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## Observability of partners' past play and cooperation: Experimental evidence

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**OBSERVABILITY OF  
PARTNERS' PAST PLAY  
AND COOPERATION:  
EXPERIMENTAL EVIDENCE**

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October 2021

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# Observability of Partners' Past Play and

## Cooperation: Experimental Evidence

by

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**Abstract:** The observability of partners' past play is known to theoretically improve cooperation in an infinitely repeated prisoner's dilemma game under random matching. This paper presents evidence from an incentivized experiment that reputational information per se may not improve cooperation. A structural estimation suggests that a certain percentage of players act according to the "Always Defect" strategy, whether or not the reputational information is available. The remaining players adopt available cooperative strategies: specifically, the tit-for-tat strategy when reputational information is not available, and a strategy that conditions on the matched partner's past play when reputational information is available.

*JEL classification:* C92, C73, D70

*Keywords:* experiment, cooperation, infinitely repeated prisoner's dilemma game, reputation

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## 1. Introduction

In research on repeated dilemmas, the effectiveness of reputation for sustaining cooperation has received considerable attention both theoretically and experimentally. However, a fundamental, but as yet unsettled, question is whether reputational information itself encourages cooperation in an infinitely repeated prisoner's dilemma game under random matching ("IRPD," hereafter). This paper provides the first experiment that isolates the role of information on partners' past play in sustaining cooperation using a new design that satisfies the theoretical condition specified by Takahashi (2010).

While prior experiments emphasized positive effects of information on the partner's past play in improving cooperation, the findings might have been driven by factors other than revealed information. First, Stahl (2013) demonstrated that the color-coded reputation mechanism (Kandori, 1992) encourages cooperation. However, in Stahl's experimental setting, the color depends on past play of the player and his/her opponent. Specifically, each player had a color, either green (good) or purple (bad), where the green turns to purple if they defect on a green opponent. When confronted with a purple opponent, the color green does not change even if a player defects; this is similar to the "Standing" discussed in Nowak and Sigmund (1998). Second, information created by voluntary reporting of opponents' actions helps improve cooperation, if reporting is not costly and enough information is accumulated in the community (Camera and Casari, 2018; Kamei and Nesterov, 2020). However, the positive effect might be due to endogeneity. Third, while non-anonymous public monitoring (Camera and Casari, 2009; Kamei, 2017) may help boost cooperation, the positive effect could be due to the observable *identity* information.

The present experiment is built on Takahashi (2010). Using a variant of Grim-trigger strategy, Takahashi derives a theoretical condition to sustain cooperation as an outcome of strict equilibrium when players are informed of their partners' past play. An experiment treatment is carefully designed to satisfy this condition. Another result derived by Takahashi is that cooperation also holds as a belief-free equilibrium outcome if players are informed of not only the partners' past actions but also the partners' *past partners' actions* (i.e., interaction outcome, e.g., (C,C), rather than the partner's action only, e.g., C).<sup>1</sup> This paper further investigates how the

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<sup>1</sup> This is not the same as the Nowak and Sigmund (1998)'s Standing.

additional information affects cooperation.

The experimental results show that reputational information alone does not boost cooperation. This suggests that the positive effects of reputation seen in earlier studies (Camera and Casari, 2009; Stahl, 2013, Kamei, 2017; Kamei and Nesterov, 2020) may be due to factors other than the information about partners' past play.

## 2. Experimental Design

The IRPD is designed using a random termination rule. There are three treatments, namely the "Baseline," "Reputation," and "Reputation-H" ("Reputation with Higher-order information") treatments, implemented using a between-subjects design.

### 2.1. Common Features

Subjects play IRPD (supergame) as many times as possible for at least 60 minutes. At the onset of each supergame, subjects are randomly assigned to a group of four; and the group composition remains the same for the entire supergame. In each round, subjects are randomly matched with another in their group and play the prisoner's dilemma game (Figure 1). The payoff matrix is obtained by converting from a normalized payoff matrix with  $g = 1/3$ , and  $l = 2/3$ . At the end of the round, subjects are informed of their own interaction outcome.

The continuation probability is set at  $14/15$ , the rationale for which will be explained in Section 2.2. The number of supergames is not predetermined (Dal Bó and Fréchette, 2011). Operationally, an integer between 1 and 15 is randomly drawn for a session in each round. If the integer drawn is 15 exactly (less than 15), the current supergame is over (continues). The experiment ends once the number 15 is drawn for the first time after 60 minutes of play.

**Figure 1: Payoff Matrix**

|           |           |        |           |                         |                         |
|-----------|-----------|--------|-----------|-------------------------|-------------------------|
|           | Cooperate | Defect |           | Cooperate               | Defect                  |
| Cooperate | 30, 30    | 5, 35  | Cooperate | $b + a, b + a$          | $-lb + a, (1 + g)b + a$ |
| Defect    | 35, 5     | 15, 15 | Defect    | $(1 + g)b + a, -lb + a$ | $a, a$                  |

(a) The present experiment

(b) Normalized matrix

*Note:* Takahashi (2010) used the standard normalization:  $a = 0$  and  $b = 1$ .

## 2.2. Treatments

In the Baseline treatment, subjects interact with each other under random matching without knowing their partners' past play. Camera and Casari (2009) shows that cooperation holds as an equilibrium outcome in this setup according to the Grim-trigger strategy if  $\delta > 0.443$ .

In the Reputation (Reputation-H) treatment, each subject is informed of their partner's past actions ((a) past actions and (b) past partners' actions) for the most recent five rounds within the current supergame before choosing an action. Reputational information does not carry over from supergame to supergame.

Using the so-called "pairwise Grim-trigger" strategy, Takahashi (2010) demonstrates that cooperation is sustained as an equilibrium outcome if  $\delta \geq g(1+l)/[(1+g)l] = 0.625$  and  $T \geq 2$  ( $T$ : the history length) when subjects are aware of their partner's past actions. Further, under the indifference condition, he provides a belief-free equilibrium condition for cooperation when they are additionally aware of their partner's past partners' actions:  $\delta \geq \max\{g/(1+g), l/(1+l)\} = 0.400$ , and only the history in the last round suffices. Under the belief-free equilibrium, players are indifferent between Cooperate and Defect at all histories. Therefore, they have weak incentives of mixing over Cooperate and Defect at all histories. Table 1 provides the summary of equilibrium conditions.

**Table 1: Equilibrium Conditions**

|                         | Baseline         | Reputation             | Reputation-H           |
|-------------------------|------------------|------------------------|------------------------|
| Strict equilibrium      | $\delta > 0.443$ | $\delta > 0.625^{\#1}$ | $\delta > 0.625^{\#1}$ |
| Belief-free equilibrium | does not exist   | does not exist         | $\delta > 0.400$       |

Note: <sup>#1</sup> Based on the pairwise Grim-trigger strategy.

According to Proposition 5 of Takahashi (2010), the continuum-population equilibrium holds in a model with finite players without changing the condition for the existence of equilibrium. Hence, the equilibrium conditions in Takahashi (2010) can directly be applied to the setup with a group size of four here.

Since the present experiment is designed to study whether cooperation evolves with reputational information in a manner consistent with Takahashi (2010), the continuation probability of 14/15 was selected to satisfy  $\delta \geq 0.625$ . The length of history information was set

at 5 since it must be greater than 1 (the theory predicts the same behavior provided that  $T \geq 2$ ). This means that the condition of  $\delta \geq 0.443$  in the Baseline treatment is also met, implying that the theory does not predict which performs better, the Baseline or the two reputation treatments. Table 1 suggests that, with  $\delta = 14/15$ , a belief-free equilibrium exists in the Reputation-H treatment. Breitmoser (2015) argues that subjects use mixed strategies in IRPDs. If this tendency holds in the present experiment, the cooperation rate will be higher in the Reputation-H than in the Reputation treatment since no belief-free equilibrium exists in the Reputation treatment.

### 3. Results

Section 3.1 reports the cooperation rate by treatment, after which Section 3.2 summarizes results from a structural estimation of subjects' strategy choices. See Appendix A for the experimental procedure.

#### 3.1. Cooperation Rates

Subjects selected cooperation around 50-60% of the time on average in all three treatments (Table 2). The cooperation rates were not significantly different among the treatments.

Figure 2 reports the across-supergame trends of cooperation rates. There are stable, and gradually increasing, trends in all treatments. A regression analysis confirms that while the cooperation rate is decreasing over time within a given supergame, subjects gradually learn to cooperate from supergame to supergame, whether or not they are aware of their partners' past play (Table B.3).

