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Note

Stake size and the power of focal points in coordination games: Experimental evidence

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ABSTRACT

We collect data from symmetric and asymmetric coordination games with a focal point and vary the stake size. The data show that in symmetric games coordination on the label-salient strategy increases with stake size. By contrast, in asymmetric games the coordination rates do not vary with stake size and are close to the levels predicted by both the mixed Nash equilibrium and the level- k model used by Crawford et al. (2008). These findings suggest that players' mode of reasoning, and the extent to which it can be explained by team reasoning or a level- k model, crucially depends on the symmetry or asymmetry of the coordination payoffs.

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1. Introduction

The experimental literature on focal points (Schelling, 1960) in pure and asymmetric one-shot simultaneous-move coordination games have found that payoff asymmetries weaken the power of focal points to serve as a coordination device. This is especially the case for focal points based on purely contextual aspects such as the game's "labels" – see Crawford et al. (2008), Isoni et al. (2013, 2014), and Crawford et al. (2013).

In this paper we investigate the hypothesis that the amount of money at stake (the stake size) might play an important role for the power of label-based focal points in these types of coordination games. Our intuition is quite simple: Suppose the monetary gains from successful coordination increase. This might make subjects more likely to engage in a focal-point (or team-based; see Sugden, 1993) mode of thinking, and hence more likely to choose the label-based focal point. High stakes might focus and sharpen players' minds, making them think harder about how they can coordinate, and hence be more likely to appreciate the usefulness of relying on the focal aspect to help them to coordinate.

We test the hypothesis that the stake size matters for the power of label-based focal points by varying the stake size in coordination games similar to those used in Crawford et al. (2008), henceforth CGR. These are battle of the sexes games with

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two strategies for each player, two pure-strategy Nash equilibria, and a symmetric mixed Nash equilibrium. The strategies are labeled “A” and “B”. We hypothesized that choosing A would be more salient than B because A is the first letter of the alphabet.² We independently vary the stake size and whether the game is symmetric or asymmetric (i.e., whether players are indifferent between the pure strategy equilibria or they prefer a different equilibrium). This allows us to measure the effects of payoff asymmetry on behavior for a given stake size (low, medium, or high stakes), and the effect of changing the stake size on the power of the focal point for a given payoff structure (symmetric or asymmetric payoffs).

While there is a large literature on stake size effects in economic experiments,³ we believe that we are the first to examine the effects of stake sizes on the power of focal points in symmetric and asymmetric coordination games.

We vary stake size as follows. In the symmetric game with medium stakes, players 1 and 2 each receive 5 British pounds⁴ (£5) from successful coordination, and zero otherwise. In the symmetric low-stakes game, all payoffs are divided by ten, such that coordination gives each player £0.5. In the symmetric high-stakes game, all medium payoffs are multiplied by three, such that coordination gives each player £15. In the asymmetric low,⁵ medium, and high stake games the coordination payoffs are (£0.5, £0.6) and (£0.6, £0.5), (£5, £6) and (£6, £5), and (£15, £18) and (£18, £15), respectively.

We observe that increasing the stakes in symmetric games from low to medium has no significant impact on coordination, while going from medium to high significantly increases the power of the focal point. In asymmetric games, on the other hand, increasing the stakes does not make the focal point more salient and there is no impact on the coordination rate.

Increasing the stake size in symmetric games thus makes the game's labels more salient, and payoff asymmetry reduces the salience of the label-based focal point significantly, no matter how much is at stake. One interpretation is that the presence of payoff asymmetries causes players to reason in a more individualistic, and less team-based, manner (see also the discussion in CGR, and Faillo et al., 2013). Players are less likely to notice the game's labels, and/or they lose faith that the other player will notice and act on them. Future research should seek to disentangle these explanations.⁶

Our findings are consistent with those from CGR who find that payoff asymmetries significantly weaken the power of focal points. Our results extend their findings by showing that the power of focal points vanishes when payoff asymmetries are introduced, even when the stake size is increased significantly.

2. Related literature

Game theory predicts that changing a game's payoffs, by multiplying all the payoffs by a positive number or adding/subtracting a constant from all payoffs, will not affect players' equilibrium behavior. However, the experimental evidence on this prediction is mixed, as shown in Camerer and Hogarth (1999), who provide a very extensive literature survey on the effect of stake sizes in a large variety of games. In some games players' choices are not affected by the fact that payoffs are scaled up or down. In other games, however, Camerer and Hogarth (1999) note that players' behavior are different when the payoffs are higher.

