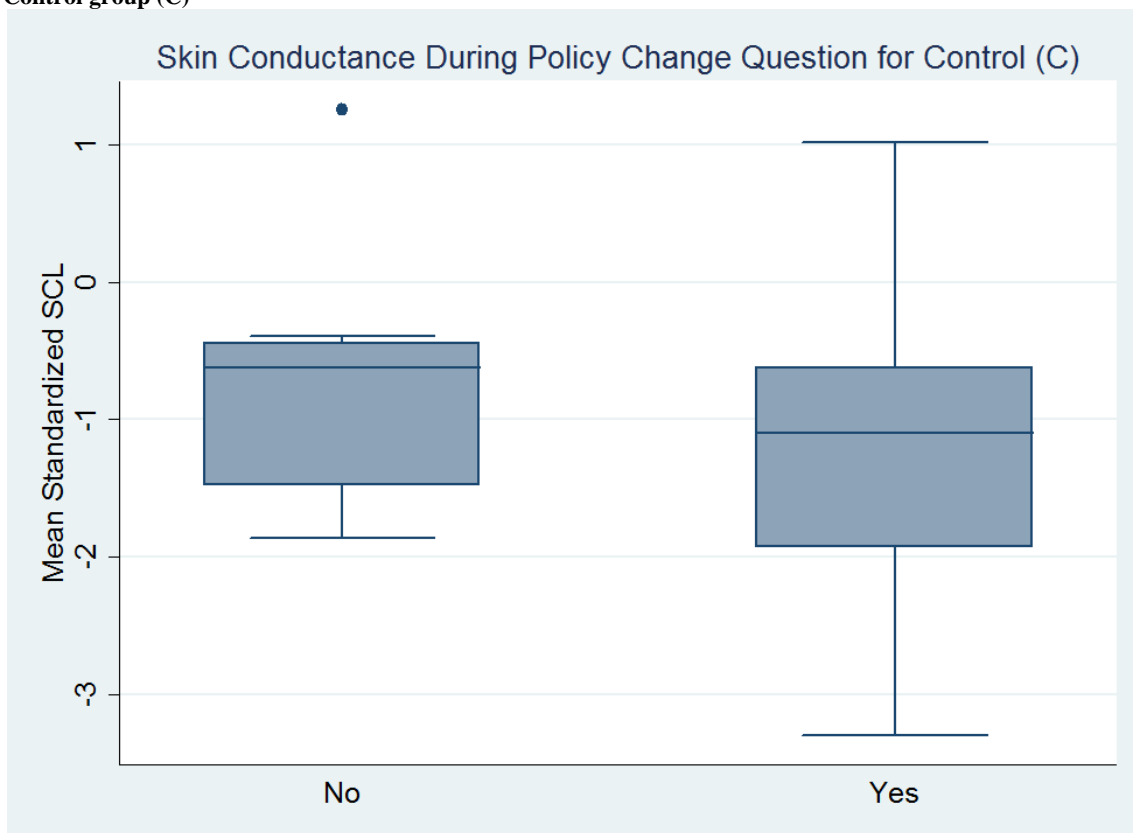
| Support for Policy Change | SCL before Trial 10 | SCL at Policy Change Question | n | t | Pr(T<t) | Pr(T > t) | Pr(T>t) |
|--|---------------------|-------------------------------|----|--------|---------|---------------|----------|
| No | -0.53712 | -0.52846 | 18 | 0.0613 | 0.5241 | 0.9518 | 0.4759 |
| Yes | -0.68595 | -0.36291 | 14 | 1.5482 | 0.9272 | 0.1456 | 0.0728 # |
| # < 0.10 SCL is mean standardized skin conductance level. | | | | | | | |

For the control group, there are only two events that are relevant. The first is the participants reading instructions about Ultimatum. The second is the policy change question. Nonetheless, the group that supported policy change saw a significant increase in their mean standardized SCL between seeing the instructions and answering the policy change question (as seen in Table 3.11 and Figure 3.6). The group that did not support policy change did not have a significant increase in arousal between the two events. If one interprets the control group's high level of support for policy change as being similar to being a wary cooperator (Hibbing and Alford 2004; Smith 2006), or being behind the veil of ignorance (Rawls 1971), then it makes sense that those who supported policy change were aroused by the question without experiencing the game. Those who did not support policy change were not aroused by the instructions and policy question.

Table 3.11 – Difference in SCL between Ultimatum Instructions and Policy Change question by Support for Policy Change in the Control Group (C)

| Support for Policy Change | SCL at Instructions | SCL at Policy Change Question | n | t | Pr(T<t) | Pr(T > t) | Pr(T>t) |
|--|---------------------|-------------------------------|----|--------|----------|---------------|---------|
| No | -0.9562 | -0.7141 | 8 | -0.968 | 0.1825 | 0.3651 | 0.8175 |
| Yes | -1.4222 | -1.2109 | 26 | -2.097 | 0.0231 * | 0.0463 * | 0.9769 |
| * < 0.05; # < 0.10 SCL is mean standardized skin conductance level. | | | | | | | |

Figure 3.6 – Mean standardized skin conductance levels during the policy change question for those in the Control group (C)



In all three experimental conditions (E1, E2 and C), those who supported policy change had, to some degree, different patterns of arousal than those who did not support policy change in the period leading up to the policy change question. While the pattern of influence was different under the three experimental conditions, there is some support for the notion that emotional arousal assists in making the choice to support policy change on fairness issues. Because of the low number of participants in each group, these results must remain tentative. Nonetheless, the trend is that there is something different about the level of emotional arousal when making a decision to support policy change regarding fairness. Further research on this issue is likely warranted.

Conclusion

The decision between the status quo and that of a change in policy is an important one in public policy. Common advice for conducting policy analyses is to always include the status quo in an analysis. Therefore, the question of whether to change the current policy to a new policy to accomplish a particular goal (such as to improve the fairness of the outcomes) is an important one in policy circles. This chapter has demonstrated several ways in which this decision can be affected by a variety of factors.

First, direct experience in the policy domain does seem to have an impact on whether policy change is favored. This is particularly the case when a fairness norm is violated during the direct experience. When a fairness norm is violated, those experiencing the negative outcome are much more likely to support policy change than those who experience no violation of the outcome. In addition, those who decide to support policy change after experiencing a large unfair offer have a different pattern of emotional arousal than those who do not support policy change.

Second, witnessing others experiencing fair and unfair treatment does not seem to affect the support for policy change. But once again, those who supported policy change after witnessing others engaged in the institution seem to have a different pattern of emotional arousal leading up to the policy decision than those who did not support policy change.

Third, those not having any experience in the policy domain are likely to support policy change if they believe the change will result in fairer outcomes for all potential affected parties. Once again, those who supported policy change without any experience seem to have a different pattern of emotional arousal than those who do not support policy change.

Fourth, there does seem to be some consistency in the criteria used for evaluating fair and unfair offers. While this is not surprising considering the previous literature on the subject (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006; Haidt and Graham 2007; Haidt 2007a), it does provide confirmation that participants are engaged in utilizing some common criteria for evaluating fairness. The source for these common criteria is likely coming from social norms and from heritable sources (Wallace *et al* 2007). Assessing the interplay of institutions, norms and heritable traits will be the principle content of the next chapter.

A Simulation of the Evolutionary Policy Model

Chapter 4

The results of the prior chapter indicate that emotions related to experience in the domain of a policy play a role in the outcomes of the policy decisions in that domain. Combined with the heritability of the second player's decision in Ultimatum as found in Wallace *et al* (2007), the theoretical model presented in Chapter 2 has some support, at least at the micro-level. However, public policy (and the model of the proposed policy process) is not merely an exercise of individuals and their individual policy preferences. Rather, public policy is a decision made by a group and mediated by the structure of the social institutions of government (Dewey 1988 [1927]; Commons 1995 [1924]; Ostrom 2005; Smith and Oxley 2008).

If individual decisions can be affected by partly heritable emotional states, then policy outcomes can be affected by the evolution of the individual decision-making traits. What might the effect on policy outcomes look like? In this chapter, I will explore how the policy process can be affected by the evolution of individual traits in the population. Using mathematical modeling of the evolution of individual traits related to decision-making in Ultimatum, I will explore the theoretical implications of this evolutionary change. The model described in Chapter 2 will be simulated using a technique known as Agent-based modeling (ABM). In this model, individual decision-making traits in Ultimatum will co-evolve with the public policies of a simulated society.

The Research Questions

- If preferences on matters of governance are influenced in part by heritable traits, then how is the public policy process affected by the evolution of these traits? (Research Question 4 from the first chapter)
 - a. What type of compliance policy (incentives, disincentives, or a mix) is more likely to lead to long term cooperation and compliance?
 - b. What type of compliance policy (incentives, disincentives, or a mix) is more likely to lead to long term successful social outcomes?
 - c. Do predisposed evaluation criteria for public policies affect policy outcomes as compared to the absence of predispositions?

Hypotheses for the Research Questions

The hypotheses are formally stated as follows:

H4.1: Disincentives are more likely than incentives to lead to long term cooperation (low self-interest) among agents.

H4.2: Incentives are more likely than disincentives to lead to long term evolutionary success of agent societies (high population levels at the end of the simulation).

H4.3: The distribution of individual preferences for the fairness threshold as a public policy will be normally distributed with a mean of 25% of the offer.

H4.4: A model with evolved individual predispositions will lead to lower levels of applied incentives as public policy compared to a model where predispositions are not present.

H4.5: A model with evolved individual predispositions will lead to higher levels of applied disincentives as public policy compared to a model where predispositions are not present.

An interesting literature has emerged with regard to hypothesis 4.1. Prospect theory suggests that people value things framed as losses greater than they do things with the same value framed as gains (Kahneman and Tversky 1979). This would suggest that

disincentives would be the policy tool more likely to promote any social goal, including cooperativeness and compliance in the population, because the loss of something that is already in a person's possession is more valuable to them than something they might gain.

In another literature, many different mechanisms have been demonstrated to lead to cooperation. These include direct reciprocity (Trivers 1971; Axelrod 1984; Nowak and Sigmund 1992) indirect reciprocity (Nowak and Sigmund 2005), costly punishment (Ostrom *et al* 1992; Fehr and Gächter 2000), multilevel selection (Traulsen and Nowak 2006) and the possibility of both targeted punishment and reward (Rand *et al* 2009). Of these, Rand *et al* (2009) is quite relevant to the present question as they found that individuals would respond to both rewards and punishment when engaged in public goods games in the lab and that both rewards and punishment lead to long term cooperation. They find, though, that rewards are more socially beneficial to the group on average because there is no destruction of gains as would be imposed by costly punishment.

This creates a conundrum when establishing the expected direction for hypothesis 4.1. Prospect theory suggests that disincentives have greater weight on individual behavior. Rand *et al* (2009) suggest that incentives produce better outcomes for the whole of society. Rand's results reflect a slightly different perspective on this question, though. First, Rand's results reflect the public goods game where there is a third party generating additional income to be distributed to the participants in each round¹. This third party pays benefits but does not incur costs. Second, almost all of the cooperation

¹ Ostensibly, this third party is either the government or the efficiencies arising from cooperation such as those found when producing goods in a production line. If it is solely from the efficiencies arising from cooperation, then a payoff of 60% of the original investment is unlikely in my opinion.

literature, including Rand *et al*, uses individual imposition of incentives and disincentives in a small group. Thus, instead of the state explicitly creating and enforcing laws through incentives and disincentives, other players punish norm violations in these models of cooperation. Given these factors, I will stick with prospect theory and suggest that disincentives will be more likely to lead to long term cooperativeness in the simulated population.

However, Rand *et al* does suggest that while both incentives and disincentives can be effective in leading to cooperativeness, it is incentives that are more likely to lead to long term overall economic success. This is because rewards improve average group wealth and penalties reduce average group wealth. One difference between Rand *et al*'s model and mine is that the explicit presence of the third party payer is excluded in theirs and included in mine. Nonetheless, I follow Rand's lab results and suggest that it is incentives that will lead to long term population success in hypothesis 4.2.

Hypothesis 4.3 suggests that agents' policy criteria for evaluating the fairness of the first player's offer in the Ultimatum game will be normally distributed around a mean of 25% of the offer. A key reason to include this hypothesis is to test the external validity of the various theoretical models with and without incentives and disincentives.

Therefore, this will test the criteria in the versions of the agent-based models against the criteria of real human beings. The criteria, as stated in hypothesis 4.3, is consistent with the literature for participants in Western, industrial societies (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006), but not necessarily consistent with that of smaller non-Western societies (Henrich *et al* 2001). Regarding this exception, Henrich *et al* did

find substantial rejection of low offers across a number of these small-scale societies and almost all of the results for individual societies were extremely low-n results².

Hypotheses 4.4 and 4.5 compare two states regarding decision-making traits: (1) the presence of and (2) the absence of a predisposition for specific preferences for the application of a particular public policy. The content of these public policies is the key dependent variable. Does the content of the public policy change when predispositions are modeled as compared to when predispositions are not modeled in an evolutionary model? Prior research suggests that there may be a reason to believe that punishment is an enjoyable human trait. de Quervain *et al* (2004) found support for the concept that the reward centers of the brain are activated when people are engaged in altruistic punishment of others. If people genuinely enjoy punishing others despite a potential personal cost, then it is likely that disincentives will be favored over incentives as the form of the public policy. Hypotheses 4.4 and 4.5 reflect this distinction.

Research Design

As an evolutionary model, the time scale required for “before and after” experimental testing is unmanageable from a research perspective. In its place, I have developed a computer simulation involving individual agents with particular heritable traits engaged in the play of Ultimatum as their sole source of resources for survival and reproduction. The agents are part of a society which includes or excludes incentives and disincentives as institutional features of the governance of the society. In some variants of the model, the organization of governance in society includes the possibility to enforce incentives for socially acceptable behavior, and in other variants of the model, the

² Some of the sample sizes of some of the societies were as low as one participant (Henrich *et al* 2001, 74).

organization of governance includes the ability to enforce disincentives for socially unacceptable behavior. This simulation can be used to theoretically consider the proposed model of the policy process, and for experimentation.

The simulation uses the method of agent-based modeling (ABM). Agent-based modeling is a method to represent complex systems and evolutionary dynamics in a formal mathematical model (Grimm and Railsback 2005; Miller and Page 2007). The technique can be utilized to simulate the evolution of characteristics of an ecological environment or social system. As a type of formal modeling, it is not empirical. While the output of an ABM can be statistically analyzed, it should not be interpreted in the same way as the collection of data from the field or lab. It is a theoretical exercise, and yet, in some instances, ABM's may provide genuine value in helping to understand the complex nature of a system. They are also effective at helping to pinpoint flaws in theoretical constructs. In this case, an ABM can be an effective tool because of the difficulty in measuring the evolution of human behavior and because the policy process resembles a complex system. The real value of an ABM for this project is that ABM techniques allow experimentation with the policy process that could not be conducted in the real world for both practical and ethical considerations.

Stochasticity is an important part of agent modeling. Random variables are utilized to inject a degree of chaos into the model. Much like real life, individual agents may be unlucky despite a high level of adaptation to their environment. This means that multiple runs of any particular model are necessary when using agent modeling. The results of the various runs are then analyzed statistically to understand what can be deduced from the model across all of the sample runs. The statistical analysis removes

the stochastic variance introduced in individual runs, and allows the examination of any systematic trends arising from the complex interaction between elements of the system.

The agents in the model play the Ultimatum game and have characteristics that evolve. For example, individual agents have preferences for the threshold between fair and unfair offers when acting as the second player in Ultimatum. These individual criteria are aggregated (when necessary) in order to establish public policy for the society at that time. Some variants of the model implement incentives and/or disincentives while other variants of the model do not. This allows for experimental comparison between those models with incentives, disincentives, both or none. In addition, the individual second player's fairness threshold is handled differently when it is considered to be predisposed. In the model variants without predispositions, individual agents have a fairness threshold value, and in model variants with predispositions, individual agents make a random draw from an individual predisposed probability distribution to arrive at a fairness threshold for that draw. Therefore, for those variants of the model where agents do not have predispositions modeled, agents have a hard rule for what is fair and unfair. For those variants of the model where agents have predispositions, each agent makes a draw each turn from their own evolved normal distribution to determine their fairness threshold for this turn. Agent traits that evolve are listed in Table 4.1.

The individual agent traits that evolve are as follows: (1 and 2) a range of values for individual self-interest when acting as the first player in Ultimatum, (3) a preference for the level where fair offers become unfair offers when acting as the second player in Ultimatum, (4) a preference for the size of the bonus when an incentive is applied, (5) a preference for the size of the penalty when a disincentive is applied, and (6) a standard

deviation value to describe the distribution of the individual fairness threshold values when predispositions are in effect. This range of heritable traits allows the agents to both play the game and to have preferences for public policies encouraging others to play the game fairly (or punishing those who play unfairly). It also models a predisposed individual fairness norm in some of the model's variants.