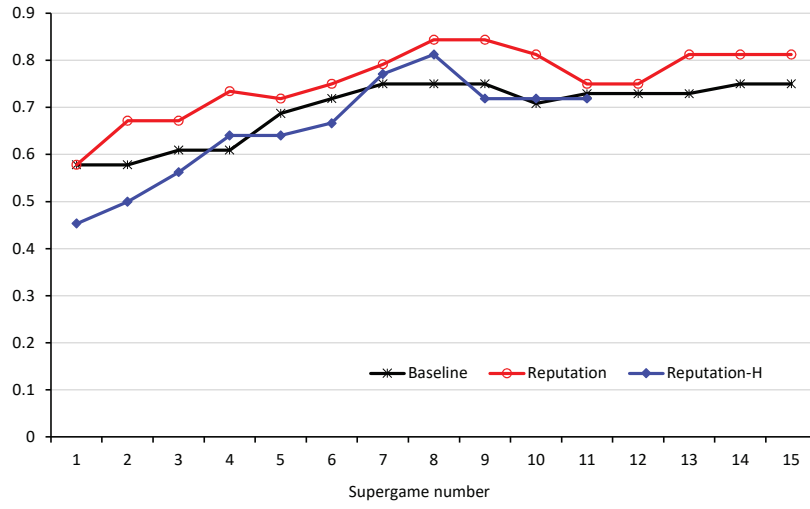
**Result 1:** *Reputational information did not improve cooperation.*

**Table 2:** *Cooperation Rates*

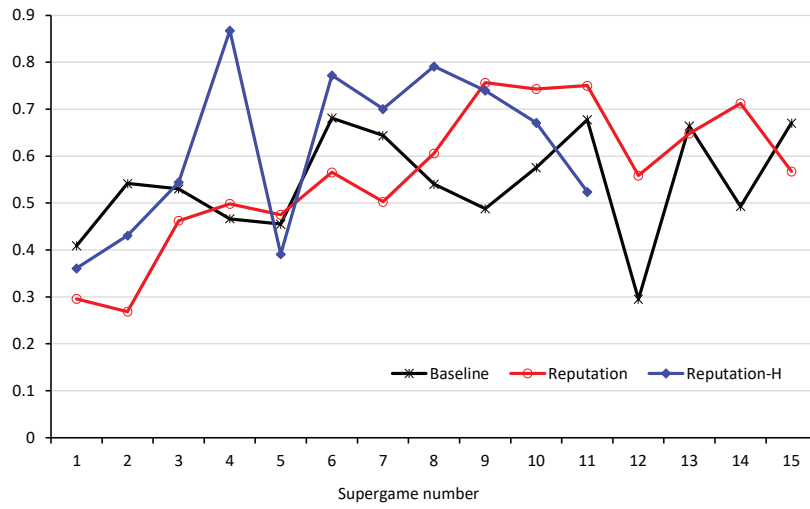
|              | Round 1 only     |                                    |              | All rounds       |                                    |              |
|--------------|------------------|------------------------------------|--------------|------------------|------------------------------------|--------------|
|              | Cooperation rate | Treatment difference <sup>#1</sup> |              | Cooperation rate | Treatment difference <sup>#1</sup> |              |
|              |                  | Reputation                         | Reputation-H |                  | Reputation                         | Reputation-H |
| Baseline     | 68.6%            | 0.996                              | 0.537        | 52.1%            | 0.703                              | 0.301        |
| Reputation   | 72.9%            | ----                               | 0.547        | 50.7%            | ----                               | 0.514        |
| Reputation-H | 63.6%            | ----                               | ----         | 58.5%            | ----                               | ----         |

Note: <sup>#1</sup> Two-sided  $p$ -values (see Appendix Table B.2).

**Figure 2: Cooperation Rates, Supergame by Supergame**



(A) Round 1 only



(B) Average over All Rounds

### 3.2. Strategy Choices

Why didn't the reputational information improve cooperation? A structural estimation finds that a certain fraction of subjects acted according to the AD (Always Defect) strategy (Figure 3).<sup>2</sup> More than 15% of subjects used the AD strategy in all treatments. This resonates with Sugaya and Wolitzky (2020) who argues theoretically that cooperation does not evolve if there is a certain fraction of AD types in the population. While the remaining subjects acted

<sup>2</sup> The same holds for the data of Camera and Casari (2009), Camera *et al.* (2012), Kamei (2017), and Kamei and Nesterov (2020) under private monitoring.

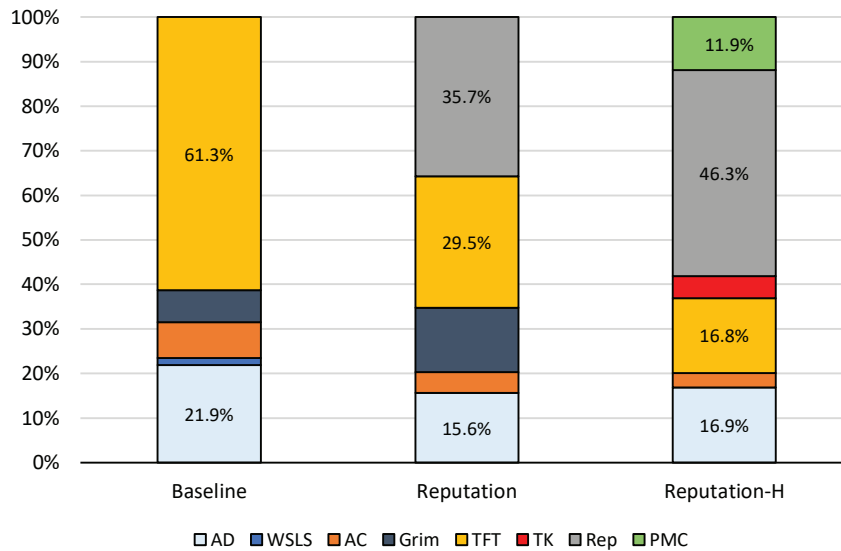


according to cooperative strategies, the popularity of cooperative strategies differs markedly by treatment. In the Baseline treatment, 61.3% of the subjects acted according to the tit-for-tat (TFT) strategy. This percentage is much larger compared with the private monitoring treatments in Camera and Casari (2009), Camera *et al.* (2012), Kamei (2017), and Kamei and Nesterov (2020) – see Appendix Tables B.6 and B.7. This difference may be due to the number of supergames: considerably more than five for this study versus five or six for these earlier studies.<sup>3</sup>

In both the Reputation and Reputation-H treatments, the TFT strategy was much less common. Instead, 35.7% (58.2%) of the subjects in the Reputation (Reputation-H) treatment selected cooperation conditional upon their partner’s reputational information. Such strategies under reputational information were also observed in the data of Camera and Casari (2009), Kamei (2017), and Kamei and Nesterov (2020) – see again the Appendix.

In summary, Result 1 is largely driven by the presence of AD types in each treatment. It is worth noting that in every treatment of Fudenberg *et al.* (2012), while strategy choices were quite heterogeneous, a substantial fraction of subjects used the AD strategy, and cooperative types found it difficult to learn optimal responses.

**Figure 3: Distributions of Strategy Choices**



*Notes:* Estimated using the method by Dal Bó and Fréchette (2011). The Rep strategy is a strategy where subject  $i$  selects cooperation conditional upon her partner  $j$ ’s cooperation rate in his reputational record. The PMC strategy is

<sup>3</sup> This could also be due to the difference in the matching condition and/or experimentation (online versus lab).

one in which  $i$  selects cooperation conditional upon  $j$ 's past experiences on mutual cooperation. The TK strategy is the trigger strategy with  $K$  rounds of punishment. Appendix Table B.5 includes the detailed results.

**Result 2:** (i) *More than 15% of subjects used the AD strategy in all treatments.* (ii) *More than the majority of subjects acted according to the TFT strategy in the Baseline treatment. Subjects in the Reputation and Reputation-H treatments relied on their partner's reputation to choose an action, rather than adopt the TFT strategy.*

#### 4. Conclusions

This paper provided evidence that reputational information by itself does not improve cooperation in an IRPD. A certain fraction of players always selected defection irrespective of the presence of the information.

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NOT FOR PUBLICATION

Online Supplementary Appendix to: Kamei, Kobayashi and Tse:<sup>#</sup>

“Observability of Partners’ Past Play and  
Cooperation: Experimental Evidence”

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## Appendix A: Experiment Procedure and Sample Instructions Used in the Experiment

Four sessions per treatment were conducted online using oTree and Zoom from February through April 2021, following the same procedure as the standard laboratory experiment.<sup>1</sup> Each session consisted of 16 subjects. A total of 192 Osaka University students participated in the experiment. No attrition occurred during the experimental game. The instructions were neutrally framed (Appendix A). The average supergame lengths were 15.22, 15.36 and 14.74 rounds in the Baseline, Reputation and Reputation-H treatments, respectively.

This part of the Appendix includes the instructions for the Reputation-H treatment as an example. All the experiment sessions were conducted in Japanese. The session time was controlled as it may affect subjects' behaviors: each treatment has two sessions conducted in the morning and the other two conducted in the afternoon.

The following includes both the original instructions in Japanese and its translated English version.

[At the onset of the experiment, the following instructions (PowerPoint file) were shown on Zoom, and were read aloud to subjects by the researchers. Subjects remained anonymous during the entire session without seeing other participants' faces, names, etc.]

### Original Japanese Version:

Slide 1:

### 実験によろこそ

- これより予定通り意思決定実験を始めます。この実験に参加することで約束した参加報酬 500 円に加え、実験におけるあなたの選択、また他の参加者の選択により決まる対価を受け取ることが出来ます。
- 実験中に他の参加者と会話をすることは認められません。また、実験中はスマートフォン、iPadなどの全ての電子機器の電源を切ってください。実験中に質問がある場合はZoomのチャットボックスで知らせてください。個別にお答えします。
- 意思決定により決まる対価はポイントで示され、ポイントは他の参加者との交流を通じて蓄積されていきます。実験終了後、蓄積したポイントは次のレートで現金に換算され、500 円を含む全ての対価をAmazon gift cardで支払われます。

3 ポイント = 1 円.

<sup>1</sup> Subjects' IDs were check using Zoom before the sessions commenced.