Feltovich (2011), Feltovich et al. (2012), and Rydval and Ortmann (2005) study the effect of varying payoffs in Hawk Dove and Stag-Hunt games in order to investigate whether loss aversion is a robust empirical phenomenon; see also Cachon and Camerer (1996) who investigate loss aversion in a median-effort game. They find evidence that when payoffs are negative, subjects make very different strategic choices than when payoffs are positive, because subjects dislike losses more than they like making gains. These papers do not investigate the effect of stake sizes on label-based focal points. Moreover, in our experiment subjects cannot make losses, so the focus of our paper differs from these studies.⁷

3. Experimental design

Participants made decisions in a one-shot simultaneous-move 2×2 coordination game.⁸ In order to preserve the one-shot nature of the games, each subject only participated in one treatment (between-subject design) and played its game only once.⁹

² Other examples include “A-grade student” versus “B-grade student”, and “Plan A” versus “Plan B”.

³ For an extensive survey please see Camerer and Hogarth (1999).

⁴ At the time of the experiment £5 = \$7.60.

⁵ The Low-stake games were proposed to us by an anonymous referee; we are grateful for this suggestion.

⁶ See for example Faillo et al. (2013).

⁷ Other experiments have investigated the effects of stake sizes on players' choices in Prisoners' Dilemma games, ultimatum games, and trust games. The conclusions are once again mixed, with some studies confirming the game theoretic prediction and other studies showing that subjects' behavior is affected by stake sizes. See for example Andersen et al. (2011), Cameron (1999), Clark and Sefton (2001), Darai and Grätz (2010), Carpenter et al. (2005), Kocher et al. (2008), and Slonim and Roth (1998). Again, none of these studies consider the effect of stake sizes in coordination games with focal points. Other studies outside the realm of coordination and social dilemma games include Parco et al. (2002), Ariely et al. (2009), Kachelmeier and Shehata (1992), and Vieider (2012).

⁸ As in CGR we choose one-shot games because we wish to concentrate on the coordination power of the salient label and abstract away from other mechanisms that can aid coordination, such as repeated interaction (e.g., through learning, reputation building, and reciprocity).

⁹ Although we could have used a within-subject design and not provide feedback on the outcomes until the end of the experiment, we choose not to because such a design would have introduced the possibility of order and learning effects, which we wanted to avoid.

Table 1
2 × 2 coordination game.

	P1	P2	
		A	B
A		a_1, a_2	0, 0
B		0, 0	b_1, b_2

Symmetric game: $a_1 = a_2 = b_1 = b_2$
Asymmetric game: $a_1 = b_2 < a_2 = b_1$

Table 2
Experimental treatments.

Treatment	P1	P2		Mixed strategy Nash equilibria		
		A	B	p	q	Coord. rates
Symmetric Low (SL)	A	£0.5, £0.5	£0, £0	0.5000	0.5000	50.0%
	B	£0, £0	£0.5, £0.5			
Symmetric Medium (SM)	A	£5, £5	£0, £0	0.5000	0.5000	50.0%
	B	£0, £0	£5, £5			
Symmetric High (SH)	A	£15, £15	£0, £0	0.5000	0.5000	50.0%
	B	£0, £0	£15, £15			
Asymmetric Low (AL)	A	£0.5, £0.6	£0, £0	0.4545	0.5455	49.6%
	B	£0, £0	£0.6, £0.5			
Asymmetric Medium (AM)	A	£5, £6	£0, £0	0.4545	0.5455	49.6%
	B	£0, £0	£6, £5			
Asymmetric High (AH)	A	£15, £18	£0, £0	0.4545	0.5455	49.6%
	B	£0, £0	£18, £15			

Note: p = probability that P1 plays A, q = probability that P2 plays A.

In all the games each strategy was labeled with a letter: “A” and “B”. Although there is a wide variety of possible labels (e.g., letters, words, numbers, colors, or graphic patterns; see Bardsley et al., 2010 and Hargreaves Heap et al., 2014), using letters is advantageous because the choice is simple for participants to understand and transcends personal biases and interpretation that could be present with most other labels designed by the experimenters. The use of letters is similar to the experiments by CGR, where strategies were labeled as “X” and “Y”.