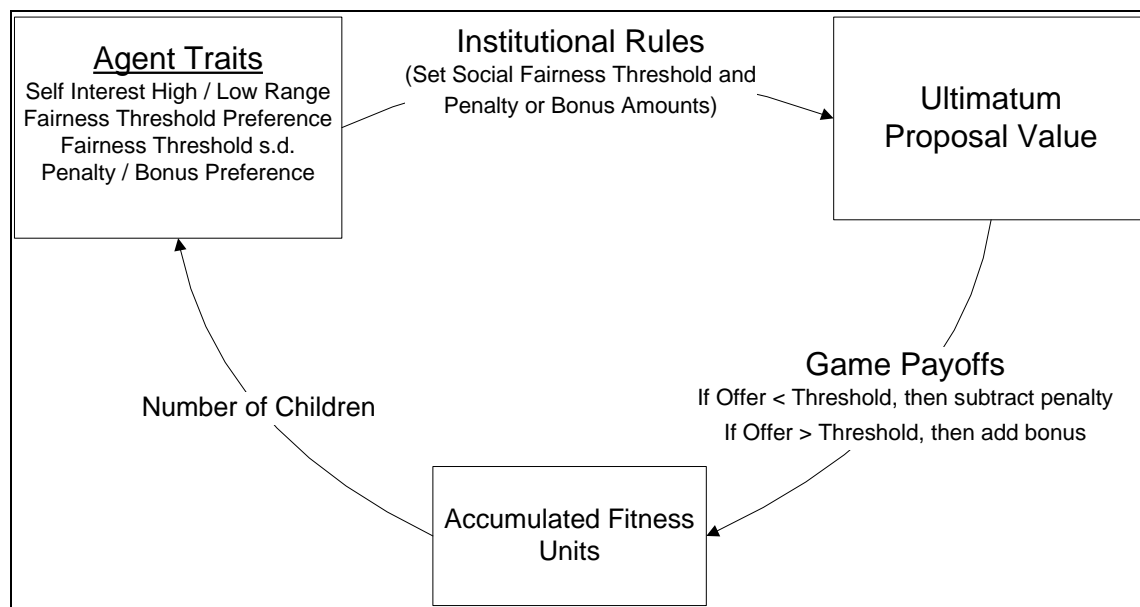
Table 4.1 – List of evolutionary agent traits, their descriptions, and the model variants which implement these traits

| Agent Trait | Without Predispositions | | | | With Predispositions | | | |
|--|--------------------------------|----------------------|-------------------|-------------|-----------------------------|----------------------|-------------------|-------------|
| | None | Disincentives | Incentives | Both | None | Disincentives | Incentives | Both |
| Self Interest High | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| The Self Interest High agent trait is the highest value used in the heuristic to decide how much to offer as the first player in Ultimatum. The heuristic is a random draw from a uniform distribution with a range from the Self Interest High to the Self Interest Low values. | | | | | | | | |
| Self Interest Low | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| The Self Interest Low agent trait is the lowest value used in the heuristic to decide how much to offer when playing as the first player in Ultimatum. The heuristic is a random draw from a uniform distribution with a range from the Self Interest High to the Self Interest Low values. | | | | | | | | |
| Fairness Threshold | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| The Fairness Threshold agent trait is the percent of the pot at which the agent will begin to reject offers when responding as the second player in Ultimatum. For those models without predispositions, the Fairness Threshold is a fixed value. For those models with predispositions, the Fairness Threshold acts as the mean for a normal distribution that each agent has. A random draw from this distribution is made to determine the actual percent of the pot that will be utilized as the criteria for each turn. In these instances, the standard deviation of the individual distributions is also a heritable trait. | | | | | | | | |
| Fairness s.d. | No | No | No | No | Yes | Yes | Yes | Yes |
| The Fairness s.d. agent trait is the standard deviation of the normal distribution that is used for the random draw to determine each agent's second player fairness criteria for model variants with predispositions. In model variants with predispositions, a random draw from a distribution with this trait as its s.d. and a mean with the Fairness Threshold value is done to determine the fairness criteria for this turn. | | | | | | | | |
| Penalty preference | No | Yes | No | Yes | No | Yes | No | Yes |
| The Penalty Preference is the agent trait which indicates the agent's attitude on what percent of the standard pot size should be utilized as a penalty for violating the social fairness threshold. | | | | | | | | |
| Bonus Preference | No | No | Yes | Yes | No | No | Yes | Yes |
| The Bonus Preference is the agent trait which indicates the agent's attitude on what percent of the standard pot size should be utilized as a bonus for making an offer that does not violate the social fairness threshold. | | | | | | | | |

The baseline model is an evolutionary system as illustrated in figure 1. Agents have traits specific to their tasks of 1) playing the Ultimatum Game and 2) participating

in the public decisions about the size of penalties (disincentives) and bonuses (incentives) applied for engaging in unfair or fair offers. The simulation is a direct implementation of the theoretical model described in Chapter 2 of this dissertation.

Figure 4.1 – The Evolutionary Model



The agents are part of a community of living agents that has the ability to govern itself through the setting of two policies related to the fairness norm. First, what should the social threshold be where an offer made by an individual is so low as to be considered socially unfair or unjust? Second, for those individuals who make offers in the Ultimatum Game that are unfair, what size should their penalty be (or bonus when playing fairly)? Individual agents have policy preferences that when aggregated affect the outcome of their games and the outcomes of others playing by the same rules. Aggregation is represented by the mean value of the characteristics of all living agents. Once aggregated, these social policies directly affect the distribution of resources among the agents.

Time in an ABM is usually broken into discrete turns. Each turn, each agent plays the Ultimatum Game as the first player (who makes an offer) with 20 fitness units to divide. Their opponent in the game is some other randomly selected agent. Thus, the connections between the agents form a random network (Siegel 2009).

The first player must play each turn and make an offer based upon their own self-interest preference. This preference is a random number from a uniform distribution with a range from the agent's low to high self-interest traits. The individual self interest range acts as a satisficing heuristic for the individual (Simon 1957; Lau 2003). In order to satisfy the heuristic rule, the individual makes a random draw, and if that value falls within the heuristic range, then it is accepted. If not, then the individual draws again and again until a solution that satisfies the heuristic rule of the individual is discovered. In the simulation as it is implemented, a random draw is made which falls between the self-interest heuristic range of the individual. Essentially, this means that the multiple draws are condensed into a single draw within the heuristic range. This represents the individual as behaving using semiautomatic rules for decision-making as suggested by Lau (2003, 48). In addition, it creates the condition where agents do not play a specific strategy during every single turn. If their individual range allows them to exceed the social fairness threshold some percentage of the time, then they can "cheat" at a rate that will approach a local optimality over evolutionary time.

Player 2's response in the Ultimatum game is dictated in part by their own individual fairness threshold. When no predisposition is modeled, then the individual fairness threshold is a fixed trait which acts as a form of individual criteria for judging the response to Player 1. If Player 1's offer is sufficiently low and exceeds the individual

fairness threshold, then Player 2 will reject. The individual fairness threshold is also used to set the social fairness threshold which determines when incentives and disincentives kick in.

The fairness threshold is handled differently when predispositions are in effect. When predispositions are modeled, each time the individual fairness threshold is needed, it will be randomly drawn from a normal distribution with a mean of the individual fairness threshold (which is heritable), and the standard deviation trait of the individual (also heritable). This standard deviation trait will only be utilized when predispositions are modeled. Predispositions are therefore modeled as a heuristic where a random draw is made from a heritable normal distribution. A random draw from each agent's normal distribution occurs each time the agent plays as the second player in Ultimatum.

In some model variants, incentives are provided for those whose offers (as Player 1) are less than the social fairness threshold in some model variants. In other model variants, disincentives are provided for those whose offers are greater than or equal to the social fairness threshold. The agents themselves can set the fairness threshold and the bonus (or penalty) amounts for each turn based upon their aggregated policy preferences. However, the application of either incentives, disincentives or both is experimentally controlled. In some variants of the model, agents have access to incentives only, disincentives only, both, or neither. Despite this, agents in a variant that models incentives or disincentives have the power within the simulation to essentially "turn off" the incentive / disincentive system by evolving preferences approaching zero for the amounts of the bonuses and/or penalties.

Each turn consists of each living agent making an offer as the first player in an Ultimatum Game once. Each turn, each agent also pays a 6 fitness unit “energy tax” simply for existing. This is realistic because organisms use energy on a regular basis simply for existence. Thus, agents who cannot average at least a 6 unit payoff per turn will eventually die. As they are dividing 20 units each turn between the two of them when playing as the first player, it should not be difficult for agents suited to the environment to maintain a 6 unit average payoff over time. Further, each agent has the possibility to play again during a turn if they are randomly selected to be some other agent’s transaction partner.

After the last living agent has played as the first player, the possibility for reproduction opens up. This step of an evolutionary system is known as the replicator dynamic (Nowak 2006). In this case, the dynamic breaks the agents into quartiles and each quartile has a different probability of reproducing. Those in the top quartile of accumulated fitness units have the highest chance of reproducing and those in the bottom quartile have the lowest chance of reproducing. Children of the agents have traits set by taking a random draw from a normal distribution where the mean of the distribution is the parent’s trait. The standard deviation of this normal distribution represents the degree to which phenotypic mutation occurs. This differential rate of growth in population size of individuals with different traits makes this model an evolutionary model.

Following reproduction, agents have the opportunity to die. Agents die when one of two conditions occurs. First, any agent that is older than one hundred turns dies. Second, any agent whose accumulated fitness is zero or less at the end of the turn also

dies. Table 4.2 summarizes the specific equations that define how each step of the evolutionary process proceeds.

Table 4.2 – Equations of the Evolutionary Model

| <i>Step</i> | <i>Equation(s)</i> |
|-----------------------------------|---|
| Offer Value by Player 1 | <ol style="list-style-type: none"> 1. Proposal Value = $20 * (0.9 * (1 - \text{Self Interest of the Proposing Agent}) + 0.1 * (\text{Random}))$ <ul style="list-style-type: none"> • Pot Size = 20 units • Percent of the Decision that is Random = 0.1 • Percent of the Decision that is Self Interest = 0.9 |
| Response to the offer by Player 2 | <ol style="list-style-type: none"> 1. Offer Percent = Player 1's Offer / Pot Size 2. If Offer Percent \geq Player 2's Fairness Threshold, then Accept Offer 3. If Offer Percent $<$ Player 2's Fairness Threshold, then Reject Offer <ul style="list-style-type: none"> • When predispositions are modeled, the Fairness Threshold is a random draw from a normal distribution |
| Individual Payoffs | <ol style="list-style-type: none"> 1. If Offer is accepted by Player 2: <ol style="list-style-type: none"> a. Player 1 Payoff = $20 - \text{Proposal Value} + \text{Incentive Bonus} - \text{Disincentive Penalty} - \text{Energy Spent in each turn (6 units)}$ b. Player 2 Payoff = Proposal Value 2. If Offer is rejected by Player 2: <ol style="list-style-type: none"> a. Player 1 Payoff = $0 - \text{Energy spent in each turn (6 units)}$ b. Player 2 Payoff = 0 |
| Replicator Dynamic | Chance of Having Children each turn (C): <ol style="list-style-type: none"> 1. Top Quartile of total accumulated fitness units: $C = 0.0175$ 2. Second Quartile: $C = 0.0125$ 3. Third Quartile: $C = 0.0075$ 4. Bottom Quartile: $C = 0.0025$ |
| Child Traits | Child Agent Trait = Random draw from a normal distribution with mean of parent's value and standard deviation of 0.2 Traits can range in value from 0.0 to 1.0 |
| Agent Death | An agent dies when one of the following conditions applies: <ul style="list-style-type: none"> • An agent exceeds 100 turns in age • An agent's accumulated fitness units ≤ 0 |
| Social Rules | <ol style="list-style-type: none"> 1. Social Fairness Threshold = Mean of All Agents' Fairness Thresholds 2. Social Incentive Bonus = Mean of all Agents' Incentive Bonus 3. Social Disincentive Penalty = Mean of all Agents' Disincentives Penalties |

Results

As illustrated in Tables 4.3 and 4.4, the model was run 460 times with the parameters set as stated in Table 4.4. These runs were distributed across different experimental conditions (or model variants). The experimental conditions test the different effects of incentives and disincentives as policies. One important contrast is between the “None” condition and the others. This control group essentially models what agents would do without any public policies (incentives or disincentives) as a mechanism

encouraging compliance. Additionally, as a test, the agents in one variant of the model had agents initially seeded with a high fairness criteria trait rather than the normal trait which reflected human beings' fairness threshold of approximately 25% of the pot (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006).

Table 4.3 – Experimental Variants of the Theoretical Model

| <i>Number</i> | <i>Condition / Model Variant</i> | <i>Predispositions?</i> | <i>Number of Runs</i> |
|---------------|---|-------------------------|-----------------------|
| 1 | High Fairness Criteria Seeding | No | 51 |
| 2 | None | No | 51 |
| 3 | Disincentives | No | 52 |
| 4 | Incentives | No | 51 |
| 5 | Both Incentives and Disincentives | No | 51 |
| 6 | None with Predisposition | Yes | 51 |
| 7 | Disincentives with Predisposition | Yes | 51 |
| 8 | Incentives with Predisposition | Yes | 51 |
| 9 | Both Incentives and Disincentives with Predisposition | Yes | 51 |

Table 4.4 – Initial Parameters for the runs of the model variants

| <i>Parameter</i> | <i>Initial Seeded Value</i> |
|--|--|
| Maximum Running Length | 20,000 turns |
| Maximum Number of Agents | 20,000 agents |
| Birth Rate - Top Quartile | 0.0175 |
| Birth Rate - 2 nd Quartile | 0.0125 |
| Birth Rate - 3 rd Quartile | 0.0075 |
| Birth Rate - Bottom Quartile | 0.0025 |
| Random factor for 1 st player offer | 10% |
| Self Interest factor for 1 st player offer | 90% |
| Initial number of agents | 500 agents |
| Pot size | 20 units |
| Minimum offer | 1 unit |
| Death in turns | 100 turns |
| Cost for player 1 to accept | 6 units |
| Starting wealth for each agent | 25 units |
| Standard Deviation of normal distribution about parent's mean for initial child traits | Most traits = 0.20 Penalty and Bonus Preference Traits = 0.10 |
| <i>Agent Traits</i> | |
| Initially seeded self interest high mean | 0.60 |
| Initially seeded self interest high s.d. | 0.10 |
| Initially seeded self interest low mean | 0.40 |
| Initially seeded self interest low s.d. | 0.10 |
| Initially seeded fairness criteria mean | Model variant 1 = 0.75 All other model variants = 0.25 |
| Initially seeded fairness criteria s.d. | 0.10 |
| Initially seeded penalty preference mean | 0.05 |
| Initially seeded penalty preference s.d. | 0.025 |
| Initially seeded bonus preference mean | 0.05 |
| Initially seeded bonus preference s.d. | 0.025 |

Descriptive Summary

The agents at the beginning of each simulation run were seeded according to the parameters stated in Table 4.4. Tables 4.5 and 4.6 represent the characteristics of the final 200 agents born during each run (summarized by model variant). In other words, Table 4.4 illustrates the state before evolutionary adaptation to the particular institutional environment, and Tables 4.5 and 4.6 illustrate the state after evolutionary adaptation to the particular institutional environment. These values are presented here primarily to provide an overview. The details will be discussed with respect to each of the specific hypotheses. All heritable agent trait values have a theoretical range from 0.0 to 1.0.

Table 4.5 – Mean values of evolved agent traits for those model variants without predispositions

| <i>Model Variant</i> | <i>n</i> | <i>Self Interest High</i> | <i>Self Interest Low</i> | <i>Mean Self Interest</i> | <i>Fairness Threshold Criteria</i> | <i>Bonus Amount Preference</i> | <i>Penalty Amount Preference</i> |
|----------------------|----------|---------------------------|--------------------------|---------------------------|------------------------------------|--------------------------------|----------------------------------|
| None | 10200 | 0.717 | 0.379 | 0.548 | 0.246 | * | * |
| Disincentives | 10400 | 0.650 | 0.274 | 0.462 | 0.255 | * | 0.501 |
| Incentives | 10200 | 0.573 | 0.232 | 0.402 | 0.302 | 0.480 | * |
| Both | 10200 | 0.511 | 0.192 | 0.352 | 0.309 | 0.489 | 0.484 |

Note: With the exception of N, all values represent the mean trait value of the last 200 agents born in each of the 51 runs. (Because of an execution error, Disincentives had 52 runs.)
* Not utilized for this model variant.

Table 4.6 – Mean values of evolved agent traits for those model variants with predispositions

| <i>Model Variant</i> | <i>n</i> | <i>Self Interest High</i> | <i>Self Interest Low</i> | <i>Mean Self Interest</i> | <i>Fairness Threshold Criteria</i> | <i>Fairness Threshold s.d.</i> | <i>Bonus Amount Preference</i> | <i>Penalty Amount Preference</i> |
|----------------------|----------|---------------------------|--------------------------|---------------------------|------------------------------------|--------------------------------|--------------------------------|----------------------------------|
| None | 10200 | 0.725 | 0.394 | 0.560 | 0.254 | 0.380 | * | * |
| Disincentives | 10200 | 0.640 | 0.268 | 0.454 | 0.250 | 0.359 | * | 0.499 |
| Incentives | 10200 | 0.569 | 0.229 | 0.399 | 0.324 | 0.424 | 0.485 | * |
| Both | 10200 | 0.503 | 0.185 | 0.344 | 0.319 | 0.425 | 0.488 | 0.495 |

Note: With the exception of N, all values represent the mean trait value of the last 200 agents born in each of the 51 runs.
* Not utilized for this model variant.