Slide 2:

## 実験によろこそ

- 実験は複数のフェーズから成り立ちます。
- 各フェーズの開始とともに参加者はランダムに **4人からなるグループに割り振られ**、グループ内で他の参加者と関わります（グループ外の人と関わることはありません）。
- 所与のフェーズが終了するとグループ内での関わりは終わり、セッション内で再度グループがランダムに形成され次のフェーズが始まります。
- フェーズの終了方法、フェーズ内のラウンド数については後述します。

Slide 3:

## 各フェーズにおける意思決定事項

- 各フェーズは複数のラウンドからなりますが、全てのラウンドは以下に述べるような**同一の構造**を持っています。
- まず、ラウンドの開始とともに、各構成員は自身のグループ内でランダムに他の1人とマッチします。当該ラウンドではそのマッチされたパートナー以外とは関わりません。
- マッチングは完全にランダムです。あなたの過去の選択や当該フェーズでの選択及びパートナーとの関わり合いの結果がマッチングに影響を与えることはありません。
- 1つのグループの人数は4人であるため、あなたがラウンド  $t$  でマッチしたパートナーとラウンド  $t + 1$  でもう一度マッチされる確率は3分の1です。

Slide 4:

## 各フェーズにおける意思決定事項

- あなたとパートナーはXかYを同時に選択します。従って、起こりうる結果は4（ $= 2 \times 2$ ）種類あります。具体的には、当該ラウンドであなたとパートナーが実際に選択した結果に応じて、あなたは次のようなポイントを獲得します。
  - (a)あなたとパートナー両者がともにXを選んだ場合は、あなたは30ポイントを獲得します。
  - (b)あなたとパートナー両者がともにYを選んだ場合は、あなたは15ポイントを獲得します。
  - (c)あなたがX、パートナーがYを選んだ場合は、あなたは5ポイントを獲得します。
  - (d)あなたがY、パートナーがXを選んだ場合は、あなたは35ポイントを獲得します。
- パートナーもあなたと同じポイント獲得の構造を持っています。

Slide 5:

## 各フェーズにおける意思決定事項

- あなたがXかYの選択をする際に、現在のパートナーの当該フェーズにおける直近5ラウンドの選択と同パートナーのマッチされたパートナーの選択を知ることができます。具体的にはコンピュータ画面の右下の表にその情報が表示されます（次のページに含まれているコンピュータ画面の例を参照してください）。
- 例えばラウンド7では、現在マッチされたパートナーがラウンド2からラウンド6におこなった5つの選択（XかY）を知ることが出来ます。
- 例えば、このパートナーはラウンド4にはYを選択し、また、このラウンドで同パートナーがマッチされたパートナーはXを選択したと分かります。
- ラウンドが5未満の場合はラウンド1から1期前までのパートナーの選択と結果が表示されます（以前のフェーズにおける選択と結果が表示されることはありません）。
- 例えば、フェーズ4のラウンド3には、同フェーズのラウンド1とラウンド2の選択と結果が表示されます。

Slide 6:

実験でのコンピュータ画面のコピー 1 (XかYの意思決定)

**あなたの選択**  
このページでの残り時間 0:39  
フェーズ 1 サウンド 7 **当該フェーズ内のラウンド番号**

XかYを選択してください  
『X』か『Y』のボタンを押すことで意思決定します。

**獲得ポイントの概要**

|     |   | パートナー          |                |
|-----|---|----------------|----------------|
|     |   | X              | Y              |
| あなた | X | 30ポイント, 30ポイント | 5ポイント, 30ポイント  |
|     | Y | 35ポイント, 5ポイント  | 15ポイント, 15ポイント |

1つ目の数字はあなたの獲得ポイント 2つ目の数字はパートナーの獲得ポイント

**過去の選択**

あなたの過去のラウンドの結果

| ラウンド | あなたの選択 | 過去のパートナーの選択 | 獲得ポイント |
|------|--------|-------------|--------|
| 6    | X      | Y           | 10ポイント |
| 5    | Y      | Y           | 10ポイント |
| 4    | Y      | X           | 10ポイント |
| 3    | X      | X           | 30ポイント |
| 2    | Y      | X           | 10ポイント |
| 1    | X      | X           | 30ポイント |

過去のラウンド7でのパートナーの過去の選択  
過去のラウンド4から54回Xを選択した

現在のパートナーの直近5ラウンドの選択と同パートナーの過去のパートナーの選択はこの表に表示されます。

注: ラウンド7における意思決定画面。ラウンド1から6の結果は例示のためのものです。

実験内容の説明

Slide 7:

▼ 実験内容の説明

### 実験によろそ

- これより予定通り意思決定実験を始めます。この実験に参加することで約束した参加報酬500円に加え、実験におけるあなたの選択、また他の参加者の選択により決まる対価を受け取ることが出来ます。
- 実験中に他の参加者と会話することは認められません。また、実験中はスマートフォン、iPadなどの全ての電気機器の電源を切ってください。実験中に質問がある場合はZoomのチャットボックスで知らせてください。個別にお答えします。
- 意思決定により決まる対価はポイントで示され、ポイントは他の参加者との交流を通じて蓄積されていきます。実験終了後、蓄積したポイントは次のレートで現金に換算され、500円を含む全ての対価をAmazon gift cardで支払われます。  
**3ポイント = 1円**

Google Slides

『>』ボタンを押すと次のスライドに移ります。



Slide 8:

## 各フェーズにおける意思決定事項

- あなたのパートナーも同様に、当該フェーズにおけるあなたの直近5ラウンドの選択と結果が知らされます。
- このセッションの参加者全てが意思決定しボタンを押すと、当該ラウンドにおける結果が知らされます。
- 具体的には
  - (1) 当該ラウンドにおけるパートナーの選択（XかYか）と
  - (2) 当該ラウンドであなたが獲得したポイントが知らされます。

Slide 9:

### 実験でのコンピュータ画面のコピー 2（各ラウンドでの結果）

結果

このページでの残り時間 0:03

フェーズ 1

ラウンド 7

二人とも X を選びました。

その結果、あなたは30ポイントを獲得しました。あなたのパートナーは30ポイントを獲得しました。

次へ <— 全ての参加者が『次へ』ボタンを押すと次のラウンドに移ります。

| ラウンド | あなたの選択 | 選択のパートナーの選択 | 獲得ポイント |
|------|--------|-------------|--------|
| 7    | X      | X           | 30ポイント |
| 6    | X      | Y           | 5ポイント  |
| 5    | Y      | Y           | 15ポイント |
| 4    | Y      | X           | 25ポイント |
| 3    | X      | X           | 30ポイント |
| 2    | Y      | X           | 35ポイント |
| 1    | X      | X           | 30ポイント |

▶ 実験内容の説明

1 から15の間の発生した乱数。15未満であるためフェーズは継続。

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ラウンド7の結果が追加されます。

注: ラウンド7の結果。ラウンド1からラウンド6の結果は例示のためのものです。

Slide 10:

## フェーズ内のラウンドの数

- フェーズ内のラウンド数は事前には決まっておらず確率的に決まります。フェーズが継続し当該フェーズ内で次のラウンドに進む確率は  $14/15$  です。
- 具体的な手続きは、各ラウンドの終わりにコンピュータが1から15の間の整数を乱数として1つ発生させます。
- 発生した乱数は当該ラウンドの結果とともにコンピュータの画面上に表示されます（実験でのコンピュータ画面のコピー2を参照してください）。
- 発生した乱数が 14以下であれば次のラウンドに進み、グループ内でランダムにペアが作られそれぞれ関わりを持ちます。
- 発生した乱数が 15の場合は当該フェーズは終了です。その場合は次のフェーズに進み、グループ構成がランダムに変更されます（セッション内でランダムに他の3人の参加者とグループに割り振られます）。

Slide 11:

## フェーズ内のラウンドの数

- 次のフェーズにおける選択の手順やポイントの決まり方は現在のものと同じ構造を持っています。
- 次のラウンドに進む確率が  $14/15$  であるため、フェーズ内のラウンド数の期待値（平均）は15ラウンドになります。
- しかしながら、フェーズ継続の決定はコンピュータによる乱数で決定するため、フェーズの長さが15ラウンドよりもずっと多い可能性もあります。同様にずっと少ない可能性もあります。

Slide 12:

## 実験の長さ

- 本実験では複数のフェーズから成り立ちます。
- 参加者と交流する長さは最低 60 分です。
- フェーズ 1 開始後 60 分をまたいだフェーズが終了した時に  
(すなわち、乱数の 15 が 60 分経過後最初に発生した時に)  
本実験は終了します。

Slide 13:

## 支払い

- 実験終了後、交流から得られた報酬の合計と参加費 500 円を  
1 人ずつ個的に支払います。
- 何か質問があれば Zoom のチャットボックスに質問を書いてく  
ださい。全ての質問を答えた後で実験を開始します。

English Translated Version:

Slide 1:

**Welcome!**

- You are now taking part in a decision-making experiment. Depending on your decisions and the decisions of other participants, you will be able to earn money in addition to the ¥500 guaranteed for your participation.
- During the experiment, you are not allowed to communicate with other participants. Please switch off all of your electronic devices (e.g., mobile phone, iPad). If you have a question during the experiment, please write it in the chat box of Zoom. We will answer your question individually.
- In the experiment, your earnings will be calculated in points. During the experiment, you can accumulate earnings through your decisions as will be explained now. At the end of the experiment, points will be converted to Japanese yen at the following rate:

**3 points = 1 Japanese yen.**

- Your total earnings (including the participation fee of ¥500) will be paid out to you using an Amazon gift card after the experiment is over.

Slide 2:

**Welcome!**

- There are multiple phases in the experiment.
- At the beginning of each phase, all participants will be randomly divided into **groups of four individuals**, and you will interact with these individuals only (you will not interact with participants outside your group in any period).
- Once a phase is over, your group composition will randomly change, i.e., you will be randomly re-assigned to a group of size four in this session and the next phase will begin.
- We will explain both the ending rule and the duration of each phase later.

Slide 3:

**Your Decisions in Each Phase:**

- While each phase consists of multiple periods, all periods have the **same** structure.
- At the onset of a given period, each participant is randomly paired with a member of his or her group.
- The pairing is completely random. Neither your decisions in previous periods in this phase nor your decisions/outcomes in previous phases affect the pairing process.
- Since there are four individuals in your group, the probability that you will be matched with the same individual in two consecutive periods of a given phase is  $1/3$ .

