NÚMERO 468

LUCIANA MOSCOSO

Labels for Misbehavior in a Population with Short-Run Players

NOVIEMBRE 2009

CIDE

www.cide.edu

Las colecciones de **Documentos de Trabajo** del **CIDE** representan un medio para difundir los avances de la labor de investigación, y para permitir que los autores reciban comentarios antes de su publicación definitiva. Se agradecerá que los comentarios se hagan llegar directamente al (los) autor(es).

Fax: 5727•9800 ext. 6314
Correo electrónico: publicaciones@cide.edu
www.cide.edu

Producción a cargo del (los) autor(es), por lo que tanto el contenido así como el estilo y la redacción son su responsabilidad.

Abstract

This paper studies how an information mechanism that labels defectors can sustain cooperative behavior in communities containing a subset of short-run players. This is done in the context of a repeated Prisoner's Dilemma game. The paper presents sufficient conditions for a sustainable equilibrium under different information technologies that identify defectors. It also analyzes imperfect labeling mechanisms.

Resumen

Este trabajo analiza cómo un mecanismo de información que identifica a quienes no cooperan puede sostener un comportamiento cooperativo en comunidades que contienen un subconjunto de jugadores de corto plazo. Esto se realiza en el contexto de un juego de Dilema del Prisionero repetido. El trabajo presenta condiciones suficientes para sostener un equilibrio cooperativo bajo diferentes tecnologías de información que identifican a quienes no cooperan. También analiza mecanismos de identificación imperfectos.

Labels for Misbehavior in a Population With Short-Run Players.

Luciana C. Moscoso Boedo*

CIDE

November 2009

Abstract

This paper studies how an information mechanism that labels defectors can sustain cooperative behavior in communities containing a subset of short-run players. This is done in the context of a repeated Prisoner's Dilemma game. The paper presents sufficient conditions for a sustainable equilibrium under different information technologies that identify defectors. It also analyzes imperfect labeling mechanisms.

*Centro de Investigación y Docencia Económicas, Carretera México-Toluca 3655, Lomas de Santa Fe, 01210 Mexico City, Mexico. Email: luciana.moscoso@cide.edu

1 Introduction

The world of the twenty-first century is replete with information on our individual identities, quite pervasive and readily available for the purpose of encouraging transactions between otherwise anonymous strangers. People carry credit cards and membership cards and analyze with diligence and care available ratings and reports and their credit history. It appears that all this information and its maintenance serve to enable transactions by promoting trust. However, even in Internet markets where information is free and accessible, fraud is still common.[1] It is not clear whether or how all this information affects the number of transactions among strangers, either those concluded successfully or unsuccessful and aborted.

It is well known that community enforcement can sustain cooperation even when agents only count on their own experience to make decisions. Social norms may sustain cooperative outcomes when transactions among members are infrequent even in the absence of information. A key feature of such norms is the threat of sanctions by future partners to deter dishonest behavior. If, however, the transactions of some agents in the society are not only infrequent but also unique then there is no reason to expect cooperation from those members. Disruption created by such agents undermines the ability of the remaining long-run players to cooperate.[2] In this cases, the availability of information besides own experience is essential.

In this paper, I explore the role of information in a population with long and short-run players. In particular, I allow for an information technology that resembles the case of bad ratings attached to participants in an Internet market. There is a mechanism that attaches labels to those who misbehave. I study the plausibility of cooperation among unlabeled players even when they are unable to distinguish between long and short-run players. To simplify the analysis, I consider a repeated Prisoner's Dilemma game with random matching.

Cooperation can be sustained even with very limited information when

[1] Bolton, Katok, Ockenfels (2004) refer to a research group GartnerG2 report concluding that fraud is 12 times higher in internet transactions.

[2] As shown in Moscoso Boedo 2007.

a large population of players is randomly matched. Examples of such results include Kandori (1992), Okuno-Fujiwara and Postlewaite (1995), Ellison (1994), Harrington (1995), Ahn and Suominen (2001), and Möller (2005). In particular, Kandori (1992) proves a Folk Theorem with a labeling mechanism that allows to vary punishment lengths. Okuno-Fujiwara and Postlewaite (1995) also assume that players possess observable labels and that this information enables cooperation. Ellison (1994) allows for a public randomization device. All these papers analyze homogeneous populations. Ghosh and Ray (1996) consider a model with heterogeneous agents, but they depart from uniform random matching. The effects of having Internet feedback mechanisms have also been studied. In particular Bolton et al. (2004) conducted experiments to analyze the enhancement of trade supported by internet feedback and the importance of information in settings with different cooperation costs.

Before continuing on to the model, it is worth noting that the difficulty created by short-run players disappears in an environment where players' types can be identified. For example, in small communities, where members know and observe each other's behavior, the presence of newcomers is easily detected and cooperation can be sustained. In particular, equilibrium strategies allow agents to play a *cooperative* strategy against long-run players and a *myopic* strategy against short-run players. This paper focuses on the more interesting settings in which information is imperfect and labels only depend on agent's misbehavior, resulting in newcomers not being identifiable before they act.

In the first part of the paper I consider an information technology that punishes players for their actions irrespective of the transaction in which they engaged. This labeling mechanism is unappealing because any defection generates a contagious process that destroys cooperation in the whole society. I restrict attention to straightforward equilibrium[3] and show that the presence of short-run players prevents cooperation in equilibrium with this mechanism.

