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On the role of non-equilibrium focal points as coordination devices☆

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ABSTRACT

Considering a pure coordination game with a large number of equivalent equilibria, we argue that a focal point that is itself *not* a Nash equilibrium, and is Pareto dominated by all Nash equilibria, may enhance coordination substantially. Besides attracting the players' choices to itself, such a non-equilibrium focal point may act as an equilibrium selection device that the players use to coordinate on a small subset of Nash equilibria. We present experimental support for these two roles of non-equilibrium focal points as coordination devices, and suggest a theoretical explanation for this.

1. Introduction

Many social interactions have to be modeled as a coordination game. Multiplicity of equilibria in such games implies that the players do not just need to find a solution to the game, but must also coordinate on the same solution. That is, they face strategic uncertainty. Schelling (1960) observed that, in everyday life, individuals who are confronted with coordination problems frequently seem to do surprisingly well, and that focal points play an important role by providing a point of convergence for individual expectations.[1] As Schelling put it: "*Most situations – perhaps every situation for people who are practiced at this kind of game – provide some clue for coordinating behavior, some focal point for each person's expectation of*

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[1] For a discussion of Schelling's analysis, see Sugden and Zamarrón (2006).

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what the other expects him to expect to be expected to do. Finding the key, or rather finding ***a*** *key – any key that is mutually recognized as the key becomes* ***the*** *key – may depend on imagination more than on logic; it may depend on analogy, precedent, accidental arrangement, symmetry, esthetic or geometric configuration, casuistic reasoning, and who the parties are and what they know about each other"* (p. 57).

Following early work on focal points presenting the idea as such,[2] a considerable focal point literature (experimental as well as theoretical) has developed in the last few decades,[3] essentially documenting and analyzing how "agents focus their attention on one equilibrium because it is more prominent or conspicuous than the others" (Young, 1993, p. 58). Thus, Peyton Young recognizes focal points as one of three broad equilibrium selection theories. The other two distinguished by Young are *introspection*, selecting some equilibria as a priori more reasonable than others (see, e.g., Harsanyi and Selten, 1988), and *dynamics* leading to the convergence of expectations through precedents (see, e.g., Crawford and Haller, 1990). With the literature centered on equilibria, the possibility that *non-equilibria* might be focal too, and might thus facilitate coordination, needs to be recognized and investigated. This paper's contribution is a step to fill this gap, thus extending the literature on focal points.[4]

Our starting point will be a two-player matrix game with common interest and a multiplicity of equivalent Nash equilibria (NE). As explained in more detail in Section 2, the usual equilibrium selection criteria are not helpful in this game. We create, next, a salient payoff in this game by *reducing* one of the equilibrium payoffs, thus *eliminating* its pure strategy equilibrium property. Our goal is to test whether this alteration of the incentive structure, which confers salience to one payoff, helps individuals to coordinate, even if this payoff does *not* correspond to an equilibrium and it is Pareto *dominated* by the equilibrium payoffs.

In a number of laboratory experiments, we show that the introduction of such a non-equilibrium focal point (FP) may have a powerful effect on coordination success. Eventually the amount of coordination success increases by up to 251% compared to the benchmark game without FP. Our experimental evidence also shows that there are two ways in which the non-equilibrium FP helps to improve coordination. First, the non-equilibrium FP in itself becomes an attractor. We show that *removing* the pure strategy equilibrium property of an outcome can actually make it *more likely* to be played. Second, the FP acts as an equilibrium selection device, becoming a 'stepping stone' from which players jump to coordinate on a small subset of related NE that we will call the Associated Nash Equilibria (ANE). In addition, the experimental evidence indicates that the relative importance of the FP and the ANE depends on the amount of the focal payoff, and the effect of the FP becoming substantially stronger as the players are given more opportunities to reconsider and adjust their actions.

Following an analysis of the experimental data, we argue that in particular Variable Frame Theory (Bacharach, 1993; Bacharach and Bernasconi, 1997; Bacharach, 2006) may be helpful to understand the role that non-equilibrium focal points can play.

In summary, like Crawford et al. (2008), we explore in this paper the limits of focal points to enhance coordination and report the findings concerning the role of non-equilibrium focal points. Our results should help to recognize that non-equilibrium focal points may enhance coordination.

The remainder of this paper is organized as follows. In Section 2 we present the coordination game that we study. Section 3 explains the design of our experiments and proposes a set of hypotheses, while the experimental results are analyzed in Section 4. In Section 5 we make some theoretical observations, and Section 6 concludes.

2. Coordination game

In order to isolate the effect of a salient non-equilibrium payoff, we present a two-player game based on the payoff matrix in Fig. 1. The game is represented in normal form with player 1 choosing from the set of rows $(r_1, \ldots, r_n)$ and player 2 from the set of columns $(c_1, \ldots, c_n)$. To each pair (r_i, c_j) corresponds a payoff that is *equal for both players*, as indicated in the corresponding cells of Fig. 1. The fact that, no matter which outcome results, the players receive the same payoff means that we have a game of common interest, which allows us to focus on pure coordination problems. The game has thirty equivalent pure NE leading to a payoff of 100 for each player. Any miscoordination leads to a payoff of 0.

Notice that no equilibrium in this game is more reasonable than others, and neither payoff nor risk considerations distinguish any of these NE. All equilibria are efficient with the same payoffs, and all are equally risky. Hence, all players want to reach an equilibrium, but they are indifferent about which equilibrium they reach. Precedents are of little help since we consider essentially a sequence of one-shot games (random re-matching at each stage game) with very limited information feedback. We also made an effort to avoid any of the equilibria becoming more conspicuous through 'label salience'.[5] In fact, we strive to make all equilibria "nondescript" (in the sense of Bacharach, 1993) by eliminating any "labels"

[2] Besides Schelling (1960), see, e.g., Lewis (1969), Gauthier (1975) and Gilbert (1989).

[3] See, e.g., Bacharach (1993), Mehta et al. (1994), Sugden (1995), Bacharach and Bernasconi (1997), Casajus (2001), Janssen (2001), Crawford and Iriberri (2007b), Crawford et al. (2008), Bardsley et al. (2010), Isoni et al. (2010) and the references therein.

[4] Brandts and MacLeod (1995), focussing on the issue of equilibrium refinements and without mentioning focal points, study the effect of public recommendations on equilibrium selection in a number of games. In the few cases that non-equilibrium play was recommended they observed no effect or little effect (if the recommended play led to the only fair and Pareto efficient outcome). See also Fehr et al. (2011) on sunspot-driven behavior.

[5] 'Label salience' has received some attention in the literature as it has been observed that in pure coordination games with n equivalent equilibria, environmental signals, "labels" or "frames" (see Mehta et al., 1994, Binmore and Samuelson, 2006, or Crawford and Iriberri, 2007b) become strategically