As in CGR we explore two payoff structures. The first is a pure coordination game, while the second is a “battle of the sexes” game. Following CGR we refer to the first as a “symmetric” and the second as an “asymmetric” game (see Table 1). Although in both types of coordination games there are two pure-strategy Nash equilibria (PSNE) and one mixed-strategy Nash equilibria (MSNE), the experimental literature has established that subjects use the label-based focal point to coordinate in the former game, thereby achieving coordination rates that are significantly higher than those predicted the MSNE (Schelling, 1960; Mehta et al., 1994a; Bardsley et al., 2010; Crawford et al., 2008). On the other hand, CGR find that labels lose their coordination-enhancing power in asymmetric coordination games (see also Poulsen et al., 2013, and Isoni et al., 2014).

For both payoff structures we implemented three stake size levels: Low, Medium and Large. The Medium-stake coordination payoffs were (£5, £5) and (£5, £6), (£6, £5), in the symmetric and asymmetric game, respectively. These earnings are comparable to the usual earnings for a thirty-minute lab session. The Low-stake payoffs were obtained by dividing the medium payoffs by ten, that is: (£0.5, £0.5) and (£0.5, £0.6), (£0.6, £0.5), respectively. The High-stake payoffs were obtained by multiplying the medium-stake payoffs by three, bringing them to (£15, £15), and (£15, £18), (£18, £15).¹⁰ This is a significant reward for a session involving a single (binary) decision and lasting only about 25 minutes. Regardless of the stake sizes, participants also received a £2 participation fee, and in the Low stake treatments they were given an additional £2 for completing the feedback. The former payment was announced at the beginning of the experiment, while the additional payment was only announced after participants submitted their decision in the coordination game. Summarizing, we apply a 2 × 3 between-subjects factorial design. Two independent variables are manipulated: payoff structure (Symmetric, Asymmetric) and stake size (Low, Medium and High). Consequently we ran six treatments: Symmetric Low (SL), Symmetric Medium (SM), Symmetric High (SH), Asymmetric Low (AL), Asymmetric Medium (SM), and Asymmetric High (AH). Table 2 shows the payoff matrices.

¹⁰ One advantage of raising the stake size by simply scaling up all money amounts by a common factor is that all relative magnitudes, and hence the mixed Nash equilibrium, as well as the level- k prediction in Crawford et al. (2008), remain unchanged. Of course, when we go from (5, 6) to (15, 18) payoffs, the absolute payoff difference between the low and the high coordination payoff is increased, from 1 to 3, and this might be behaviorally relevant. A referee pointed out that this could be investigated by comparing payoffs (5, 6) and (15, 16). This is something that can be investigated in future work.

Table 3
Results.

	Symmetric Low (SL)	Symmetric Medium (SM)	Symmetric High (SH)	Asymmetric Low (AL)	Asymmetric Medium (AM)	Asymmetric High (AH)
Payoffs for coordinating on "A"	£0.5, £ 0.5	£5, £5	£15, £15	£0.5, £ 0.6	£5, £6	£15, £18
Payoffs for coordinating on "B"	£0.5, £ 0.5	£5, £5	£15, £15	£0.6, £ 0.5	£6, £5	£18, £15
N	48 P1s and P2s	48 P1s and P2s	48 P1s and P2s	24 P1s 24 P2s	24 P1s 24 P2s	24 P1s 24 P2s
N choosing "A"	41(85.4%) P1s and P2s	40(83.3%) P1s and P2s	47(97.9%) P1s and P2s	13(54.2%) P1s 11(45.8%) P2s	12(50%) P1s 10(41.7%) P2s	11(45.8%) P1s 13(54.2%) P2s
Expected coordination rates	74.6%	71.6%	95.8%	49.7%	50.0%	49.7%
Mixed strategy Nash equilibria coordination rates	50.0%	50.0%	50.0%	49.6%	49.6%	49.6%

4. Experimental procedures

A total of 288 students from University of East Anglia (Norwich, UK) participated in the study (average age = 23 years; 163 females and 125 males). Participants were recruited online using ORSEE (Greiner, 2004) and hroot (Bock et al., 2012). On average a session lasted 25 minutes. We conducted a total of twenty-four sessions (four per treatment), which all took place at the CBESS Zicer lab facility. All data were collected during March and April 2013, except the SL and AL data which were collected during November 2014.