Next, I consider a technology that monitors transactions. I apply the labeling mechanism proposed by Kandori (1992) to my setting and show

[3] Definition 2 on Page 72 of Kandori (1992).

the set of restrictions that need to be satisfied in equilibrium. When non-cooperative players are present, long-run players need to be more patient. Besides, given that in equilibrium defection occurs, the loss when cheated cannot be too large.

Finally, I allow for errors in the information technologies. I study the effect of two kinds of mistakes: a mechanism that sometimes labels *innocent* players and one that sometimes forgets to label *guilty* players. These two kinds of mistakes impose different requirements in order to sustain cooperation. I show a rationale for caring more about the first error, which is more disruptive of cooperation.

The rest of paper is organized as follows. Section 2 introduces the specific example that will be used throughout the paper. Section 3 presents the notation in the case of a homogeneous population of only long-run players. Section 4 provides the restrictions that need to be satisfied to sustain cooperation among unlabeled members of the society for different information technologies when there are short-run players present. Section 5 shows how the results change when the labeling mechanism is not perfect. The last section concludes.

2 The Model

For the remainder of the paper, I analyze the model described below.

There is a population of M players, where M is an even number. S of the players are short-run. In each period, players are randomly matched into pairs to play a Prisoner's Dilemma game. The matching rule is uniform and independent across periods with:

$$\Pr\{\mu(i,t) = j \mid h_{t-1}\} = \frac{1}{M-1}, \qquad \forall j \neq i, \forall h_{t-1},$$

where the function $\mu(i,t)$ represents the opponent of player i at time t. In each period S new short-run players enter the game to replace the last period short-run players who leave. Thus, the probability that a long-run player faces a short-run player in a given period is $\rho = \frac{S}{M-1}$.

K denotes the number of defectors from a given strategy and $\kappa = \frac{K}{M-1}$, is the probability that a non-defector faces a defector.

In each period, agents play a Prisoner's Dilemma stage game. Letting $l > 0$ denote the loss when cheated and $g > 0$ the gain from defection, the payoff matrix is as depicted in the figure:

		Player j	
		C	NC
Player i	C	$1, 1$	$-l, 1+g$
	NC	$1+g, -l$	$0, 0$

Short-run players enter the game only for one period. They have a discount factor of zero, given they do not care about the future and play only the myopic best response, NC. In contrast, long-run players are concerned about the future and maximize the expected lifetime utility given their common discount factor $\delta \in (0, 1)$. In each period long-runs decide whether to cooperate (C) or defect (NC).

There is an information technology available, i.e., a labeling mechanism, that is exogenous and trustworthy. It follows a publicly known rule that attaches labels to agents and is independent of players' willingness to provide feedback. This mechanism can only assign a label or not assign it. Given this, player i' status can only be: L_i (labeled) or U_i (unlabeled). The labeling rule that defines each mechanism depends only on players' current actions and on their previous period labels. The mechanism cannot ex-ante identify long-run or short-run players. In this paper, I consider two kind of mechanisms: one that monitor players' actions and another that monitors whole transactions. In addition, I also consider the case in which the labeling works imperfectly, perhaps forgetting to penalize bad behavior or mistakenly penalizing good behavior.

3 Benchmark: No Short-Run Players

In this section I introduce the different labeling mechanisms in a setting with only long-run players. This section follows Kandori (1992) and it is useful in building intuition and introducing the notation.

I restrict attention to a mechanism that can assign a label to each player i conditional on the previous period labels and actions of i and $\mu(i,t)$. I assume that a label is a sign of misbehavior. The restriction to one label implies that the mechanism either assigns the label forever after one defection or assigns it for only one period. For each mechanism, I am interested in the sustainability of cooperative behavior among unlabeled opponents.

3.1 Mechanism That Monitors Actions

First I consider a mechanism that only monitors actions as opposed to monitoring transactions and that assigns labels to any defecting player. In this case the labeling function is given by:

$$\tau_i(\omega_i, a) = \begin{cases} U & \text{if } \omega_i = U_i \text{ and } a_i = C \\ L & \text{else,} \end{cases}$$

where ω_i is a possible status for player i: U_i or L_i, and $a_i = C$ is the cooperative action taken by i. In this case, once a player defects he gets a label forever. A mechanism that only considers $a_i = C$ and ignores ω_i, assigns the labels just for one period.

The timing is as follows. Each player enters the game unlabeled, observes his opponent's label and afterwards chooses an action. I consider the unforgiving contagious strategy: *Cooperate with unlabeled players, defect against labeled people. Once you are labeled, defect forever.*

To verify that this strategy supports a cooperative outcome, I need to check that:

1. (C) against unlabeled people is better than (NC) : $V_i^C(U_i, U_j) \geq V_i^{NC}(U_i, U_j)$.
2. (NC) against labeled people is better than (C) : $V_i^{NC}(U_i, L_j) \geq V_i^C(U_i, L_j)$
3. (NC) once you are labeled is better than (C) : $V_i^{NC}(L_i) \geq V_i^C(L_j)$

Restriction 1 implies that when labels are permanent, this strategy is a Nash Equilibrium as long as $\delta \geq \frac{g}{1+g}$.

Off the equilibrium path, the strategy asks players to cooperate against unlabeled opponents for any beliefs regarding the amount of labeled players in the population. I denote $b_i(K)$ player $i's$ belief that there are K defectors in the population.[4] After any history in which labeled players have been seen, the beliefs regarding the amount of labeled players in the economy converges to one.[5] Thus, for some histories, this strategy asks players to cooperate against unlabeled opponents even under the belief that there are $K = M - 2$ labeled players in the community. In a sequential equilibrium :

$$\begin{aligned} V_i^C(U_i, U_j, M-2) &\geq V_i^{NC}(U_i, U_j, M-2) \\ \frac{1}{1-\frac{\delta}{M-2}} &\geq 1+g \\ \delta &\geq \frac{g}{1+g}(M-2). \end{aligned}$$

For this condition to hold, g has to be low relative to the size of the population $\left(g < \frac{1}{M-3}\right)$.