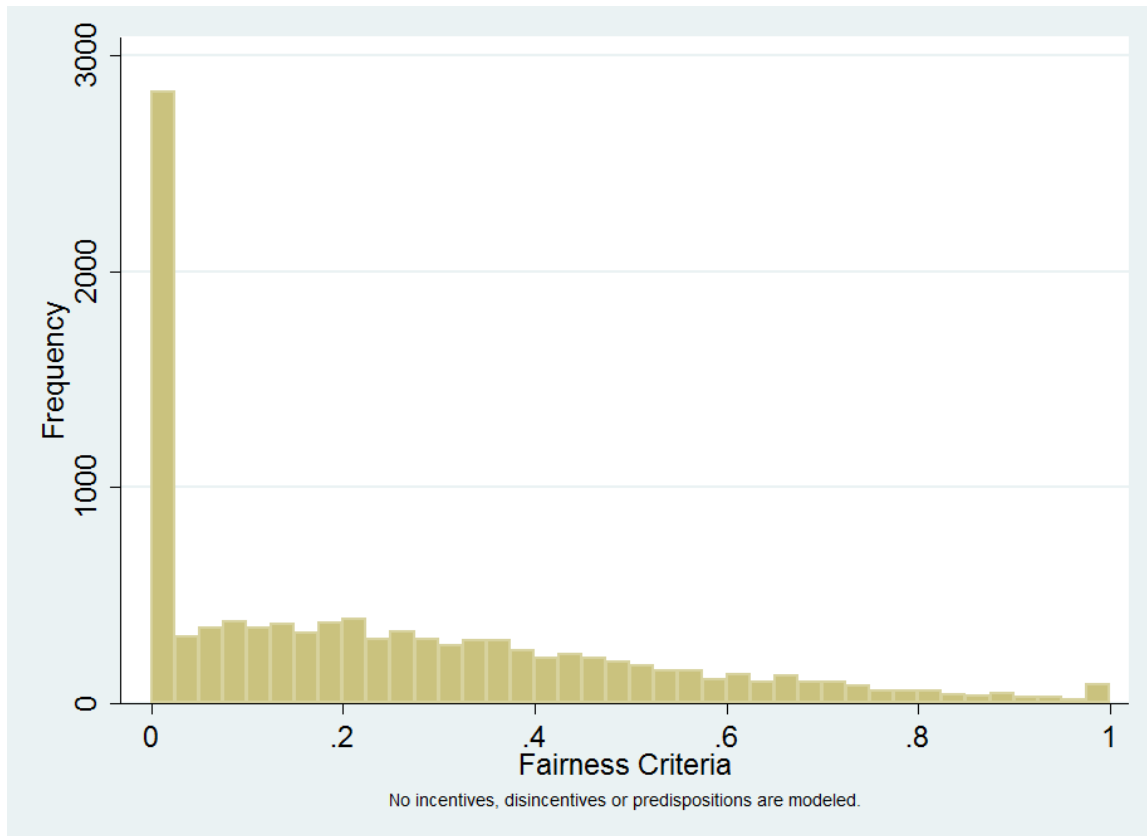
The Fairness Threshold and the External Validity of the Model

Hypothesis 4.3 acts as a test of the external validity of the decision-making heuristics of the model. Do the agents evolve to have similar criteria to human beings for what is and isn't fair when playing the Ultimatum game?

Remember that prior research suggests that rejection begins to occur by the second player in the Ultimatum game usually when the offer from the first player reaches approximately 20%-30% of the pot (Güth and Tietz 1990; Sanfey *et al* 2003; Knoch *et al* 2006). Figure 4.2 is a histogram showing the distribution of fairness criteria for the model variant without any incentives, disincentives or predispositions (the None variant). The fairness criteria agent trait represents the percentage of the pot above which the agent will accept, and below which the agent will reject. It is also the preference of the individual agent that is aggregated to form the social criteria for incentives and disincentives in those model variants which have them.

It is quite obvious from examination of Figure 4.2 that this trait is not normally distributed in the population of agents. This is confirmed with a Shapiro-Wilk test ($W=0.953^{***}$; $p=0.000$). One obvious deviation from normality is the large quantity of items residing at the minimum range. A zero or near zero value for the fairness criteria can be interpreted as accepting nearly any offer from the first player. In other words, these agents have entirely turned off any criteria for the offers from the first player. In fact, 2,487 of the 10,000 evolved agents in this model variant turned off their fairness criteria entirely and were indifferent to the offers made from the first player. This strategy is clearly consistent with the Nash equilibrium for the Ultimatum game which suggests that any positive offer be accepted by the second player. By playing the Nash equilibrium solution for Ultimatum, these agents are behaving rationally in the classic sense.

Figure 4.2 – Histogram of the Fairness Criteria for the model variant without incentives, disincentives or predispositions modeled



However, 75% of the players are not playing rationally. The characteristics of the 25% of the players that are playing the Nash equilibrium are similar to the characteristics of the other 75% who are not. This comparison is demonstrated in Table 4.7.

Table 4.7 – Characteristics of Agents with Fairness Criteria = 0.0 in the “None” model variant

| <i>Trait</i> | <i>Fairness Criteria = 0.0</i> | <i>Fairness Criteria > 0.0</i> | <i>All Agents</i> |
|--------------------|--------------------------------|-----------------------------------|-------------------|
| Self Interest High | 0.711 | 0.719 | 0.717 |
| Self Interest Low | 0.372 | 0.381 | 0.379 |
| Self Interest Mean | 0.541 | 0.550 | 0.548 |
| Fairness Criteria | 0.000 | 0.326 | 0.246 |
| n | 2487 | 7713 | 10200 |

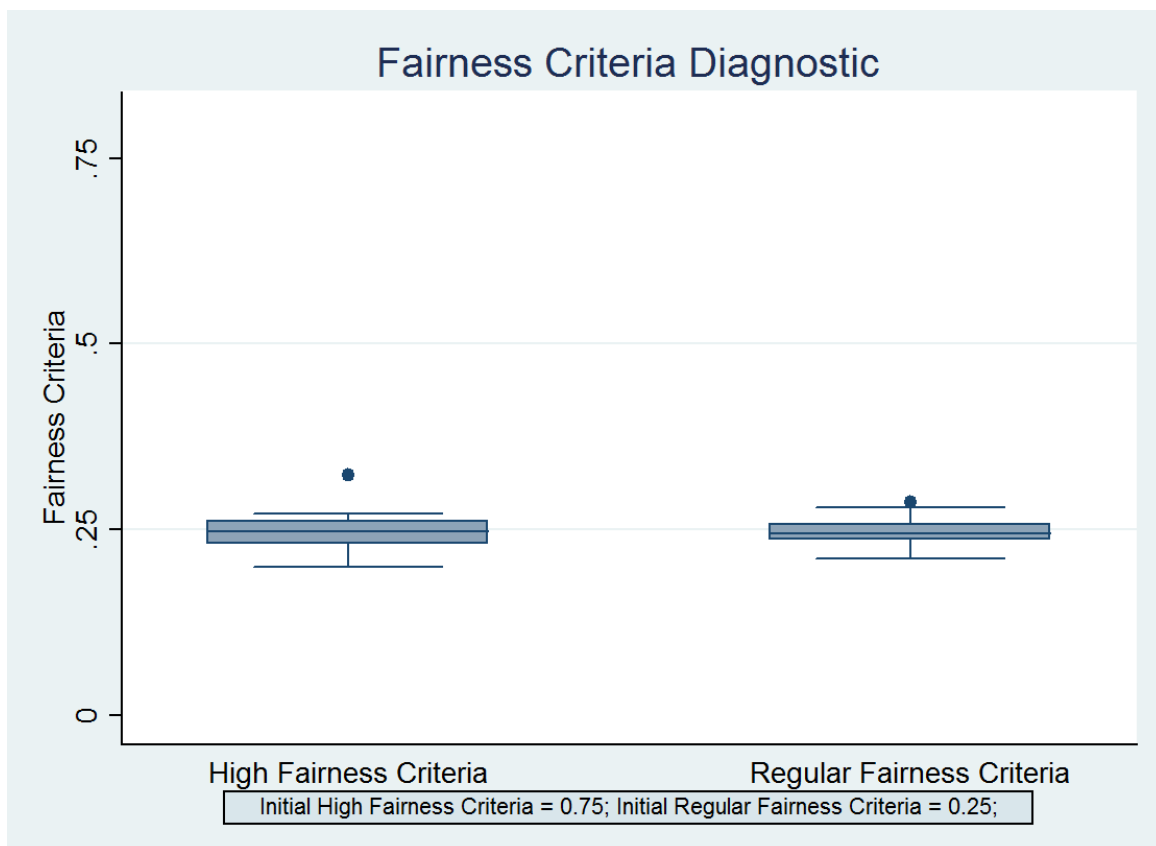
Note: Statistics are from the model variant where no incentives, disincentives, or predispositions are modeled.

Despite being non-normal and having so many agents with near zero fairness criteria traits, the fairness criteria mean for this model variant is still 0.246. This is

remarkably close to both the typical mean for human beings playing Ultimatum and also to the initially seeded value of 0.25. Therefore, the question is, did agents really evolve to have this mean, or did it simply remain static over the course of the simulation?

Figure 4.3 demonstrates a diagnostic to assure that the model is not sensitive to varying levels of the fairness threshold. It compares the evolved levels of the fairness threshold for two states. The first state was initially seeded with agents having high levels of the fairness criteria (75% of the pot). The other state was seeded with agents who had a fairness criteria mean of 25% of the pot. Following the evolutionary process, both models settle to equilibrium at approximately 25% of the pot.

Figure 4.3 – High Fairness Criteria Diagnostic



These ridiculously close mean results are demonstrated to not be significantly different in Table 4.8. This implies that the agents did evolve to an equilibrium point at an approximate mean of 0.246 regardless of whether the high or normal initial conditions were in effect.

Table 4.8 – Comparison of High Initial Fairness Seeding to Normal Initial Fairness Seeding

| | Mean Evolved Fairness Criteria | t | Ha: Diff < 0 Pr(T<t) | Ha: Diff != 0 Pr(T > t) | Ha: Diff > 0 Pr(T>t) |
|---|--------------------------------|---------|-------------------------|--------------------------------|-------------------------|
| High Initial Fairness Criteria (0.75) | 0.2462046 | -0.0528 | 0.4789 | 0.9579 | 0.5211 |
| Normal Initial Fairness Criteria (0.25) | 0.2463863 | | | | |
| * < 0.01; | | | | | |

In fact, all of the model variants had agent traits evolve to between 24% and 31% of the pot. It is reasonable to assert that these values are similar to the approximate point where human beings begin to reject in Ultimatum. This provides some element of external validity to the overall model.

A brief bit of speculation on why the model works at this point is merited. I believe that one of two possibilities have led to the similar results. First, it is possible that the heuristic used to implement the agents mimics similar heuristics utilized by human beings. The agents receive an offer from the first player that varies randomly within a heuristic range. Human beings may have an emotion heuristic that says, “fire an emotional response when you encounter unfair situations, and 25% of the pot in Ultimatum is when to start.” There is some reason to believe, though, that 25% is not a predisposed value. Henrich *et al* (2001) found differences in how Ultimatum is played in societies with different norms. However, Wallace *et al* (2007) found a correlation on this threshold between monozygotic twins (identical), but not dizygotic twins (fraternal). It seems as if sometimes norms play a role and that other times predispositions play a role.

My suspicion is that the environmental context that triggers the predisposed version of the response in human beings is not fully understood at this point.

Given what is known about human neurology, the specific heuristics at work are likely to be not exactly the same in the agents as they are in human beings. Therefore, if this is not how the heuristic in human beings works, then it is possible that the agents and human beings arrived at similar strategies through different underlying mechanisms. In this case, the context is particularly important. The first player in the agent model can be always selfish, always altruistic or sometimes selfish and sometimes altruistic in varying degrees based upon how it has evolved. This is because the percentage of the pot that constitutes the offer from the first player is a random draw between two evolved values (self interest high and self interest low). The agents, on average, evolved to have the self interest high value on the more selfish side of the equation, and the self interest low side on the more altruistic side of the equation. This means that during any given turn, an agent acting as the first player has the possibility of offering a selfish or generous offer. Therefore, even if the second player is evaluating offers from the exact same first player every turn, they can still receive either an even split, an altruistic offer, or a selfish offer from the first player on subsequent turns. This context for the second player's decision is likely similar to the context that human beings encounter because human beings rarely encounter individuals who are always sharing, always giving, or always taking in their interactions. Rather, individual human beings likely share sometimes, give sometimes and take sometimes. The difference in strategies for human individuals is in the relative proportion of time that they are engaged in each behavior. If this individual variation is similar to the environmental context created in the model, then both the agents' evolution

and human evolution have led to an implementation of a strategy which has 75% of individuals engaged in some level of altruistic punishment and 25% who accept any positive offer. The evolved strategy also includes a mean fairness criteria of approximately 25% of the pot before rejection starts to occur (typically). Perhaps this is an optimal distribution of strategies in the group for engaging the context where some individuals are selfish one day and altruistic the next.

There also may be a biological explanation for the first player's variation in strategy. If human beings are attempting to maintain some measure of homeostasis, then it would make sense that some days would need to be selfish days with regard to energy intake and other days would be selfless days. This variation could be providing the context that leads to the evolution of fairness criteria.

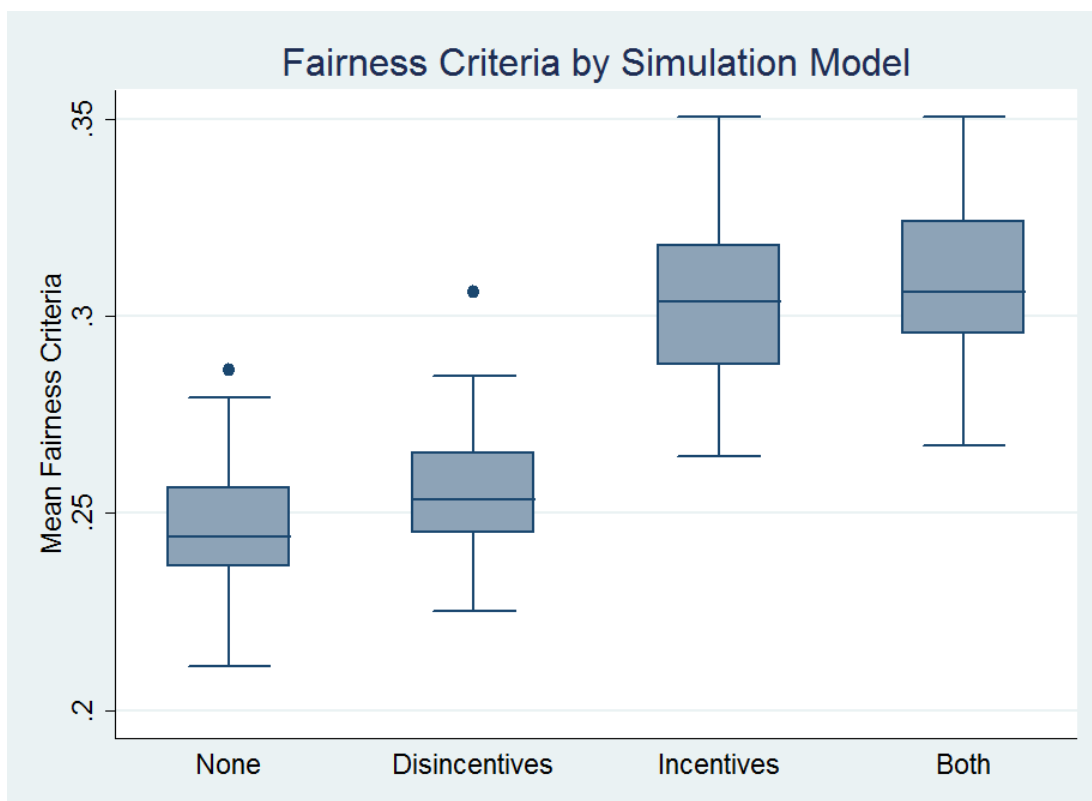
Regardless of this speculation on the heuristics at work, there were experimental differences amongst the model variants. Some of the model variants did reach slightly different mean levels of the fairness criterion. The model variants differed in that each modeled incentives, disincentives and predispositions differently. Therefore, mean differences amongst these variants may say something about how fairness criteria might evolve in differing institutional conditions. The differences for those model variants without predispositions are provided in Table 4.9. It should be noted that while there are significant differences in the means, the magnitude of these differences are relatively small.

Table 4.9 – Comparison of variants of the model by the mean evolved fairness criteria

| | | | | |
|--|--------------------------------|--------------------------------|-----------------|-----------------------------|
| ANOVA on evolved agent fairness criteria by model | n = 92000 | F = 163.66 | Prob>F = 0.0000 | Adj R ² = 0.0139 |
| | Mean Evolved Fairness Criteria | Mean Evolved Fairness Criteria | Difference | Tukey HSD Test |
| None vs. Disincentives | 0.2464 | 0.2554 | 0.0090 | 3.384 |
| None vs. Incentives | 0.2464 | 0.3021 | 0.0557 | 21.036** |
| None vs. Both | 0.2464 | 0.3088 | 0.0624 | 23.568** |
| Disincentives vs. Incentives | 0.2554 | 0.3021 | 0.0468 | 17.653** |
| Disincentives vs. Both | 0.2554 | 0.3088 | 0.0535 | 20.185** |
| Incentives vs. Both | 0.3021 | 0.3088 | 0.0067 | 2.532 |
| Note: Only comparisons without predispositions have been included in the list of Tukey values. All of the variants of the model have been included in the ANOVA. | | | | |
| ** <0.01, Studentized Range Critical Value (0.01, 9, 91991) = 5.0776 | | | | |

What is particularly interesting about these results is what is presented in Figure 4.4. Figure 4.4 shows that the means for model variants differed based upon the inclusion of incentives. The means for the “Incentives” and “Both” model variants were closer to the 0.30 level than the means in the “None” or “Disincentives” model variants. This implies that the inclusion of incentives in the model increased the willingness for agents to altruistically punish those other agents who were more selfish in their offers.

