University of Heidelberg

Department of Economics

Discussion Paper Series | No. 660

# Identifying the Ranking of Focal Points in Coordination Games on the Individual Level

Robert J. Schmidt

March 2019

# Identifying the Ranking of Focal Points in Coordination Games on the Individual Level

Robert J. Schmidt*, University of Heidelberg, Germany

March 23, 2019

**Abstract**

We propose a method to identify the ranking of focal points (Schelling, 1960) on the individual level. By contrast to conventional coordination, where subjects bet on only one alternative, subjects coordinate by the distribution of points. This allows them to invest in multiple alternatives and to weigh their choices. As a result, subjects not only reveal which alternative appears most focal to them, but the ranking of the available alternatives with regard to the degree of focality. In an experiment on the elicitation of social norms (Krupka and Weber, 2013), we compare the proposed mechanism with conventional coordination. The data confirms the theoretical predictions regarding coordination behavior and demonstrates that the proposed technique is suited to identify the heterogeneity of focal points on the individual level. Moreover, using Monte Carlo simulations, we find that the proposed mechanism identifies focal points on the group level significantly more efficiently than ordinary coordination. Finally, we point to the possibility to use the mechanism as a simple and direct tool to measure the degree of strategic uncertainty on the individual level.

*Keywords:* coordination, focal points, game theory, methodology, social norms
*JEL Classifications:* B41, C70, C91

*Alfred-Weber-Institute for Economics, University of Heidelberg, Bergheimer Str. 58, 69115 Heidelberg, Germany. Phone: +49 152 34181300, email: rojoschmidt@gmail.com. We thank Hannes Rau as well as seminar audiences at Frankfurt, Heidelberg, GATE Lyon Saint Etienne, the 9th International Conference of the ASFEE in Nizza, the ESA World Meeting in Berlin and the ESA Asia-Pacific Meeting in Abu Dhabi for very valuable comments and suggestions.

## 1. Introduction

Shelling (1960) argues that in pure coordination games with multiple equivalent equilibria, subjects perceive varying degrees of saliences regarding the available alternatives. This renders some of the equilibria more or less "focal", and thereby constitutes an implicit coordination device. Schelling (1960) himself conducted a series of informal experiments to illustrate this effect. For example, he asked subjects whether they would pick either "heads" or "tails" in a coordination game. Of the 42 respondents, 36 chose heads. As no formal differences between the strategies or the respective equilibria were present in that setting, he concluded that the obvious presence of a coordination device could only be attributed to shared perceptions and that, apparently, "heads" appeared to be more focal than "tails". Since then, both experimental and theoretical work has corroborated the relevance of focal points in a variety of coordination settings (e.g. Binmore and Samuelson, 2006; Casajus, 2000; Crawford et al., 2008; Isoni et al., 2013, 2014, 2019; Janssen, 2001, 2006; Metha et al. 1992, 1994a, 1994b; Pope et al., 2015; Sudgen, 1995; Sugden and Zamarrón, 2006).

Focal points are interesting not only because they help subjects to coordinate, but because of their potential to reveal shared perceptions. For example, in the original version of the Keynesian beauty contest (Keynes, 1936), respondents are provided with pictures of women, and their task is to coordinate on the most attractive pictures. According to Shelling´s concept, focal points might, for example, be determined by shared perceptions about prevalent beauty ideals within the guesser's population. Capitalizing on this very mechanism, Krupka and Weber (2013) propose using coordination games to elicit social norm perception. In their approach, subjects are confronted with the description of a particular behavior and they then have to coordinate on appropriateness ratings. The assumption that underlies the method is that social norms are constituted through shared perceptions (Crawford and Ostrom, 1995) which thereby determine the focality of alternatives. Consequently, the subjects´ coordination choices will correspond to their perception about prevailing social norms.