For Restriction 2, given that in this scenario $V_i(L_i) = 0$, the current loss for facing a defector needs to be lower than the gain for staying labeled in the community: $l \geq \delta V_i(U_i|K)$. The value of being unlabeled when there are K labeled depends on the probability of meeting unlabeled players each consecutive period.[6] $V_i(U_i|K)$ is the weighted sum of the probabilities of meeting an unlabeled player each consecutive period given that there are K labeled players. It is independent of l and is bounded above by one. It is sufficient to have $l \geq \delta$.

Restriction 3 is satisfied as long as $l > 0$.

[4] The value of taking any action a depends on this belief: $V_i^a(\omega_i, \omega_j, b_i(K))$.

[5] This is a contagious process. Once trigered, it affects the whole population with probability one (Moscoso Boedo (2007)).

[6] Following Kandori's (1992) paper, let's define the diffusion Markov matrix A, of dimension $(M \times M)$. Define X_t as the number of non-cooperative players at time t. Then each element of the matrix is defined by $a_{ij} = \Pr(X_{t+1} = j \mid X_t = i)$. Notice that $a_{ij} = 0$ for all $(j \leq i)$, for all j odd and for all $j \geq 2i$. Matrix A has a unique absorbent state, which occurs when all M players are non-cooperative. Define $\tau = \frac{1}{M-1}(M-1, M-2, M-3, \cdots, 1, 0)^T$ a column vector of dimension $(M \times 1)$. The ith element of τ represents the conditional probability that a non-cooperative player meets a cooperative player given that there are $[M-i]$ cooperative players in the economy. In addition we define e_i to be the $[1 \times M]$ row vector with ith element 1 and zeros everywhere else. Then the restriction becomes: $l \geq e_1 \tau \left[(I - \delta A)^{-1} - I\right]$.

This information mechanism is unable to distinguish defectors from players forced to punish a labeled opponent. It induces a contagious process after any defection. Nevertheless, when agents are sufficiently patient, there are payoffs and population sizes for which this strategy is an equilibrium strategy. The unappealing feature of this strategy is that any tremble (deviation) triggers the contagion of the labeling mechanism, destroying cooperation in the population.[7]

The previous information mechanism which only monitors actions is unappealing. The extra information does not allow players to punish deviators without punishing themselves by getting a label. Even when deviators are identified in the population, their existence triggers a contagious process of labels.

3.2 Mechanism That Monitors Transactions

I will now proceed to show the conditions under which a mechanism that monitors transactions is able to sustain cooperation among unlabeled players. As in the previous section, players have two sources of information, their own history and the labels. I look for strategies that only use the information contained in the labels. This section follows Kandori (1992), Section 5.

The information mechanism attaches one period labels to defecting players. When player i meets opponent j, the relevant states are $\omega = \{U_iU_j, U_iL_j, L_iU_j, L_iL_j\}$, with $\omega_i = \{U_i, L_j\}$. For each player the available actions are $a_i = \{C, NC\}$. The mechanism is described by:

$$\tau_i(\omega, a_i) = \begin{cases} U & \text{if } a_i = \sigma_i(\omega) \\ L & \text{else.} \end{cases}$$

Strategies using this extra capacity of the mechanism require actions that depend on the state which is affected by the opponent's status.

[7]If we had a public randomization device to forgive players, making the labels not perpetual, then we could sustain an equilibrium for any population size and any payoffs as long as players are sufficiently patient. This is a straightforward application of Ellison's 1994 result. In this case, the equilibrium is robust to trembles.

For this mechanism, I consider the strategy *Cooperate against unlabeled opponents and defect against labeled ones*:

$$\sigma_i(\omega) = \begin{cases} C & \text{if } \omega_j = U_j \\ NC & \text{if } \omega_j = L_j. \end{cases}$$

This is an equilibrium strategy if:
1. (C) against unlabeled people is better than (NC)

$$\begin{aligned} V_i^C(U_i, U_j) &\geq V_i^{NC}(U_i, U_j), \\ V_i^C(L_i, U_j) &\geq V_i^{NC}(L_i, U_j). \end{aligned}$$

2.(NC) against labeled people is better than (C)

$$\begin{aligned} V_i^{NC}(U_i, L_j) &\geq V_i^C(U_i, L_j), \\ V_i^{NC}(L_i, L_j) &\geq V_i^C(L_i, L_j). \end{aligned}$$

When facing a labeled opponent, the strategy is asking i to defect and thus enjoy a current and future gain.[8] These two restrictions are always satisfied. The first two are the restrictive conditions. The first one is:

$$\begin{aligned} V_i^C(U_i, U_j) &\geq V_i^{NC}(U_i, U_j) \\ 1 + \frac{\delta}{(1-\delta)} &\geq 1 + g + \delta(-l) + \frac{\delta^2}{(1-\delta)} \\ \delta &\geq \frac{g}{1+l}. \end{aligned}$$

The second one is:

$$\begin{aligned} V_i^C(L_i, U_j) &\geq V_i^{NC}(L_i, U_j) \\ -l + \delta\frac{1}{1-\delta} &\geq 0 \\ \delta &\geq \frac{l}{1+l}. \end{aligned}$$

In this mechanism deviators are forgiven after one period of good behavior. The proposed strategy is an equilibrium whenever $\delta \geq \frac{\max\{g,l\}}{1+l}$ and

[8] This is true when the value of being labeled in the future is larger than tha value of being unlabeled.

