



Asymmetric social norms[☆]

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HIGHLIGHTS

- We study cooperation and social norms among heterogeneous strangers.
- Occasional defections may be part of efficient play.
- If so, then contagious punishment is needed to support high payoffs.
- We derive computable closed-form expressions for continuation payoffs.

ARTICLE INFO

Article history:

Received 17 August 2016

Received in revised form 8 December 2016

Accepted 16 December 2016

Available online 23 December 2016

JEL classification:

C6

C7

Keywords:

Cooperation

Repeated games

Social dilemmas

ABSTRACT

Studies of cooperation in infinitely repeated matching games focus on homogeneous economies, where full cooperation is efficient and any defection is collectively sanctioned. Here we study heterogeneous economies where occasional defections are part of efficient play, and show how to support those outcomes through contagious punishments.

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1. Introduction

The social norms literature has extended the study of cooperation in infinitely repeated games from the case of stable partnerships (Rubinstein, 1979; Fudenberg and Maskin, 1986) to unstable meetings among homogeneous strangers (Kandori, 1992; Ellison, 1994). Patient strangers can attain the efficient outcome by triggering community-wide responses to privately observed defections (“grim” play). However, this requires sufficiently small groups. Large groups must be able to publicly monitor defections, which makes the economy’s size irrelevant, and homogeneity greatly reduces the information that must be shared; since full cooperation

is efficient, knowing that not everyone acted identically is sufficient. The open question is how results change when strangers are heterogeneous. Here, the structure of incentives may vary across meetings and efficient play may require some players to cooperate and others not.

We study social norms among heterogeneous strangers. Players receive iid productivity shocks, so payoff matrices stochastically vary across meetings, and can be asymmetric. Before choosing an action, players see productivities in *their* match. If full cooperation is efficient, publicly exposing defections supports cooperation; heterogeneity simply alters the admissible discount factors relative to the homogeneous case. Otherwise, if occasional defections are part of efficient play, then we need contagious punishments to support high payoffs because publicly exposing defections without productivities in other matches cannot reveal off-equilibrium play. Contagious punishment can deter defections only under moderate productivity differences.

The analysis has merit because little exists about cooperation under heterogeneity. The closest paper is Blonski and Spagnolo

[☆] We thank an anonymous referee for comments that improved the exposition of the paper. Partial support from National Science Foundation grant CCF-1101627 is acknowledged.

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		Player $-i$	
		C	D
Player i	C	$\theta_i c, \theta_{-i} c$	$-l, \theta_i(c+g)$
	D	$\theta_{-i}(c+g), -l$	$0, 0$

Fig. 1. The game between player i and $-i$.

(2015), an infinitely repeated PD game in fixed pairs where cooperation is efficient but asymmetrically benefits players. The technique we present generates tractable closed-form expressions for continuation payoffs, which can be employed to calibrate laboratory economies.

2. Model

In every period $N \geq 4$ (even) players are paired with uniform probability (Kandori, 1992; Ellison, 1994). Subsequently, each player $i = 1, \dots, N$, draws a random iid productivity shock $\theta_i \in \{1, \alpha\}$, $\alpha > 1$: $\theta_i = \alpha$ (productive) with probability q , and $\theta_i = 1$ (unproductive) otherwise. A match between i and opponent $-i$ is either symmetric ($\theta_i = \theta_{-i}$) or asymmetric. Payoffs are in Fig. 1.

Let $c, g, l > 0$ and $\theta_i c > \theta_i g - l$. The cooperative outcome (C, C) maximizes total earnings if

$$c \geq \alpha g - l, \tag{1}$$

thus amounting to a proper Prisoners' Dilemma (PD). Otherwise, we have an asymmetric social dilemma where D is dominant but asymmetric cooperation, (D, C) or (C, D), is efficient. Iterated PDs in fixed pairs assume (1) to rule out taking turns at selecting C and D (e.g., Rapoport and Chammah, 1965). Interestingly, Kandori (1992) and Ellison (1994) do not assume (1), possibly because pairs are short-lived and break up over time, which complicates coordination on action alternation.

Before choosing, players observe productivities only in their match, not in others. At the period's end players are informed if everyone chose identically or not. Full defection is an equilibrium – giving payoff 0 – because D is a best response to D by everyone else. Other equilibria exist. If (1) holds, public monitoring supports full cooperation. Everyone chooses C unless someone acted differently, in which case everyone chooses D forever. This equilibrium exists – independent of N – if

$$\beta \geq \frac{c(\alpha - 1) + g\alpha}{qc(\alpha - 1) + \alpha(c + g)} \in (0, 1).$$

If (1) does not hold, the available public information is no longer useful to attain efficiency. Earnings in matches with unequal productivities are maximized by asymmetric cooperation; hence, (C, D) is part of efficient play. As players cannot see productivities in other matches, making defections public cannot reveal deviations from efficient play.