Slide 4:

**Your Decisions in Each Phase:**

- In each period, you and your partner simultaneously choose X or Y. Since both you and your partner make binary choices, there are 4 ( $= 2 \times 2$ ) possible interaction outcomes. The earnings resulting from each scenario will be summarized as below:
  - (a) If you choose X and your counterpart also chooses X, you earn 30 points.
  - (b) If you choose Y and your counterpart also chooses Y, you earn 15 points.
  - (c) If you choose X and your counterpart chooses Y, you earn 5 points.
  - (d) If you choose Y and your counterpart chooses X, you earn 35 points.
- Your partner has the same earnings formulas as you.

## Slide 5:

### Your Decisions in Each Phase:

- You will be informed of your matched partner's choices (either X or Y) **in the most recent five periods** and choices of your partner's matched partners in these five periods (i.e., you will learn the interaction outcomes). This information will be shown in the table on the lower right side of the computer screen (please see an image on the next slide).
- For example, in period 7, you will be informed of your partner's choice, either X or Y, in each of periods 2 to 6.
- In the screen image on the next slide, you can see that this partner selected Y in period 4 and that this partner's period 4 partner selected X in period 4.
- Until five periods have passed, you will be informed of your current partner's choices and interaction outcomes in all periods of the phase so far (you will not be informed of your partner's choices in the previous phases).
- For example, suppose now that it is period 3 of phase 4. You will then be informed of your current partner's action choices (X or Y) in periods 1 and 2 and his/her interaction outcomes in these periods.

Slide 6: (note: There is no "current (e.g., period 7) partner's past partner's choice" column for the Reputation treatment. The two reputation treatments are identical except for this difference.)

### An Example of Computer Screen 1: (when making decisions)

Screen image with translation in English

**Your choices:**

Remaining time: 0:20

Phase 1 Period 7

Please choose one from the two options: X or Y.

**Payoff structure**

|     |   | Your partner         |                      |
|-----|---|----------------------|----------------------|
|     |   | X                    | Y                    |
| You | X | 30 points, 30 points | 5 points, 35 points  |
|     | Y | 35 points, 5 points  | 15 points, 15 points |

**Previous choices:**

**History of your interaction outcomes**

| Period | Your choice | Your partner's choice | Your points earned |
|--------|-------------|-----------------------|--------------------|
| 6      | X           | Y                     | 5 points           |
| 5      | Y           | Y                     | 15 points          |
| 4      | Y           | X                     | 35 points          |
| 3      | X           | X                     | 30 points          |
| 2      | Y           | X                     | 35 points          |
| 1      | X           | X                     | 30 points          |

**Current (period 7) partner's past choice:**  
This partner selected "X" 4 times in the recent 5 periods.

| Period | Previous choice | Current (period 7) partner's past partner's choice |
|--------|-----------------|--|
| 6      | X               | Y  |
| 5      | X               | Y  |
| 4      | Y               | X  |
| 3      | X               | Y  |
| 2      | X               | Y  |

**Experiment instructions**

Notes: Period 7. Decisions from periods 1 to 6 here are for illustration only.

Slide 7:

▼ Experiment instructions

**Welcome!**

- You are now taking part in a decision-making experiment. Depending on your decisions and the decisions of other participants, you will be able to earn money in addition to the 500 Japanese yen guaranteed for your participation.
- During the experiment, you are not allowed to communicate with other participants. Please switch off all of your electronic devices (e.g., mobile phone, iPad). If you have a question during the experiment, please write in in the chat box of Zoom. We will answer your question individually.
- In the experiment, your earnings will be calculated in points. During the experiment, you can accumulate earnings through your decisions as will be explained now. At the end of the experiment, points will be converted to Japanese yen at the following rate:  
**3 points = 1 Japanese yen.**
- Your total earnings (including the participation fee of ¥500) will be paid out to you using an Amazon gift card after the experiment is over.

1

▶ > スライド1 ◀ ⌂ ⌕ ⚙ Google Slides

You can move on to the next slide by clicking the ">" button.

Slide 8:

**Your Decisions in Each Phase:**

- Your partner will also be informed of your choices made in the most recent five periods and the interaction outcomes in these periods.
- Once all participants in a session have made their decisions and click the button, you will be informed of the outcome of the interactions in a given period.
- Specifically, you will be informed of:
  - (1) your partner's choice in the current period (X or Y);
  - (2) your earnings (in points) for that period.

Slide 9:

An Example of Computer Screen 2: (the outcome screen)

**Results**

Remaining time: 0:03

A randomly-generated integer between 1 and 15. The phase continues since it is less than 15.

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Phase 1

Period 7

You and your partner both selected X.

As a result, you earned 30 points; your partner earned 30 points.

You will move on to the next period once everyone clicks the "Continue" button.

| Period | Your choice | Your partner's choice | Your points earned |
|--------|-------------|-----------------------|--------------------|
| 7      | X           | X                     | 30 points          |
| 6      | X           | Y                     | 5 points           |
| 5      | Y           | Y                     | 15 points          |
| 4      | Y           | X                     | 35 points          |
| 3      | X           | X                     | 30 points          |
| 2      | Y           | X                     | 35 points          |
| 1      | X           | X                     | 30 points          |

Period 7 result was added in the summary table.

Notes: Period 7. Decisions from periods 1 to 6 here are for illustration only.

Experiment instructions

Slide 10:

**The Number of Periods in Each Phase:**

- The number of periods in each phase is not predetermined. It is instead determined by a randomization. **The probability that a given phase will continue and you will have another period in a given phase is 14/15.**
- Specifically, at the end of each period, the computer randomly draws an integer between 1 and 100 for this session.
- The integer drawn will be shown on the computer screen along with your interaction outcome (please see the "An Example of Computer Screen 2" image shown on the previous slide).
- If the integer drawn is less than or equal to 14, your interaction in the current phase continues. You will be randomly paired with another individual in your group and will interact with that individual.
- If the integer drawn is 15, then the current phase is over. You will move on to the next phase, and you will be randomly re-assigned to a group of four individuals in the session.



Slide 11:

**The Number of Periods in Each Phase:**

- The next phase has the same structure (e.g., what kinds of decisions to make, how to calculate earnings) as the current one.
- Since the probability that the current phase will continue to the next period is  $14/15$ , the expected number of periods in any given phase is 15 mathematically.
- However, since the decision to discontinue your interactions in each phase is randomly determined by the computer, you may have a phase with more or less than 15 periods.

Slide 12:

**The Experiment Duration**

- This experiment consists of multiple phases.
- The experiment interactions will continue for at least 60 minutes.
- Your interactions will end once the number 15 is randomly drawn for the first time by the computer, after 60 minutes of interactions have passed.

Slide 13:

**Payment**

- After the experiment, you will be paid privately based on your accumulated earnings across all the phases in addition to the participation fee of ¥500.
- Please write any question that you may have in the chat box of Zoom. We will start the experiment once all questions are answered.

## Appendix B: Additional Tables

**Table B.1:** *Descriptive Statistics and Cooperation Rates by Session*

|                                  | Session date | Average round 1 cooperation rate [%] | Average cooperation rate across all rounds [%] | Number of supergames played | Avg SG length [rounds] | Number of subjects per session | % of female subjects | % of economics major |
|----------------------------------|--------------|--------------------------------------|--|-----------------------------|------------------------|--------------------------------|----------------------|----------------------|
| <b>A. Baseline treatment</b>     |              |                                      |  |                             |                        |                                |                      |                      |
| Session 1                        | 2021/02/22   | 56.25%<br>(3.21)                     | 26.96%<br>(0.87)                               | 15                          | 10.87                  | 16                             | 6.25%                | 6.25%                |
| Session 4                        | 2021/03/02   | 82.92%<br>(2.43)                     | 57.27%<br>(0.81)                               | 15                          | 15.47                  | 16                             | 18.75%               | 0.00%                |
| Session 7                        | 2021/03/03   | 52.68%<br>(4.74)                     | 51.39%<br>(0.95)                               | 7                           | 25.00                  | 16                             | 20.00% <sup>#1</sup> | 18.75%               |
| Session 9                        | 2021/03/05   | 75.00%<br>(3.01)                     | 67.93%<br>(0.84)                               | 13                          | 14.69                  | 16                             | 50.00%               | 18.75%               |
| <b>B. Reputation treatment</b>   |              |                                      |  |                             |                        |                                |                      |                      |
| Session 2                        | 2021/03/01   | 78.33%<br>(2.67)                     | 57.83%<br>(0.93)                               | 15                          | 11.87                  | 16                             | 25.00%               | 12.50%               |
| Session 5                        | 2021/03/02   | 77.78%<br>(3.48)                     | 72.51%<br>(1.03)                               | 9                           | 13.11                  | 16                             | 33.33% <sup>#1</sup> | 12.50%               |
| Session 8                        | 2021/03/04   | 56.25%<br>(5.58)                     | 34.17%<br>(1.15)                               | 5                           | 21.40                  | 16                             | 31.25%               | 12.50%               |
| Session 11                       | 2021/04/13   | 66.96%<br>(4.46)                     | 36.79%<br>(0.99)                               | 7                           | 21.43                  | 16                             | 43.75%               | 12.50%               |
| <b>C. Reputation-H treatment</b> |              |                                      |  |                             |                        |                                |                      |                      |
| Session 3                        | 2021/03/01   | 61.93%<br>(3.67)                     | 59.38%<br>(1.04)                               | 11                          | 12.73                  | 16                             | 50.00%               | 6.25%                |
| Session 6                        | 2021/03/03   | 60.80%<br>(3.69)                     | 54.37%<br>(1.04)                               | 11                          | 13.00                  | 16                             | 56.25%               | 0.00%                |
| Session 10                       | 2021/03/05   | 52.50%<br>(5.62)                     | 32.75%<br>(1.17)                               | 5                           | 20.00                  | 16                             | 50.00%               | 12.50%               |
| Session 12                       | 2021/04/20   | 76.56%<br>(3.76)                     | 81.34%<br>(0.85)                               | 8                           | 16.63                  | 16                             | 31.25%               | 18.75%               |

*Notes:* The numbers in parentheses are standard errors. <sup>#1</sup> One subject did not answer gender each in Session 5 and Session 7. The % of female subjects was 33.33% (5/15) in Session 5 and 20.00% (3/15) in Session 7.