$g \leq (1 + l)$. When the gain from deviation is too large, punishment periods need to be longer to sustain cooperation among unlabeled opponents .

An alternative labeling mechanism assigns permanent labels (infinite punishment periods) and does not monitor transactions when they involve labeled players. This mechanism is unforgiving, and consequently beliefs regarding the number of labeled players in the population are again relevant. Off the equilibrium path, after any history where an unlabeled player encountered labeled players, beliefs when meeting an unlabeled opponent have to be that there is at least one cooperating player. Thus, a sufficient restriction in equilibrium is:

$$\delta \geq \frac{g}{1 + g - \frac{M-2}{M-1}}.$$

With homogeneous agents, the two mechanisms sustain cooperation for some values of g, l and δ. The unforgiving mechanism entails the negative aspect that after a deviation, players need to be willing to cooperate against unlabeled opponents no matter their belief regarding the number of deviators.

4 Perfect Mechanisms With Short-Runs

This section applies the previously presented plausible mechanisms to a setting with short-run players. The aim is to understand whether each mechanism allows the sustainability of cooperation among permanent members of a society by identifying defectors. With no information technology, the presence of short-run players prevents cooperation among long-run players (Moscoso Boedo (2007)). I here introduce informational mechanisms that resemble the negative reports non-cooperative participants get in an Internet market. First, I consider an informational technology that assigns labels to any non-cooperative players. Secondly, I consider a mechanism that monitors transactions and labels only players who defect against an unlabeled opponent or who failed to repent when required.

All players, including short-runs, enter the game unlabeled. Under both information technologies a label identifies a long-run player who has deviated. In contrast, the type of an unlabeled opponent is uncertain: He could be either a cooperative long-run player or a short-run player. Thus, if a long-run player cooperates with unlabeled opponents he needs to be willing to accept some periods of loss, as in those when he meets a short-run. This implies that the payoff is at most $\rho(-l) + (1-\rho)$ .This payoff is individually rational if it is positive, imposing a restriction on the payoffs when cheated $l : l \leq \frac{1-\rho}{\rho}$. An increase in the proportion of short-runs (ρ increases) results in a tighter restriction on l. In the limit, if all players are short-runs, there is no positive l that can sustain cooperation.

4.1 Labels Following Any Non-Cooperative Behavior

I first consider a technology that assigns labels forever to those who play NC. Labels in this setting are analogous to bad reports. Any player who does not cooperate gets a label. Therefore, all short-run players get a label which is irrelevant given that they leave the game after one period. All short-runs leave the game labeled.

The timing is as follows. Each player observes his own and his opponent's label before choosing an action. Consider the unforgiving contagious strategy: *Cooperate with unlabeled players, defect against labeled players. Once you are labeled, defect forever.*

In equilibrium the following conditions hold:

1. If unlabeled, (C) against unlabeled people is better than (NC),
2. If unlabeled, (NC) against labeled people is better than (C),
3.(NC) once you are labeled is better than (C).

Conditions 2 and 3 are satisfied as long as $l > 0$.

For Condition 1, the beliefs regarding the number of deviators are taken into account. Define $\kappa = \frac{K}{M-1}$ to be the probability that an unlabeled player meets a deviator in the economy. Notice that off the equilibrium path, if an unlabeled player has seen a labeled opponent in the past, the amount of unlabeled opponents in the society approaches the number of short-run players: $\lim_{t\to\infty}(\#U| \quad h_t = L_j) = S$. Hence, for any unlabeled player i :

$$\lim_{t\to\infty} b_i(\#U| \quad h_{ti} = L_j, U_i) = S - 1$$

If player i is unlabeled but saw a labeled opponent in the past, he has to believe that any unlabeled opponent he meets is a short-run player. Any deviation results in assigning probability one to this belief. This implies that the proposed strategy is not an equilibrium strategy. Under the belief that any unlabeled opponent is a short-run, the best response for a long-run player i is to defect, even when his opponent is unlabeled. The contagious process of labels starts with probability one given short-runs' behavior, and this shuts down cooperation among long-runs. An alternative strategy that keeps track of own histories (such as *cooperate against labeled opponents if you have not seen a labeled opponent, defect otherwise*) solves this problem but is not a straightforward equilibrium[9].

The previous strategy is a Nash Equilibrium when:

$$\delta \geq \frac{g\,(1-\rho)-\rho l}{(1+g)\,(1-\rho)}.$$

Even on the equilibrium path players need to be patient enough in order to ignore some periods of losses due to the presence of short-run players.

4.2 Labels Following Defection Against a Cooperative Player

In this subsection I consider Kandori's information mechanism as introduced in Section 3.2 . I show the conditions under which a strategy that asks players to cooperate against unlabeled opponents, defect against labeled ones, and repent when labeled[10] supports a sequential equilibrium. In contrast with the technology of the previous section, this technology monitors not only behavior but also outcomes of the game. An intuitive explanation for this kind of behavior is that only cooperative players take the time to fill in a complaint. With this mechanism, everybody in the game is unlabeled unless they defected against someone who cooperated or fail to repent.

[9] In this strategy, players labels do not provide all the relevant information to make a decision: players also need to take into account their own history.

[10] In this game a labeled player repents by choosing to cooperate when an the unlabeled opponent does not cooperate against him. There is a current loss in the repentance process taken in order to be unlabeled again.

