

**The Fundamental Functions of Government: A Simulation Approach to
Promoting Economic Prosperity Through Cooperation**

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ABSTRACT

This paper uses a simulation model based on the Prisoner's Dilemma to explore the role of governments in creating and maintaining the cooperative systems that often underpin economic prosperity. In addition to the role of governmental contract-enforcing mechanisms, we examine: 1) the behavioral tendencies of participants and their proportions in the total population; 2) the optimism of participants; and 3) the ability of participants to "exit" the relationship. The primary conclusions of the paper are that governmental contract-enforcing policies are key ingredients in the establishment and maintenance of cooperative systems regardless of changes in other variables and that the effects of these policies may be nonlinear in nature. We discuss implications for governmental policy makers, corporate executives, and the economic development and prosperity of nations.

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“Thus, even the most economically insignificant enterprise
is vitally affected by government policy.”

Edwin M. Epstein,
The Corporation in American Politics, 1969, p.7

There are many reasons to examine the role of governments in economic systems. Scholars have recognized this need; a forthcoming special issue of the Academy of Management Review will be devoted to the topic: “Why Governments Matter.” Furthermore, recent corporate scandals have presented governmental policy makers with a serious problem: what should be done to reduce the incidence and impact of unethical behavior on the part of actors in the corporate economy? In addition to those directly harmed by this behavior, the economy itself becomes less efficient when confidence in markets – financial markets in particular -- is reduced. This paper explores the role of governmental contract-enforcing mechanisms -- primarily the legal sanctions of criminal and civil law -- in promoting and maintaining the cooperation understood by many to be the foundation of economic prosperity. The mode of analysis is a multiple player, multiple-play, feedback-based Prisoner’s Dilemma game. The unit of analysis is the economic “contract” -- a transaction or relationship -- between or among actors in the economy. We show that regardless of the behavioral propensities of the players (individuals or organizations), governmental policies designed to reduce the level of temptation to potential wrong doers and/or reduce the level of risk to potential cooperators will benefit the economy as a whole, in some cases very substantially.

In addition to the obvious implications for government policy makers, this conclusion has implications for managers as well, although these insights may run counter to conventional wisdom. Corporate executives have long argued that less governmental involvement in the economy is preferable to greater involvement, but if mutual cooperation is as potent a means of value creation as many believe, the results of this study suggest that managers of honest firms ought to welcome and support governmental activism in the enforcement of economic contracts.

We begin the paper by reviewing some of the relevant literature on cooperation in economic relationships and outlining our basic research proposition. We then describe the Prisoner's Dilemma game and discuss its applicability to real world business transactions. This is followed by a discussion of the role of simulations in organizational research and a description of the model itself. We then run through two simple iterations of the model to gain insight into what might happen in a more complex and "realistic" application. Finally, we run the full model with several types of player strategies and several different population proportions to detect general patterns. Finally we draw conclusions about the role of governments in promoting economic prosperity.

One major contribution of the paper is its use of a simulation model to examine the effects of the interactions of several variables on economic outcomes involving a social situation that is unlikely to surrender easily to experimental techniques. In addition, one of our findings is unexpected and another is counterintuitive, at least from the perspective of corporate managers.

Cooperation in Economic Relationships

The collective value of cooperation in economic relationships has become so widely accepted that it is a virtual cliché. Several authors, including Frank (1988), Jones (1995), Noreen

(1988) and, in perhaps the most precise account, Uzzi (1997) have pointed this out in fairly explicit terms. In Fukuyama's (1995) analysis, social institutions, such as governmentally promulgated legal sanctions, are critical determinants of trust. Trust, in turn, is critical to the development of economic prosperity. Observational evidence also is consistent with the more specific relationships under examination in this paper. In general, the world's most prosperous societies -- the U.S., Canada, Western Europe, and to a lesser extent, Japan -- are those with the best-developed systems of governmental enforcement of economic contracts. In sharp contrast, some of the world's least prosperous nations -- Russia, the republics of the former Soviet Union, and so-called Third World countries -- also have very primitive legal systems, including those elements that govern economic transactions. Were it not for oil revenues, many countries in the Middle East would also fit into this category. Given these conclusions and observations regarding trust, cooperation, and economic prosperity, the only remaining question seems to be how to assure the presence of cooperation on a significant scale in the economy. This paper investigates one such approach -- enthusiastic governmental enforcement of economic contracts.

Scholars in the organizational sciences have contributed to our understanding of the role of cooperation in various social settings. Much of this work involves the use of game theory, often applications of the Prisoner's Dilemma or its close cousin the social dilemma (see Parkhe, 1993; Zeng & Chen, 2003; and Komarita & Parks, 1994 for good reviews). Of the many studies on the subject, a number have examined the role of sanctions in promoting cooperation. McCusker and Carnevale (1995) used a laboratory study to show that sanctions play a major role in solving social dilemmas. Yamagishi (1986; 1988) and Yamagishi and Sato (1986) provided similar evidence. In a field study, Ostrom, Gardner, and Walker (1994) found that solutions to social dilemmas are often facilitated by the use of specific rules, active monitoring, and

punishment for infractions. Lindsay, Irvine, and Lindsay (1996) draw on this evidence to suggest that sanctions are critical to signaling and reinforcing ethical norms. The general thrust of these conclusions does not go uncontested. Deci and Ryan (1988) and Pfeffer (1994) argue that sanctions may undermine an actor's intrinsic motivation to cooperate. Tenbrunsel and Messick (1999) show that even small sanctions can put people in an "instrumental" frame of mind and reduce their willingness to cooperate. In the large sanction condition of this study, however, cooperation was enhanced because it made instrumental sense to cooperate. Since our model relies explicitly on instrumental behavior, we do not regard the former finding as terribly alarming and are buoyed by the latter finding. Furthermore, at the level of actors on the national economic stage we suspect that instrumental thinking will already be well entrenched.

In addition to these studies, there is a common understanding that making life harder for potential defectors and easier for potential cooperators in a PD game generally results in greater cooperation among the players. These findings and understandings, coupled with the fact that mutual cooperation produces larger aggregate payoffs in individual PD games, leads us to the following general proposition.

Research Proposition: Governmental policies that reduce the level of temptation to potential defectors and/or reduce the level of risk to potential cooperators will result in greater aggregate payoffs to the economic system.

The Prisoner's Dilemma

Since this paper focuses on the government's ability to affect system-wide economic outcomes through its effect on individual transactions and relationships between/among participants, a model aggregating micro-level effects into macro-level outcomes would be most

appropriate. Our simulation model of a multiple-player, multiple-play, feedback-based Prisoner's Dilemma (PD) game does exactly this. Our unit of analysis is the economic transaction, the simplest form of which involves one actor exchanging something of value with another actor. Presumably, the objects or services exchanged have more value to the recipient than to the giver, an assumption that lies at the heart of value enhancement in market-based economies. Sociologists call these "opportunities for productive exchange" (Lawler, Thye, and Yoon, 2000) and they are of particular interest to those who regard value creation as an important part of their professional missions. Trust, which we define in behavioral terms as a willingness to cooperate, plays an important role in such transactions. Indeed, it is difficult to imagine a world in which no trust existed. Without a minimal level of trust, how could any productive exchanges occur?