In all the described settings, however, subjects choose only *one* strategy. As a result, the coordination choice of a single participant only reveals which alternative she considers to be *most* focal. For example, a subject´s coordination choice in the above described Keynesian beauty contest reveals which picture she considers most focal, but it is not identified which picture is second or third most focal. In order to analyze how one alternative relates to other alternatives in terms of focality, and to determine a ranking of alternatives regarding their focality, it is necessary to aggregate the choices of many participants. Yet, such a ranking would only be visible on the *aggregate* level, i.e. based on the choices of *many* participants.

Consequently, the ranking refers to the perception of focal points by the whole group of subjects that participate in coordination. By contrast, the ranking of focal points on the *individual* level, i.e. regarding a single respondent, remains unidentified. This results from the nature of the technique, since subjects can only bet on one alternative.

We propose a *point beauty contest* that allows eliciting the ranking of focal points on the individual level. The mechanism represents a coordination setting that allows participants to bet on multiple outcomes and to weigh their choices. By contrast to conventional coordination settings, where subjects coordinate on only one alternative, subjects are equipped with a budget of points that they can distribute between multiple alternatives. Like in ordinary coordination games, subjects are incentivized to reveal their beliefs about the other participants´ behavior, as they are paid according to the precision with which they anticipate the other participants´ choices. While coordination with a single choice reveals the most focal alternative, this approach allows the elicitation of the full ranking of focal points on the level of a single participant.

We analyze the proposed mechanism both theoretically and experimentally. In the theoretical part, we derive predictions for coordination behavior depending on risk preferences and strategic uncertainty. In an experiment on the elicitation of social norms (Krupka and Weber, 2013), we compare the proposed mechanism with conventional coordination. We find that the coordination outcomes correspond, i.e. averaging the individual rankings produced by the proposed method matches the aggregate ranking elicited using the conventional approach. Looking at behavior on the subject level confirms the theoretical predictions regarding coordination behavior and demonstrates that the proposed technique is suited to identify the ranking of focal points on the individual level. Moreover, using Monte Carlo simulations, we find that the point beauty contest identifies focal points more efficiently, as it yields a given level of precision about the underlying distribution with significantly fewer subjects. Finally, we point to the possibility to use the mechanism as a simple and direct tool to measure the degree of strategic uncertainty on the individual level.

## 2. Theoretical Framework

### *2.1. The Game*

Consider a one-shot coordination game where subjects $i = 1, \dots, n$ see alternatives $j = 1, \dots, m$. Each subject receives a budget of $X$ points and distributes the points between alternatives. The number of points that an individual $i$ assigns to $j$ is denoted as $x_{ij}$. All points must be used, i.e. $\sum_{j=1}^{m} x_{ij} = X$. We refer to the vector $X_i = (x_{i1}, \dots, x_{ij})$ as a subject´s coordination choice. After all subjects decided about their $X_i$, the average number of points $\overline{x_j}$ assigned to alternative $j$ is calculated as $\overline{x_j} = (\sum_{i=1}^{n} x_{ij})/n$. The alternative that received most points on average is considered the *winning alternative* $j^*$.[1] If more than one alternative received the maximum number of points, $j^*$ is determined randomly among these alternatives.[2] Finally, each participant receives a payoff $\pi_i$ that is proportional to the number of points $x_{ij^*}$ that she assigned to the winning alternative, i.e. $\pi_i \sim x_{ij^*}$.

### *2.2. Belief Formation, Preferences and Strategic Uncertainty*

**Focal points and belief formation.** For each alternative $j$, a subject perceives focality $\varphi_{ij} \geq 0$ and the vector $\Phi_i = (\varphi_{i1}, \dots, \varphi_{ij})$ determines a subject´s ranking of focalities. A subject´s $\Phi_i$ is induced by the framing of the game, i.e. the question at hand. By definition, subjects assume that perceptions about focalities are correlated among participants and that the remaining subjects use it as a coordination device (Sudgen, 1995). Based on $\Phi_i$, a subject derives beliefs $p_{ij}$ which reflect the probability that alternative $j$ becomes the winning alternative $j^*$. That is, stronger focality of an alternative renders the respective alternative as a more promising bet for the investment of points: $\varphi_{ik} > \varphi_{il} \Leftrightarrow p_{ik} > p_{il}$ for two alternatives $k$ and $l$. The vector $P_i = (p_{i1}, \dots, p_{ij})$, with $\sum_{j=1}^{m} p_{ij} = 1$, is the probability distribution that an individual perceives regarding the coordination outcome. The translation of focalities into actual probabilities allows to view the agent´s optimization problem as a game against nature (Luce and Raiffa, 1957).