In this setting I consider the same unforgiving strategy as before: *Cooperate with unlabeled people, defect against labeled people*. The labeling mechanism is:

$$\tau_i(\omega, a_i) = \begin{cases} U & \text{if } a_i = \sigma_i(\omega) \\ L & \text{else,} \end{cases}$$

and the strategy:

$$\sigma_i(\omega) = \begin{cases} C & \text{if } \omega_j = U_j \\ NC & \text{if } \omega_j = L_j. \end{cases}$$

This is an equilibrium strategy if:

1. (C) against unlabeled people is better than (NC)

$$\begin{aligned} V_i^C(U_i, U_j) &\geq V_i^{NC}(U_i, U_j) \\ V_i^C(L_i, U_j) &\geq V_i^{NC}(L_i, U_j) \end{aligned}$$

2.(NC) against labeled people is better than (C)

$$\begin{aligned} V_i^{NC}(U_i, L_j) &\geq V_i^C(U_i, L_j) \\ V_i^{NC}(L_i, L_j) &\geq V_i^C(L_i, L_j) \end{aligned}$$

In the second set of conditions player i recognizes his opponent is a long-run player, and the strategy requires i to enjoy a present and future gain. Naturally, those are satisfied in equilibrium.

For the first restriction, I denote $\widetilde{\rho}$ the probability of meeting a short-run conditional on meeting an unlabeled player. When there are labeled players in the population $\widetilde{\rho}$ is larger than ρ. The restriction becomes :

$$\begin{aligned} V_i^C(U_i, U_j) &\geq V_i^{NC}(U_i, U_j) \\ \delta &\geq \frac{(1-\widetilde{\rho})\, g + \widetilde{\rho} l}{(1-\rho)(1+l)}. \end{aligned}$$

The second restriction, which asks a labeled player to cooperate in repentance, is:

$$\begin{aligned} V_i^C(L_i, U_j) &\geq V_i^{NC}(L_i, U_j) \\ \delta &\geq \frac{l}{(1-\rho)(1+l)}. \end{aligned}$$

When $g \leq l$ the second condition is binding. It still needs to be the case that $l \leq \frac{(1-\rho)}{\rho}$, which also ensures $\delta < 1$ and there is no equilibrium as ρ tends to one.

If $g > l$, the worst case scenario occurs when $\widetilde{\rho} = \rho$, thus the restriction becomes:

$$g \leq \frac{(1-\rho) + l(1-2\rho)}{(1-\rho)}.$$

In this case, $l \leq \frac{(1-\rho)}{\rho}$ ensures that the restriction implies a positive g[11]. In both cases, the loss when meeting a short-run has to be sufficiently low. This equilibrium is satisfied for a much more restricted set of payoffs than in the case with $\rho = 0$.

The payoffs for which these restrictions are satisfied are: $l \in (0, \frac{1-\rho}{\rho}]$. If $g \leq l$, then $g \in (0, \frac{1-\rho}{\rho}]$, but if $g > l$, then $g \in (1, \frac{1}{\rho}]$. Thus, the higher the proportion of short-run in the economy, the smaller the set of payoffs for which this strategy sustains an equilibrium.

So far, by restricting attention to one-period punishments, I get a set of payoffs with an associated discount factor in which this is supported. Changing punishment lengths would allow the sustainability of equilibria for any payoffs $v_i \in [0, (1 - \rho - \rho l)]$[12]. If there are too many short-run players in a population and the loss when cheated is large, then cooperation cannot be sustained with an information technology that is unable to identify short-run players.

If the information mechanism assigns permanent labels to misbehavior even when it monitors transactions, the existence of short-runs results in a plausible off the equilibrium history in which payer i believes that all unlabeled players are short-runs. Under this belief $i's$ best response is to defect. This strategy cannot sustain cooperation.

[11] For $\rho \leq \frac{1}{2}$, the restriction is always positive. For $\rho > \frac{1}{2}$ it is required that $l \leq \frac{(1-\rho)}{2\rho-1}$ which is satisfied whenever $l \leq \frac{(1-\rho)}{\rho}$.

[12] The proof is in Kandori 1992 but the result in the setting of this paper still depends on l to make payoffs individually rational.

5 Imperfect Mechanisms With Short-Runs

In this section, I consider an imperfect mechanism that monitors transactions and punishes deviators for only one period. Two types of errors are analyzed, not labeling a guilty player with probability α or labeling an innocent one with probability β. I study the restrictions that need to be satisfied for the previous section's strategy to be an equilibrium strategy.

A mechanism that makes the error α is extra-forgiving, sometimes a deviator is not penalized. This error reduces the costs of a deviation because it reduces the punishment when deviating. The relevant restrictions become:

$$\delta (1-\alpha) \geq \frac{\max \{l, (1-\widetilde{\rho}) g + \widetilde{\rho} l\}}{(1-\rho)(1+l)}.$$

The possibility of a mistake in this scenario is only requiring players to be more patient than before. The previous restriction on the discount factor is now the one applied to a discount factor modified by the probability of not making a mistake $(1-\alpha)$.

Error β characterizes a mechanism that is extremely unconfident and penalizes even those who behave according to the specified strategy.

Under this error, the two restrictions imply that:

$$\delta (1-\beta) [V_i(U_i) - V_i(L_i)] > \max \{l, (1-\widetilde{\rho}) g + \widetilde{\rho} l\}$$

so:

$$\delta (1-\beta) \geq \frac{\max \{l, (1-\widetilde{\rho}) g + \widetilde{\rho} l\}}{(1-\rho)((1-\beta)(1+l) + \beta (1+g))}.$$

Error β affects the discount rate differently. As it implies that sometimes innocent players are labeled, the payoffs g is relevant on the equilibrium path. This affects the payoffs negatively, making the restriction on δ sharper.