A common element of these potential exchanges is the risk that one (or both) of the parties will take advantage of the other by misleading him/her, under contributing, or cheating in some other way. Therefore, they become excellent examples of micro-level transactions that can be modeled in terms of the PD, a staple of game theory. In the context of the economic transactions that we wish to examine, the PD can represent the economic value to "partners" to a potentially productive exchange under various outcome conditions. If both partners follow through on their commitments to the mutually agreed upon arrangement (called *cooperation* by PD convention), each will receive a substantial payoff -- R (for reward). If, however, both renege on their commitments (called *defection*), each will suffer a penalty -- P (for punishment). If only one of the partners defects, s/he receives a reward *greater* than that offered under mutual cooperation -- T (for temptation) -- while the lone cooperator receives S (for the "sucker's" payoff). The PD payoff matrix looks like this:

Player 1

Player 2

	Cooperate	Defect
Cooperate	1 gets R (4) 2 gets R (4)	1 gets S (-4) 2 gets T (6)
Defect	1 gets T (6) 2 gets S (-4)	1 gets P (-1) 2 gets P (-1)

According to Axelrod (1984), the Prisoners' Dilemma requires that:

- 1) $T > R > P > S$
- 2) $2R > T + S$ (This ancillary restriction assures that parties can't take turns defecting, thereby working together to effectively cheat the game).

We deliberately set P at -1 (below) because, in the case of economic transactions, it also makes sense to require that:

- 3) $T + S > 2P$ (The cooperation of one player yields more total output than the cooperation of neither player.)

In the game we examine in this paper, we have assigned the following *initial* values:

R = 4 [Total reward for mutual cooperation = 8]

T = 6 (7 in Phase III) [A legitimate "temptation" for each player]

P = -1 [A loss commensurate with the modest cost of making the initial arrangement]

S = -4 [A real loss for the "sucker" who invests substantially in the arrangement, but is exploited by his/her "partner"]

In the PD game, the dilemma is that the optimal strategy for each individual *for a single play* is defection, which leads to a clearly suboptimal collective outcome – mutual defection. The question then becomes: how can players 1 and 2 get to quadrant 1 (upper left) or even quadrants 2 or 3 (upper right and lower left) without some level of trust? Under an assumption of rational self-interest, without trust they would forever be locked in quadrant 4 (lower right). This is the prisoner's dilemma in a nutshell.

Microsoft as an Illustrative Example

The prisoner's dilemma, and game theory in general, is rather abstract fare, with terminology meaningful only to a small number of scholars and assumptions that may seem removed from real world business applications. Therefore, a practical example might serve to make this application of game theory more vivid. A look at the experience of a single high-tech firm – Microsoft – yields revealing examples of mutual cooperation, mutual defection, and cooperation met with defection (for a good review of Microsoft, its collaborators, and its opponents see Ken Auletta's "World War 3.0").

A classic example of cooperation to mutual advantage is Microsoft's long-running alliance with Intel. Microsoft specializes in software while Intel is in the hardware business. Each has improved its own core competence without working against its alliance partner. As a case in point, Intel has entered new product markets like chipsets and motherboards to stimulate demand for its core product of microprocessors, but has foregone opportunities to invade the software market. Meanwhile, Microsoft creates the "killer apps" necessary to expand the usefulness of Intel's hardware.

Mutual defection is apparent in the conflict between Microsoft and Sun Microsystems. After initially endorsing Sun's JAVA software architecture, Microsoft began to offer "JAVA upgrades" that only worked on the Windows operating system, thereby undermining the platform and impinging on Sun's good faith. Sun then made newer versions of JAVA incompatible in crucial ways with Microsoft products and filed suit for breach of contract. Microsoft retaliated by abandoning JAVA and supporting the technically inferior products of XLM and Active Directory. This mutual defection resulted in the lose/lose predicament of consumers and designers who were confused about the best standard to use, a state of affairs that translated into lost economies and opportunities for both Microsoft and Sun.

In a final note that illustrates our general theme, Sun brought two separate suits against Microsoft – over the violation of their JAVA licensing agreement and over unfair competitive practices – in 1999 and 2000. Settlements in these suits totaled over \$1 billion. Presumably, the availability of these civil remedies not only will reduce Microsoft's (and others') temptation in the future, but will reduce the prospective "sucker's penalty" to Sun (and others) in the future as well.

Early in its history, Microsoft engaged in what could be deemed a cooperate/defect interaction. As a young entrepreneur, Microsoft's Bill Gates entered into a negotiation to provide an operating system for IBM's new personal computers. But since Microsoft didn't actually have an operating system, Gates went to Seattle Computer Products (SCP) and bought the rights to a software program called QDOS (for quick and dirty operating system) for \$50,000. He did this without mentioning that IBM was involved, a fact that presumably would have caused SCP to reassess the value of its software. Microsoft then promptly sold the program to IBM (without mentioning SCP's role) for an exponentially larger sum while retaining key licensing rights. SCP

was understandably annoyed at Microsoft's lack of full disclosure. Some might argue that Microsoft's arbitrage was technically legal, but few would describe it as cooperative. Since SCP ended up suing Microsoft, the example underscores the appropriateness of our focus on the role of government sanctions.

Governmental Sanctions

This paper seeks to investigate the factors *over which governments have some control* that influence trust and the cooperation that it fosters. To this end, it is instructive to further analyze the Prisoner's Dilemma matrix. Since we are concerned only with the effect of governmental actions, we hold constant the two parameters that can be thought of as functions of the transaction itself: Reward (R) and Punishment (P). R represents (one half of) the total value of a transaction that is successfully completed with cooperation from both players; P is the cost that each player bears if both defect. Thus we isolate the parameters over which the government has some control; that is, temptation (T) and the "sucker's" payoff (S).

A more detailed examination of the government's role will help clarify this point. For the sake of simplicity, we assume that there are two types of sanctions available – governmental (criminal and administrative) penalties, and civil litigation. T (temptation) represents the expected *net* value of unilateral defection and is affected by both governmental and civil sanctions; that is, defectors can be fined as well as sued in civil actions. T would then be composed of the benefit of unpunished defection *times* its probability of occurrence *minus* the cost of potential criminal, administrative, and civil penalties *times* their probability of occurrence. Since governments can affect: 1) the extent of criminal and administrative penalties through legislation, regulation, and prosecution; 2) the probability of getting caught through

enforcement; 3) the extent of a civil recovery through the availability of, and limits on, civil remedies; and 4) the probability of a successful civil action through the rules of civil procedure, they can affect the *net* level of temptation of those contemplating defection.

Similarly, S (the “sucker’s” payoff) represents the magnitude of an unreimbursed loss *times* its probability of occurrence *minus* the amount of any recovery *times* its probability of occurrence. Since governments can affect; 1) the extent of a recovery through the availability of, and limits on, civil remedies; and 2) the probability of a successful civil action through the rules of civil procedure, they can affect the *net* risk facing those contemplating cooperation. In fact, many real players in PD type situations will simultaneously contemplate cooperation and defection, and thus will be affected by governmental efforts to both reduce temptation and reduce the “sucker’s” penalty (negative payoff). Based on the predicted results for any individual PD game, it would seem that governments, in order to promote economic efficiency through cooperation, should discourage defection by reducing temptation and encourage cooperation by reducing the associated risk. However, the best policy for multiple-play, multiple-player, feedback-dependent PD games is not so easily predictable and therefore is the focus of this study. We now turn to a discussion of simulations in organizational research and a description of our simulation model.