**Preferences.** Subjects exhibit von-Neumann-Morgenstern utility functions. For convenience, we normalize $\pi_i = x_{ij^*}$, so that profit will simply equal the number of points assigned to $j^*$. As a result, utility simplifies to $U_i = \sum_{j=1}^{m} p_{ij}\, u(x_{ij})$. The utility function $u$ is continuous and twice differentiable with $u'(x) > 0$. Subjects can be risk averse ($u''(x) < 0$), risk neutral ($u''(x) = 0$) or risk seeking ($u''(x) > 0$).

**Strategic uncertainty and coordination behavior.** A subject is *certain*, if she is sure about the outcome of the game: $p_{ij} = 1$ for some $j$. A subject is *partially uncertain*, if she considers at least one alternative $k$ to be more promising than another alternative $l$, without being fully confident: $0 < p_{il} < p_{ik} < 1$ for

[1] We assume that subjects perceive the coordination outcome to be exogenous, i.e. they do not strategically assign points in order to influence the outcome of $j^*$. This assumption is adequate when the number of participants is sufficiently large.
[2] It is necessary that only one $j$ becomes the winning alternative. This ensures that subjects are not incentivized to equalize points among all alternatives which would maximize the profit of all participants, but render the outcome uninformative.

some $k$ and $l$. A subject is *fully uncertain*, if she is clueless regarding the outcome of the game: $p_{ij} = 1/m$ for all $j$. Accordingly, we say that a subject applies *gambling*, if she assigns all points to one alternative: $x_{ij} = X$ for some $j$. A subject applies *ranking*, if she assigns more points to one alternative $k$ than to another alternative $l$: $0 < x_{il} < x_{ik} < X$. A subject applies hedging, if she fully hedges her profit by assigning equally many points to all alternatives: $x_{ij} = X/m$ for all $j$.

### *2.3. Predictions for Coordination Behavior and Revelation of Focalities*

For simplicity, predictions refer to a game with two alternatives $k$ and $l$, without loss of generality. Table 1 shows predictions for coordination behavior depending on risk preference and strategic uncertainty. If subjects are either risk-averse or if subjects are certain about the coordination outcome, then a subject´s coordination choice $X_i$ reflects her perception of underlying focalities $\Phi_i$. That is, subjects apply gambling in case of certainty, they apply ranking in case of partial uncertainty and they apply hedging in case of full uncertainty. In these cases, subjects reveal their ranking of focal points, as they assign more points to alternatives that are considered more promising: $p_{ik} > p_{il} \Leftrightarrow x_{ik} > x_{il}$. Since we assume that subjects derive success probabilities of alternatives based on their degree of focalitity, i.e. $\varphi_{ik} > \varphi_{il} \Leftrightarrow p_{ik} > p_{il}$, a subject´s ranking of points will correspond to her ranking of focalities, i.e. $\varphi_{ik} > \varphi_{il} \Leftrightarrow x_{ik} > x_{il}$ in these cases. Note that this also holds in a game with more than two alternatives.

**Proposition 1.** If an individual is risk averse or certain about the coordination outcome, then she fully reveals her ranking of focalities by assigning more points to alternatives that are considered more focal.