5.1 Types of Errors to Avoid

A relevant question when designing a labeling mechanism is which of the previous two types of mistakes is more important to avoid. Two aspects can be considered for the comparison, the restrictions imposed on δ and the payoffs along the equilibrium path.

Regarding the restrictions on δ:

- if $l = g$, both errors impose the same requirements on δ
- if $l > g$, the β error is worst
- if $l < g$, the α error is worst.

The intuition is straightforward. If the payoff for defecting is large, then an error by the mechanism that lowers the punishment when deviating is less likely to sustain cooperation. On the other hand, if the repentance payment or the loss when meeting a short-run is too high, then a mechanism that forces players to repent by making mistakes will find it more difficult to support cooperation.

Regarding the payoff along the equilibrium path, with error α, it is:

$$V_i^C(U_i, \alpha) = \frac{\rho(-l) + (1-\rho)}{1-\delta}.$$

This payoff is the same as with the perfectly functioning mechanism. By cooperation you can sometimes face a short-run, which is costly.

Error β implies a payoff given by:

$$V_i^C(U_i, \beta) = \frac{\rho(-l) + (1-\rho) + (1-\rho)\beta\left[g - \delta\left(1 + g\beta + l(1-\beta)\right)\right]}{1-\delta}.$$

In this case, the payoff is affected by the probability of being incorrectly labeled and of meeting an innocent opponent incorrectly labeled. Notice that if $l = g$ and $\delta \to 1$, then the numerator is lower in the case with β error than in the case with α error.

Internet feedback mechanisms are more concerned with avoiding false bad labels than with monitoring the veracity of good ones. In this setting good labels means not having a label. Focusing on the consequences of the previous model, this behavior suggests that the β error is a more costly mistake. Thus, the costs when cheated might be larger than the gain from punishment. In a mechanism that only monitors actions, the β error is the most costly because it triggers a contagious process in labels that destroys cooperation.

6 Conclusions

In this paper, I have presented a model of random pairwise interactions in a large population of agents who play a Prisoner's Dilemma stage game and get information from a labeling mechanism that identifies defectors. I have shown how the inclusion of a short-run player makes the sustainability of a cooperative outcome more complex. Short-run players disguise as cooperative players in the population. When only one label provides information, long-run players need to be more patient, and the loss when meeting a short-run has to be relatively low. Furthermore, the presence of short-run players results in the collapse of a cooperative strategy based on a system that monitors players actions instead of transactions.

My model is an application of Kandori's (1992) model. In that paper, a Folk theorem for a matching game with homogenous agents and a labeling mechanism was proven. The ability of the information mechanism to adjust punishment lengths is essential for Kandori's result. In this paper I have restricted attention to a mechanism with only one label. I have shown how the presence of short-run players results in more restrictive conditions on discount rates and players' payoffs. In addition, I have studied the effects of having an imperfect labeling mechanism. When *innocent* players are mistakenly labeled the set of parameters that sustain cooperation is further restricted. In many settings this kind of mistake is more detrimental for cooperation than forgetting to label a *guilty* player.

While this paper analyzed the effects of an informational technology that identifies defectors in an economy with heterogeneous players, some interesting questions are still unanswered. First, a strategy that sustains cooperation for any set of parameters in a population with short-run players and labels for misbehavior remains to be defined. Second, the effect of having a mechanism with more labels, i.e. longer punishment periods or labels for good and bad behavior, may be crucial. Finally, in an attempt to explain the functioning of Internet feedback, it would be interesting to study the functioning of an endogenous mechanism that depends on players willingness to provide feedback.

References

[1] Ahn, I., and M. Suominen (2001), "Word-of-Mouth Communication and Community Enforcement," International Economic Review, 42: 399-415.

[2] Bolton, G., Katok, E., and A. Ockenfels (2005), "Cooperation Among Strangers with Limited Information About Reputation," Journal of Public Economics, 89:1457-1468.

[3] Bolton, G., Katok, E., and A. Ockenfels (2004), "How Effective are Online Reputation Mechanisms? An Experimental Investigation," Management Science, 50(11):1587-1602.

[4] Dellarocas, C. (2003), "The Digitization of Word of Mouth: Promise and Challenges of Online Reputation Mechanisms," Management Science 49(10):1407-1424

[5] Ellison, G. (1994), "Cooperation in the Prisoner's Dilemma With Anonymous Random Matching," Review of Economic Studies, 61: 567-88.

[6] Fudenberg, D. Kreps, D. and E. Maskin (1990), "Repeated Games With Long-run and Short-run Players," Review of Economic Studies, 57: 555-73.

[7] Ghosh P., and D. Ray (1996), "Cooperation in Community Interaction Without Information Flows," Review of Economic Studies 63 (3): 491-519.

[8] Greif, A. (1993), "Contract Enforceability and Economic Institutions in Early Trade: the Maghribi Traders' Coalition," American Economic Review 83:525–548.

[9] Haag, M. and Lagunoff R. (2004), "Social Norms, Local Interaction, and Neighborhood Planning," International Economic Review, forthcoming.

[10] Harrington, J. E. (1995), "Cooperation in a One-Shot Prisoners' Dilemma," Games and Economic Behavior, 8: 364-377.