Simulation Models in Organizational Research

Simulations involve mathematically programmed agents that interact using (often simple) rules that are controlled by the researcher. The keys to a useful simulation are that the rules themselves are reasonably accurate representations of the phenomena they are intended to model and that they produce system-level patterns that can be observed in real life.

Simulations can often be very useful analytic tools for several reasons. First, although simulation models do not employ data in the commonly understood sense, they require researchers to make explicit their underlying assumptions and logic. They are thus the embodiment of Weick's (1989) argument for "disciplined imagination" in theory building, demanding clear statements of the problem, careful explorations of alternatives, and producing accurate and elaborate results. Second, simulations have the virtue of allowing investigation of the complex interaction of several variables simultaneously and often they are able to sort out nonlinear effects in ways that other experimental designs cannot (Axelrod, 1997). Logically coherent but counterintuitive results that are otherwise difficult to detect can often be found through simulation analysis. An excellent example is Harrison and Carroll's (1991) simulation of turnover and the transmission of organizational culture that showed that high turnover might result in *more stable* cultures and that these cultures might become stronger during periods of organizational decline because individuals that are not highly socialized leave the organization.

A final advantage is that simulations may also be the only effective means of exploring phenomena for which the key variables cannot be manipulated as they might be in an experiment. Large-scale institution-level relationships like those we explore in this paper – i.e., the effect of government sanctions, designed to promote cooperation, on economic prosperity – certainly do not submit easily to experimental techniques. Moreover, simulations are well suited to investigating the macro-level effects of micro-level phenomena. Since we aggregate the very diverse effects of a large number of Prisoner's Dilemma games, simulation is a good means of investigating our research question.

Simulations have been successfully employed to examine patterns of culture formation (Harrison & Carroll, 1991), the dynamics of diversity (Carroll & Harrison, 1998), decision-

making (Cohen, March, & Olsen, 1972), organizational evolution and change (Bruderer & Singh, 1996), and management fads (Strang & Macy, 2001). In contrast to this relatively short list of papers, scholars in the fields of sociology, economics, biology, artificial intelligence, and political science have embraced simulation in their research. Thus, in the process of examining the role of government sanctions, agent strategies, agent optimism, the ability to exit a relationship, and the proportion of strategies of various types in creating and maintaining cooperative systems in the economy, we hope to partially redress this relative underutilization of simulation models in the organization sciences and expose management scholars to some of the techniques of computer simulation.

Our Simulation Model

The simulation model itself is a 40 by 40 matrix of “BOTS” (for robots), each of which plays each of its 8 immediate neighbors (east, west, north, south, northeast, southeast, northwest, and southwest) simultaneously in PD games. Mathematically, the matrix “wraps” back on itself, matching the top with the bottom and the left side with the right side, so that there are no edge or corner effects. Visually, the matrix would look like a torus (or “doughnut”) in three dimensions. Payoffs for each round of play are determined by the values in the four quadrants of the payoff matrix. Each BOT gets a payoff from the PD game with each of its eight neighbors, resulting in its total payoff for the round. System payoffs are the sum of 1600 (40 X 40) BOT payoffs for the period in question -- 30 rounds per simulation. Each BOT has only one strategy – a program instructing it when to cooperate and when to defect -- which it employs with all of its neighbors simultaneously. In this paper, the options for these algorithms included an “imitation” strategy, a “fixed” strategy with a fixed proportion of cooperative plays (including 0.0 and 1.0), and a “fixed

no play” strategy – fixed but with the added option of not playing when it is irrational to do so. In various iterations of the game, we varied the proportion of the total population devoted to each of these BOT types (always adding to 100%), the probability that each BOT type will cooperate (on either the first round or on all rounds, depending on BOT type), and the payoff parameters of the PD game (within the limits set by the structure of the PD game itself). For example, the matrix might be made up of 80% *imitator* BOTS (one of the three general types), 60% of which cooperate in the first round and 40% of which defect in the first round. The remaining 20% of the population could be made up of *fixed* BOTS that cooperate 70% of the time and defect 30% of the time, according to a random process. Half of these fixed BOTS (10% of the total) could be assigned a *fixed no play* strategy.

Phase I – The Imitation Model

In the initial variation of the simulation model, all players (BOTS) are imitators. In the first round of play, the imitator cooperates according to a randomly generated assignment based on the initial proportion of cooperators. In other words, the matrix might originally be populated with (about) 80% cooperators and (about) 20% defectors. On any given round of play after the first, this BOT type chooses the strategy employed by its most successful neighbor in the previous round, hence the term imitator.

There are many scholarly perspectives that could serve to justify an assumption that players will adopt an imitative posture in transactions of this sort. First, Simon’s (1957) notion of “bounded rationality” suggests that individuals and organizations frequently settle on relatively simple, less-than-optimal strategies when optimal strategies are costly or impossible to figure out. Under conditions such as those posed by a repeat play PD, imitating winners is certainly one

such (perhaps sub-optimal) strategy. Second, classic theories of human psychology, including social comparison (Festinger, 1954), social learning (Bandura, 1977), and social information processing (Salancik & Pfeffer, 1978) are built around the profound tendency of human beings to look towards others for cues regarding appropriate behavior. At the organizational level of analysis, institutional theorists such as DiMaggio and Powell (1983) propose that organizations seek the legitimacy that attends conforming to standards set by similar organizations. They call this phenomenon “mimetic isomorphism.” Strang and Macy (2001) go a step further, using a simulation model to show that imitation can be combined with rationality as agents may imitate their *successful* neighbors in such management “fads” as quality circles, TQM, and six sigma. Third, in the realm of moral behavior,¹ Kohlberg (1976) and Rest (1986), prominent researchers in cognitive moral development, provide ample evidence that relatively few “moral agents” are morally autonomous; a large majority looks to others for moral cues. Looking to “winners” among one’s immediate peers is a strategy consistent with both a “pre-conventional” instrumental stage and a “conventional” stage, stages that together describe a large majority of human beings. Fourth, in a recent article, Jones and Ryan (1997) theorized that many individuals have “referent groups” that they use as aids for making moral decisions. Since firms are run by individuals, these theoretical perspectives from the psychology of moral behavior may have implications for organizational decision making as well. Together these perspectives provide ample justification for beginning with a model composed entirely of imitators.

In terms of actual mechanics, the imitation version of the simulation proceeds as follows. As noted above, the original 40 by 40 matrix is randomly populated with BOTs instructed to

¹ Deciding whether or not to cheat/defect on your business partner is certainly a moral decision. As argued by Kramer and Messick (1996), cooperation is the only moral choice in a dilemma situation. Whether one adopts a utilitarian perspective that attempts to maximize total output, a feminist perspective that honors the relationship, or a

either cooperate or defect *on the first round only* according to input instructions (e.g., 80% cooperators; 20% defectors). This initial willingness to cooperate is analogous to optimism -- an assumption that one's partner/opponent will cooperate as well. After cooperating with (or defecting on) all of its eight neighbors according to its instructions, each BOT receives a payoff, determined by the payoff matrix instructions, from each of these eight games and thus a total payoff from that round. It then figuratively "looks around" at its eight neighbors to see which strategy produced the greatest payoff. On the next round, each BOT adopts the strategy of its most successful neighbor -- cooperate or defect. In the case of a tie between a cooperator and a defector for the highest payoff, the BOT continues with its existing strategy for another round. Subsequent rounds follow the same pattern; individual BOTs switch from cooperate to defect as the relative success of their neighbors changes. Note that individual BOTs are not committed to any "moral" strategy aside from their initial instructions on the first round. Thus, cooperation and defection *as phenomena* can exist long after individual BOTs have abandoned (or perhaps changed repeatedly) their original strategies.

