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Justifiable punishments in repeated games

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ABSTRACT

In repeated games, subgame perfection requires all continuation strategy profiles must be effective to enforce the equilibrium; they serve as punishments should deviations occur. It does not require whether a punishment can be justified for the deviation, which creates a great deal of freedom in constructing equilibrium strategies, resulting the well-known folk theorem. We introduce justifiable punishments in repeated games. After one player deviates, the corresponding continuation or punishment is justifiable if either the deviation is bad to the other player or the continuation itself is good to the other player. We characterize the set of payoff vectors that can be supported by subgame perfect equilibria with justifiable punishments, as the discount factor goes to one. This limiting set of equilibrium payoffs can be quite different from the set of subgame perfect equilibrium payoffs. Any efficient, feasible, and strictly individually rational payoff can be supported by equilibrium with justifiable punishments.

1. Introduction

It has been recognized for long that numerous new equilibria emerge when a stage game is played repeatedly. The well-known folk theorem asserts that under certain conditions, any feasible and strictly individually rational payoff vector of a stage game can be sustained by a subgame perfect equilibrium in the corresponding infinitely repeated game when the players value their future high enough, see for example, Fudenberg and Maskin (1986).[1] Typically, there are often many different strategy profiles that result in the same payoff vector. Most of strategy profiles studied in the literature punish the deviating player in the continuation game, regardless the consequence of the deviation or the intention of the deviating player. As long as punishments are effective to deter deviations, sequential rationality itself does not impose any other restriction on the punishments. In order to weaken the equilibrium conditions, researchers often use the most severe punishment available to punish a player for any of his deviations. This independence between deviations and punishments creates a great deal of freedom in constructing equilibrium strategies. As a result, almost all reasonable, i.e., feasible and strictly individually rational, payoffs may arise in equilibria. The negative side of this coin is that folk theorem provides little guidance on which equilibrium to adopt when applying repeated game models in researches.

In reality, however, histories often provide some meaningful references or justifications on what future plan of actions should be. Changing future course of actions must be caused by some incident that is outside of what we expect to happen, such as someone deviated in a repeated game. Social justice often provides the options on what to do in the future to

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[1] For a more comprehensive overview on the recent developments in the repeated game literature, see Mailath and Samuelson (2006).

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everyone (the non-deviating player) except the party who is responsible for the incident (the deviating player). The change on future course of actions that is good to the non-deviating player is "economically" justifiable, because it is in this non-deviating player's interest to make such a change. If the non-deviating player is the victim of the incident, punishing the deviating player is "morally" justifiable even if it is costly to the non-deviating player to carry out the punishment. On the other hand, if the non-deviating player is a beneficiary of the incident, carrying out the punishment that is costly to the non-deviating player would seem very unreasonable because carrying out costly punishment cannot be justified on either economical or moral ground.

Based on the arguments on what continuations are deemed to be justifiable, we study subgame perfect equilibria in two-person repeated games such that all continuations are justifiable.[2] An equilibrium in repeated games can be viewed as an implicit contract between the players. The strategy profile prescribes a course of actions in the future for every possible history of plays. If a player deviates from what the strategy profile prescribed, i.e., breach the implicit contract, it is necessary to change the course of actions in the future. Whether such a change is justifiable or not depends on the consequence of the deviation. If one player's deviation is bad to the other player, then any continuation will be justifiable, as a mean to punish such a "bad" behavior. Otherwise, a continuation is justifiable if and only if the non-deviating player benefits from the new continuation, meaning receive a high continuation payoff from it than from the continuation when no such a deviation occurs. Requiring all continuations to be justifiable seems intuitive and innocent, yet as Example 1 demonstrates, it has dramatic implications on what payoffs can be supported by subgame perfect equilibrium with justifiable punishments.[3]

Example 1. Consider the infinitely repeated game with the following stage game:

	L	R
T	$2,\ 2$	$0,-1$
B	$-1,\ 0$	$-2,-2$

First observe that (T, L) is the unique Nash equilibrium in the stage game, and its payoff vector $(2, 2)$ strictly dominates all other feasible payoff vectors. According to the folk theorem of Fudenberg and Maskin (1986), every feasible payoff vector that strictly dominates the minmax point $(0, 0)$ can be supported by a SPE of the repeated game when the discount factor is sufficiently close to 1. For example, to support a symmetric payoff vector that is strictly dominated by $(2, 2)$, Fudenberg and Maskin (1986) adopted a simple strategy profile (see Abreu, 1988) where the two players play the mutual minmax (B, R) for some number of periods followed by the stage-game Nash equilibrium (T, L) forever. This simple strategy profile requires to restart this sequence of plays after someone deviates. During the mutual minmax (B, R), if player 1 deviates to T, which increases player 2's payoff from -2 to -1, so player 2 actually benefits from player 1's deviating. In some sense, player 1's deviation from B to T is a good "initiation" aiming for a better situation (T, L) for both players. Punishing player 1 by restarting this sequence of play also lowers player 2's future payoff, which is neither "economically" nor "morally" justifiable for player 2 to do. As we will show later in detail, this repeated game has a unique subgame perfect equilibrium where all continuations are justifiable: the two players play the dominant stage-game Nash equilibrium (T, L) in every period.

Imposing justifiable continuations or punishments explicitly links players' future course of actions to their current payoffs, which has been absent from most studies on repeated games with perfect monitoring. In repeated games with imperfect monitoring, such as Green and Porter (1984) (see also Mailath and Samuelson, 2006, for more references), players do not directly observe what actions have been played, but rather some imperfect signal of the current play. In most cases, such a signal is directly linked to a player stage game payoff, such as market price. Therefore, whether to start a punishment depends on the nature of the signal. If the signal is "good", all players receive relatively higher payoffs, it is more likely that the players have complied the strategy profile so no revision on future course of actions is needed. If a player received a significantly lower payoff in a period than what is expected when no deviation occurs, on the other hand, this could signal someone has deviated, then a punishment will be implemented. Even though we focus on repeated games with perfect monitoring in this paper, the idea of using current payoff as the trigger of future punishment in repeated games with imperfect monitoring provides us an alternative reasoning for justifiable punishments. After all, why should a player care about what action the other player takes? Instead, a player should care for the welfare consequences of the other player's action and the corresponding continuations. These observations on when the players initiate a punishment in repeated game with imperfect monitoring provides us another motivation for the idea of justifiable punishment.

Our research belongs to the literature on equilibrium refinements for repeated games. One significant achievement in this area is the idea of renegotiation proofness.[4] The basic idea for renegotiation proofness is that any continuation should be Pareto efficient, or at least, within all possible continuations of the equilibrium strategy profile. When motivating this

[2] It is not obvious what continuation should be considered to be justifiable in an N-person repeated game. For example, after a deviation that is beneficial to two non-deviating players, but one of them is better off but the other one is worse off from the punishment, the two non-deviating players may not have a common consensus on whether the punishment is justifiable.

[3] Example 1 also explicitly motivates the idea of justifiable punishments in the context of a repeated game.

[4] See Bernheim and Ray (1989), Farrell and Maskin (1989), van Damme (1989), Abreu and Pearce (1991), Asheim (1991), Abreu et al. (1993), Bergin and MacLeod (1993), Benoit and Krishna (1993), and Wen (1996).