[11] Hasker, K. (2007), "Social Norms and Choice: a Weak Folk Theorem for Repeated Matching Games," International Journal of Game Theory 36:137–146

[12] Kandori, M. (1992), "Social Norms and Community Enforcement," Review of Economic Studies, 59: 63-80.

[13] Kandori, M.(2002), "Introduction to Repeated Games With Private Monitoring," Journal of Economic Theory,102 (1): 1-15.

[14] Matsushima, H. (1990), "Long-term Partnership in a Repeated Prisoner's Dilemma With Random Matching," Economics Letters 34:245–248.

[15] Milgrom, P., North, D. and Weingast, B. (1990), "The Role of Institutions in The Revival of Trade: The Law Merchant, Private Judges, and the Champagne Fairs," Economics and Politics , 2: 1-23.

[16] Möller, M. (2005), "Optimal Partnership in a Repeated Prisoners' Dilemma," Economic Letters, 88(1):13-19.

[17] Moscoso Boedo, L. (2007), "Cooperation in the Prisoners' Dilemma With Short-Run Players," Working Paper.

[18] Okuno-Fujiwara, M. and A. Postlewaite (1995), "Social Norms in Random Matching Games," Games and Economic Behavior, 9: 79-109.

[19] Resnick, P. and R. Zeckhauser (2002), "Trust Among Strangers in Internet Transactions: Empirical Analysis of Ebay's Reputation System," The Economics of the Internet and E-Commerce, Michael R. Baye, editor, Advances in Applied Microeconomics 11:127-157.

[20] Takahashi, S. (2008), "Community Enforcement When Players Observe Partners' Past Play," Working Paper.

Novedades

División de Administración Pública

Laura Sour, *Correspondencia entre las políticas públicas del PND y el gasto ejercido de la CHPF en México*, DTAP-213

José Ramón Gil, Judith Mariscal y Fernando Ramírez, *Gobierno electrónico en México*, DTAP-214

Judith Mariscal, José Ramón Gil y Armando Aldama, *Políticas de acceso a tecnologías de la información: El caso de e-México*, DTAP-215

Laura Sour y Miguel Ángel Gutiérrez, *Extrinsic Incentives and Tax Compliance*, DTAP-216

Laura Sour y Fredy Girón, *The Flypaper Effect in Mexican Local Governments, 1990-2006*, DTAP-217

Judith Mariscal y Fernando Ramírez, *Retos para el desarrollo del sector de las telecomunicaciones en México*, DTAP-218

Alejandra Ríos y Juan E. Pardinas, *Hacia la reforma constitucional: Las entidades de fiscalización superior en México*, DTAP-219

Laura Sour, *Regional Differences in Infrastructure Investment at the State Level in Mexico*, 1998-2005, DTAP-220

José Felipe Martínez *et al.*, *Exploring the Links Between Immigration and Educational Quality and Opportunity in Mexico*, DTAP-221

Judith Mariscal, *Oportunidades móviles: Pobreza y acceso telefónico en Latinoamérica y el Caribe. El caso de México*, DTAP-222

División de Economía

Rodolfo Cermeño y Huver Rivera, *La demanda por importaciones y exportaciones: evidencia de cointegración para México, 1991-2005*, DTE-449

Juan Manuel Torres, Octavio S. Magaña y Francisco Moreno, *Determinantes del cambio de uso/cobertura arbolada en México*, DTE-450

Juan M. Torres, David B. Bray y Octavio S. Magaña, *The Role of Scale in Mexican Community Forest Management*, DTE-451

Richard H. Adams, Jr. and Alfredo Cuecuecha, *Remittances, Consumption and Investment in Ghana*, DTE-452

Alejandro Villagómez y Juan Ignacio Hernández, *Impacto de la reforma al sistema de pensiones en México sobre el ahorro*, DTE-453

Alejandro Villagómez y Juan Ignacio Hernández, *Monetary Policy Rules in a Small Open Economy: An Application to Mexico*, DTE-454

Alfredo Cuecuecha, *The Effect of Remittances and Migration on Human Capital: Evidence from Mexico*, DTE-455

Arturo Antón, *Efectos del ciclo económico en EE. UU. sobre la producción y el empleo en México*, DTE-456

María José Roa *et al.*, *Preferencias sociales, cooperación y desarrollo financiero: un experimento de campo*, DTE-457

María José Roa *et al.*, Desarrollo financiero y capital social: un estudio empírico de la caja popular Mixtlán, DTE-458

División de Estudios Internacionales

Alejandro Anaya, *Free Trade, "Spillover" and Human Rights Foreign Policies in North America*, DTEI-176

Alejandro Anaya, *Security and Human Rights in Mexico: Do Pressure from Above and Argumentation Have Anything to Do With It?*, DTEI-177

Jorge Chabat, *The International Role of Latin America After September 11: Tying the Giant*, DTEI-178

Jorge Chabat, *The Bush Revolution in Foreign Policy and Mexico: The Limits to Unilateralism*, DTEI-179

Jorge Chabat, *Franchises for Crime: "Maras" and North American Security*, DTEI-180

Jorge Schiavon, *Migración México-Estados Unidos: Intereses, simulaciones y realidades*, DTEI-181

Ferrán Martínez y Robert Duval, *Hostility Towards Immigration in Spain*, DTEI-182

Guadalupe González *et al.*, *Mexico, The Americas and the World 2008. Foreign Policy: Public and Leader Opinion*, DTEI-183

Guadalupe González *et al.*, *México, Las Américas y el Mundo 2008. Política exterior: opinión pública y líderes*, DTEI-184

Guadalupe González *et al.*, *Las Américas y el Mundo 2008. Política exterior y opinión pública en Colombia, Chile, México y Perú*, DTEI-185