This mode of interaction was repeated for 30 rounds. Total scores for each BOT type over the 30 rounds were then summed. Scores for all BOT types were then combined to yield a system payoff for that set of rounds. Because the process is affected by random factors -- the actual number and placement of initial cooperators and defectors -- ten sets of 30 rounds were run to produce more stable results. As noted below, these results were quite stable at some levels of initial cooperation/defection and payoff matrix parameters; at other levels, much less stability was observed. Again, the variables in the exercise were: 1) the cooperator/defector proportion in the initial population of the matrix (1600 BOTs); and 2) the variable payoffs in the payoff matrix

Kantian perspective that insists on universal and reversible decisions based on reason, the appropriate choice is the same -- cooperate.

-- T (temptation) and S (“sucker’s” payoff). In general, cooperator/defector proportions were varied from 90/10 to 10/90; T was varied from 6 (7 in later phases) to 4.5; and S was varied from -4 to -1.5.

In the imitation model, three primary conclusions emerged. First, as the parameters subject to governmental policies (T and S) were varied, the chance that cooperation *as a phenomenon* survived changed significantly.

[Table 1 about here]

As Table 1 clearly indicates, declining levels of T (i.e., reduced temptation to defect) noticeably increase the probability that some cooperation will survive. Also indicated is the indication that lower (numerical) levels of S (i.e., smaller penalties for “suckers”) also result in increased survival rates for cooperation *as a phenomenon*. For any given proportion of C/D, the proportion of times that cooperation is eliminated *generally* declines with declining (numerical) levels of S. (These are, after all, random processes.)

Interesting though this result may be, the survival of cooperation *per se* may be of little consequence to economies that hope to thrive. By the time the survival of cooperation becomes an issue, it is already at very low levels. Put more prosaically, defectors may have “won,” but the world that they have taken over is hardly prosperous. Of greater interest to governmental policy makers is the overall output of the system, something akin to gross national product (GNP), national income or, more generally, national economic development and prosperity. To explore the effects of governmental institutions on these system output variables, we examined the relationship between levels of T and S and system output. For various levels of T and S, we noted the proportion of initial cooperation at which each system became “profitable” (i.e.,

showed a positive total output). Table 2 details the results of this exploration and illustrates our second major conclusion.

[Table 2 about here]

As Table 2 clearly indicates, as the levels of T decline or the levels of S increase (become less negative), system output becomes positive at lower proportions of initial cooperation. [Note that the actual cutoff point for positive system output has no substantive significance since payoff parameters are arbitrary to begin with.]

Since the both the survival of cooperation and the onset of “profitable” systems are dependent on the proportion of initial cooperators, it follows that system output will rise with rising proportions of initial cooperation. In the third phase of our study, we advance a hypothesis to this effect.

In the simulation itself, the dynamic interaction of cooperation and defection proceeds along similar lines for a few rounds regardless of the values of T and S. However, beyond this point (3 or 4 rounds), the values of T and S begin to make a significant difference. For higher values of T and S, if cooperation survives at all, it grows only along the rough edges of patches of cooperation (regardless of size) until the patches have squared edges, and then stops growing. We call this phenomenon *limited growth*. For somewhat lower values of T and S, cooperation will grow along the rough edges of patches of cooperation *and create new rough edges* and continue to grow at those newly created rough edges. We call this phenomenon *sustained growth*. Finally, for even lower values of T and S, cooperation actually grows along the straight edges of patches of cooperation (as well as the rough edges) and will continue to do so until defectors are reduced to at most 10% (often 5% or less) of the entire population of the matrix. We call this phenomenon *aggressive growth*. It is important to note that defection, *as a*

phenomenon, can never be fully eliminated because of the nature of payoffs in the PD game. It is often said that the ideal situation in life is to be a cheater in a world full of honest people; the same is true here. Surviving defectors can profitably “feed” off of cooperative neighbors without being the most profitable neighbor of those neighbors. If they were the most profitable, of course, their neighbors would imitate them and defect in the next round. Hence the isolation, but not the elimination, of defectors when T and S are relatively low. Table 3 documents the relationship between T and S and the point at which *sustained* growth begins. Since the *sustained growth* of cooperation alone is an ambitious goal for an economic system, we focus on the onset of this phenomenon.

[Table 3 about here]

As Table 3 indicates, the sustained growth of cooperation is not possible unless the (numerical) combination of T and S is sufficiently low. Since $T - S$ is the denominator of the “K Index,” a measure of the relative advantage of cooperation in the PD matrix developed by Rapoport and Chammah (1965), we report that better-known index as well. [$K = R - P/T - S$ and since we hold R at 4 and P at -1, the break point for our analysis is between 0.588 and 0.600 in terms of the K Index.] Also apparent is the fact that the relationship between T and S at this “break point” for aggressive growth is not linear. We can say that as T (or S, numerically) increases, S (or T) monotonically decreases, and that the difference between T and S (or their numerical sum) is between 8.33 and 8.50 [K is between 0.588 and 0.600.] at this break point for sustained growth. These values hold for all proportions of C/D.

The very existence of this break point suggests that in dynamic, feedback-dependent environments, the relationship between factors that governments have some control over – the levels of temptation and risk – may be related to economic output in a nonlinear way. As

cooperation becomes the predominant form, the system output shoots up dramatically. This phenomenon in the simulation results may have an analog in real social systems. Once cooperation reaches a certain degree of attractiveness, the gains to the system may accelerate for three reasons. First, cooperation may begin to pay dividends to more than just a participant's *most* successful neighbor (i.e., there are more examples of successful cooperation in the neighborhood) thus making cooperation appealing as a *popular* strategy. This conclusion might hold even if the player's *most* successful neighbor is a defector. A *rational* player who selects the strategy that produced the greatest aggregate value for his/her neighbors would fall into this category. Second, if human beings and organizations have a bias toward cooperative behavior, they might find the mere presence of several successful cooperators an adequate incentive to cooperate even if the most successful neighbor is a defector, reasoning that it is possible to cooperate *and* do well, even if someone does better. Third, if cooperation becomes attractive enough, and enough agents adopt it, it may come to be seen as the norm rather than simply a strategy that works under some conditions. In a later section, we advance a hypothesis based on these possibilities. This analysis completes our examination of systems made up entirely of imitators. As the following sections will reveal, the effect of other behavioral possibilities can be explored with our simulation model as well.