Hence, consider community-based enforcement triggered by privately observed deviations. Players cooperate whenever their productivity is no smaller than their opponent's; otherwise, they defect. If they observe someone choosing D when C should be chosen, then they switch to play “always defect”.

Definition 1 (Asymmetric Cooperation). At the start of any period, player i either “cooperates” by choosing C if $\theta_i \geq \theta_{-i}$, and D otherwise, or “punishes” by unconditionally choosing D. Player i follows “cooperate” but permanently switches to “punish” if someone deviates to D when C should be chosen.

The equilibrium payoff is $(1 - \beta)^{-1} \pi^*$, where

$$\pi^* = q^2 \alpha c + (1 - q)^2 c + (1 - q)q(\alpha c + \alpha g - l)$$

denotes expected period earnings.

Theorem 1. Fix q . If $\frac{c}{g}$ is sufficiently small, then there exists $\alpha \in (\underline{\alpha}, \alpha_q)$ such that if β and l are sufficiently large, then Asymmetric Cooperation is a sequential equilibrium.

The conditions on discounting β and sucker's payoff l are standard. Players must be patient to prefer C to D in equilibrium; the sucker's payoff must be sufficiently large for punishment to be incentive-compatible. The new conditions involve the temptation payoff and the productivity parameter. Productivities cannot be too different or productive players would avoid punishing in asymmetric meetings. The proof follows.

2.1. Contagious punishment

When everyone follows the strategy in Definition 1, partition the population into $N - k$ cooperators and $k \in \kappa := (1, \dots, N)^T$ defectors. Cooperators follow equilibrium play; Defectors only play D. The economy is off-equilibrium if $k \geq 2$; $k = 1$ denotes when player i moves off-equilibrium in a match $\theta_i \geq \theta_{-i}$. Indeed, player i has no incentive to deviate to C from D if $\theta_i < \theta_{-i}$.

The $N \times N$ upper-triangular transition matrix

$$\mathcal{Q}_N = \begin{pmatrix} Q_{11} & Q_{12} & 0 & 0 & 0 & 0 & \dots & 0 & 0 \\ 0 & Q_{22} & Q_{23} & Q_{24} & 0 & 0 & \dots & 0 & 0 \\ 0 & 0 & Q_{33} & Q_{34} & Q_{35} & Q_{36} & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots & Q_{N-1,N-1} & Q_{N-1,N} \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots & 0 & 1 \end{pmatrix} \tag{2}$$

describes the contagious punishment process.

The first row applies if i moves off-equilibrium when $\theta_i \geq \theta_{-i}$, with probability $Q_{12} = 1 - q(1 - q)$. This triggers contagious punishment, gradually bringing the economy to full defection. $Q_{11} = (1 - q)q$ is the probability that $\theta_i < \theta_{-i}$, so no punishment is triggered.

In the second row there are two defectors $i = \ell, m$. The number of defectors doubles with probability Q_{24} , if they both are in mixed matches where $\theta_i \geq \theta_{-i}$. If the defectors meet each other or are in matches where $\theta_i < \theta_{-i}$, then the number of defectors does not increase (with probability Q_{22}). If only one defector $i = \ell, m$ is in a mixed match with $\theta_i \geq \theta_{-i}$, then there is only one additional defector, with probability Q_{23} .

Not all mixed matches – cooperator-defector matches – contribute to spread punishment since D is part of equilibrium play. This is the central difference with the homogeneous economies in Kandori (1992). When cooperator i meets defector $-i$ and $\theta_i > \theta_{-i}$, i will not start defecting since $-i$ follows equilibrium play. This match occurs with probability $q(1 - q)$, so, if there are j mixed matches, contagion occurs in $n < j$ of those with probability $\binom{j}{n} [1 - q(1 - q)]^n [q(1 - q)]^{j-n}$.

A transition from $k \geq 2$ to $k' \geq k$ defectors occurs with probability

$$Q_{kk'}(N) := \sum_{j=k'-k}^{\min(k,N-k)} \lambda_{kj} \binom{j}{k'-k} [1 - q(1 - q)]^{k'-k} [q(1 - q)]^{j-k'+k},$$

where N is omitted in \mathcal{Q}_N . The probability of j mixed matches

$$\lambda_{kj} := \frac{j! \binom{k}{j} \binom{N-k}{j} (k-j-1)! (N-k-j-1)!}{(N-1)!},$$

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