División de Estudios Jurídicos

Ana Laura Magaloni, *Arbitrariedad e ineficiencia de la procuración de justicia: dos caras de la misma moneda*, DTEJ-26

Ana María Ibarra, *Los artificios de la Dogmática Jurídica*, DTEJ-27

Ana Elena Fierro y Adriana García, *Responsabilidad patrimonial del Estado. Interpretación de la SCJN del artículo 113 constitucional*, DTEJ-28

Adriana García y Dirk Zavala, *El análisis económico del derecho como herramienta para el diseño normativo…*, DTEJ-29

Carlos Elizondo y Luis Manuel Pérez de Acha, *¿Un nuevo derecho o el debilitamiento del Estado? Garantía de audiencia previa en la expropiación*, DTEJ-30

Ana Elena Fierro y Adriana García, *Guía de las decisiones del PJF en materia de competencia económica: Cómo generar una cultura de la competencia*, DTEJ-31

Carlos Elizondo y Ana Laura Magaloni, *La depuración de las corporaciones policiacas y el juicio de amparo*, DTEJ-32

Marcelo Bergman y Hernán Flom, *Policía y comunidad: una comparación…*, DTEJ-33

Gustavo Fondevila, *"Madrinas": Informantes y parapolicías. La colaboración ilegal con el trabajo policial en México*, DTEJ-34

Gustavo Fondevila, *Costumbres sociales y moral judicial*, DTEJ-35

María Mercedes Albornoz, Choice of Law in International Contracts in Latin American Legal Systems, DTEJ-36

DIVISIÓN DE ESTUDIOS POLÍTICOS

Julio Ríos Figueroa, *Judicial Institutions and Corruption Control*, DTEP-204

Allyson Benton, *The Effect of Electoral Rules on Indigenous Voting Behavior in Mexico's State of Oaxaca*, DTEP-205

Andreas Schedler y Cas Mudde, *The Quantitative Skeleton of Comparative Politics*, DTEP-206

Joy Langston y Francisco Javier Aparicio, *The Past as Future: Prior Political Experience and Career Choices in Mexico, 1997-2006*, DTEP-207

Francisco Javier Aparicio y Sandra Jessica Ley, *Electoral Institutions and Democratic Consolidation in the Mexican States, 1990-2004*, DTEP-208

Joy Langston, *Las reformas electorales de 2007*, DTEP-209

Carlos Elizondo, *La industria del amparo fiscal*, DTEP-210

María de la Luz Inclán, *Threats and Partial Concessions in the Exhaustion of the Zapatista Wave of Protest*, 1994-2003, DTEP-211

Andreas Schedler, *Inconsistencias contaminantes. Gobernación electoral y conflicto postelectoral en las elecciones presidenciales de 2006*, DTEP-212

Andreas Schedler, *Academic Market Failure. Data Availability and Quality in Comparative Politics*, DTEP-213

DIVISIÓN DE HISTORIA

Rafael Rojas, *José María Heredia y la tradición republicana*, DTH-48

Rafael Rojas, *Traductores de la libertad: el americanismo de los primeros republicanos*, DTH-49

Mónica Judith Sánchez, *History* vs. *the Eternal Present or Liberal Individualism and the Morality of Compassion and Trust*, DTH-50

Luis Medina, *Salida: los años de Zedillo*, DTH-51

Michael Sauter, *The Edict on Religion of 1788 and the Statistics of Public Discussion in Prussia*, DTH-52

Michael Sauter, *Conscience and the Rhetoric of Freedom: Fichte's Reaction to the Edict on Religion*, DTH-53

Jean Meyer, *El celibato sacerdotal en la Iglesia Católica*, DTH-54

Jean Meyer, *El celibato sacerdotal católico en los siglos XIX y XX*, DTH-55

Mauricio Tenorio, *Around 1919 and in Mexico City*, DTH-56

Michael Sauter, *Between Outer Space and Human Space: Knowing Space as the Origin of Anthropology*,DTH-57

Ventas

El **CIDE** es una institución de educación superior especializada particularmente en las disciplinas de Economía, Administración Pública, Estudios Internacionales, Estudios Políticos, Historia y Estudios Jurídicos. El Centro publica, como producto del ejercicio intelectual de sus investigadores, **libros, documentos de trabajo,** y **cuatro revistas especializadas:** *Gestión y Política Pública*, *Política y Gobierno*, *Economía Mexicana Nueva Época* e *Istor*.

Para adquirir cualquiera de estas publicaciones, le ofrecemos las siguientes opciones:

VENTAS DIRECTAS:	VENTAS EN LÍNEA:
Tel. Directo: 5081-4003 Tel: 5727-9800 Ext. 6094 y 6091 Fax: 5727 9800 Ext. 6314 Av. Constituyentes 1046, 1er piso, Col. Lomas Altas, Del. Álvaro Obregón, 11950, México, D.F.	Librería virtual: **www.e-cide.com** Dudas y comentarios: **publicaciones@cide.edu**

¡¡Colecciones completas!!

Adquiere los **CDs de las colecciones completas** de los documentos de trabajo de todas las divisiones académicas del CIDE: **Economía**, **Administración Pública**, **Estudios Internacionales**, **Estudios Políticos**, **Historia** y **Estudios Jurídicos.**

¡Nuevo! ¡¡Arma tu CD!!

Visita nuestra Librería Virtual www.e-cide.com y selecciona entre 10 y 20 documentos de trabajo. A partir de tu lista te enviaremos un CD con los documentos que elegiste.