Figure 4.4 – Differences in Fairness Criteria traits for evolved agents without predispositions



One explanation for the effect of incentives on the evolved behavior is that the additional benefit that arises from receiving incentives can offset any additional cost incurred from punishing non-cooperators (Rand *et al* 2009). In other words, the behavior of altruistic punishment may have evolved in the context of a society which provided enough resources for the costs of punishment to be offset. This is speculative, but if it were so, then it would mean that the organization of society preceded the evolution of the altruistic punishment behavior because the institutional environment to offset the costs would be necessary to allow the adaptation of the behavior.

What is demonstrated by the results concerning the fairness criteria is (1) the model seems to have some element of external validity in its comparison to human beings, and (2) the inclusion of policy systems that allow incentives seem to have an effect on the optimal fairness evaluation criteria. Hypothesis 4.3 is partly supported

because the means of the fairness criteria in the various models are approximately 25% of the pot. However, the distribution about the mean is definitely not normal.

Policy and Cooperation

Hypothesis 4.1 asserts that it is disincentives as an institutional structure that will create the environment for encouraging the most cooperativeness amongst the agents. However, the results, as can be seen in Table 4.10 and Figure 4.5, indicate that it is incentives rather than disincentives that lead to significantly lower mean levels of self interest. The magnitude of the difference between the Incentives model variant and the Disincentives model variant is relatively small at 0.06, but this does disconfirm the hypothesis.

Table 4.10 – Comparison of variants of the model by the evolved mean self interest

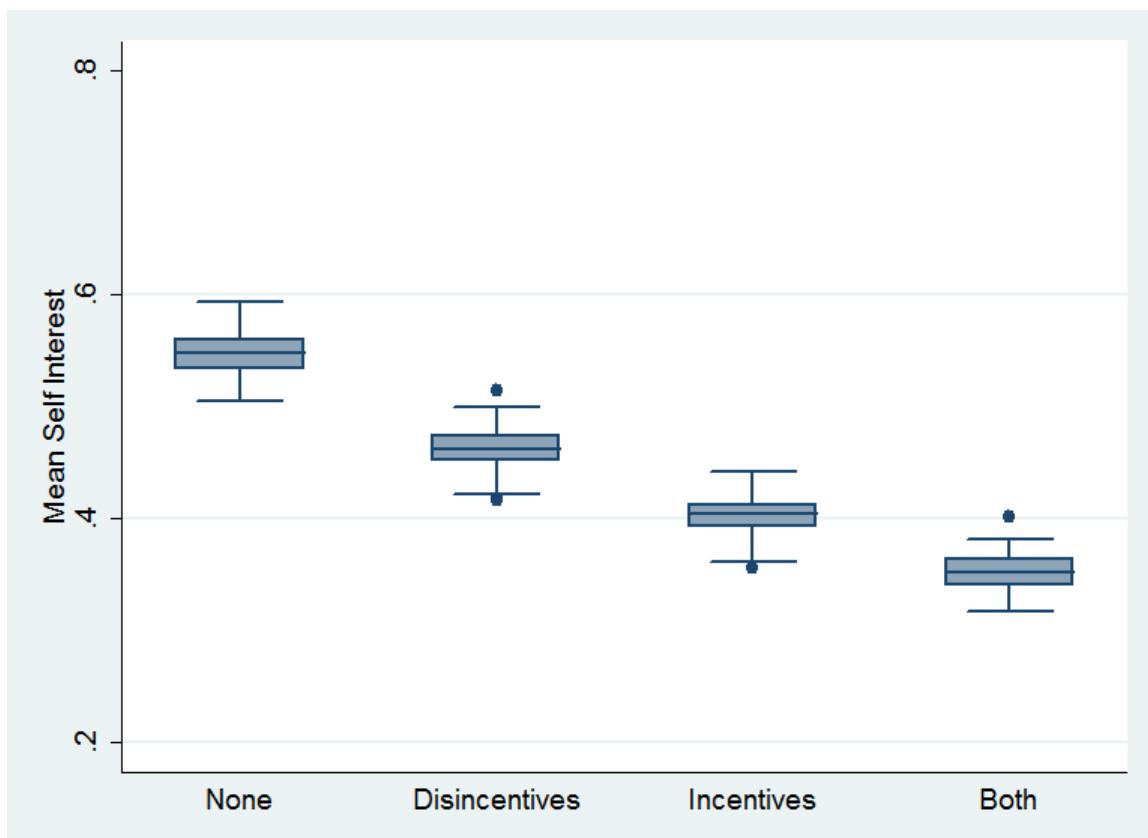
| ANOVA on evolved agent mean self interest by model | n = 92000 | F = 1377.64 | Prob>F = 0.0000 | Adj R ² = 0.1069 |
|--|----------------------------|----------------------------|-----------------|-----------------------------|
| | Evolved Mean Self Interest | Evolved Mean Self Interest | Difference | Tukey HSD Test |
| None vs. Disincentives | 0.5479 | 0.4625 | 0.0854 | 37.7044** |
| None vs. Incentives | 0.5479 | 0.4023 | 0.1455 | 64.2440** |
| None vs. Both | 0.5479 | 0.3518 | 0.1961 | 86.5790** |
| Disincentives vs. Incentives | 0.4625 | 0.4023 | 0.0601 | 26.5396** |
| Disincentives vs. Both | 0.4625 | 0.3518 | 0.1107 | 48.8745** |
| Incentives vs. Both | 0.4023 | 0.3518 | 0.0506 | 22.3350** |
| Note: Only comparisons without predispositions have been included in the list of Tukey values. All of the variants of the model have been included in the ANOVA. ** <0.01, Studentized Range Critical Value (0.01, 9, 91991) = 5.0776 | | | | |

Despite the absence of evidence for the hypothesis, there are some interesting aspects to the evolution of cooperation in this model. In the Incentives model variant, there is a social incentive when playing as the first player to not violate society's norms regarding what constitutes a fair offer. If the agents are playing cooperatively as the first player and receiving the bonus from this cooperation, then they have the resources to altruistically punish those who violate their personal fairness expectations when playing

as the second player. This puts two types of pressure on selfish agents: social pressure to not miss out on the bonus, and transactional pressure to not be altruistically punished by their second player.

In the Disincentives model variant, cooperative players have a thinner budget to work with when attempting to altruistically punish others who violate their personal norms. This should allow more players over time to become more selfish because they face fewer potential punishers in the population. Further, since the fairness criteria in the disincentives model is slightly lower than in the incentives model, this allows more selfishness amongst the population in the disincentives model variant.

Figure 4.5 – Mean self interest trait values for evolved agents in models without predispositions



Another interesting result regarding cooperativeness is that when both incentives and disincentives were available for the agents to reign in non-cooperators, they did have

an additive effect on the overall evolved self-interest of the agents. The magnitude of the difference between the None and Both model variants is the greatest difference of any of the model variants (difference = 0.1961). Further, the model variant without incentives or disincentives led to agents that were slightly more selfish than cooperative (mean self interest = 0.5479).

Policy and Evolutionary Success

Hypothesis 4.2 examines which institutional forms of policy have the greatest impact on the long term evolutionary success of the society. This hypothesis asserts that it is incentives that will have the greater impact on the long term population. This hypothesis is confirmed as demonstrated in the results presented in Table 11.

Table 4.11 – Mean population and time at the end of each run of each variant

| <i>Model Variant</i> | <i>Last Turn Population Mean (agents)</i> | <i>Last Turn Time Mean (turns)</i> | <i>Ratio (agents / turns)</i> | <i>Number of Runs</i> |
|-------------------------|--|--|-----------------------------------|-----------------------|
| Without Predispositions | | | | |
| None | 19,983.88 | 6,829.21 | 2.9262 | 51 |
| Disincentives | 19,852.73 | 14,129.95 | 1.4050 | 52 |
| Incentives | 19,982.45 | 5,203.66 | 3.8401 | 51 |
| Both | 19,980.88 | 6,099.05 | 3.2761 | 51 |
| With Predispositions | | | | |
| None | 19,982.18 | 7790.39 | 2.5650 | 51 |
| Disincentives | 11,254.75 | 19,994.58 | 0.5629 | 51 |
| Incentives | 19,983.88 | 5,195.40 | 3.8465 | 51 |
| Both | 19,981.29 | 6399.41 | 3.1224 | 51 |

The simulation had two stopping points. A run of the simulation would end if either of the following conditions were met: (1) it would stop if the current living population of agents reached 20,000 in a particular run, or (2) it would stop if the number of total turns in the run reached 20,000. Given the standard parameters utilized for all of the simulations, most of the runs reached the population of 20,000 before reaching 20,000 turns. The exception to this was the Disincentives model variant with predispositions enabled. Many runs of this model ended because the number of turns reached twenty

thousand. Table 4.11 presents the average population mean and the average time to get to that mean. It also presents the ratio of average agents at the end of the simulation to the average number of turns needed to reach that population. This ratio reflects the average growth rate of runs in that particular model variant. It is this ratio that is a test of hypothesis 4.2.

The highest values for this ratio occurred when only Incentives were applied. In fact, when both disincentives and incentives are in effect, the average ratio was lower than when only incentives were in effect. This confirms hypothesis 4.2 that incentives play a more important role in the long term population success of the agent societies. This result is likely for the same reason that Rand *et al* (2009) suggest in their lab experiment; that incentives increase the average payout to each individual and disincentives reduce the average payout.

Predispositions

Hypotheses 4.4 and 4.5 address the content of the policies and the difference between a predisposed agent and a non-predisposed agent. The content of policies is essentially what percentage of the pot would be added or subtracted as either a bonus or a penalty. The agents have a heritable preference for these amounts and, therefore, this amount should adapt to the institutional environment. Unfortunately, the content of the policies (the bonus preference and penalty preference) seem to become randomly distributed once evolution to equilibrium occurs. In fact, the agents are initially seeded with a 5% bonus and penalty preference. At the end of the simulation, the mean is almost always extremely close to 50%, and the distribution is generally uniform (with the exception of the boundaries). This means that there is nothing about the environment

against which the agents would be selected for regarding these traits. These distributions can be seen in Figure 4.6 and Figure 4.7.

Figure 4.6 – Histograms of the preferences for the amount of disincentives amongst evolved agents in variants of the model which included disincentives

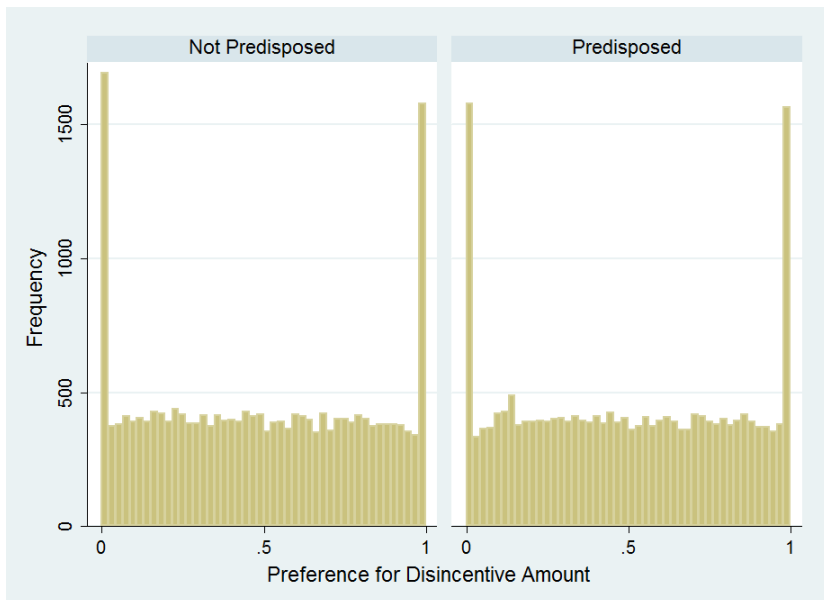
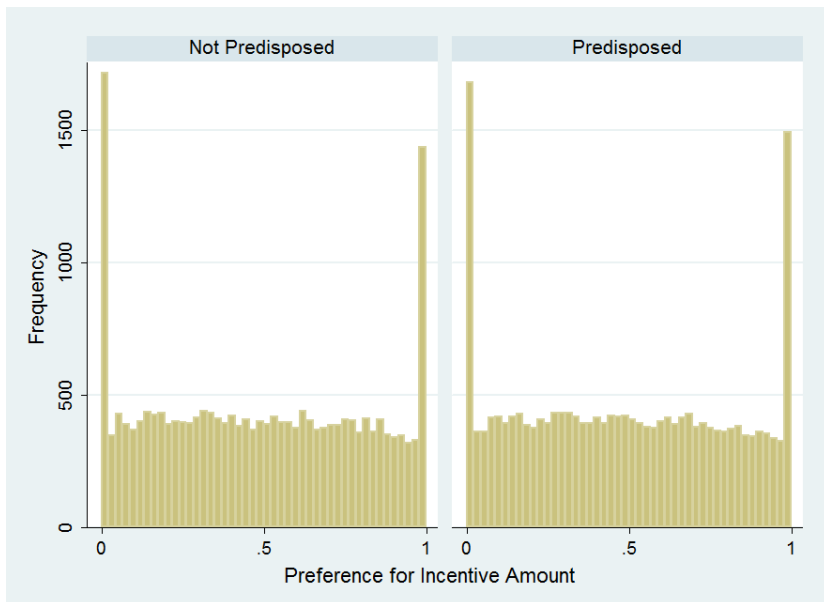


Figure 4.7 – Histograms of the preferences for the amount of incentives applied amongst evolved agents in variants of the model which included incentives



Unfortunately, since the preferences for incentives and disincentives seem to become randomly distributed in the population after evolution in this model, no real

comparison between predispositions and non-predispositions can be made. In fact, the models with and without predispositions modeled were very similar to one another (see Table 4.4 and Table 4.5 for a comparison of other traits). This implies that the algorithms utilized to model a predisposition were essentially synonymous with the algorithms utilized to model the non-predisposed state. In other words, the introduction of a normally distributed random element to the application of the fairness criteria did not substantively affect the evolution of the agent traits. Therefore, there were no differences between predisposed and non-predisposed agents in their play and hypotheses 4.4 and 4.5 cannot be evaluated with the algorithms utilized in the model.

Conclusion

Overall, this theoretical model suggests that more attention should be paid to incentives. The application of incentives by the state seems to lead to two socially desirable outcomes: higher levels of cooperativeness in the population, and faster population growth / efficiency. This result to some degree stands in contrast to prospect theory (Kahneman and Tversky 1979) which suggests that disincentives are more likely to lead to cooperativeness in the population because of their greater effect on individual behavior.

This result needs to be qualified with the caveat that the incentives are generated by the state without any form of taxation of the population to pay for the incentives. In other words, the model is an open system with regard to wealth (aka energy). In the model as implemented, there is a large abundant energy source that can provide as much in incentives as might be desired by the population. In the real world, if the state were to print money any time an incentive were needed, there would eventually be an inflation

problem. A more realistic model would implement energy as either (1) a closed system or (2) as an open system with a fixed amount of energy being introduced in each turn.

This fundamental change in the model is an exercise for future research.

The model does provide further evidence that cooperativeness in a population can be achieved over the long run through the application of social institutions. Amongst the various types of models that have been demonstrated to lead to cooperation, this model is most like Rand *et al* (2009) because of the application of targeted punishment and reward. Unlike Rand *et al*, this model has its punishment arising from an arbitrary third party (society or government) and not only punishment arising directly from other participants in a transaction.

The other exciting aspect of this model is that the heuristic utilized for the fairness criteria in Ultimatum leads to results very similar to the results seen in human Ultimatum play. As discussed earlier, it is likely that the agents faced an environment similar to that which human beings have faced in their interactions that require a split of available resources. This environment is one where agents can have a range of potential selfish or altruistic offers. Further exploration of variation in strategies and their evolutionary effect is likely warranted based upon the results of this model.

Synthesis

“At a fundamental level, public policy is the study of decision-making.”
Smith and Larimer (2009, 49)

Chapter 5

This dissertation has comprised three distinct components in the attempt to examine how the evolution of values and decision-making might affect the policy process. In chapter 2, a theoretical description of an evolutionary model of the policy process was presented. In chapter 3, some of the behaviors that would be expected as a result of this model were tested. In chapter 4, a simulation of the evolutionary model was developed and tested for its implications. This chapter will attempt to synthesize these results into a somewhat coherent whole and provide some commentary on what I think it might all mean.

The Emotions of Fairness as Policy Criteria

As described in chapter 2, if public policy were to be influenced by evolutionary forces, then it would likely come in one of three forms. First, the technological solutions to policy problems goes through what amounts to an evolutionary process as ideas or memes spread through the process of policy diffusion (Ayres 1978 [1944]; Dawkins 2006 [1976]; John 2003; Hecl 1974; Hall 1993; Freeman 2006). Second, biological evolution has the potential to set the context for policy decision-making through partly predisposed values and through the neurological components of decision-making. One way in which partly predisposed values can be expressed is through emotional responses to stimuli in the environment. Fairness / Justice is one value identified as being part of a fundamental moral foundation (Haidt and Joseph 2004; Haidt and Graham 2007). This value provides

a basis for judgment of public policy alternatives (among many other things). In the context of the Ultimatum game, the violation of a fairness norm can invoke an emotional response (Pillutla and Murnighan 1996; Sanfey *et al* 2003). However, the Ultimatum game exposes fairness evaluations primarily in the context of the evaluation of unfairness to the person making the judgment. Therefore, one question that was posed in chapter 3 was whether or not experiencing unfairness was different from witnessing unfairness in its effect on the individual's desire for policy change. Unfortunately, while the means were different between the group that received an even split while playing Ultimatum and the group that witnessed Ultimatum play, they were not significantly different. It could be, though, that the sample size of the groups may be the issue here.