For each treatment we recruited 48 subjects (24 pairs). The instructions explained that they would be randomly matched with another participant in the room and that all decisions would be anonymous (see Appendix A). Half of the participants were assigned to the "Person 1" (P1) and the other half to the "Person 2" (P2) player role.

Each participant received a copy of the instructions (see Appendix A), and an empty (white) envelope was placed on their desk. After the instructions had been read out, participants received a brown envelope containing two pieces of paper. Each piece of paper was labeled with a letter (A or B) and the monetary reward that each participant would get if he or she and the co-participant chose the same piece of paper. The instructions made it clear that if the two matched participants chose a different piece of paper they would receive only the participation fee (£2). Participants were informed that they had to take the two pieces of paper out of the brown envelope and put them on the desk in front of them. They then had to choose one of the two pieces of paper (A or B) and put it inside the white envelope, which later on would be collected by the experimenter.¹¹

Participants were given as much time as they needed to make their decision. Once all participants had put the chosen piece of paper in the white envelope, one of the experimenters collected all the white envelopes. A demographics and feedback questionnaire was then administered using paper and pencil procedure (see Appendix B).

5. Results

Table 3 summarizes the results. In the symmetric games (SL, SM and SH) Player 1 and Player 2's (P1 and P2) choices can be theoretically pooled since there is no difference between the two roles (i.e., for both players, coordinating on any of the two alternatives yields exactly the same payoff). The table also reports for each treatment the coordination rate implied by the data; this is often referred to as the "expected coordination rate" (ECR), and in what follows we will use this terminology. ECR measures the probability that two different participants selected at random from the set of participants choose the same strategy, i.e., it measures the probability of coordination within a given treatment.¹² These are also shown in Fig. 1. Finally, as a benchmark the table reports the expected coordination rate predicted by the Mixed Strategy Nash Equilibrium (MSNE) for each game.

¹¹ In half of the brown envelopes given to the participants, the paper with "A" was on top; in the other half, the one with "B" was on top. Subjects were required to take the two pieces of paper out of the brown envelope and put them on the desk themselves, in order to minimize the potential nuisance effects that could arise if the experimenters had already laid out the pieces of papers on the participants' desks. For example, in the latter case, subjects might find it salient to choose the top or left piece of paper.

¹² For the symmetric games P1s and P2s are theoretically poolable; therefore for each label $k = A, B$, let n_k be the numbers of participants (P1s and P2s) who choose label k , and let N be the total number of participants. Then $ECR_{\text{symm}} = \sum_k \binom{n_k}{N} [(n_k - 1)/(N - 1)]$ (see Mehta et al., 1994b, p. 663). For the asymmetric games, the ECR is equal to the product of the proportions of players 1 and 2 who choose A plus the product of the proportions of players 1 and 2 who choose B; that is, $ECR_{\text{asym}} = \sum_k \binom{i_k}{N} \binom{j_k}{N}$ where i_k is the number of P1s who choose label k , and j_k the number of P2s who choose label k .

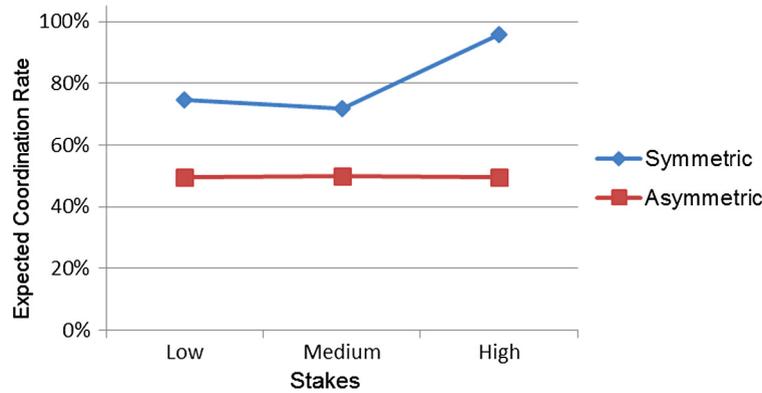


Fig. 1. Expected coordination rates.