Phase II - The Imitation Model With “Saints” And “Rogues”

Although imitation is a good behavioral assumption for a simple model of the effect of legal institutions on cooperation in economic transactions, not all economic (and moral) agents are imitators. Indeed, many social institutions have, as one of their important goals, the instilling of moral values that promote the smooth and efficient functioning of social relationships,

including economic relationships. In particular, families, religious groups, and schools often stress the importance of “keeping promises” for both deontological and consequential reasons. A number of scholars, including Kohlberg (1976) and Rest (1986), have accumulated evidence that some (although relatively few) moral agents are autonomous in their moral decision-making and do not respond (at least directly) to moral cues from others. Others, including Jones and Ryan (1997), have theorized that some individuals refer primarily to their own moral frameworks to resolve ethical problems. Corporations may also have codes of conduct that prevent them from “defecting” regardless of circumstances. Where these individual or corporate standards originate is not important here; the important point is that some agents are not imitators. Since the decision to cooperate with (or defect on) one’s partner/opponent in a PD-type situation is, among other things, a moral decision, it is likely that some individuals will cooperate (or defect) on a consistent basis regardless of the behavior of their immediate neighbors. This phase of the analysis examines the effect of such individuals on the development of cooperation in an economic system. Here we employ a specified percentage of BOTs that *always* cooperate (“Saints”) or *always* defect (“Rogues”) [terminology from Messick (1998)] in environments otherwise made up entirely of imitators. In the following simulation, the matrix is initially populated with combinations of Saints, Rogues, initial cooperators, and initial defectors. The former two groups maintain constant strategies throughout the 30 rounds of play; the latter two have set strategies for the first round and then imitate in subsequent rounds (as in Phase I). The initial population of the matrix is again set by a random process according to a preset formula -- e.g., 10% Saints; 50% initial cooperators; 40% initial defectors. Tables 4 and 5 show the results of this analysis. No table is presented for the survival of cooperation in the case in which Saints appear since cooperation will always survive. Also note that, although the presence of Saints

makes the emergence of a break point more likely since cooperation will always survive, the numerical values of this break point for the sustained growth of cooperation are not affected by the presence of Saints or Rogues.

[Tables 4 and 5 about here]

Table 4 indicates that the presence of Saints (which always cooperate) or Rogues (which always defect) does alter the onset of positive systemic output (compared to the case in which they do not exist) in the expected directions – sooner with Saints, later with Rogues. And, as a comparison of Table 5 to Table 1 suggests, the presence of Rogues slightly lowers the probability that cooperation will survive. However, the presence of Saints or Rogues does not alter the fundamental relationship between lower levels of temptation (T) and lower penalties to “suckers” (S) and the earlier emergence of economic prosperity. Lower levels of T and lower numerical values of S still lead to an earlier onset of positive system output. Furthermore, Table 5 shows that lower values of T and lower numerical values of S still improve the likelihood that cooperation *as a phenomenon* will survive.

Phases I and II of the analysis have dealt with relatively simple situations in which the results are relatively predictable. They do, however, lead us to insights that are not so predictable, simply because the behavior of systems with interaction among variables, phenomena that simulations are particularly good at describing, sometimes yields results that are neither predictable nor intuitive. The following section -- Phase III -- looks at environments in which a large number of relevant parameters vary simultaneously.

Phase III – Various Mixes Of “Realistic” Strategies

As noted above, one of the virtues of simulations is that they are capable of examining complex phenomena that are impossible to examine any other way, and certainly not through experimentation. Other than looking at observational evidence, as we did earlier, there may be no means other than a simulation to empirically examine the relationship between governmental promotion of cooperation and economic prosperity. This phase of our analysis examines situations that are, in our view, as realistic as we can make them with the BOT strategies that we have – imitation, fixed, and fixed no-play. Our point is to see what happens to system output as we vary: 1) the proportion of the population made of each BOT type; 2) the initial cooperation proportion for imitator BOTs; 3) the ability of BOTs with fixed strategies to refuse to transact at all when it is irrational to do so (the ratio of fixed to fixed no-play BOTs) and, of course, 4) the payoff structure of the PD matrix. This phase of the analysis gives us a chance to test some hypotheses developed from the findings of the first two phases as well. These hypotheses are listed below.

Research Hypotheses

The central research question of this paper involves the relationship between governmental sanctions designed to promote cooperation in the economy and overall economic welfare; do such sanctions in fact promote economic prosperity? In terms of our model, the key variables under examination are: 1) the magnitude of the temptation presented to would-be defectors; and 2) the extent of the risk presented to would-be cooperators. Since the effects of reducing T and increasing S are the same in terms of increasing the K Index, we combine these variables and use the K Index instead. [Recall that $K = R - P/T - S$ and that we have held R and

P constant.] Therefore, findings in the first two phases of the analysis suggest that this research question, in hypothesis form, would read as follows.

H1: In a model intended to simulate economic systems, increased governmental efforts to reduce the temptation to potential defectors (T in the PD game) and/or reduce the risk to potential cooperators (S in the PD game), as measured by increases in the K Index, will result in increased economic system output.

In view of one finding in Phase I of this study and the possible theoretical explanations for this result suggested above, we advance the following additional hypothesis.

H1a: In a model intended to simulate economic systems, the relationship between changes in the K Index and economic system output will be nonlinear and positive; that is, the first derivative will be positive.

In addition to these hypotheses related to our central research question, our findings in Phase II of the analysis allow us to advance the following hypothesis.

H2: The presence of some participants with consistent cooperation/defection tendencies (fixed & fixed no-play) in the system will not alter the fundamental relationship between governmental sanctions and economic system output.

Logic suggests a corollary to H2. Since some players (imitators) will be more directly responsive to the effects of changes in governmental sanctions than others (fixed; fixed no-play), we add the following hypothesis.

H2a: Greater proportions of participants with imitation strategies (vs. fixed & fixed no-play) in the system will lead to a stronger relationship between governmental sanctions (K Index) and economic system output.

Another hypothesis can be derived from the results of Phases I and II.

H3: Greater levels of optimism among participants (higher levels of initial cooperation by imitators) in the system will lead to greater economic output without altering the fundamental relationship between governmental sanctions and economic system output.

There is a final hypothesis that has largely escaped discussion but is nonetheless important. As noted earlier, some of the BOTs have an exit option and will refuse to play when doing so will probably result in a negative payoff. Other BOTs have no option but to participate in transactions regardless of the prospects for a favorable outcome. This specification relates to the fact that, in real life, some economic actors are structurally or personally empowered while others are unable to resist unfavorable circumstances. As noted by Orbell and Dawes (1993), many players aren't prisoners at all and have the freedom to deal with whomever they wish. On the other hand, there *are* situations where potential exchange partners are severely constrained. Buyers may be dependent on monopolistic sellers (e.g., power utilities) and sellers are sometimes limited to a monopsonistic buyer (e.g., Walmart).

These powerless players will often find themselves victims of defectors and recipients of the "suckers" payoff. They may also inspire uncooperative behavior on the part of others. For example, a public utility might provide inferior service for an exorbitant price simply because it knows that its customers have no other choice. This behavior will, in turn, lead to less cooperation and lower system output. In contrast, those with an exit option will resist getting taken advantage of. The presence of this option may have a profound effect on other agents by shading the cost benefit calculus of today with the "shadow of the future" (Axelrod, 1984). As the perfidious player comes to have only other defectors to interact with, this leads imitators to mimic the more profitable cooperators, thereby raising system output. Thus, we offer the following hypothesis.

H4: Greater proportions of participants able to avoid disadvantageous relationships (fixed no-play) will lead to higher economic system output without altering the fundamental relationship between governmental sanctions and economic welfare.