It *was* demonstrated in chapter 3 that those who did personally receive unfair allocations overall were very supportive of policy change in the game. Those who did not personally experience a fairness norm violation during game play were very much in favor of keeping the status quo. The group in favor of the status quo was less emotionally aroused by a large unfair offer at the end of the game as measured by standardized skin conductance levels than the group in favor of policy change. Thus, experience and emotion do seem to be influencing the policy decision to move away from the status quo.

This is an interesting result because it implies that unfair treatment can create a context where policy change is more likely to occur. The emotional experience of the September 11th terrorist attacks did not merely provide scientific information to policy-makers that the design of the national defense against terrorism was inadequate. It also created the conditions whereby policy change was more likely to be supported by the

many people who were emotionally affected by the attacks. This result stands in contrast to what Stone calls “the rationality project”: the notion that policy can be treated as a science with only objective measures utilized as criteria (Stone 2002, 7). Lasswell suggested that public policy has a value orientation, and my results are consistent with that theory (Lasswell 1951). However, Lasswell suggested that these values be acknowledged in order to achieve some degree of objectivity. My results suggest that a policy decision-maker may not be able to completely acknowledge his or her values because they may be dependent upon recent and continuously changing experience in addition to heritable values that are expressed reflexively through emotional response. If the immediate emotional context of the decision-maker is in flux, then it can be difficult to consciously acknowledge which values are affecting a decision.

Therefore, something new is afoot. Values have always been recognized as important in the various models of the policy process, and disputes based upon differing values has occupied quite a bit of attention in public policy circles as well as political science more broadly. However, when considering the importance of predisposed values being expressed as emotional criteria for policy decisions, the differences are not as important as the similarities amongst people. A predisposed value that is universal or nearly universal in a population can create a standard against which policies need to adhere.

My results lend additional credence to the theories of the policy process which involve punctuations (Baumgartner and Jones 1993; Jones and Baumgartner 2005a) and synchronicity amongst the policy streams (Kingdon 1984) because some emotional contexts for policy decisions are created by informational stimuli that apply to many

people involved in the policy arena (Wood and Vedlitz 2007). The September 11th attacks are certainly this type of emotional stimulus for most people. Under these conditions (where the same stimuli create similar reflexive emotional reactions), it would be expected that policy change could occur much more quickly as in a punctuation.

Experience in the domain of the policy also has been found to have an effect. My results suggest that policy entrepreneurs are likely utilizing prior experience in the domain of the public policy to inform their advocacy. Those with certain types of experience in the game (an even split of the pot) made policy choices differently from those without experience in the game. An intense emotional experience would likely lead one to be more supportive of policy change as a result of that experience.

People not only can share emotional responses to policy information, but they can also share values. Consistent with prior research on Western study participants (Güth and Tietz 1990; Haidt and Joseph 2004; Haidt and Graham 2007), most participants who witnessed Ultimatum play evaluated even split offers as fair and offers of less than 30% of the pot as unfair. This is not particularly surprising, but it and the notion that emotions and experience influence policy decisions give some credence to the basic assumptions of the policy simulation presented in Chapter 4.

This is because the simulation is predicated on the idea that heritable individual traits can affect policy decision-making. If a partly heritable emotional response affects policy decisions and human beings share partly heritable values that provide criteria for policy decisions, then the simulation's primary assumption has some degree of external validity. In other words, the results from chapter 3 give me reason to believe that the micro-level of the model simulated in chapter 4 is similar to real human beings engaged

in decision-making. Are the simulated agents perfectly aligned with their human decision-making counterparts? This is certainly not the case. But the key basic assumptions of the model do have some support.

The simulated agents also arrive at the same evaluation criteria when playing as the second player as do human beings in Western, industrial nations. As stated in chapter 4, this is likely the result of the model establishing the correct context for the second player's fairness evaluation decision. Human beings have probably evolved an emotional response to being treated unfairly where the splits that arise from sharing are fair one day and unfair the next. Of course, guessing about the nature of the environment of evolutionary adaptation can lead to some questionable deductions (Buller 2006). Nonetheless, the external validity of the agents' evaluation criteria is further evidence that the macro-level of the model is set on a reasonable foundation as provided by the micro-level.

It is a concern that the application of incentives has no restraint holding it back. This is the issue that there is no balance of the government's budget in the simulation. The simulated government can keep infusing as much energy into the society as the agents can consume under the incentives model, but not under the disincentives model. This creates an abundance of resources that may be realistic, but it is likely that it is not. In the real world, resources are mostly scarce. Therefore a modification of the model is warranted, and will likely be pursued in future research.

What the simulated model can tell us about public policy, though, is that under conditions where there is an abundance of resources, incentives provide a greater impact on cooperativeness and social success than disincentives. The application of both

incentives and disincentives does lead to greater levels of cooperativeness than incentives alone, but not to greater levels of the population growth rate¹. The model variant that had only incentives grew the population the fastest.

With regards to policy compliance, this model suggests that incentives may have a greater impact on compliance assuming that the incentive provides individual actors with adequate resources to cover the costs of altruistically punishing violators of social norms. Incentives thus provide a double whammy for policy compliance. They directly give cooperators a reason to cooperate, and they also give cooperators who are willing to altruistically punish non-cooperators enough resources to absorb the costs of the altruistic punishment (Rand *et al* 2009). My model would thus predict that there would be less altruistic punishment under policy institutions where only disincentives are utilized to encourage compliance than under a model where incentives are either used alone or along with disincentives.

Future Directions for Research

There are many different fixes, extensions and additional questions posed by this research. I will first list several fixes to the implementation that might have improved the results.

The first item that would have been desirable would have been to increase the number of participants in the survey and experiment. This is primarily because the mean support for policy change between the groups were substantively, but not significantly different. An increase from 34 in each group to approximately 90 in each group would

¹ I would expect that the application of both incentives and disincentives would lead to greater levels of the population growth rate if the amount of incentives were restricted by available resources.

make the group that witnessed the game more likely to be significantly different from the other groups.

Second, the stakes should be raised for at least some participants in the survey. This means that real money should be used to pay participants based upon their performance in the game. In addition, unfair offers should be delivered by real human beings. It is possible that some participants would behave differently when playing against computers compared to playing against human beings.

Third, it would have been better to utilize elites and non-elites rather than just non-elites in evaluating decision-making traits. Since experience in the policy domain does seem to make a difference, it is possible that with greater levels of policy decision-making experience the results would be different.

Fourth, a Likert scale for the dependent variable would have indicated the level of individual desire for policy change. Measuring this form of intensity does change the context of the task a bit from making a decision to expressing an attitude. However, having both the policy change question and a question indicating the degree of intensity for the change would improve the analysis.

Along these lines, some participants might have responded differently if the dependent variable were based upon specifically defined alternatives which included the status quo as one of the alternatives. Policy change in the abstract may be different from policy change based upon real alternatives. It is certainly the case that most policy analyses which decision-makers encounter are limited in the number of alternatives presented as viable.

Sixth, as has been discussed, the simulation might be more realistic with a closed system approach rather than an open system. A form of taxation or a fixed size for the incentives may solve this problem. In fact one idea for altering the model would be to fix the size of the incentives and test the sensitivity of the model to different sizes of the incentive amounts.

Of course, making slight alterations to the existing study is not as interesting as future research that might be based upon the insights provided by this research. One potential interesting source of additional research might be to examine how long an emotional impact on policy decision-making might last. Is the time for the effect on policy decision-making to wear off dependent upon the intensity of the emotional experience?

One way to extend the simulation model would be to mediate the relationship between individual preferences and the policy outcomes through a variety of different institutional relationships. While this has been explored to some degree, the external validity of the model in this dissertation provides a good reason to experiment with different institutional structures as a mediator between the individual and aggregate levels.

Further, the model's outcomes should be compared to real world policy situations. Are there punctuations occurring in the simulated system like those witnessed during agenda setting (Baumgartner and Jones 1993; Jones and Baumgartner 2005)? Would institutional structures like those described in the Advocacy Coalition Framework act as effective mediators in a revised version of the simulation? Changes in the model, though, are not a panacea. Any change in the basic design of the model would make it a new

model that changes the nature of the formal model, and any external validity it may have. Regardless of this caveat, the decision-making heuristics of the players in the model do bear some resemblance to actual human beings. So, it potentially can act as an effective platform for further extension.

Another potential area of further research would be to examine which values affect policy decisions and which do not. It is possible that only those values that Haidt has associated with ideology would have an impact because of the social orientation of those values (Haidt and Joseph 2004; Haidt and Graham 2007). Or it is possible that any substantial change in emotional state would create a context that would alter decision-making. Further research in this area is warranted.

Finally, one of the reasons that human beings institutionally organize to make decisions is to avoid any undue emotional influence over a decision. Processes exist to assure that friends and family members of either the victims or the accused are unable to serve in jury trials. Committees help assure that one individual who is having a bad day cannot have that emotional context lead to decisions being affected by it. What is the nature of institutions that are able to use the information provided by the emotions of its participants to make better decisions rather than worse decisions? Committees and other institutional structures cannot eliminate emotions in its decisions, nor would it make sense to do so. However, the emotional state of participants in an institution can be funneled to better purposes by institutional rules.

A Model of the Policy Process

Does this dissertation hold up to the claim of its title to provide an individual basis for the policy process based upon the value of fairness / justice? Well, in a word,

yes. The model uses a particular value, fairness / justice, and demonstrates that policy decisions can be affected by the emotional reaction to unfairness and injustice. Further, individuals share these intuitive criteria and they are partly heritable. A simulation demonstrates that these evolved criteria affect and are affected by the nature of the environment created by the policy institutions at work in society.

Public policy has historically taken an objectivist approach and tried to deny a role for emotion in public policy decision-making (Stone 2002). Even when emotion has been acknowledged in influencing policy decisions, it has been principally seen as a form of bias from a cognitive / rational ideal (Simon 1957; Simon 1995; Jones 2001). However, our evolutionary heritage is providing human beings with information in the form of decision-making criteria that come from our emotional assessment of objects in the environment (including public policy alternatives). These criteria have been demonstrated to have an influence on the desire to engage in policy change, and a formal model of the evolution of these criteria does lead to specific recommendations for achieving cooperation and other desirable social outcomes.

On a fundamental level, values such as fairness / justice provide a base upon which public policy resides. Policy proposals are judged for their fairness. Further, they are judged according to a common set of policy criteria that emanates from heritable and intuitive emotional responses to policy alternatives. Because society and its policies can alter the fecundity of individuals operating in that society, there is some reason to believe that selective pressures can influence the course of human values. As human values adapt, the base upon which policy resides changes.

Most formal policy efforts take something on the scale of decades to work through the policy process (Sabatier 1999). Some laws have lasted for centuries. The basic idea of government utilizing incentives and disincentives to provide order in society has gone on for at least millennia. Why then, should we not be concerned with the evolutionary basis upon which public policy rests? Evolutionary change of the biological sort may be slow, but so is change in the form of government.

There are many social problems and government programs that attempt to address them. If something as fundamental as an emotional reaction to unfairness is prevalent as decision-making criteria for the nature of the programs, then these emotional reactions are worth an extensive examination. This work has taken a shot at such an examination.

While this work is not definitive, it does provide several reasons why policy scholars should be turning their attention towards the psychology of individual decision-makers in the broader context of the policy process. I look forward to the further exploration of these issues.

Appendix A – Survey Protocol

[Participants will be randomly assigned to one of three groups, Group E1, Group E2, and Group C. The survey administered to each group is as follows.]

[Following briefing and consent to participate, the participant will have electrodes attached to their index and middle finger of their non-dominant hand in order to measure skin conductance. A small circular collar with adhesive will be applied to the finger. Electrode paste will then be applied within the collar and the electrode will be attached with both the adhesive and a small velcro strap. The participant will use their dominant hand to respond to the computer-based questionnaire.]

[Group E1 Survey]

[Instructions]

The survey is about to begin. Please press the continue button below each time you are ready to move on to the next question.

[Demographic Information]

In what year were you born?

[Fill-in-the-blank answer. If the participant answers in such a way that they are calculated to be less than 19 years old, then the survey will end]

What is the highest level of education you have completed?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your father?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your mother?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What geographic area best describes your family's place of residence?

- 1 – United States, Northeast
- 2 – United States, Midwest
- 3 – United States, South
- 4 – United States, West
- 5 - Other

What is your occupation?

- 1-Student
- 2-Professional
- 3-Business, self-employed
- 4-Business/corporation
- 5-Other white collar
- 6-Service industry
- 7-Custodial/factory worker
- 8-Construction
- 9-Other blue collar
- 10-Homemaker
- 11-Clerical
- 12-Unemployed
- 13-Other

What is your family income?

- 1-Under \$20,000
- 2-\$20,000-\$40,000
- 3-\$40,001-\$60,000
- 4-\$60,001-\$80,000
- 5-\$80,001-\$100,000
- 6-Over \$100,000

Which of the following best describes your race?

- 1-African-American
- 2-Hispanic
- 3-Asian-American
- 4-Native-American
- 5-White
- 6-Other

What is your gender?

- 1-Male
- 2-Female

How often do you attend religious services?

- 1-Never
- 2-Occasionally
- 3-Once or twice a month
- 4-Once or more per week

What is your current marital status?

- 1-Single
- 2-Married
- 3-Divorced
- 4-Widowed
- 5-Remarried
- 6-Living together, never married

Do you have children?

- 1-Yes
- 2-No

Are you registered to vote?

- 1-Yes
- 2-No

Do you usually vote in elections?

- 1-Yes
- 2-No

How often do you discuss political issues with other people?

- 1-Very often
- 2-Often
- 3-Sometimes
- 4-Once in a while
- 5-Rarely

On a scale of 1-7, with one being strongly liberal, 4 being centrist, and 7 being strongly conservative, where would you place yourself?

- 1 – Strongly Liberal
- 2 –
- 3 –
- 4 – Centrist
- 5 –
- 6 –
- 7 – Strongly Conservative

Do you consider yourself a Democrat, a Republican, an Independent, or other?

- 1 - Strong Democrat
- 2 - Weak Democrat
- 3 - Independent, leaning Democrat
- 4 - Independent
- 5 - Independent, leaning Republican
- 6 - Weak Republican
- 7 - Strong Republican
- 8 - Other party

How much education in the field of Economics have you had?

- 1 – I read or watch the news, but have not had an actual class in Economics
- 2 – I have taken an introductory course in high school or college on Economics
- 3 – I have taken some advanced undergraduate courses in Economics
- 4 – I have taken some graduate courses in Economics
- 5 – I have a graduate degree (Masters / PhD) in Economics

How familiar are you with game theory as it is used in the social sciences?

- 1 – I am not familiar with game theory
- 2 – I know a little about game theory
- 3 – I am reasonably familiar with game theory
- 4 – I am very knowledgeable about game theory

[Playing the Ultimatum Game]

[Instructions about the game]

In the next section, you will play a game against another player for several rounds.

During each round, you will be asked to imagine that there is an amount of money to split between two players. There is no actual compensation for participating in this research, though. This is only a game.

In this game, there are two players. The first player will make an offer to the second player about how to split a pot of money. The second player will then make a decision about whether to accept or reject the

offer. If the second player accepts the offer, then you each get the amount described in the offer. If the second player rejects the offer, then both players get nothing.

The amount in the pot will vary during each round. Most pots will have less than \$100 to split, but it is possible that some of the pots could have substantially more.

[*Ultimatum Game First Player Page Round 1 (there will be five rounds as player 1)*]

For the next few rounds, you will be the first player.

Round 1 [or 2,3,4,5]

Imagine that you are splitting the following pot of money with the other player.

The amount in the pot for this round is:

[Round 1, $P = \$60$,

Round 2, $P = \$20$,

Round 3, $P = \$80$,

Round 4, $P = \$500$,

Round 5, $P = \$120$]

How much of the $\$[P]$ would you like to offer to the other player?

[Fill in the blank, this is the O value]

[*Player 2 Response Page - If the participant responds with an offer of greater than 25% of the pot, then the offer will be accepted. If the participant responds with an offer of less than 25% of the pot, then the offer will be rejected.*]

The second player has decided to [accept / reject] your offer. You will receive $[P-O]$ points for this round.

[*The participant repeats the prior two pages until all five rounds are completed*]

[*Ultimatum Game Second Player Instructions (there will be five rounds as player 2)*]

For the next few rounds, you will be the second player and receive an offer from the first player. You may decide to accept or reject the offer. The first player will receive the remainder of the pot.

[*Player 2 round pages*]

Round 1 [or 2,3,4,5]

Imagine that you are splitting the following pot of money with the other player.

The amount in the pot for this round is:

[Round 1, $P = \$80$,

Round 2, $P = \$60$,

Round 3, $P = \$120$,

Round 4, $P = \$20$,

Round 5, $P = \$500$]

The other player has offered you [Round 1, $O = \$40$, Round 2, $O = \$5$, Round 3, $O = \$55$, Round 4, $O = \$3$, Round 5, $O = \$40$]. If you accept, they would get to keep $\$[P-O]$.

Would you like to accept or reject this offer?

1 – Accept, you would both get the amounts above

2 – Reject, you would both receive nothing for this round

[*Player 2 Round response page*]

You have selected to [prior page response]. Your current total in the game would be: $\$[Current Total]$.