**Remark:** The collected demographic information was used as control variables in regression analyses reported in Table B.2 to Table B.4.

**Table B.2:** *Treatment Effects of Reputational Information (supplementing Table 2 of the paper)*

Two models were used to test the impact of reputational information. The first one is a probit regression considering that each subject's decision is binary (either cooperate or defect). In the estimation, subject random effects are included to control for the panel structure; and session random effects are included to control for within-session dependencies in subjects' behaviors. Notice that within-session dependencies can be controlled by including session-level clustering. However, there is no theoretically valid way to include subject random effects and session-level clustering simultaneously for the probit model (Wooldridge, 2010). The second model is a standard linear probability model with subject random effects and session-level clustering. A linear probability model, rather than non-linear estimators such as probit, may be appropriate for experiment data, since the sample size of experiment data is usually small unlike empirical research. The following table, which reports estimation results when control variables are included, indicates no significant treatment differences in the cooperation rate, regardless of which model is used. Results are qualitatively similar even if control variables are not included.

| Dependent variable: a dummy which equals 1(0) if a subject $i$ cooperated (defected) in round $t$ |                    |   |                   |  |                   |
|---|--------------------|---|-------------------|--|-------------------|
| Independent variables:  | Estimation method: | Mixed effects probit regressions<br>(i.e., both session random effects and subject random effects are included) |                   | Subject random effects linear regressions<br>with session-level clustering |                   |
|   |                    | Round 1 only<br>(1)   | All rounds<br>(2) | Round 1 only<br>(3)  | All rounds<br>(4) |
| (a) Reputation treatment dummy  |                    | 0.002<br>(0.453)  | 0.149<br>(0.392)  | -0.008<br>(0.078)  | 0.047<br>(0.087)  |
| (b) Reputation-H treatment dummy  |                    | -0.275<br>(0.447)   | 0.408<br>(0.394)  | -0.039<br>(0.076)  | 0.124<br>(0.095)  |
| Constant  |                    | 2.199<br>(3.056)  | 1.518<br>(1.650)  | 0.936<br>(0.618)   | 0.802*<br>(0.417) |
| # of Observations   |                    | 1,430   | 21,615            | 1,437  | 21,615            |
| R-squared   |                    | ---   | ---               | 0.147  | 0.104             |
| Wald $\chi^2$   |                    | 96.57   | 958.24            | ---  | ---               |
| Prob > Wald $\chi^2$  |                    | 0.000   | 0.000             | ---  | ---               |
| Wald $\chi^2$ test for $H_0$ : (a) = (b)  |                    |   |                   |  |                   |
| Wald $\chi^2$   |                    | 0.360   | 0.430             | 0.280  | 0.650             |
| Two-sided $p$ -value  |                    | 0.547   | 0.514             | 0.597  | 0.422             |

Notes: The number of rounds in the previous supgame, a female dummy which equals 1 for female, an economics major dummy, the national center test score for university admissions (self-report), age dummies, supgame number dummies are also included as control variables. The coefficient estimates of these controls are omitted to conserve space. The number in parentheses are standard errors.

\*, \*\*, and \*\*\* indicate significance at the .10 level, at the .05 level and, at the .01 level, respectively.

**Table B.3: Cooperation Trends by Treatment (supplementing Figure 2 of the paper)**

Dependent variable: a dummy which equals 1(0) if a subject  $i$  cooperated (defected) in round  $t$

| <div><div></div><div>Data:</div></div> | Round 1 only        |                    |                     | All rounds           |                      |                      |
|--|---------------------|--------------------|---------------------|----------------------|----------------------|----------------------|
| Independent variables:                 | Baseline<br>(1)     | Reputation<br>(2)  | Reputation-H<br>(3) | Baseline<br>(4)      | Reputation<br>(5)    | Reputation-H<br>(6)  |
| Supergame number {= 1, 2, 3, 4, ...}   | 0.073***<br>(0.026) | 0.139**<br>(0.057) | 0.187***<br>(0.044) | 0.030***<br>(0.005)  | 0.097***<br>(0.008)  | 0.085***<br>(0.008)  |
| Rounds within supergame                | ---                 | ---                | ---                 | -0.010***<br>(0.001) | -0.027***<br>(0.002) | -0.019***<br>(0.002) |
| Constant                               | 5.785<br>(4.452)    | 8.671**<br>(8.742) | -3.051<br>(4.218)   | 5.794**<br>(2.731)   | 1.318*<br>(3.977)    | -5.179*<br>(2.774)   |
| # of Observations                      | 617                 | 402                | 403                 | 9,511                | 6,143                | 5,961                |
| Wald $\chi^2$                          | 34.24               | 19.47              | 45.45               | 325.01               | 446.62               | 308.04               |
| Prob > Wald $\chi^2$                   | 0.0006              | 0.1092             | 0.0000              | 0.0000               | 0.0000               | 0.0000               |

Notes: Mixed effects probit regressions (both session random effects and subject random effects are included). The number of rounds in the previous supergames, the 1<sup>st</sup> supergame dummy which equals 1 for the first supergame (0 otherwise) as the previous supergame length cannot be defined, a female dummy which equals 1 for female, an economics major dummy, the national center test score for university admissions (self-report), and age dummies are also included as control variables. The coefficient estimates of these controls are omitted to conserve space. The number in parentheses are standard errors.

\*, \*\*, and \*\*\* indicate significance at the .10 level, at the .05 level and, at the .01 level, respectively.

**Remark:** Key messages, namely, stable or gradually increasing across-supergame trends, are similar even if subject random effects linear regressions with standard errors clustered by session ID are used instead. The results are summarized below:

1. Results on the increasing trend in cooperation in the Baseline treatment are somewhat weaker due to larger standard errors when the subject random effects linear regressions are used. However, the supergame variable obtains a positive and significant coefficient at the 5% level (two-sided  $p = 0.15$ ) for subjects' decisions to cooperate in the first round when data before the 10<sup>th</sup> supergame are used.
2. Results in the Reputation treatment are qualitatively the same as the ones summarized in columns (2) and (5) above. The supergame variable is significantly positive regardless of whether data from round 1 or all data are used.
3. Results in the Reputation-H treatment are somewhat weaker due to larger standard errors when the subject random effects linear regressions are used. However, the supergame variable obtains a positive and significant coefficient at the 10% level (two-sided  $p = 0.87$ ) for subjects' decisions to cooperate in the first round. The trends are stable if all data are used.

**Table B.4: Reputational Information and Decisions to Cooperate**Dependent variable: a dummy which equals 1(0) if a subject  $i$  cooperated (defected) in round  $t$ 

| Independent variables:  | Treatment:          |                     |                     |                     |                     |                     |
|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|   | I. Reputation       |                     | II. Reputation-H    |                     |                     |                     |
|   | (i)                 | (ii)                | (i)                 | (ii)                | (iii)               | (iv)                |
| (a) $i$ 's round $t$ partner's past cooperation rate according to his recorded information  | 2.449***<br>(0.067) | ---                 | 2.315***<br>(0.069) | ---                 | ---                 | ---                 |
| (b) $i$ 's round $t$ partner's cooperation decision in round $t - 1$ {=1(0) if he cooperated(defected)}   | ---                 | 1.149***<br>(0.074) | ---                 | 0.959***<br>(0.064) | ---                 | ---                 |
| (c) $i$ 's round $t$ partner's cooperation rate between rounds $t - 2$ and $t - 5$ in his recorded information ( $\in[0,1]$ )                         | ---                 | 1.453***<br>(0.086) | ---                 | 1.562***<br>(0.082) | ---                 | ---                 |
| (d) % in which mutual cooperation was realized for recent five rounds in the $i$ 's round $t$ partner's reputational record ( $\in[0,1]$ )            | ---                 | ---                 | ---                 | ---                 | 2.286***<br>(0.071) | ---                 |
| (e) $i$ 's round $t$ partner's round $t - 1$ mutual cooperation dummy {= 1 if his round $t - 1$ outcome was mutual cooperation}                       | ---                 | ---                 | ---                 | ---                 | ---                 | 0.934***<br>(0.068) |
| (f) % in which mutual cooperation was realized between round $t - 2$ and $t - 5$ in the $i$ 's round $t$ partner's reputational record ( $\in[0,1]$ ) | ---                 | ---                 | ---                 | ---                 | ---                 | 1.600***<br>(0.085) |
| Constant  | 0.403<br>(4.365)    | 0.336<br>(4.338)    | -6.055*<br>(3.143)  | -6.556**<br>(3.300) | -5.299*<br>(2.875)  | -5.706*<br>(3.057)  |
| # of Observations   | 5,741               | 5,383               | 5,550               | 5,174               | 5,550               | 5,174               |
| Wald $\chi^2$   | 1567.36             | 1503.97             | 1484.69             | 1428.13             | 1401.84             | 1357.46             |
| Prob > Wald $\chi^2$  | 0.0000              | 0.0000              | 0.0000              | 0.0000              | 0.0000              | 0.0000              |

Notes: Mixed effects probit regressions (both session random effects and subject random effects are included). The number of rounds in the previous supergames, a female dummy which equals 1 for female, an economics major dummy, the national center test score for university admissions (self-report), age dummies, and supergame number dummies are also included as control variables. The coefficient estimates of these controls are omitted to conserve space. The number in parentheses are standard errors. Only observations where variable (a) (variables (b) and (c)) can be defined were used in columns I.i and II.i (I.ii and II.ii). Only observations where variable (d) (variables (e) and (f)) can be defined were used in column II.iii (II.iv). Results for coefficient estimates (a) to (f) are qualitatively the same when subject random effects linear regressions with standard errors clustered by session ID are instead used (the results are omitted to conserve space). \*, \*\*, and \*\*\* indicate significance at the .10 level, at the .05 level and, at the .01 level, respectively.