The mechanics of the model can be described as follows. Because we believe that the imitation strategy describes many actors in the economic system, we set a majority proportion of the population (0.60 and 0.80) as imitators. Within these imitator groups, we set initial cooperation proportions at 0.60, 0.70, 0.80, and 0.90. The remaining BOTs (0.40 and 0.20) were assigned fixed strategies. Half of these (0.20 and 0.10) were assigned to cooperate 80% of the time (according to a random number) and the other half (another 0.20 and 0.10) were assigned to cooperate 60% of the time. Of the BOTs with fixed strategies (both 80% and 60% cooperators), some are assigned fixed no-play strategies and the others are left with fixed strategies. In various iterations of the simulation, the fixed/fixed no-play split is 20-80, 40-60, 60-40, and 80-20. [The fixed no-play BOT figuratively scans its neighbors' decisions (cooperate, defect, or no-play) on the previous round to see if a decision to play the next round is rational (i.e., if playing will yield a positive outcome) and plays its random strategy (80% or 60% as assigned) if it is rational, and does not play the round (accepting a zero payoff) if it is not.] Thus, with two proportions of imitators, four levels of initial cooperation for imitators, four splits between fixed and fixed no-play, as well as 16 combinations of T (7, 6, 5, and 4,5) and S (-4, -3, -2, and -1.5), we ran 512 different versions of the game. Each version consisted of 10 games of 30 rounds each. In our view, this range of versions of the simulation should cover most realistic combinations of player types. Conclusions drawn from this wide variety of conditions should be relatively compelling.

Results

Since statistical tests are not terribly meaningful when used with simulation results, our primary mode of conveying the findings of our study is in the form of “ribbon” graphs. Figure 1 is set of a ribbon graphs plotting system payoffs against our measure of cooperation for the payoff matrix as a whole, the K Index, for “optimism” (initial cooperation) proportions of 0.6 to 0.9. This set of graphs charts results for imitators/fixed strategies of 80/20 (Figure 1a) and 60/40 (Figure 1b).

[Figure 1 about here]

These graphs clearly indicate that system payoffs rise substantially with increases in K. In fact, the graphs also make clear the nonlinearity of the relationship, especially at low levels of optimism (0.6) with 0.80 imitators and at high levels of optimism (0.9) with 0.60 imitators. In all cases, steep gains in system output appear as K reaches about 0.700.

[Figure 2 about here]

The plots of system payoffs against the K Index for “exit option” proportions (proportion of fixed no-play BOTs from the total proportion of fixed BOTs) are shown in Figure 2 – for 0.8 initial cooperators (0.04 to 0.16 fixed no-play) in Figure 2a and for 0.6 initial cooperators (0.08 to 0.32 fixed no-play) in Figure 2b. Again system payoffs rise substantially with increases in K, strikingly so for versions with low numbers of players with an exit option. This result holds for both 0.8 imitators and 0.6 imitators cases. These two graphs, coupled with 1a and 1b, lend support to Hypothesis 2, since both involve the inclusion of non-imitator BOTs (fixed and fixed no-play) in the system. Also noteworthy in this set of graphs is the relatively high system outputs

for high levels of fixed no-play BOTs even at very low levels of K. This result holds for both 0.8 and 0.6 imitators cases as well.

To assess the effect of the proportion of imitators in the system (0.8 vs. 0.6), one must visually compare Figures 1a and 1b and Figures 2a and 2b. Since this is not an easy comparison, a determination of the effect of these proportions is best left to the regression results.

The standardized regression coefficients for the two levels of imitators (0.8 and 0.6) are shown in Table 6.

[Table 6 about here]

These statistical results make clear what the graphs could not. Since all of the *differences* in regression coefficients are significant at the 0.001 level, and since those related to the K and K squared terms are greater for 0.8 imitators than for 0.6 imitators, it is fair to say that the relationship between the K Index and system output is stronger when more imitators (thus fewer fixed strategies) are present. Support is therefore lent to Hypothesis 2a.

Also clear from these statistics is the conclusion that optimism (initial cooperators) has a positive effect on system outcomes for both proportions of imitators. This effect is more pronounced for the model with 80% imitators. Since Figures 1a and 1b show that variations in initial cooperation do not alter the fundamental relationship between K and system output, Hypothesis 3 is supported.

In addition, the since the fixed no-play coefficient is significantly positive for both models and since Figures 2a and 2b show that the fundamental relationship between the K Index and system output is not altered, Hypothesis 4 is supported.

Finally, the relationship between the K Index and system output is significantly positive under all circumstances modeled here. Not only are the linear effects significantly positive for both models, but the nonlinear (squared term) effects are significantly positive for both models as well. Both Hypotheses 1 and 1a are therefore supported.

Distributive Effects

Our results can be understood better by reference to the changes in outcomes for each of the player types as the K-Index increases.

[Figure 3 about here]

As shown in Figures 3a and 3b, it is clear that as K increases, the payoffs to BOTs with fixed strategies without the exit option increase steadily in a nearly linear fashion and that the payoffs of imitator BOTs and fixed no-play BOTs do not improve much until K reaches about 0.650, at which point their payoffs improve with increasing K. These results suggest two very different mechanisms by which sanctions improve system cooperation. First, for players who are powerless (must play with known defectors), greater sanctions reduce losses from being a sucker, while increasing the probability that imitators will cooperate. From a normative perspective, policy makers can take comfort in the fact that strengthening sanctions will always help the distribution of payoffs to those without power.

But the curvilinear effect of sanctions on system output is built around a different dynamic, observable only by viewing the actual simulation in progress. At low levels of sanctions, there is a high level of defection by imitators. At moderate levels of sanctions, there is a dynamic equilibrium between large (but not necessarily equal) numbers of cooperators and defectors. Interestingly, this dynamic balance creates only slightly higher system outputs as

sucker payoffs and punishments seem to roughly balance out temptation payoffs and rewards. But at high levels of sanctions (high K values), the payoffs for both imitator BOTs and fixed no-play BOTs increase substantially with each increase in sanctions. At high levels of sanctions, the effect of steady improvement in the lot of fixed players is joined by newly improving outcomes for imitators and fixed no-play BOTs to produce system outcomes that improve at an accelerating rate – the nonlinear effect observed in system payoffs.

Conclusions, Implications, and Future Research

The most important conclusion of this paper is that, for a variety of conditions and a variety of population compositions, increases in the K Index, a proxy for government's enthusiasm for enforcing economic contracts, produces increases in system output. This result was not entirely unexpected, but its emergence under a complex set of interactive conditions could not be assumed. What was not expected was the nonlinearity of this relationship. Discovering that system output increases at an accelerating rate with increases in K substantially strengthens our basic conclusion. Governmental policy makers should take this finding quite seriously. Despite a fair amount of economic rhetoric to the contrary, governments can improve the prosperity of their economies by increasing their involvement with respect to measures designed to enforce economic contracts. Any policy maker who takes seriously a mandate to pursue "the greatest good for the greatest number" should be able support such measures without reservation.

Business executives who intend to be honest in their commercial dealings should also regard our conclusions favorably, despite the fact that few are likely to do so for a number of possible reasons. Perhaps the consequences of running afoul of the law are more vivid to them

than the day-to-day benefits of mutually honest transacting. Or they may negatively frame the possibility of legal trouble (however remote) and seek to avoid it at all costs. Or perhaps the benefits of mutually honest dealings are so highly diffuse that they don't seem to register as benefits at all. Any of these reasons could prevent managers from supporting contract-enforcing mechanisms in the political arena. Whatever the reason, our research suggests that such a posture is probably misguided.