The other player has $\$[Other player's total]$

[The participant repeats the prior two pages until all five rounds are completed]

[Social Perspective]

In the game that you just played, do you believe that rules should be made to make sure that offers from the first player to the second player are fair?

- 1 – Yes
- 2 – No

If so, what type of rules would you suggest?

[Open ended question]

An additional rule for the game has been proposed. The additional rule would fine any player who plays unfairly. Would you like to vote in favor or against this proposal?

- 1 – Vote FOR the proposal to add fines
- 2 – Vote AGAINST the proposal to add fines

If this rule is added to fine players who play unfairly, then how much should the fine be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

A second additional rule for the game has been proposed. This additional rule would provide a bonus to be paid to any player who plays fairly. Would you vote for or against this proposal?

- 1- Vote FOR the proposal to add bonuses
- 2- Vote AGAINST the proposal to add bonuses

If a rule is added to provide a bonus to players who play fairly, then how much should the bonus be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

If both proposals (Fines for unfair play and Bonuses for fair play) were available, would you prefer to have neither one, one of them individually, or both?

- 1 – Neither
- 2 – Fines for unfair play
- 3 – Bonuses for fair play
- 4 – Both Fines and Bonuses

Imagine that you had learned of a report by scientists that indicated that people are more likely to act fairly in games when fines are used. Would this report influence your choice on whether to vote for or against fines?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

Imagine that you had learned of a report by church leaders that indicated that people are more likely to act fairly in games when bonuses are used. Would this report influence your choice on whether to vote for or against bonuses?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

[Mach Scale]

Please answer 1-Yes, 2-No to the following question: Would you be prepared to deceive someone completely if it were to your advantage?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to do a bad turn to someone in order to get something you particularly wanted for yourself?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Do you often act in a cunning way in order to get what you want?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to "walk all over people" to get what you want?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Do you enjoy manipulating people?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Do you tend to most things with an eye to your own advantage?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Do you agree that the most important thing in life is winning?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to be quite ruthless in order to get ahead in your job?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to be humble and honest rather than important and dishonest?

1-Yes
2-No

Please answer 1-Yes, 2-No to the following question: Would you like to be very powerful?

1-Yes
2-No

[Fairness Stimuli]

[Instructions for stimuli]

At this time, please relax, settle in, and remain still while a few videos will be shown. You do not need to do anything while the videos are playing other than to pay attention to them. They will appear for a fixed amount of time and the video will automatically appear once the prior one is finished.

[stimuli]

- a. A fixation point (plus sign) for 15 seconds.

- b. A local news report on retail store employees selling spots in the checkout line on the day after Thanksgiving. (approximately 2 minutes)
- c. A fixation point (plus sign) for 15 seconds.
- d. A local news story about the possibility that the city will acquire a business' property through eminent domain. (approximately 2 minutes)
- e. A fixation point (plus sign) for 15 seconds
- f. A video of a bee flying amongst some flowers (approximately 1 minute)
- g. A fixation point (plus sign) for 15 seconds
- h. A local news story about an innocent man who was released from prison as a result of DNA testing. (approximately 2 minutes)
- i. A fixation point (plus sign) for 15 seconds
- j. A video of a common Windows screen saver (approximately 1 minute)
- k. A fixation point (plus sign) for 15 seconds
- l. A local news report about an innocent man attacked by police which ultimately led to his being in a coma. The attack was caught on surveillance tape and is run 4 times in the video. It shows a person identified as police running up to the man and shoving him into a wall where the man's head snaps forward. There is also a picture of the man in a hospital bed. (approximately 2 minutes)
- m. A fixation point (plus sign) for 15 seconds

[Completion]

[Completion Instructions]

Please inform the proctor that you have completed the survey. Thank you for your participation.

[Group E2 Survey]**[Instructions]**

The survey is about to begin. Please press the continue button below each time you are ready to move on to the next question.

[Demographic Information]

In what year were you born?

[Fill-in-the-blank answer. If the participant answers in such a way that they are calculated to be less than 19 years old, then the survey will end]

What is the highest level of education you have completed?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your father?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your mother?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What geographic area best describes your family's place of residence?

- 1 – United States, Northeast
- 2 – United States, Midwest
- 3 – United States, South
- 4 – United States, West
- 5 - Other

What is your occupation?

- 1-Student
- 2-Professional
- 3-Business, self-employed
- 4-Business/corporation
- 5-Other white collar
- 6-Service industry
- 7-Custodial/factory worker
- 8-Construction
- 9-Other blue collar
- 10-Homemaker
- 11-Clerical
- 12-Unemployed

13-Other

What is your family income?

- 1-Under \$20,000
- 2-\$20,000-\$40,000
- 3-\$40,001-\$60,000
- 4-\$60,001-\$80,000
- 5-\$80,001-\$100,000
- 6-Over \$100,000

Which of the following best describes your race?

- 1-African-American
- 2-Hispanic
- 3-Asian-American
- 4-Native-American
- 5-White
- 6-Other

What is your gender?

- 1-Male
- 2-Female

How often do you attend religious services?

- 1-Never
- 2-Occasionally
- 3-Once or twice a month
- 4-Once or more per week

What is your current marital status?

- 1-Single
- 2-Married
- 3-Divorced
- 4-Widowed
- 5-Remarried
- 6-Living together, never married

Do you have children?

- 1-Yes
- 2-No

Are you registered to vote?

- 1-Yes
- 2-No

Do you usually vote in elections?

- 1-Yes
- 2-No

How often do you discuss political issues with other people?

- 1-Very often
- 2-Often
- 3-Sometimes
- 4-Once in a while
- 5-Rarely

On a scale of 1-7, with one being strongly liberal, 4 being centrist, and 7 being strongly conservative, where would you place yourself?

- 1 – Strongly Liberal
- 2 –
- 3 –
- 4 – Centrist
- 5 –
- 6 –
- 7 – Strongly Conservative

Do you consider yourself a Democrat, a Republican, an Independent, or other?

- 1 - Strong Democrat
- 2 - Weak Democrat
- 3 - Independent, leaning Democrat
- 4 - Independent
- 5 - Independent, leaning Republican
- 6 - Weak Republican
- 7 - Strong Republican
- 8 - Other party

How much education in the field of Economics have you had?

- 1 – I read or watch the news, but have not had an actual class in Economics
- 2 – I have taken an introductory course in high school or college on Economics
- 3 – I have taken some advanced undergraduate courses in Economics
- 4 – I have taken some graduate courses in Economics
- 5 – I have a graduate degree (Masters / PhD) in Economics

How familiar are you with game theory as it is used in the social sciences?

- 1 – I am not familiar with game theory
- 2 – I know a little about game theory
- 3 – I am reasonably familiar with game theory
- 4 – I am very knowledgeable about game theory

[Witnessing the Ultimatum Game]

[Instructions about the game]

In the next section, you will watch one player play a game against another player for several rounds.

In this game, there are two players. The first player will make an offer to the second player about how to split a pot of money. The second player will then make a decision about whether to accept or reject the offer. If the second player accepts the offer, then they each get the amount described in the offer. If the second player rejects the offer, then both players get nothing.

The amount in the pot will vary during each round. Most pots will have less than \$100 to split, but it is possible that some of the pots could have substantially more. After each round of the game, you will be asked to assess the fairness of the play in the game.

[Witnessing the ultimatum game –There will be ten rounds of Ultimatum witnessed with the following outcomes (P = Pot size, O= Player 1 Offer to player 2):

- Round 1, P = \$60, O=\$30, Player B Accepts*
- Round 2, P = \$20, O=\$15, Player B Accepts*
- Round 3, P = \$80, O=\$20, Player B Rejects*
- Round 4, P = \$500, O=\$50, Player B Rejects*
- Round 5, P = \$120, O=\$108, Player B Accepts*
- Round 6, P = \$80, O=\$60, Player A Accepts*
- Round 7, P = \$60, O=\$15, Player A Rejects*
- Round 8, P = \$120, O=\$10, Player A Rejects*

Round 9, $P = \$20$, $O = \$10$, Player A Accepts
 Round 10, $P = \$500$, $O = \$450$, Player A Accepts
]

[Each Round Pages – For each of the ten rounds, the following will be displayed / asked.]
 Round [round #] of 10

The players have to split a pot of money. In this round, the amount of money to be split is $\$[P]$. Player [“A” for first five rounds, “B” for second five rounds] gets to split the pot and decides to offer $\$[O]$ to Player [“B” for first five rounds, “A” for second five rounds]. Player [“B” for first five rounds, “A” for second five rounds] has decided to [accept / reject] the offer.

For this round, Player A receives $\$[O - P \text{ for first five rounds, } O \text{ for second five rounds}]$. For this round, Player B receives $\$[O \text{ for first five rounds, } O - P \text{ for second five rounds}]$. The total for each player so far is: Player A $\$[Total \text{ Sum of Player A winnings}]$, Player B $\$[Total \text{ Sum of Player B winnings}]$.

Do you believe that Player [“A” for first five rounds, “B” for second five rounds]’s offer was fair?

- 1 – Yes
- 2 – No

[This page will be repeated for each of the ten rounds]

[Social Perspective]

In this game, do you believe that rules should be made to make sure that offers from the first player to the second player are fair?

- 1 – Yes
- 2 – No

If so, what type of rules would you suggest?

[Open ended question]

An additional rule for the game has been proposed. The additional rule would fine any player who plays unfairly. Would you like to vote in favor or against this proposal?

- 1 – Vote FOR the proposal to add fines
- 2 – Vote AGAINST the proposal to add fines

If this rule is added to fine players who play unfairly, then how much should the fine be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

A second additional rule for the game has been proposed. This additional rule would provide a bonus to be paid to any player who plays fairly. Would you vote for or against this proposal?

- 1- Vote FOR the proposal to add bonuses
- 2- Vote AGAINST the proposal to add bonuses

If a rule is added to provide a bonus to players who play fairly, then how much should the bonus be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

If both proposals (Fines for unfair play and Bonuses for fair play) were available, would you prefer to have neither one, one of them individually, or both?

- 1 – Neither

- 2 – Fines for unfair play
- 3 – Bonuses for fair play
- 4 – Both Fines and Bonuses

Imagine that you had learned of a report by scientists that indicated that people are more likely to act fairly in games when fines are used. Would this report influence your choice on whether to vote for or against fines?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

Imagine that you had learned of a report by church leaders that indicated that people are more likely to act fairly in games when bonuses are used. Would this report influence your choice on whether to vote for or against bonuses?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

[Mach Scale]

Please answer 1-Yes, 2-No to the following question: Would you be prepared to deceive someone completely if it were to your advantage?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to do a bad turn to someone in order to get something you particularly wanted for yourself?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Do you often act in a cunning way in order to get what you want?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to "walk all over people" to get what you want?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Do you enjoy manipulating people?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Do you tend to most things with an eye to your own advantage?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Do you agree that the most important thing in life is winning?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to be quite ruthless in order to get ahead in your job?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Would you be prepared to be humble and honest rather than important and dishonest?

- 1-Yes
- 2-No

Please answer 1-Yes, 2-No to the following question: Would you like to be very powerful?

- 1-Yes
- 2-No

[Fairness Stimuli]

[Instructions for stimuli]

At this time, please relax, settle in, and remain still while a few videos will be shown. You do not need to do anything while the videos are playing other than to pay attention to them. They will appear for a fixed amount of time and the video will automatically appear once the prior one is finished.

[stimuli]

- a. A fixation point (plus sign) for 15 seconds.
- b. A local news report on retail store employees selling spots in the checkout line on the day after Thanksgiving. (approximately 2 minutes)
- c. A fixation point (plus sign) for 15 seconds.
- d. A local news story about the possibility that the city will acquire a business' property through eminent domain. (approximately 2 minutes)
- e. A fixation point (plus sign) for 15 seconds
- f. A video of a bee flying amongst some flowers (approximately 1 minute)
- g. A fixation point (plus sign) for 15 seconds
- h. A local news story about an innocent man who was released from prison as a result of DNA testing. (approximately 2 minutes)
- i. A fixation point (plus sign) for 15 seconds
- j. A video of a common Windows screen saver (approximately 1 minute)
- k. A fixation point (plus sign) for 15 seconds
- l. A local news report about an innocent man attacked by police which ultimately led to his being in a coma. The attack was caught on surveillance tape and is run 4 times in the video. It shows a person identified as police running up to the man and shoving him into a wall where the man's head snaps forward. There is also a picture of the man in a hospital bed. (approximately 2 minutes)
- m. A fixation point (plus sign) for 15 seconds

[Completion]

[Completion Instructions]

Please inform the proctor that you have completed the survey. Thank you for your participation.

[Group C Survey]**[Instructions]**

The survey is about to begin. Please press the continue button below each time you are ready to move on to the next question.

[Demographic Information]

In what year were you born?

[Fill-in-the-blank answer. If the participant answers in such a way that they are calculated to be less than 19 years old, then the survey will end]

What is the highest level of education you have completed?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your father?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What is the highest level of education completed by your mother?

- 1-Did not finish high school
- 2-High school graduate
- 3-Trade school
- 4-Some college
- 5-College degree
- 6-Graduate / Professional degree

What geographic area best describes your family's place of residence?

- 1 – United States, Northeast
- 2 – United States, Midwest
- 3 – United States, South
- 4 – United States, West
- 5 - Other

What is your occupation?

- 1-Student
- 2-Professional
- 3-Business, self-employed
- 4-Business/corporation
- 5-Other white collar
- 6-Service industry
- 7-Custodial/factory worker
- 8-Construction
- 9-Other blue collar
- 10-Homemaker
- 11-Clerical
- 12-Unemployed

13-Other

What is your family income?

- 1-Under \$20,000
- 2-\$20,000-\$40,000
- 3-\$40,001-\$60,000
- 4-\$60,001-\$80,000
- 5-\$80,001-\$100,000
- 6-Over \$100,000

Which of the following best describes your race?

- 1-African-American
- 2-Hispanic
- 3-Asian-American
- 4-Native-American
- 5-White
- 6-Other

What is your gender?

- 1-Male
- 2-Female

How often do you attend religious services?

- 1-Never
- 2-Occasionally
- 3-Once or twice a month
- 4-Once or more per week

What is your current marital status?

- 1-Single
- 2-Married
- 3-Divorced
- 4-Widowed
- 5-Remarried
- 6-Living together, never married

Do you have children?

- 1-Yes
- 2-No

Are you registered to vote?

- 1-Yes
- 2-No

Do you usually vote in elections?

- 1-Yes
- 2-No

How often do you discuss political issues with other people?

- 1-Very often
- 2-Often
- 3-Sometimes
- 4-Once in a while
- 5-Rarely

On a scale of 1-7, with one being strongly liberal, 4 being centrist, and 7 being strongly conservative, where would you place yourself?

- 1 – Strongly Liberal
- 2 –
- 3 –
- 4 – Centrist
- 5 –
- 6 –
- 7 – Strongly Conservative

Do you consider yourself a Democrat, a Republican, an Independent, or other?

- 1 - Strong Democrat
- 2 - Weak Democrat
- 3 - Independent, leaning Democrat
- 4 - Independent
- 5 - Independent, leaning Republican
- 6 - Weak Republican
- 7 - Strong Republican
- 8 - Other party

How much education in the field of Economics have you had?

- 1 – I read or watch the news, but have not had an actual class in Economics
- 2 – I have taken an introductory course in high school or college on Economics
- 3 – I have taken some advanced undergraduate courses in Economics
- 4 – I have taken some graduate courses in Economics
- 5 – I have a graduate degree (Masters / PhD) in Economics

How familiar are you with game theory as it is used in the social sciences?

- 1 – I am not familiar with game theory
- 2 – I know a little about game theory
- 3 – I am reasonably familiar with game theory
- 4 – I am very knowledgeable about game theory

[Instructions and questions about the game]

The following few questions are about a game.

In this game, there are two players. The first player makes an offer to the second player about how to split a pot of money. The second player will then make a decision about whether to accept or reject the offer. If the second player accepts the offer, then they each get the amount described in the offer. If the second player rejects the offer, then both players get nothing.

The amount in the pot will vary during each round. Most pots will have less than \$100 to split, but it is possible that some of the pots could have substantially more.

[Social Perspective]

In the game that was just described, do you believe that rules should be made to make sure that offers from the first player to the second player are fair?

- 1 – Yes
- 2 – No

If so, what type of rules would you suggest?

[Open ended question]

An additional rule for the game has been proposed. The additional rule would fine any player who plays unfairly. Would you like to vote in favor or against this proposal?

- 1 – Vote FOR the proposal to add fines
- 2 – Vote AGAINST the proposal to add fines

If this rule is added to fine players who play unfairly, then how much should the fine be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

A second additional rule for the game has been proposed. This additional rule would provide a bonus to be paid to any player who plays fairly. Would you vote for or against this proposal?

- 1- Vote FOR the proposal to add bonuses
- 2- Vote AGAINST the proposal to add bonuses

If a rule is added to provide a bonus to players who play fairly, then how much should the bonus be?

- 1 – \$10 or less
- 2 – Between \$10 and \$50
- 2 – Between \$50 and \$100
- 3 – More than \$100

If both proposals (Fines for unfair play and Bonuses for fair play) were available, would you prefer to have neither one, one of them individually, or both?

- 1 – Neither
- 2 – Fines for unfair play
- 3 – Bonuses for fair play
- 4 – Both Fines and Bonuses

Imagine that you had learned of a report by scientists that indicated that people are more likely to act fairly in games when fines are used. Would this report influence your choice on whether to vote for or against fines?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

Imagine that you had learned of a report by church leaders that indicated that people are more likely to act fairly in games when bonuses are used. Would this report influence your choice on whether to vote for or against bonuses?