**Table B.5.** *Structural Estimation of Subjects' Strategy Choices (Supplementing Figure 3 of the paper)*

The table on the next page summarizes the estimated percentages of strategies chosen by the subjects in each treatment based on the maximum likelihood method (Dal Bó and Frech  tte, 2011). In addition to the strategies used in Dal B   and Frech  tte 2011 (namely, AD, AC, Grim, TFT, WSLS, and T2), other possible strategies were also included in the estimation. The definition of each strategy is as follows:

AD (“Always Defect”): a strategy in which a subject selects defection unconditionally.

AC (“Always Cooperate”): a strategy in which a subject selects cooperation unconditionally.

Grim (“Grim Trigger”): a strategy in which a subject selects defection as soon as s/he experiences defection (until which s/he selects cooperation).

TFT (“Tit For Tat”): a strategy in which a subject selects cooperation (defection) if her last-round partner cooperated (defected).

WSLS (“Win Stay Lose Shift”): a strategy in which a subject selects cooperation if either mutual cooperation or mutual defection was realized in last round.

# *Dal B   and Frech  tte (2011) only considered the T2 strategy below as a trigger strategy with some duration of punishment mode in their structural estimation. The present paper includes not only the T2 strategy, but also the T1, T3 and T4 strategies, because, to the knowledge of the authors, there is no stylized evidence on the duration of the punishment mode under random matching.*

T1 (“Trigger Strategy with 1 Round of Punishment”): a strategy in which a subject defects for one round, after which she returns to cooperation, when she experiences defection.

T2 (“Trigger Strategy with 2 Rounds of Punishment”): a strategy in which a subject defects for two rounds, after which she returns to cooperation, when she experiences defection.

T3 (“Trigger Strategy with 3 Rounds of Punishment”): a strategy in which a subject defects for three rounds, after which she returns to cooperation, when she experiences defection.

T4 (“Trigger Strategy with 4 Rounds of Punishment”): a strategy in which a subject defects for four rounds, after which she returns to cooperation, when she experiences defection.

# *The LRep, Rep20, Rep40, Rep60, Rep80 and Rep100 strategies below are relevant for the Reputation and Reputation-H treatments. Subjects who fall into these categories condition their action choices on their matched partners' past action choices.*

LRep (“Cooperate based on the Last-round Reputation”): a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation in round  $t - 1$ .

Rep20: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation for at least 20% of the occasions in the past according to the partner's reputational information.

Rep40: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation for at least 40% of the occasions in the past according to the partner's reputational information.

Rep60: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation for at least 60% of the occasions in the past according to the partner's reputational information.

Rep80: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation for at least 80% of the occasions in the past according to the partner's reputational information.

Rep100: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner selected cooperation for all the occasions in the past according to the partner's reputational information.

# *The LMC, MC20, MC40, MC60, MC80 and MC100 strategies below are relevant for the Reputation-H treatment only. Subjects who fall into these categories condition their action choices on their matched partners' past action profiles.*

LMC (“Cooperate based on Last-round Mutual Cooperation”): a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner achieved mutual cooperation in round  $t - 1$ .

MC20: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner experienced mutual cooperation at least for 20% of the occasions in the past according to the partner’s reputational information.

MC40: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner experienced mutual cooperation at least for 40% of the occasions in the past according to the partner’s reputational information.

MC60: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner experienced mutual cooperation at least for 60% of the occasions in the past according to the partner’s reputational information.

MC80: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner experienced mutual cooperation at least for 80% of the occasions in the past according to the partner’s reputational information.

MC100: a strategy in which a subject selects cooperation in round  $t$  if her round  $t$  partner experienced mutual cooperation for all of the occasions in the past according to the partner’s reputational information.

These strategies (LRep, Rep20, Rep40, Rep60, Rep80, and Rep100, LMC, MC20, MC40, MC60, MC80, and MC100) were considered in the estimation because partial correlations between  $i$ ’s cooperation rate and  $i$ ’s partner’s reputation were positive and significant (Appendix Table B.4).

The following table summarizes the estimated distributions of strategy choices, the standard errors and two-sided  $p$ -values for each treatment. The standard errors were calculated based on three-level bootstrapping: The computer first selects sessions randomly 100 times for each treatment. The computer then chooses 16 subjects and also supergames randomly for each selected session.

The % of the TK strategy (Trigger Strategy with  $K$  Rounds of Punishment) in Figure 3 of the paper is the sum of estimated percentages for T1, T2, T3 and T4. The % of the Rep strategy (Cooperate based on Partner’s Reputation) in Figure 3 is the sum of estimated percentages for LRep, Rep20, Rep40, Rep60, Rep80, and Rep100. The % of the PMC strategy (Cooperate based on partner’s past experiences of mutual cooperation) in Figure 3 is the sum of estimated percentages for LMC, MC20, MC40, MC60, MC80, and MC100.

[I. Estimation Result:]

| Treatment: |          | Baseline     |                      | Reputation |              |                      | Reputation-H |              |                      |
|------------|----------|--------------|----------------------|------------|--------------|----------------------|--------------|--------------|----------------------|
| Strategy   | Fraction | Bootstrap SE | $p$ -value (2-sided) | Fraction   | Bootstrap SE | $p$ -value (2-sided) | Fraction     | Bootstrap SE | $p$ -value (2-sided) |
| AD         | 0.219    | 0.069        | 0.001***             | 0.156      | 0.055        | 0.002***             | 0.169        | 0.089        | 0.028**              |
| AC         | 0.080    | 0.060        | 0.092*               | 0.047      | 0.036        | 0.093*               | 0.032        | 0.046        | 0.239                |
| Grim       | 0.072    | 0.051        | 0.079*               | 0.145      | 0.061        | 0.009***             | 0.000        | 0.024        | 0.500                |
| TFT        | 0.613    | 0.088        | 0.000***             | 0.295      | 0.050        | 0.000***             | 0.168        | 0.057        | 0.002***             |
| WSLS       | 0.016    | 0.022        | 0.243                | 0.000      | 0.005        | 0.500                | 0.000        | 0.008        | 0.500                |
| T1         | 0.000    | 0.000        | 0.500                | 0.000      | 0.010        | 0.500                | 0.000        | 0.008        | 0.500                |
| T2         | 0.000    | 0.005        | 0.500                | 0.000      | 0.001        | 0.500                | 0.000        | 0.011        | 0.500                |
| T3         | 0.000    | 0.002        | 0.500                | 0.000      | 0.009        | 0.500                | 0.000        | 0.023        | 0.500                |
| T4         | 0.000    | 0.000        | 0.000***             | 0.000      | 0.010        | 0.500                | 0.049        | 0.014        | 0.000***             |
| LRep       |          |              |                      | 0.029      | 0.043        | 0.252                | 0.026        | 0.032        | 0.213                |
| Rep20      |          |              |                      | 0.120      | 0.047        | 0.005***             | 0.176        | 0.044        | 0.000***             |
| Rep40      |          |              |                      | 0.067      | 0.035        | 0.029**              | 0.211        | 0.055        | 0.000***             |
| Rep60      |          |              |                      | 0.090      | 0.051        | 0.037**              | 0.050        | 0.036        | 0.082*               |



|          |       |       |       |       |       |          |       |       |          |
|----------|-------|-------|-------|-------|-------|----------|-------|-------|----------|
| Rep80    |       |       |       | 0.000 | 0.013 | 0.500    | 0.000 | 0.010 | 0.500    |
| Rep100   |       |       |       | 0.051 | 0.000 | 0.000*** | 0.000 | 0.008 | 0.500    |
| LMC      |       |       |       |       |       |          | 0.000 | 0.023 | 0.500    |
| MC20     |       |       |       |       |       |          | 0.012 | 0.032 | 0.354    |
| MC40     |       |       |       |       |       |          | 0.036 | 0.026 | 0.082*   |
| MC60     |       |       |       |       |       |          | 0.038 | 0.033 | 0.126    |
| MC80     |       |       |       |       |       |          | 0.033 | 0.029 | 0.128    |
| MC100    |       |       |       |       |       |          | 0.000 | 0.000 | 0.000*** |
| $\gamma$ | 0.481 | 0.058 | 0.000 | 0.432 | 0.046 | 0.000    | 0.494 | 0.026 | 0.000*** |
| $\beta$  | 0.889 |       |       | 0.910 |       |          | 0.883 |       |          |

Notes: <sup>a</sup> The table reports the estimated percentage of each strategy in the population. <sup>b</sup>  $\beta = \frac{1}{1+\exp(-1/\gamma)}$ .