5.1. Symmetric games

In all symmetric games (SL, SM and SH), a significant majority of the subjects chose the letter “A” (85.4%, 83.3% and 97.9%, respectively). We can reject the hypothesis that they chose randomly between “A” and “B” (binomial test, $p < 0.001$). In all three treatments the expected coordination rates (ECRs) are significantly higher (74.6% in SL, 71.6% in SM and 95.8% in SH) than the MSNE and random choice coordination rates (binomial test, $p < 0.005$). Moreover, we find a statistically significant difference between the low and the high-stake treatment, and between the medium and the high stake treatment. In the latter, a significantly higher number of subjects chose the strategy with the salient label “A” than in the both the low-stake treatment and the medium stake treatment (chi2 test, $p < 0.05$) and the resulting ECR is significantly higher in the high stake treatment (chi2 test, $p < 0.01$). We found no significant difference between the low and the medium stake treatment.

5.2. Asymmetric games

In the asymmetric treatments (AL, AM, and AH), the strategy “A” was not chosen with higher frequency than “B”, not even by players 2 (P2s) for whom the payoff-salient strategy was “A” (only 45.8%, 41.7%, and 54.2% of P2 chose A in AL, AM and AH, respectively). In the three treatments the observed distributions of choices for both players are not significantly different from a binary random distribution (binomial test, $p > 0.10$) and the ECRs are substantially lower than in the symmetric treatments and very close to both the MSNE and random-choice coordination rates.

We find no evidence of a change in the coordination pattern between low and high-stakes treatments. Although a larger number of subjects chose their payoff preferred strategy in the high than in the medium-payoff treatment (54.2% vs. 41.7%), this difference is not statistically significant (chi2 test, $p > 0.10$).

5.3. Comparison between symmetric and asymmetric games

The data show that a change in the payoff structure (symmetric versus asymmetric) affects the frequency of label-salient choices and coordination rates. If we compare the proportion of players who chose “A” in the asymmetric treatments (low, medium and high) with their symmetric (low, medium and high stakes) counterparts, we find that they are significantly lower (chi2 test, $p < 0.001$). Furthermore, the ECRs in the asymmetric (low, medium and high stakes) treatments are also significantly lower than the coordination rates in their symmetric (low, medium and high stakes) treatment counterparts (chi2 test, $p < 0.05$, $p < 0.10$ and $p < 0.001$, respectively).

5.4. Comparison with CGR

CGR find in their symmetric labeled (\$5, \$5) treatment that 76% of the players chose “X”, giving an ECR of 64%. The percentages choosing “A” and the ECR in our symmetric A–B games are similar, 85.4%, 83.3% and 71.6%, respectively. So the salience of “A” relative to “B” is similar to the salience of “X” relative to “Y”. In their asymmetric (\$5, \$6) game coordination falls, since 33% of P1s chose “X” and 61% of P2s chose “X”; the ECR is 46%. In our asymmetric payoff treatments the ECR is very similar (around 50%).

6. Explaining the data

In this section we consider the extent to which different theories can explain our main finding, that higher stakes increase coordination in symmetric but not asymmetric games.

6.1. The mixed strategy Nash equilibrium

The MSNE predicts that an increase in stake size should have no effect on players' choices in equilibrium. Table 3 above shows that the MSNE clearly fails to organize our data for the symmetric games with both low and high payoffs. For the asymmetric games, however, the ECR is not statistically different from the one predicted by the MSNE.

6.2. Level- k modeling

The level- k model (see, e.g., Crawford et al., 2008, 2013; Nagel, 1995, and Stahl and Wilson, 1995) postulates that players have different level of strategic sophistication, and that players with a high level of strategic sophistication best reply to players with lower level of strategic sophistication.

Such a level- k model predicts that there should be no effect of a change in stake size on behavior and the coordination rate in both the asymmetric and symmetric games. The reason is that since L0's behavior is not affected by a change in stake size, the same is true for L1 and L2's behavior (see Appendix C for more details). This is not consistent with the data for our symmetric game; however, the data from the asymmetric games are in line with the level- k prediction, since the ECR in the high- and low-stake asymmetric games are very close.