Another useful conclusion relates to the distributive effects of strong contract enforcing policies. The parties most benefited by such policies are those least capable of protecting themselves – those without exit options. The fate of such actors improves steadily with increasing sanctions until they are on a par with actors who can better protect themselves through a wider range of behavioral choices. Policy makers concerned with distributive equity issues should find this conclusion a persuasive argument for advocating stronger sanctions. In summary, there seem to be both utilitarian (aggregate economic prosperity) and distributive justice (help for the weaker members of society) reasons to support more extensive governmental contract-enforcing efforts.

Future Research

Our findings suggest several avenues for future research. First, while it would be impossible to experiment with government sanctions or with actor characteristics, it should still be possible to verify these results empirically. One could measure the extent and enforcement of governmental enforcement of economic contracts across nations and then see if that measure relates to economic output in a strong, positive, and curvilinear way. This archival research could broadly corroborate the findings of our more dynamic approach, but it would suffer from a

lessened ability to test mechanisms or explain why patterns emerge. Besides empirical verification, there are opportunities to use similar simulations to investigate other phenomena. For example, one intriguing opportunity would be to see if this analytic approach would be useful in exploring the evolution of fairness norms. Using the "ultimatum bargaining game" in the place of the Prisoner's Dilemma, researchers could vary characteristics of players (e.g., their sense of equity), characteristics of networks (e.g., size and variety of neighborhoods), and psychological assumptions (e.g., imitation, rationality, reinforcement). Perhaps fairness norms propagate through social networks in the same way that cooperation does in economic transactions. This highly speculative possibility awaits future investigation.

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Table 1
The Survival of Cooperation
Pure Imitation Strategies

Number of games (Out of 10) that cooperators were eliminated, S constant, varying T values				
Beginning Cooperator/ Defector ratio	S= -4			
	T=6	T=5.5	T=5	T=4.5
90/10	0	0	0	0
80/20	1	0	0	0
70/30	3	0	0	0
60/40	8	0	0	0
50/50	10	5	1	0
40/60	-	7	4	1
30/70	-	10	5	5
20/80	-	-	10	10
10/90	-	-	-	-

Number of games (Out of 10) that cooperators were eliminated, T constant, varying S values						
Beginning Cooperator/ Defector ratio	T=6					
	S= -4	S= -3.5	S= -3	S= -2.5	S= -2	S= -1.5
90/10	0	0	0	0	0	0
80/20	1	0	0	1	0	0
70/30	3	4	3	4	0	2
60/40	8	9	8	6	2	1
50/50	10	8	9	8	5	2
40/60	-	8	7	9	6	6
30/70	-	10	10	10	7	4
20/80	-	-	-	-	9	9
10/90	-	-	-	-	10	10

Table 2
The Onset of Economic Prosperity
Pure Imitation Strategies

Lowest C/D proportions at which system output is positive, S constant, varying T values			
S=-4			
T=6	T=5.5	T=5	T=4.5
89/11	87/13	84/16	71/29

Lowest C/D proportions at which system output is positive, T constant, varying S values					
T=6					
S= -4	S= -3.5	S= -3	S= -2.5	S= -2	S= -1.5
89/11	89/11	88/12	88/12	55/45*	45/55*

* Note: At (numerically) low S values and low C/D proportions, output values are highly erratic because cooperation is sometimes eliminated in the first 3 or 4 rounds, yielding very low total output values. However, when cooperation is not eliminated in the first 3 or 4 rounds, it may experience sustained (or even aggressive) growth and yield very high values of total output. See Table 1 above.

Table 3
The Onset of Sustained Growth of Cooperation

<u>For fixed values of S =</u>	<u>Sustained growth begins at T =</u>	<u>T - S =</u>	<u>“K Index”</u>
-1.5	7.00	8.50	0.588
-2.0	6.33	8.33	0.600
-2.5	5.83	8.33	0.600
-3.0	5.33	8.33	0.600
-3.5	5.00	8.50	0.588
-4.0	4.33	8.33	0.600
<hr/>			
<u>For fixed values of T =</u>	<u>Sustained growth begins at S =</u>	<u>T - S =</u>	<u>“K Index”</u>
4.5	-3.99	8.49	0.589
5.0	-3.50	8.50	0.588
5.5	-2.83	8.33	0.600
6.0	-2.49	8.49	0.589
6.5	-1.99	8.49	0.589
7.0	-1.50	8.50	0.588

Note: The “K Index” = $\frac{R - P}{T - S}$

**Table 4 - The Onset of “Profitability” with 10% Saints
(or 10% Rogues) and 90% Imitators**

Lowest C/D proportion (%) at which system output is positive for S = -4

<u>T =</u>	<u>10% Saints; 90% Imitators</u>	<u>100% Imitators (for reference)</u>	<u>10% Rogues 90% Imitators</u>
6	76/14 (84%)	89/11 (89%)	89/01 (99%)
5.5	73/17 (81%)	87/13 (87%)	88/02 (98%)
5	69/21 (77%)	84/16 (84%)	85/05 (94%)
4.5	56/34 (62%)	71/29 (71%)	73/17 (81%)

Lowest C/D proportion (%) at which system output is positive for T = 6

<u>S =</u>	<u>10% Saints; 90% Imitators</u>	<u>100% Imitators (for reference)</u>	<u>10% Rogues 90% Imitators</u>
-4	76/14 (84%)	89/11 (89%)	89/01 (99%)
-3.5	75/15 (83%)	89/11 (89%)	88/02 (98%)
-3	75/15 (83%)	88/12 (88%)	88/02 (98%)
-2.5	74/16 (82%)	88/12 (88%)	88/02 (98%)
-2	55/35 (61%)*	55/45 (55%)*	78/18 (87%)
-1.5	45/45 (50%)*	45/55 (45%)*	70/20 (78%)

* Note: At low S values and low C/D proportions, output values are highly erratic because cooperation is sometimes eliminated (except for the 10% “Saints”) in the first 3 or 4 rounds, yielding very low total output values. However, when cooperation is not eliminated in the first 3 or 4 rounds, it may experience sustained (or even aggressive) growth and yield very high values of total output. See Table 1 above.

Table 6 – System Payoffs as a Function of Exit Option, Optimism, and Sanctions

	<u>60% Imitators**</u>	<u>80% Imitators**</u>
Proportion of Fixed No-Play	0.247*	0.219*
Initial Cooperators Among Imitators	0.096*	0.129*
K Index	0.789*	0.871*
Variance Explained w/ 3 Variables	69%	82%
K Index Squared	0.812*	0.891*
Variance Explained Adding Squared Term	78%	90%

* $p < 0.001$

**N = 256 versions (with 10 simulation runs per version and 30 rounds per simulation run)

FIGURE 1A
Relationship between Sanctions, Optimism, and System Payoffs (for 80% imitators)