## [II. Comparison of Estimated Percentages across the Treatments:]

### AD strategy:

|              | Reputation           | Reputation-H          |
|--------------|----------------------|-----------------------|
| Baseline     | 5.755 ( $p < 0.01$ ) | 5.558 ( $p < 0.01$ )  |
| Reputation   | ---                  | 1.125 ( $p = 0.262$ ) |
| Reputation-H | ---                  | ---                   |

### AC strategy:

|              | Reputation           | Reputation-H           |
|--------------|----------------------|------------------------|
| Baseline     | 9.500 ( $p < 0.01$ ) | 7.457 ( $p < 0.01$ )   |
| Reputation   | ---                  | -1.739 ( $p = 0.084$ ) |
| Reputation-H | ---                  | ---                    |

### Grim strategy:

|              | Reputation            | Reputation-H          |
|--------------|-----------------------|-----------------------|
| Baseline     | -5.735 ( $p < 0.01$ ) | 12.081 ( $p < 0.01$ ) |
| Reputation   | ---                   | 17.315 ( $p < 0.01$ ) |
| Reputation-H | ---                   | ---                   |

### TFT strategy:

|              | Reputation            | Reputation-H          |
|--------------|-----------------------|-----------------------|
| Baseline     | 28.950 ( $p < 0.01$ ) | 38.882 ( $p < 0.01$ ) |
| Reputation   | ---                   | 15.032 ( $p < 0.01$ ) |
| Reputation-H | ---                   | ---                   |

Notes:  $t$  tests using 300 estimated distributions of strategy choices (100 per treatment) based on three-level bootstrapping (session, supergame, subject). Numbers in the tables are  $t$  values with (two-sided)  $p$ -values in parentheses.

Remark: 1. Subjects may need some time to reach stable strategy choices, for which reason Dal Bó and Frechette (2011) excluded subjects' decision data in earlier supergames. In the context of the present paper, subjects' cooperation rates were on average low in the first supergame as seen in Figure 2 of the paper. Hence, as a robustness check, a strategy estimation was also performed for data excluding the observations from the first supergame, finding qualitatively similar results. The results are omitted to conserve space.

2. The number of supergames differs by session, which may render the treatment comparisons shown in I and II above imprecise. To address this concern, an additional strategy estimation was performed by restricting the data to the observations up to (and including) the 5<sup>th</sup> supergame because all 12 sessions went through the first five supergames. The estimation results are qualitatively similar to the ones reported above. The results are omitted to conserve space.

**Table B.6. Structural Estimation of Subjects' Strategy Choices in Camera and Casari (2009)**

We estimated distributions of strategies chosen by the subjects in the “Private Monitoring” treatment, the “Anonymous Public Monitoring” treatment and the “Non-Anonymous Public Monitoring” treatment of Camera and Casari (2009) based on the maximum likelihood method (Dal Bó and Frech  tte, 2011), using their replication data files. All the strategies used in Dal B   and Frech  tte 2011 (namely, AD, AC, Grim, TFT, WSLS, and T2) were considered in the estimations. In addition, the strategies considered in Table B.5 were also included as possible strategies for the “Non-Anonymous Public Monitoring” treatment. As the subjects in their two public monitoring treatments were also aware of the list of three members’ actions in every previous round, the following strategies were also considered for these treatments:

- LRepXX\_partners: A subject selects cooperation in round  $t$  if at least XX% of partners in community (i.e., out of three other members) selected cooperation in round  $t-1$ .
- RepXX\_community: A subject selects cooperation in round  $t$  if the cooperation rate in the community including the subject him/herself thus far was at least XX% according to the history table.
- RepXX\_partners: A subject selects cooperation in round  $t$  if the cooperation rate among partners in the community thus far was at least XX% according to the history table.
- RepXX\_community\_5rounds: A subject selects cooperation in round  $t$  if the cooperation rate in the community including the subject him/herself for the last five rounds was at least XX% according to the history table.
- RepXX\_partners\_5rounds: A subject selects cooperation in round  $t$  if the cooperation rate among the partners in the community for the last five rounds was at least XX% according to the history table.

Note that the LRep, RepXX, and RepXX\_5rounds in the table below are defined as follows:

- LRep: A subject selects cooperation in round  $t$  if his/her partner matched in round  $t$  selected cooperation in round  $t-1$ .
- RepXX: A subject selects cooperation in round  $t$  if the cooperation rate of his/her partner matched in round  $t$  thus far was at least XX% according to the history table.
- RepXX\_5rounds: A subject selects cooperation in round  $t$  if the cooperation rate of his/her partner matched in round  $t$  for the last 5 rounds was at least XX% according to the history table.

The estimation result for the Private Monitoring treatment (see column A below) finds that a non-negligible fraction of subjects acted according to the AD strategy, whose finding is similar to the private monitoring treatments of the present paper (Appendix Table B.5), Camera *et al.* (2012) and Kamei and Nesterov (2020).

Columns B and C below indicate that similar to the findings of the present paper (Appendix Table B.5) and Kamei and Nesterov (2020), a large fraction of subjects selected cooperation conditional upon their partner’s reputational information.

[Estimation Result:]

| Treatment: | (A) Private Monitoring |              |                      | (B) Anonymous Public Monitoring |              |                      | (C) Non-Anonymous Public Monitoring |              |                      |
|------------|------------------------|--------------|----------------------|---------------------------------|--------------|----------------------|-------------------------------------|--------------|----------------------|
| Strategy   | Fraction               | Bootstrap SE | $p$ -value (2-sided) | Fraction                        | Bootstrap SE | $p$ -value (2-sided) | Fraction                            | Bootstrap SE | $p$ -value (2-sided) |
| AD         | 0.202                  | 0.100        | 0.021**              | 0.098                           | 0.050        | 0.026**              | 0.050                               | 0.066        | 0.224                |

|                          |       |       |          |       |       |          |       |       |          |
|--------------------------|-------|-------|----------|-------|-------|----------|-------|-------|----------|
| AC                       | 0.297 | 0.075 | 0.000*** | 0.038 | 0.016 | 0.008*** | 0.000 | 0.002 | 0.454    |
| Grim                     | 0.156 | 0.064 | 0.007*** | 0.072 | 0.064 | 0.128    | 0.000 | 0.002 | 0.479    |
| TFT                      | 0.268 | 0.117 | 0.011**  | 0.110 | 0.052 | 0.017**  | 0.053 | 0.053 | 0.157    |
| WSLS                     | 0.025 | 0.028 | 0.187    | 0.000 | 0.014 | 0.500    | 0.000 | 0.000 | 0.000*** |
| T1                       | 0.051 | 0.051 | 0.157    | 0.000 | 0.002 | 0.500    | 0.000 | 0.000 | 0.000*** |
| T2                       | 0.000 | 0.025 | 0.500    | 0.000 | 0.012 | 0.500    | 0.000 | 0.009 | 0.495    |
| T3                       | 0.000 | 0.023 | 0.500    | 0.000 | 0.007 | 0.500    | 0.000 | 0.018 | 0.498    |
| T4                       | 0.000 | 0.000 | 0.000*** | 0.000 | 0.002 | 0.500    | 0.000 | 0.018 | 0.498    |
| LRep33_partners          |       |       |          | 0.162 | 0.078 | 0.019**  | 0.084 | 0.055 | 0.063*   |
| LRep67_partners          |       |       |          | 0.078 | 0.053 | 0.069*   | 0.000 | 0.019 | 0.497    |
| LRep100_partners         |       |       |          | 0.000 | 0.001 | 0.500    | 0.000 | 0.000 | 0.000*** |
| Rep20_community          |       |       |          | 0.037 | 0.021 | 0.037**  | 0.000 | 0.002 | 0.454    |
| Rep40_community          |       |       |          | 0.001 | 0.033 | 0.493    | 0.000 | 0.009 | 0.492    |
| Rep60_community          |       |       |          | 0.123 | 0.080 | 0.063*   | 0.078 | 0.061 | 0.102    |
| Rep80_community          |       |       |          | 0.093 | 0.047 | 0.023**  | 0.000 | 0.001 | 0.448    |
| Rep100_community         |       |       |          | 0.000 | 0.009 | 0.500    | 0.000 | 0.000 | 0.355    |
| Rep20_partners           |       |       |          | 0.045 | 0.054 | 0.200    | 0.000 | 0.002 | 0.454    |
| Rep40_partners           |       |       |          | 0.000 | 0.010 | 0.500    | 0.000 | 0.011 | 0.483    |
| Rep60_partners           |       |       |          | 0.000 | 0.002 | 0.500    | 0.000 | 0.000 | 0.000*** |
| Rep80_partners           |       |       |          | 0.000 | 0.010 | 0.500    | 0.000 | 0.000 | 0.000*** |
| Rep100_partners          |       |       |          | 0.000 | 0.002 | 0.500    | 0.000 | 0.000 | 0.000*** |
| Rep20_community_5rounds  |       |       |          | 0.000 | 0.002 | 0.500    | 0.000 | 0.002 | 0.455    |
| Rep40_community_5rounds  |       |       |          | 0.094 | 0.069 | 0.087*   | 0.000 | 0.015 | 0.490    |
| Rep60_community_5rounds  |       |       |          | 0.000 | 0.020 | 0.500    | 0.030 | 0.022 | 0.082*   |
| Rep80_community_5rounds  |       |       |          | 0.000 | 0.010 | 0.500    | 0.010 | 0.006 | 0.044**  |
| Rep100_community_5rounds |       |       |          | 0.000 | 0.003 | 0.500    | 0.000 | 0.000 | 0.353    |
| Rep20_partners_5rounds   |       |       |          | 0.000 | 0.028 | 0.500    | 0.000 | 0.002 | 0.455    |
| Rep40_partners_5rounds   |       |       |          | 0.048 | 0.034 | 0.080*   | 0.000 | 0.000 | 0.068*   |
| Rep60_partners_5rounds   |       |       |          | 0.000 | 0.006 | 0.500    | 0.000 | 0.015 | 0.497    |
| Rep80_partners_5rounds   |       |       |          | 0.000 | 0.009 | 0.500    | 0.000 | 0.000 | 0.000*** |
| Rep100_partners_5rounds  |       |       |          | 0.000 | 0.000 | 0.000*** | 0.000 | 0.000 | 0.000*** |
| LRep                     |       |       |          |       |       |          | 0.048 | 0.047 | 0.153    |
| Rep20                    |       |       |          |       |       |          | 0.052 | 0.048 | 0.137    |

|                |       |       |          |       |       |          |       |       |          |
|----------------|-------|-------|----------|-------|-------|----------|-------|-------|----------|
| Rep40          |       |       |          |       |       |          | 0.040 | 0.051 | 0.219    |
| Rep60          |       |       |          |       |       |          | 0.191 | 0.059 | 0.001*** |
| Rep80          |       |       |          |       |       |          | 0.054 | 0.064 | 0.201    |
| Rep100         |       |       |          |       |       |          | 0.000 | 0.000 | 0.000*** |
| Rep20_5rounds  |       |       |          |       |       |          | 0.000 | 0.041 | 0.498    |
| Rep40_5rounds  |       |       |          |       |       |          | 0.169 | 0.071 | 0.009*** |
| Rep60_5rounds  |       |       |          |       |       |          | 0.031 | 0.061 | 0.306    |
| Rep80_5rounds  |       |       |          |       |       |          | 0.093 | 0.054 | 0.041**  |
| Rep100_5rounds |       |       |          |       |       |          | 0.011 | 0.000 | 0.000*** |
| $\gamma$       | 0.587 | 0.049 | 0.000*** | 0.554 | 0.043 | 0.000*** | 0.579 | 0.089 | 0.000*** |
| $\beta$        | 0.846 |       |          | 0.859 |       |          | 0.849 |       |          |

Notes: <sup>a</sup> The table reports the estimated percentage of each strategy in the population. <sup>b</sup>  $\beta = \frac{1}{1+\exp(-1/\gamma)}$ .