6.3. Team reasoning

Focal point-based or team reasoning (see Bacharach, 2006; Bardsley et al., 2010; Schelling, 1960, and Sugden, 1993) can be defined as each player trying to find a strategy that if used by both players would lead to an outcome that is better for each player than what they would get if they used a different decision rule. In our setting, team reasoning makes the recommendation that players should choose the label-salient strategy A in both the symmetric and asymmetric games; this is clearly inconsistent with the data from the asymmetric games. It also does not explain why people become better at coordinating in symmetric games when stakes increase.¹³

The data show that neither the level- k model by CGR, nor a very simple team reasoning approach, can account for all the data. Clearly, much more work is needed to explain why players' mode of reasoning seem to switch from a level- k to a team-reasoning mode as payoffs switch from asymmetric to symmetric.

7. Conclusion

Does an increase in stake size affect players' ability to coordinate on a focal point? We collect data from symmetric and asymmetric games with a label salient focal point and that differ in stake size. Our results show that when players have more at stake in symmetric games then coordination on the salient focal point increases significantly. But in asymmetric games, increasing the stakes has no effect on coordination. These findings show that players' mode of reasoning differs depending on whether the game is symmetric or asymmetric, as also shown in Crawford et al.'s (2008) study.

Appendix A. Experimental instructions

During this experiment you will be randomly matched with another participant in the room. The two of you will play anonymously. That is, no one will learn whom they are matched with.

You and the participant you are matched with will be referred to as Person 1 and Person 2.

You are Person____, and the participant you are matched with is Person____.

You and the participant you are matched with will make a decision in a task that will be described shortly. How much you earn depends on your decision *and* on the decision of the other person. Your earnings will be paid to you in cash at the end of the experiment. In addition, you will receive £2 for taking part in the experiment.

Please do not turn this page over until you are instructed to do so by the experimenter.

¹³ A more refined team reasoning hypothesis for symmetric games is that higher stakes makes people more likely to use labels as a coordination device since the loss in terms of foregone earnings increase. Again, this begs the question of why we do not observe the same in asymmetric games, and raises the deeper question of why team reasoning only seems to apply to symmetric and not asymmetric games.

Aggregate choice proportions: Suppose $p < 6/11$. Denote by $1 - q$, the probability that P1 chooses “A”, and the probability that he/she chooses “B” is q . When $q = 0.7$ the choices probabilities are (0.3, 0.7). For P2, the probabilities that he/she chooses “A” is q , and that he/she chooses “B” is $1 - q$, with $q = 0.7$ this gives (0.7, 0.3). The ECR is thus $2q(1 - q) = 0.42$.

When $p > 6/11$, the P1 choice probabilities are (0.7, 0.3), and those for P2 are (0.3, 0.7). The ECR is thus $2q(1 - q) = 0.42$.

C.2. (£15, £18) asymmetric games

As in the low-payoff game, L0 players choose the payoff-salient strategy with probability $p > 1/2$. In this game, coordination on “A” gives payoff £15 to P1 L0, and coordination on “B” gives payoff £18 to P1 L0. Therefore the payoff salient strategy for P1 L0 is “B”. So P1 L0 chooses “A” with probability $1 - p < 1/2$, and “B” with probability $p > 1/2$.

Similarly, P2 L0 chooses “A” with probability $p > 1/2$, and “B” with probability $(1 - p < 1/2)$.

P1 L1 gets expected payoff $15p$ from choosing “A”, and expected payoff $18(1 - p)$ from choosing “B”. Therefore P1 L1 chooses A when $15p > 18(1 - p)$. In other words P1 L1 chooses A if $p > 6/11$, and B if $p < 6/11$. These conditions are the same as in the asymmetric game with low payoffs. The behavior of L1, and hence also L2, is therefore not sensitive to the stake size, and the same is true for the expected coordination rate (ECR).

C.3. (£0.5, £0.6) asymmetric games

It is straightforward to verify that the predictions of the level- k model coincide with the ones for the Medium and High stake size games.

C.4. (£5, £5) symmetric games

In this game P1 L0 and P2 L0 choose “A” with probability $p > 1/2$, and “B” with probability $1 - p < 1/2$. It follows that P1 L1 and P2 L1, and hence also P1 L2 and P2 L2, choose “A”, giving $ECR = 1$.

C.5. (£15, £15) symmetric games

Type L0 again choose “A” if $p > 1/2$, and b otherwise. As above in this case all players choose “A” if $p > 1/2$, and otherwise choose “B”. Thus the behavior of all L1 and L2 players is the same as in the (£5, £5) game.

C.6. (£0.5, £0.5) symmetric games

It is again straightforward to verify that the predictions of the level- k model are exactly the same as for the other symmetric games.

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