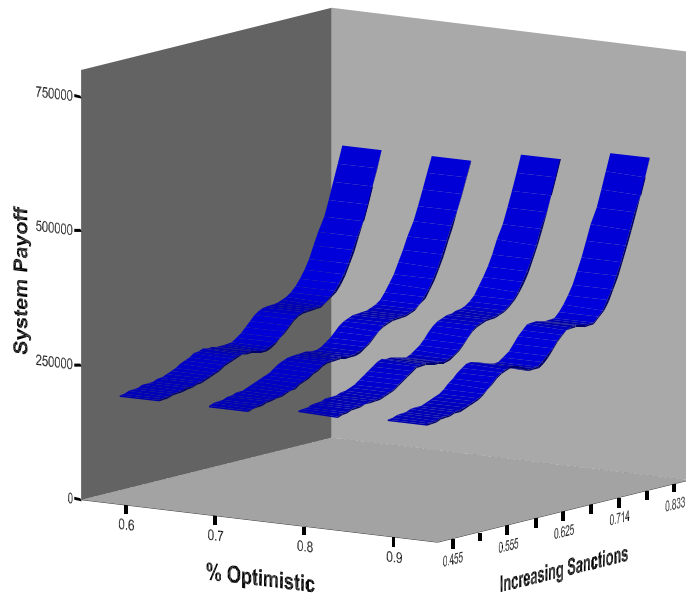


FIGURE 1B
Relationship between Sanctions, Optimism, and System Payoffs (for 60% imitators)

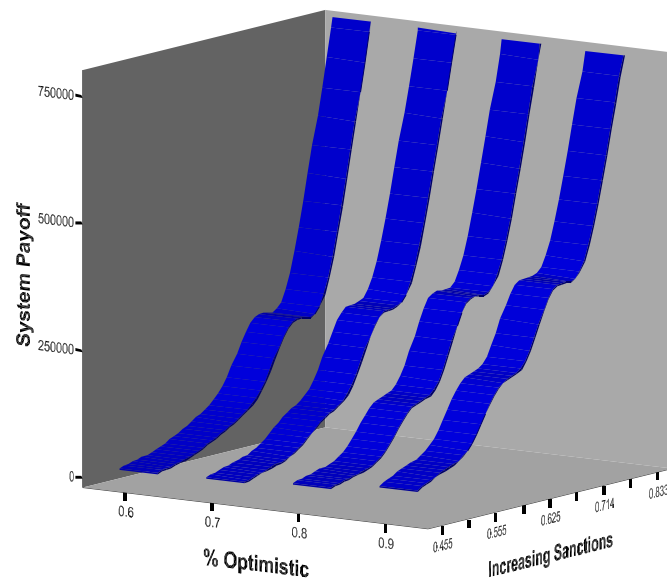


FIGURE 2A
Relationship between Sanctions, Exit Option,
and System Payoffs (for 80% imitators)

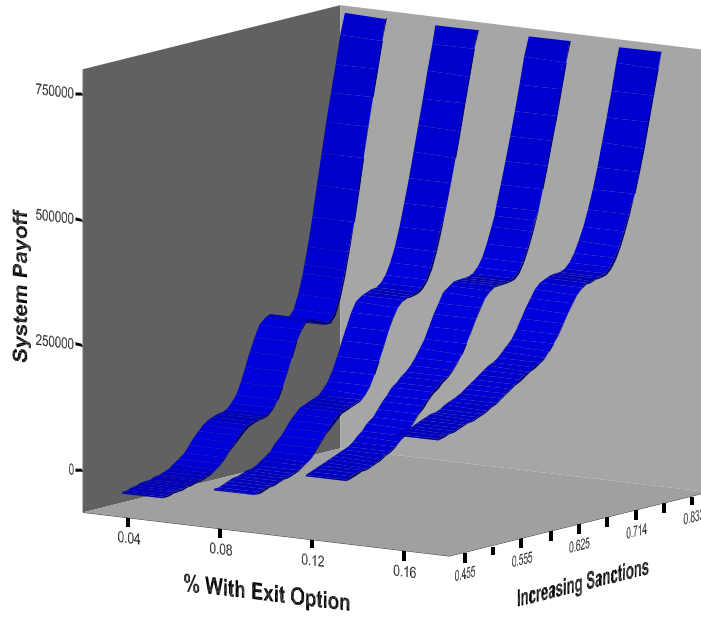


FIGURE 2B
Relationship between Sanctions, Exit Option
and System Payoffs (for 60% imitators)

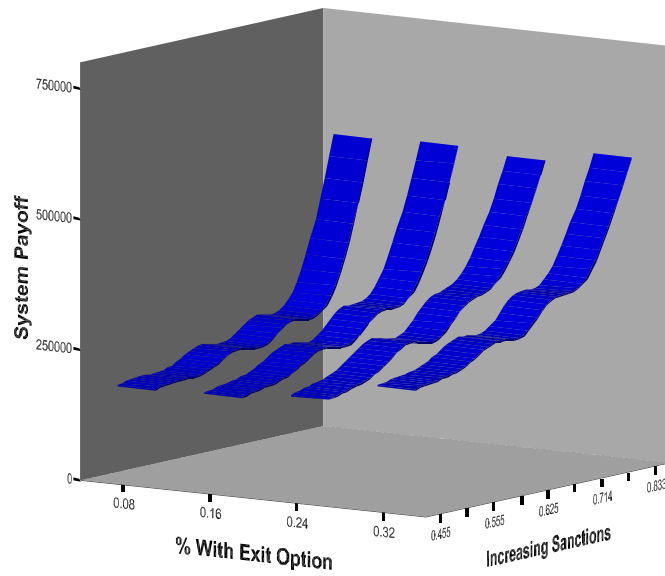


FIGURE 3A

Distributive Payoffs for Different Players

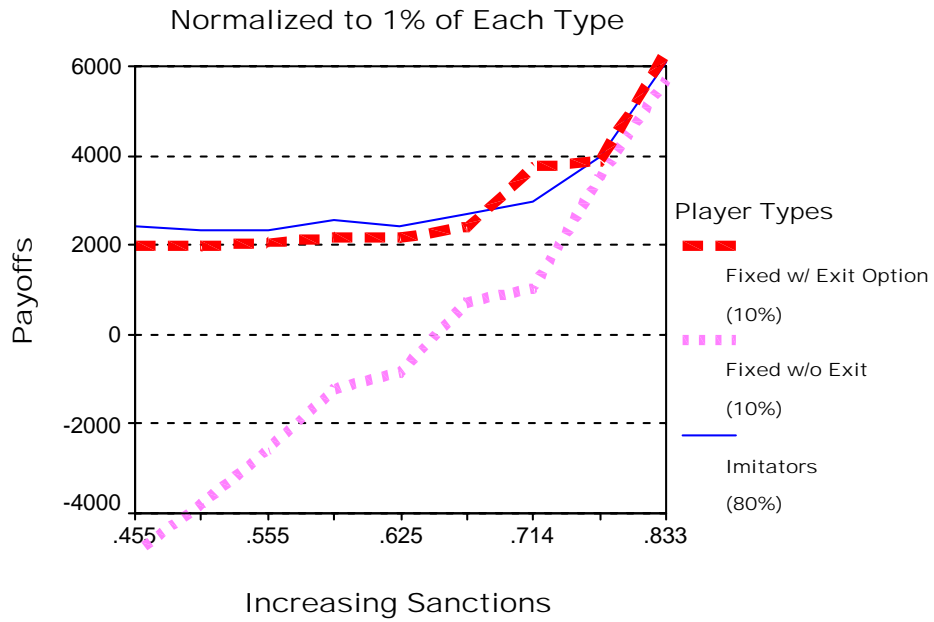


FIGURE 3B

Distributive Payoffs for Different Players