**Table B.7. Structural Estimation of Subjects' Strategy Choices in Kamei (2017)**

We estimated distributions of strategies chosen by the subjects in the N treatment, the RG treatment and the RP treatment of Kamei (2017), again based on the maximum likelihood method (Dal Bó and Frechétte, 2011). The N and RG treatments of Kamei (2017) are the same as the “Private Monitoring” and “Non-anonymous Public Monitoring” treatments, respectively, of Camera and Casari (2009). The same sets of strategies used in Appendix Table B.6 were considered here as well for these two treatments.

The RP treatment of Kamei (2017) is similar to the RG treatment, except that subjects in the former have smaller sizes of reputational information compared with the latter. In the RP treatment, as in the RG treatment, subject  $i$  is informed of his/her current-round partner's ID before choosing an action. Subject  $i$  is also given the record of the partner's actions taken towards  $i$  in the past. However,  $i$  is not informed of any actions chosen by the partner towards the other two players in the group. In estimating a distribution of subjects' strategy choices in the RP treatment, the LIRep and IRepXX strategies defined as follows, were considered:

LIRep (“Cooperate based on the Last-Interaction Reputation”): A subject  $i$  selects cooperation in round  $t$  if his/her round  $t$  partner  $j$  selected cooperation toward  $i$  in their last interaction.

IRepXX: A subject  $i$  selects cooperation in round  $t$  if the cooperation rate of his/her round  $t$  partner  $j$  thus far was at least XX% according to the past interaction record between  $i$  and  $j$ .

The estimation result for the N treatment (see column A below) finds that a non-negligible fraction of subjects acted according to the AD strategy, whose finding is similar to the private monitoring treatments of the present paper (Appendix Table B.5), the data of Camera and Casari (2009) – summarized in Table B.6, Camera *et al.* (2012) and Kamei and Nesterov (2020).

Columns B and C below indicate that similar to the findings of the present paper (Appendix Table B.5), the data of Camera and Casari (2009), and Kamei and Nesterov (2020), a large fraction of subjects selected cooperation conditional upon their partner's reputational information.

[Estimation Result:]

| Treatment:      | (A) N treatment (private monitoring) |              |                      | (B) RG treatment (non-anonymous public monitoring) |              |                      | (C) RP treatment |              |                      |
|-----------------|--------------------------------------|--------------|----------------------|--|--------------|----------------------|------------------|--------------|----------------------|
| Strategy        | Fraction                             | Bootstrap SE | $p$ -value (2-sided) | Fraction   | Bootstrap SE | $p$ -value (2-sided) | Fraction         | Bootstrap SE | $p$ -value (2-sided) |
| AD              | 0.439                                | 0.165        | 0.004***             | 0.083  | 0.075        | 0.132                | 0.156            | 0.082        | 0.029**              |
| AC              | 0.100                                | 0.058        | 0.043**              | 0.002  | 0.031        | 0.472                | 0.127            | 0.063        | 0.021**              |
| Grim            | 0.052                                | 0.051        | 0.155                | 0.000  | 0.041        | 0.500                | 0.062            | 0.043        | 0.073*               |
| TFT             | 0.370                                | 0.102        | 0.000***             | 0.000  | 0.000        | 0.427                | 0.028            | 0.015        | 0.028**              |
| WSLS            | 0.025                                | 0.044        | 0.286                | 0.000  | 0.023        | 0.500                | 0.000            | 0.026        | 0.500                |
| T1              | 0.000                                | 0.000        | 0.333                | 0.000  | 0.000        | 0.399                | 0.000            | 0.018        | 0.500                |
| T2              | 0.000                                | 0.005        | 0.500                | 0.000  | 0.011        | 0.500                | 0.000            | 0.000        | 0.393                |
| T3              | 0.000                                | 0.000        | 0.334                | 0.000  | 0.027        | 0.500                | 0.000            | 0.004        | 0.500                |
| T4              | 0.014                                | 0.000        | 0.000***             | 0.000  | 0.003        | 0.500                | 0.000            | 0.005        | 0.500                |
| LRep33_partners |                                      |              |                      | 0.025  | 0.025        | 0.157                |                  |              |                      |
| LRep67_partners |                                      |              |                      | 0.030  | 0.046        | 0.256                |                  |              |                      |

|                          |       |       |          |       |       |         |
|--------------------------|-------|-------|----------|-------|-------|---------|
| LRep100_partners         | 0.000 | 0.000 | 0.403    |       |       |         |
| Rep20_community          | 0.109 | 0.039 | 0.002*** |       |       |         |
| Rep40_community          | 0.000 | 0.016 | 0.500    |       |       |         |
| Rep60_community          | 0.000 | 0.004 | 0.500    |       |       |         |
| Rep80_community          | 0.090 | 0.013 | 0.000*** |       |       |         |
| Rep100_community         | 0.000 | 0.010 | 0.500    |       |       |         |
| Rep20_partners           | 0.000 | 0.003 | 0.500    |       |       |         |
| Rep40_partners           | 0.000 | 0.006 | 0.500    |       |       |         |
| Rep60_partners           | 0.000 | 0.000 | 0.407    |       |       |         |
| Rep80_partners           | 0.000 | 0.003 | 0.500    |       |       |         |
| Rep100_partners          | 0.000 | 0.000 | 0.407    |       |       |         |
| Rep20_community_5rounds  | 0.002 | 0.031 | 0.472    |       |       |         |
| Rep40_community_5rounds  | 0.000 | 0.019 | 0.500    |       |       |         |
| Rep60_community_5rounds  | 0.000 | 0.001 | 0.500    |       |       |         |
| Rep80_community_5rounds  | 0.000 | 0.003 | 0.500    |       |       |         |
| Rep100_community_5rounds | 0.000 | 0.000 | 0.482    |       |       |         |
| Rep20_partners_5rounds   | 0.000 | 0.003 | 0.500    |       |       |         |
| Rep40_partners_5rounds   | 0.038 | 0.066 | 0.280    |       |       |         |
| Rep60_partners_5rounds   | 0.000 | 0.000 | 0.403    |       |       |         |
| Rep80_partners_5rounds   | 0.000 | 0.000 | 0.392    |       |       |         |
| Rep100_partners_5rounds  | 0.000 | 0.000 | 0.470    |       |       |         |
| LRep                     | 0.062 | 0.042 | 0.069*   |       |       |         |
| Rep20                    | 0.258 | 0.109 | 0.009*** |       |       |         |
| Rep40                    | 0.098 | 0.077 | 0.102    |       |       |         |
| Rep60                    | 0.055 | 0.051 | 0.142    |       |       |         |
| Rep80                    | 0.000 | 0.001 | 0.500    |       |       |         |
| Rep100                   | 0.000 | 0.000 | 0.474    |       |       |         |
| Rep20_5rounds            | 0.052 | 0.112 | 0.321    |       |       |         |
| Rep40_5rounds            | 0.049 | 0.042 | 0.119    |       |       |         |
| Rep60_5rounds            | 0.045 | 0.044 | 0.152    |       |       |         |
| Rep80_5rounds            | 0.000 | 0.009 | 0.500    |       |       |         |
| Rep100_5rounds           | 0.000 | 0.000 | 0.000*** |       |       |         |
| LIRep                    |       |       |          | 0.388 | 0.191 | 0.021** |

|          |       |       |          |       |       |          |       |       |          |
|----------|-------|-------|----------|-------|-------|----------|-------|-------|----------|
| IRep20   |       |       |          |       |       |          | 0.000 | 0.060 | 0.500    |
| IRep40   |       |       |          |       |       |          | 0.081 | 0.088 | 0.180    |
| IRep60   |       |       |          |       |       |          | 0.000 | 0.000 | 0.450    |
| IRep80   |       |       |          |       |       |          | 0.158 | 0.104 | 0.065*   |
| IRep100  |       |       |          |       |       |          | 0.000 | 0.000 | 0.000*** |
| $\gamma$ | 0.540 | 0.057 | 0.000*** | 0.402 | 0.049 | 0.000*** | 0.423 | 0.030 | 0.000*** |
| $\beta$  | 0.864 |       |          | 0.923 |       |          | 0.914 |       |          |

Notes: <sup>a</sup> The table reports the estimated percentage of each strategy in the population. <sup>b</sup>  $\beta = \frac{1}{1+\exp(-1/\gamma)}$ .

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