- 1 – Yes, it would influence my vote
- 2 – No, it would not influence my vote

[Mach Scale]

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[Fairness Stimuli]

[Instructions for stimuli]

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- m. A fixation point (plus sign) for 15 seconds

[Completion]

[Completion Instructions]

Please inform the proctor that you have completed the survey. Thank you for your participation.

Appendix B – Simulation Source Code

All code is copyright 2010 by Douglas R. Oxley

The code operates within the Repast Symphony programming environment, and is written in Java.

fairAgent.java

```

/**
 *
 */
package fairness2;

import java.util.Iterator;

import cern.jet.random.Normal;
import repast.simphony.annotate.AgentAnnot;
import repast.simphony.context.Context;
import repast.simphony.engine.environment.RunEnvironment;
import repast.simphony.engine.environment.RunState;
import repast.simphony.engine.schedule.*;
import repast.simphony.essentials.*;
import repast.simphony.parameter.Parameters;
import repast.simphony.random.*;

/**
 * @author Douglas R. Oxley
 */
@AgentAnnot(displayName = "fairAgent")
public class fairAgent {

    // set the attributes for the agent
    private double siHigh = 1.0;
    private double siLow = 0.0;
    private double fairCrit = 0.5;
    private double fairCritSD = 0.1;
    private double penaltyPref = 0.05;
    private double bonusPref = 0.05;
    private int age = 0;
    private int quartile = 4;
    private long wealth = 25;
    private int offer = 0;
    private boolean acceptb = false;
    private long children = 0;
    private cern.jet.random.Normal fairCritDist;
    private double turnborn = 0.0;
    private double turndeath = 0.0;

    // initialize variables for new agents with no parents (normally at beginning of
    simulation)
    public fairAgent(Normal siHighDist, Normal siLowDist, Normal FairCritDist, Double
    FairCritSD, Normal penaltyDist, Normal bonusDist)
    {
        Parameters p = RunEnvironment.getInstance().getParameters();
        int RunType = (Integer) p.getValue("runType");

        // set the double value variables
        this.setSIHigh(siHighDist.nextDouble());
        this.setSILow(siLowDist.nextDouble());
        this.setFairCrit(FairCritDist.nextDouble());
        this.setFairCritSD(FairCritSD);

        // set the penalty and bonus values
        this.setPenaltyPref(penaltyDist.nextDouble());
        this.setBonusPref(bonusDist.nextDouble());
    }
}

```

```

        // set the turn born tick
        this.setTurnborn(RepastEssentials.GetTickCount());

        // create the individual fairness distribution for the predisposed
environment
        if(RunType == 2)
        {
            this.CreateFairDist();
        }
    }

    // initialize variables for new agents with parents (normally during simulation)
    public fairAgent(fairAgent parent)
    {
        fairAgent child = this;

        Parameters p = RunEnvironment.getInstance().getParameters();
        int RunType = (Integer) p.getValue("runType");
        double variation = (Double) p.getValue("variationSD");
        double PVarSD = (Double) p.getValue("variationPB");

        // create the distributions based upon the parent's values
        Normal SIHighDist = RandomHelper.createNormal(parent.getSIHigh(),
variation);
        Normal SILowDist = RandomHelper.createNormal(parent.getSILow(),
variation);
        Normal FairCritDist = RandomHelper.createNormal(parent.getFairCrit(),
variation);
        Normal PenaltyDist = RandomHelper.createNormal(parent.getPenaltyPref(),
PVarSD);
        Normal BonusDist = RandomHelper.createNormal(parent.getBonusPref(),
PVarSD);
        Normal FairCritSDDist = RandomHelper.createNormal(parent.getFairCritSD(),
variation);

        // set the double value variables
        child.setSIHigh(SIHighDist.nextDouble());
        child.setSILow(SILowDist.nextDouble());
        child.setFairCrit(FairCritDist.nextDouble());
        child.setFairCritSD(FairCritSDDist.nextDouble());
        child.setPenaltyPref(PenaltyDist.nextDouble());
        child.setBonusPref(BonusDist.nextDouble());

        this.setTurnborn(RepastEssentials.GetTickCount());

        if(RunType == 2)
        {
            child.CreateFairDist();
        }
    }

    public fairAgent()
    {
    }

    public void birth()
    {
        fairContext context = (fairContext)
RunState.getInstance().getMasterContext();
        fairAgent agent = new fairAgent(this);
        context.add(agent);

        // add the new child to the birthList
        BirthContext birthList = (BirthContext)
context.findContext(context.getBirthContextID());
        birthList.addAgent(agent.getSIHigh(), agent.getSILow(),
agent.getFairCrit(), agent.getFairCritSD(), agent.getPenaltyPref(),
agent.getBonusPref(), agent.getTurnborn(), agent.getID());
    }
}

```

```

        children++;
    }

    private void CreateFairDist()
    {
        Parameters p = RunEnvironment.getInstance().getParameters();
        int RunType = (Integer) p.getValue("runType");
        // set the agent's fairness criteria distribution based upon their
criteria values
        // this applies when the predisposed model is running
        if (RunType == 2)
        {
            fairCritDist = RandomHelper.createNormal(this.getFairCrit(),
this.getFairCritSD());
        }
    }

    // schedule the step method
    @ScheduledMethod(start = 1.0, interval = 1, priority =
ScheduleParameters.FIRST_PRIORITY)
    public void step()
    {
        // get the parameters needed
        Parameters p = RunEnvironment.getInstance().getParameters();
        double q1 = (Double) p.getValue("birthRate1");
        double q2 = (Double) p.getValue("birthRate2");
        double q3 = (Double) p.getValue("birthRate3");
        double q4 = (Double) p.getValue("birthRate4");
        int deathAge = (Integer) p.getValue("deathInTurns");

        // play Ultimatum
        this.playUltimatum();

        // check for whether a child is born this turn, and create it if so.
        /*
        * Note: The birth statistics do not account for the previous round of
Ultimatum.
        * This is because the birth procedure occurs before the new quartiles
have been
        * set. Therefore, the birth rate is for the quartile as established in
the last turn.
        */
        fairContext fc = (fairContext) RunState.getInstance().getMasterContext();

        double birthChance = 0.0;
        double dWealth = (double) this.getWealth();

        if (dWealth >= fc.getGQuartile1())
        { quartile = 1; } // top quartile
        else {
            if (dWealth >= fc.getGQuartile2())
            { quartile = 2; } // 50-75%
            else {
                if (dWealth >= fc.getGQuartile3())
                { quartile = 3; } // 25%-50%
                else { quartile = 4; } // bottom quartile
            }
        }

        switch (quartile) // this sets different rates of birth for those with
different amounts of fitness
        {
            case 1:
                birthChance = q1;
                break;
            case 2:
                birthChance = q2;
                break;
            case 3:
                birthChance = q3;

```



```

        break;
    case 4:
        birthChance = q4;
        break;
    default:
        birthChance = q4;
        break;
    }
    if(RepastEssentials.RandomDrawAgainstThreshold(1.0 - birthChance))
    {
        this.birth();
    }

    // check for death
    if((this.getAge() > deathAge) || (this.getWealth() <= 0)) // agents die
when they get too old or lose all energy reserves
    {
        this.die();
    }

    // increment the age of the agent
    age++;
}

@SuppressWarnings("unchecked")
public void die()
{
    // set the turndeadth value
    this.setTurndeadth(RepastEssentials.GetTickCount());

    // Get the context in which the agent resides.
    Context<fairAgent> context = RunState.getInstance().getMasterContext();

    // Remove the agent from the context if the context is not empty
    if (context.size() > 1)
    {
        // context.remove(this);
        RepastEssentials.RemoveAgentFromModel(this);
    }
    // Otherwise if the context is empty, end the simulation
    else
    {
        RunEnvironment.getInstance().endRun();
    }
}

// a method to play the Ultimatum game
public void playUltimatum()
{
    // set the local variables
    fairContext context = (fairContext)
RunState.getInstance().getMasterContext();
    Parameters p = RunEnvironment.getInstance().getParameters();
    Integer xMax = (Integer) p.getValue("xMax");
    Integer xMin = (Integer) p.getValue("xMin");
    int AOffer = 0;
    double BDecision = 0.0;
    boolean BAccept = false;
    Integer costAAccept = (Integer) p.getValue("costToAAccept");

    Integer diff = xMax - xMin;

    // This plays the ultimatum game as an A player, with a random other
    // individual as the B player.
    fairAgent PlayerA = this;
    Iterator<?> iter2 = context.getRandomObjects(PlayerA.getClass(), 1).iterator();
    fairAgent o = (fairAgent) iter2.next();

    // make sure that PlayerB and PlayerA are two different fairAgents
    while (PlayerA.equals(o) || !(o instanceof fairAgent))
    {

```

```

        iter2 = context.getRandomObjects(PlayerA.getClass(), 1).iterator();
        o = (fairAgent) iter2.next();
    }

    fairAgent PlayerB = (fairAgent) o;

    // get A's offer value
    AOffer = PlayerA.setOfferValue();

    // get B's decision
    Integer RunType = (Integer) p.getValue("runType");
    Boolean runTypeBonus = (Boolean) p.getValue("runTypeBonus");
    Boolean runTypePenalty = (Boolean) p.getValue("runTypePenalty");
    switch (RunType)
    {
    case 1:
        BDecision = (double) PlayerB.getFairCrit(); // not predisposed
        break;
    case 2:
        // predisposed (utilize a distribution rather than a value)
        BDecision = PlayerB.getFairCritDist().nextDouble();
        if (BDecision > 1.0) {BDecision = 1.0;}
        if (BDecision < 0.0) {BDecision = 0.0;}
        break;
    }

    // Calculate B's minimum offer before rejecting or accepting
    int BMinOffer = (int) Math.round(BDecision * diff);

    // test to see if the individual offer is accepted or rejected by Player B
    if (AOffer >= BMinOffer) // B's decision test
    {
        // B Accepts
        BAccept = true;
        PlayerB.addWealth(AOffer); // player b payoff
        PlayerA.addWealth(xMax - AOffer); // payoff for A
        PlayerA.addWealth(-costAAccept); // cost for existing
    }
    else
    {
        // B Rejects, so both parties get nothing, but apply cost to A
        BAccept = false;
        PlayerA.addWealth(-costAAccept);
    }

    // get the social fairness criteria so that bonuses and penalties can be
    applied if necessary
    double socialFairCrit = context.getGFairCritMean();
    int policyCrit = (int) Math.round(socialFairCrit * diff); // convert from
    percentage to integer value

    // apply a bonus if the player plays fairly according to social criteria
    if (runTypeBonus) // only apply if bonuses are turned on
    {
        if (AOffer >= policyCrit) // apply a bonus
        {
            double bonusCrit = context.getGBonusPrefMean();
            int bonusAmt = (int) Math.round(bonusCrit * diff);
            PlayerA.addWealth(bonusAmt);
        }
    }

    // apply a penalty if the player plays unfairly according to social
    criteria
    if (runTypePenalty) // only apply if penalties are turned on
    {
        if (AOffer < policyCrit) // apply a penalty
        {
            double penaltyCrit = context.getGPenaltyPrefMean();
            int penaltyAmt = (int) Math.round(penaltyCrit * diff);
            PlayerA.addWealth(-penaltyAmt);
        }
    }

```

```

    }
}

// set the values to be calculated for stats calculation
PlayerA.setOffer(AOffer);
PlayerA.setAcceptB(BAccept); // since a player b can have multiple player A
rounds, this value is stored in the player A object
}

public int setOfferValue()
{
    //This function calculates the X value for this person.
    //It is based on the stochastic, and self interest values.
    // It is also between the Xmax and Xmin values.

    // get the parameters
    Parameters p = RunEnvironment.getInstance().getParameters();

    //Calculate the stochastic element using a uniform distribution
    double rnd = (double) RandomHelper.nextDoubleFromTo(0.0, 1.0);

    //get the needed variables set up
    double factorrnd = (Double) p.getValue("factorRND"); // this is the degree to
which randomness plays a role
    double factorsi = (Double) p.getValue("factorSI"); // this is the degree to which
self interest plays a role
    double xval = 0; // this is the intermediate double calculation
    int xcalc = 0; // this is the rounded integer value for the offer
    int xMin = (Integer) p.getValue("xMin"); // this is the minimum offer for the
simulation
    int xMax = (Integer) p.getValue("xMax"); // this is the maximum offer for the
simulation

    // calculate the amount of self interest that Player A applies to the offer from a
uniform distribution
    // this low to high range acts as a heuristic for the individual
    double si = (double) RandomHelper.nextDoubleFromTo(this.siLow, this.siHigh);

    // calculate the range for the potential offer
    int diff = Math.abs(xMax - xMin);

    // add in the components to the xval
    xval = (rnd * factorrnd); // stochastic element
    xval = xval + (factorsi * (1.0 - si)); // inverse relationship for self interest
and the offer

    // calculate the integer value between XMax and XMin
    xval = xval * diff;
    xcalc = (int) Math.round(xval + xMin);

    // Assure maximums and minimums
    if (xcalc < xMin)
    { xcalc = xMin; }
    if (xcalc > xMax)
    { xcalc = xMax; }

    return xcalc;
}

public cern.jet.random.Normal getFairCritDist()
{
    return fairCritDist;
}

public boolean isFairAgent()
{
    return true;
}

public long getWealth()
{ return wealth; }

```

```
public void setWealth(long newValue)
{ wealth = newValue; }

public void addWealth(long addValue)
{ wealth = wealth + addValue; }

public double getSIHigh()
{ return siHigh; }

public void setSIHigh(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }

    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }

    // make sure siHigh is never set below siLow
    if (siLow >= value)
    { value = siLow;
    }

    siHigh = value;
}

public double getSILow()
{ return siLow; }

public void setSILow(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }

    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }

    // make sure siLow is never set above siHigh
    if (siHigh <= value)
    { value = siHigh; }

    siLow = value;
}

public double getFairCrit()
{ return fairCrit; }

public void setFairCrit(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }

    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }

    fairCrit = value;
}

public double getFairCritSD()
{ return fairCritSD; }

public void setFairCritSD(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }

    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }

    fairCritSD = value;
}
```

```
public double getPenaltyPref()
{ return penaltyPref; }

public void setPenaltyPref(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }
    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }
    penaltyPref = value;
}

public double getBonusPref()
{ return bonusPref; }

public void setBonusPref(double value)
{
    // make sure it is never greater than one
    if (value >= 1.0) { value = 1.0; }
    // make sure it is never lower than zero
    if (value <= 0.0) { value = 0.0; }
    bonusPref = value;
}

public int getAge()
{ return age; }

public void setAge(int value)
{ age = value;}

public int getQuartile()
{ return quartile; }

public void setQuartile(int value)
{ quartile = value; }

public int getOffer()
{ return offer; }

public void setOffer(int value)
{ offer = value; }

public boolean getAcceptB()
{ return acceptb; }

public double getAcceptBd()
{
    if (acceptb)
    { return 1.0; }
    else { return 0.0; }
}

public void setAcceptB(boolean value)
{ acceptb = value; }

public long getChildren()
{ return children; }

public double getTurnborn() {
    return turnborn;
}

public void setTurnborn(double turnborn) {
    this.turnborn = turnborn;
}

public double getTurnddeath() {
    return turnddeath;
}

public void setTurnddeath(double turnddeath) {
```

```

        this.turndeadth = turndeadth;
    }

    public String getID()
    {
        return this.toString();
    }

    // end of fairAgent class
}

```

fairContext.java

```

package fairness2;

import java.util.Iterator;
import cern.colt.list.DoubleArrayList;
import cern.jet.random.*;
import cern.jet.stat.quantile.*;
import repast.simphony.context.Context;
import repast.simphony.context.DefaultContext;
import repast.simphony.dataLoader.ContextBuilder;
import repast.simphony.engine.environment.RunEnvironment;
import repast.simphony.engine.environment.RunState;
import repast.simphony.parameter.Parameters;
import repast.simphony.random.RandomHelper;
import repast.simphony.engine.schedule.*;

/**
 * Fairness model
 * This model is based upon the ContextCreator class available from Repast
 * at http://repast.sourceforge.net/docs/tutorial/SIM/3-99%20Java%20Agent%20Source%20Code.html
 *
 * @author Douglas R. Oxley
 *
 */
public class fairContext extends DefaultContext<Object> implements
ContextBuilder<Object>{
    /**
     * Builds and returns a context. Building a context consists of filling it with
     * agents, adding projects and so forth. When this is called for the master
context
     * the system will pass in a created context based on information given in the
     * model.score file. When called for subcontexts, each subcontext that was added
     * when the master context was built will be passed in.
     *
     * @param context
     * @return the built context.
     */

    // define the global variables (globals have a g prefix)
    private long gPopulation = 0;
    private double gSIHighMean = 0.0;
    private double gSILowMean = 0.0;
    private double gFairCritMean = 0.0;
    private double gFairCritSDMean = 0.0;
    private double gPenaltyPrefMean = 0.0;
    private double gBonusPrefMean = 0.0;
    private double gAcceptBMean = 0.0;
    private Integer maxAgents = 20000;
    private double gQuartile1 = 0.0;
    private double gQuartile2 = 0.0;
    private double gQuartile3 = 0.0;
    private double gQuartile4 = 0.0;
    private Object birthContextID;

    public Context<Object> build(Context<Object> context) {

        // set the type id for this context

```

```

context.setTypeID("RootFairContext");

// Get parameters and the number of agents
Parameters p = RunEnvironment.getInstance().getParameters();
long numAgents = (Long) p.getValue("initNumAgents");
double initSIHighMean = (Double) p.getValue("initSIHighMean");
double initSIHighSD = (Double) p.getValue("initSIHighSD");
double initSILowMean = (Double) p.getValue("initSILowMean");
double initSILowSD = (Double) p.getValue("initSILowSD");
double initFairCriteriaMean = (Double) p.getValue("initFairCriteriaMean");
double initFairCriteriaSD = (Double) p.getValue("initFairCriteriaSD");
double initPenaltyMean = (Double) p.getValue("initPenaltyMean");
double initPenaltySD = (Double) p.getValue("initPenaltySD");
double initBonusMean = (Double) p.getValue("initBonusMean");
double initBonusSD = (Double) p.getValue("initBonusSD");

// get the subcontexts needed (government is separate)
BirthContext bl = new BirthContext();
bl.setTypeID("BirthList");
String x = "BirthList_".concat(bl.getId().toString());
bl.setId(x);
context.addSubContext(bl);
context.add(bl);
((FairContext) context).setBirthContextID(bl.getId());

ContextGovt govt = new ContextGovt();
govt.setTypeID("Govt");
String y = "Govt_".concat(govt.getId().toString());
govt.setId(y);
context.addSubContext(govt);
context.add(govt);

// Create the distributions for the new agents values to be drawn from
Normal SIHighDist = RandomHelper.createNormal(initSIHighMean,
initSIHighSD);
Normal SILowDist = RandomHelper.createNormal(initSILowMean, initSILowSD);
Normal FairCriteriaMeanDist =
RandomHelper.createNormal(initFairCriteriaMean, initFairCriteriaSD);
Normal PenaltyDist = RandomHelper.createNormal(initPenaltyMean,
initPenaltySD);
Normal BonusDist = RandomHelper.createNormal(initBonusMean, initBonusSD);

// Populate the root context with the initial agents
for (int i = 0; i < numAgents; i++) {
    fairAgent agent = new fairAgent(SIHighDist, SILowDist,
FairCriteriaMeanDist, initFairCriteriaSD, PenaltyDist, BonusDist);
    context.add(agent);
    bl.addAgent(agent.getSIHigh(), agent.getSILow(),
agent.getFairCrit(), agent.getFairCritSD(), agent.getPenaltyPref(),
agent.getBonusPref(), agent.getTurnborn(),
agent.getID());
}

// Populate the government with 1 agent
government g = new government();
govt.add(g);

// Schedule the end actions
ISchedule fairSchedule =
RunEnvironment.getInstance().getCurrentSchedule();
ScheduleParameters sp =
ScheduleParameters.createAtEnd(ScheduleParameters.LAST_PRIORITY);
fairSchedule.schedule(sp, context, "FinalActions");

// If running in batch mode, tell the scheduler when to end each run.
if (RunEnvironment.getInstance().isBatch()){

    String strRun = "Run " +
RunState.getInstance().getRunInfo().toString();
    System.out.println(strRun);
    double endAt = (Double)p.getValue("runlength");
}

```

```

        RunEnvironment.getInstance().endAt(endAt);
    }
    return context;
}

public void FinalActions()
{
    fairContext c = (fairContext) RunState.getInstance().getMasterContext();
    c.clear();
}

@ScheduledMethod(start=0.5, interval = 1, priority =
ScheduleParameters.FIRST_PRIORITY)
public void CalcSocialValues()
{
    // calculate the aggregate values for the whole of society

    // define temp variables
    double tSIH = 0.0;
    double tSIL = 0.0;
    double tFC = 0.0;
    double tFCSD = 0.0;
    double tPen = 0.0;
    double tBon = 0.0;
    double tAcc = 0.0;
    long pop = 0;

    fairContext fc = (fairContext) RunState.getInstance().getMasterContext();

    Iterator<Object> iter = fc.iterator();
    while (iter.hasNext())
    {
        Object o = iter.next();
        if (o instanceof fairAgent)
        {
            fairAgent a = (fairAgent) o;
            tSIH = tSIH + a.getSIHigh();
            tSIL = tSIL + a.getSILow();
            tFC = tFC + a.getFairCrit();
            tFCSD = tFCSD + a.getFairCritSD();
            tPen = tPen + a.getPenaltyPref();
            tBon = tBon + a.getBonusPref();
            tAcc = tAcc + a.getAcceptBd();
            pop++;
        }
    }

    this.setGPopulation(pop);

    if (pop != 0)
    {
        gSIHighMean = tSIH / pop;
        gSILowMean = tSIL / pop;
        gFairCritMean = tFC / pop;
        gFairCritSDMean = tFCSD / pop;
        gPenaltyPrefMean = tPen / pop;
        gBonusPrefMean = tBon / pop;
        gAcceptBMean = tAcc / pop;
    }

    // establish the new quartiles based upon the new wealth data.
    // this is used as a method of selection with different reproduction rates
    // for each quartile of wealth.
    this.calcQuartiles();

    // check for simulation end
    Parameters p = RunEnvironment.getInstance().getParameters();
    Integer tmpMA = (Integer) p.getValue("numAgentsMax");
    if ((this.getGPopulation() >= tmpMA) || (this.getGPopulation() <= 1))
    {
        if (RunEnvironment.getInstance().isBatch())

```



```

        {
            RunEnvironment.getInstance().endRun();
        } else
        {
            RunEnvironment.getInstance().pauseRun();
        }
    }
}

public void calcQuartiles()
{
    // This function sets cutoff values for wealth for each quartile.

    // establish the engine for generating the quantile approximations
    // the parameters for the factory are as follows:
    /*
    * Known n: true, we know the n
    * N value: the number of active agents
    * epsilon: the approximation error guaranteed not to be exceeded
    * delta: the probability that the approximation error is not exceeded
(set to 0.0 to be exact)
    * quantiles: the number of quantiles
    * random engine: set to null to use the default engine
    */
    DoubleQuantileFinder f =
QuantileFinderFactory.newDoubleQuantileFinder(true, this.getGPopulation(), 0.0001, 0.0,
3, null);

    Iterator<Object> iter = this.iterator();
    while (iter.hasNext())
    {
        Object o = iter.next();
        if (o instanceof fairAgent)
        {
            fairAgent agent = (fairAgent) o;
            f.add((double) agent.getWealth());
        }
    }

    // create the quantile values for wealth
    DoubleArrayList quantiles = new DoubleArrayList();
    DoubleArrayList phis = new DoubleArrayList();
    phis.add(0.75);
    phis.add(0.50);
    phis.add(0.25);
    quantiles = f.quantileElements(phis);

    this.gQuartile1 = quantiles.get(0);
    this.gQuartile2 = quantiles.get(1);
    this.gQuartile3 = quantiles.get(2);
}

public long getGPopulation() {
    return gPopulation;
}

public void setGPopulation(long population) {
    gPopulation = population;
}

public double getGSIHighMean() {
    return gSIHighMean;
}

public void setGSIHighMean(double highMean) {
    gSIHighMean = highMean;
}

public double getGSILowMean() {
    return gSILowMean;
}
}

```

```
public void setGSILowMean(double lowMean) {
    gSILowMean = lowMean;
}

public double getGFairCritMean() {
    return gFairCritMean;
}

public void setGFairCritMean(double fairCritMean) {
    gFairCritMean = fairCritMean;
}

public double getGFairCritSDMean() {
    return gFairCritSDMean;
}

public void setGFairCritSDMean(double fairCritSDMean) {
    gFairCritSDMean = fairCritSDMean;
}

public double getGPenaltyPrefMean() {
    return gPenaltyPrefMean;
}

public void setGPenaltyPrefMean(double penaltyPrefMean) {
    gPenaltyPrefMean = penaltyPrefMean;
}

public double getGBonusPrefMean() {
    return gBonusPrefMean;
}

public void setGBonusPrefMean(double bonusPrefMean) {
    gBonusPrefMean = bonusPrefMean;
}

public double getGAcceptBMean() {
    return gAcceptBMean;
}

public void setGAcceptBMean(double acceptBMean) {
    gAcceptBMean = acceptBMean;
}

public void setMaxAgents(Integer value)
{
    maxAgents = value;
}

public double getGQuartile1() {
    return gQuartile1;
}

public void setGQuartile1(double quartile1) {
    gQuartile1 = quartile1;
}

public double getGQuartile2() {
    return gQuartile2;
}

public void setGQuartile2(double quartile2) {
    gQuartile2 = quartile2;
}

public double getGQuartile3() {
    return gQuartile3;
}

public void setGQuartile3(double quartile3) {
```

```

        gQuartile3 = quartile3;
    }

    public double getGQuartile4() {
        return gQuartile4;
    }

    public void setGQuartile4(double quartile4) {
        gQuartile4 = quartile4;
    }

    public Integer getMaxAgents() {
        return maxAgents;
    }

    public void setBirthContextID(Object birthContextID) {
        this.birthContextID = birthContextID;
    }

    public Object getBirthContextID() {
        return birthContextID;
    }
}

```

government.java

```

/**
 *
 */
package fairness2;

import repast.simphony.annotate.AgentAnnot;
import repast.simphony.engine.environment.RunState;
import repast.simphony.engine.schedule.ScheduleParameters;
import repast.simphony.engine.schedule.ScheduledMethod;

/**
 * @author Douglas R. Oxley
 *
 * This class is primarily to get around the restriction that agent data is collected
 * Repast, and not data from the context. Therefore, the whole purpose of this agent
 * is to collect data from the context and allow it to be accessed by the runtime
 * so that aggregate values can be written to file.
 */
@AgentAnnot(displayName = "government")
public class government {

    // Variables that need to be reported
    private long gPopulation = 0;
    private double gSIHighMean = 0.0;
    private double gSILowMean = 0.0;
    private double gFairCritMean = 0.0;
    private double gFairCritSDMean = 0.0;
    private double gPenaltyPrefMean = 0.0;
    private double gBonusPrefMean = 0.0;
    private double gAcceptBMean = 0.0;
    private double gQuartile1 = 0.0;
    private double gQuartile2 = 0.0;
    private double gQuartile3 = 0.0;
    private double gQuartile4 = 0.0;

    // allow instantiation
    public government()
    {
    }
}

```

```

    @ScheduledMethod(start = 0.7, interval = 1, priority =
ScheduleParameters.FIRST_PRIORITY)
    public void step()
    {
        getVars();
    }

    private void getVars()
    {
        // get the context
        fairContext fc = (fairContext) RunState.getInstance().getMasterContext();

        // set the initial values for the variables
        gPopulation = fc.getGPopulation();
        gSIHighMean = fc.getGSIHighMean();
        gSILowMean = fc.getGSIHighMean();
        gFairCritMean = fc.getGFairCritMean();
        gFairCritSDMean = fc.getGFairCritSDMean();
        gPenaltyPrefMean = fc.getGPenaltyPrefMean();
        gBonusPrefMean = fc.getGBonusPrefMean();
        gAcceptBMean = fc.getGAcceptBMean();
        gQuartile1 = fc.getGQuartile1();
        gQuartile2 = fc.getGQuartile2();
        gQuartile3 = fc.getGQuartile3();
        gQuartile4 = fc.getGQuartile4();

    }

    public boolean isGovtAgent()
    {
        return true;
    }

    public boolean isFairAgent()
    {
        return false;
    }

    public long getGPopulation() {
        return gPopulation;
    }

    public void setGPopulation(long population) {
        gPopulation = population;
    }

    public double getGSIHighMean() {
        return gSIHighMean;
    }

    public void setGSIHighMean(double highMean) {
        gSIHighMean = highMean;
    }

    public double getGSIHighMean() {
        return gSILowMean;
    }

    public void setGSIHighMean(double lowMean) {
        gSILowMean = lowMean;
    }

    public double getGFairCritMean() {
        return gFairCritMean;
    }

    public void setGFairCritMean(double fairCritMean) {
        gFairCritMean = fairCritMean;
    }

    public double getGFairCritSDMean() {

```

```

        return gFairCritSDMean;
    }

    public void setGFairCritSDMean(double fairCritSDMean) {
        gFairCritSDMean = fairCritSDMean;
    }

    public double getGPenaltyPrefMean() {
        return gPenaltyPrefMean;
    }

    public void setGPenaltyPrefMean(double penaltyPrefMean) {
        gPenaltyPrefMean = penaltyPrefMean;
    }

    public double getGBonusPrefMean() {
        return gBonusPrefMean;
    }

    public void setGBonusPrefMean(double bonusPrefMean) {
        gBonusPrefMean = bonusPrefMean;
    }

    public double getGAcceptBMean() {
        return gAcceptBMean;
    }

    public void setGAcceptBMean(double acceptBMean) {
        gAcceptBMean = acceptBMean;
    }

    public double getGQuartile1() {
        return gQuartile1;
    }

    public void setGQuartile1(double quartile1) {
        gQuartile1 = quartile1;
    }

    public double getGQuartile2() {
        return gQuartile2;
    }

    public void setGQuartile2(double quartile2) {
        gQuartile2 = quartile2;
    }

    public double getGQuartile3() {
        return gQuartile3;
    }

    public void setGQuartile3(double quartile3) {
        gQuartile3 = quartile3;
    }

    public double getGQuartile4() {
        return gQuartile4;
    }

    public void setGQuartile4(double quartile4) {
        gQuartile4 = quartile4;
    }
}

```

contextGovt.java

```

package fairness2;

import repast.simphony.context.Context;
import repast.simphony.context.DefaultContext;

```

```

import repast.simphony.dataLoader.ContextBuilder;

public class ContextGovt extends DefaultContext<government> implements
ContextBuilder<government> {
    public Context<government> build(Context<government> context)
    {
        context.setTypeID("Govt");
        government g = new government();
        context.add(g);
        return context;
    }

    public boolean isFairAgent()
    {
        return false;
    }

    public boolean isContextGovt()
    {
        return true;
    }
}

```

BirthContext.java

```

package fairness2;

import repast.simphony.context.Context;
import repast.simphony.context.DefaultContext;
import repast.simphony.dataLoader.ContextBuilder;
import repast.simphony.engine.environment.RunState;
import repast.simphony.engine.schedule.ScheduleParameters;
import repast.simphony.engine.schedule.ScheduledMethod;

/*
 * The BirthContext is a container for agents that are born in any given turn. It is
used
 * so that data can be sent to a file only for those agents born in a turn.
 */
public class BirthContext extends DefaultContext<BirthAgent> implements
ContextBuilder<BirthAgent> {
    public Context<BirthAgent> build(Context<BirthAgent> context)
    {
        return context;
    }

    @ScheduledMethod(start = 0.7, interval = 1, priority =
ScheduleParameters.FIRST_PRIORITY)
    public void clearBirthList()
    {
        fairContext fc = (fairContext) RunState.getInstance().getMasterContext();
        BirthContext birthList = (BirthContext)
fc.findContext(fc.getBirthContextID());

        birthList.clear();

        // Iterator<BirthAgent> iter = (Iterator<BirthAgent>)
birthList.getAgentLayer(BirthAgent.class).iterator();
        // while (iter.hasNext())
        // {
        //     Object agent = iter.next();
        //     if (agent instanceof BirthAgent)
        //     {
        //         birthList.fireRemoveEvent(agent);
        //         birthList.remove(agent);
        //     }
        // }
}

```

```

    public void addAgent(double aSIHigh, double aSILow, double aFairCrit, double
aFairCritSD, double aPenalty, double aBonus, double aTurnBorn, String ID)
    {
        BirthAgent a = new BirthAgent();

        a.setSiHigh(aSIHigh);
        a.setSiLow(aSILow);
        a.setFairCrit(aFairCrit);
        a.setFairCritSD(aFairCritSD);
        a.setPenaltyPref(aPenalty);
        a.setBonusPref(aBonus);
        a.setTurnborn(aTurnBorn);
        a.setID(ID);

        this.add(a);
    }
}

```

BirthAgent.java

```

package fairness2;

import repast.simphony.annotate.AgentAnnot;

@AgentAnnot(displayName = "BirthAgent")
public class BirthAgent {

    private double siHigh = 1.0;
    private double siLow = 0.0;
    private double fairCrit = 0.5;
    private double fairCritSD = 0.1;
    private double penaltyPref = 0.05;
    private double bonusPref = 0.05;
    private double turnborn = 0.0;
    private String ID = "";

    public BirthAgent()
    {
    }

    public double getSiHigh() {
        return siHigh;
    }

    public void setSiHigh(double siHigh) {
        this.siHigh = siHigh;
    }

    public double getSiLow() {
        return siLow;
    }

    public void setSiLow(double siLow) {
        this.siLow = siLow;
    }

    public double getFairCrit() {
        return fairCrit;
    }

    public void setFairCrit(double fairCrit) {
        this.fairCrit = fairCrit;
    }

    public double getFairCritSD() {
        return fairCritSD;
    }

    public void setFairCritSD(double fairCritSD) {

```

```
        this.fairCritSD = fairCritSD;
    }

    public double getPenaltyPref() {
        return penaltyPref;
    }

    public void setPenaltyPref(double penaltyPref) {
        this.penaltyPref = penaltyPref;
    }

    public double getBonusPref() {
        return bonusPref;
    }

    public void setBonusPref(double bonusPref) {
        this.bonusPref = bonusPref;
    }

    public double getTurnborn() {
        return turnborn;
    }

    public void setTurnborn(double turnborn) {
        this.turnborn = turnborn;
    }

    public void setID(String value) {
        this.ID = value;
    }

    public String getID() {
        return ID;
    }
}
```

All source code is copyright 2010 by Douglas R. Oxley

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