**Table 1.** Predictions for Coordination Behavior

| | Certainty: $p_k = 1$ | Partial uncertainty: $0 < p_l < p_k < 1$ | Full Uncertainty: $p_k = p_l$ |
|---|---|---|---|
| Risk averse | $\boldsymbol{x_k = X}$ | $\boldsymbol{0 < x_l < x_k < X}$ | $\boldsymbol{x_k = x_l}$ |
| Risk neutral | $\boldsymbol{x_k = X}$ | $x_k = X$ | Indifferent |
| Risk seeking | $\boldsymbol{x_k = X}$ | $x_k = X$ | $x_k = X$ or $x_l = X$ |

*Notes:* The bold printing refers to those combinations of risk preference and strategic uncertainty, where a subject's coordination choice fully reflects her beliefs.

## 3. Experiment

### *3.1. Design*

We experimentally tested our predictions by applying the two approaches to the elicitation of social norm perception. The approach to use coordination games to measure social norm perception has been proposed by Krupka and Weber (2013). In their approach, subjects are asked to evaluate a particular behavior (e.g. "how appropriate is it to do X?") and different answer alternatives to evaluate that behavior (e.g. "very appropriate", "somewhat appropriate", "somewhat inappropriate", "very inappropriate"). The subject´s task is to choose the answer of which they think, that it would be chosen by the majority of participants. We compared their approach, where subjects can only bet on one alternative, with our proposition, where subjects can bet on multiple alternatives and weigh their choices. Note that the elicitation of social norm perception is just an arbitrary context to test the proposed mechanism. Any contexts, in which participants are asked to coordinate, would have been suited for an experimental test.

We conducted two treatments: *classical beauty contest (CBC)* and *point beauty contest (PBC)*. In both treatments, we elicited injunctive social norms (part 1) and descriptive social norms (part 2) for five daily life behaviors. Injunctive social norms refer to perceptions of *normatively appropriate* behavior while descriptive social norms refer to perceptions of *common behavior*, i.e. the behavior practiced by most people (Cialdini et al., 1990). Table X shows the five behaviors that we use for the elicitation of injunctive and descriptive social norms.

**Table 2.** Items Used for the Elicitation of Social Norms

1. Taking some money out of a found wallet before bringing it to the lost-property office.
2. Lying for reasons of courtesy.
3. Treating unfair a person of which one has been treated unfair before.
4. Keeping the money when the cashier accidentally returned too much change.
5. Mainly paying attention to the own well-being in daily-life.

For the elicitation of injunctive social norms, subjects were confronted with a particular item and they were asked, how they evaluate the respective behavior regarding its appropriateness. Subjects could then coordinate on the answer options "very appropriate", "somewhat appropriate", "somewhat inappropriate", "very inappropriate". For the elicitation of descriptive social norms, subjects were confronted with a particular item and were then asked how many people would act according to the described behavior. Subjects could then coordinate on the answer options "a large majority", "a majority", "a minority", "a small minority".

In *CBC*, we employed conventional coordination, as done by Krupka and Weber (2013). That is, for each item, a subject received €10 if she managed to pick the answer alternative that was chosen by the majority of the respondents in the session (and zero otherwise). In the *PBC* subjects were endowed with 100 points in each item and their task was to distribute the 100 points between the available alternatives.

In each item, subjects gained 0.10€ for each point that they assigned to the *winning alternative*, i.e. the alternative that has received most points on average. Therefore, the payoff function is symmetric in the sense that assigning all 100 points to one alternative in *PBC* is equivalent to *CBC* in payoff terms, as it yields the same price of €10.

In both treatments, subjects received detailed instructions on the coordination mechanisms in part 1 and 2 and about how their payment would be determined. Specifically, subjects were provided with several examples to illustrate how their payment would be calculated depending on their behavior and the coordination outcome. Subjects answered several control questions regarding comprehension of profit calculation. In particular, we paid attention to make clear that subjects were not asked about their own opinion, bur that their task was to coordinate with the remaining participants in the room. In order to make sure that subjects consider this feature, we reminded subjects on each screen, on which they had to enter a coordination choice, that their task is to coordinate with the other respondents, and not to state their own opinion.

Finally, (in part 3) we elicited risk preferences using the Eckel and Grossmann (2008) approach, in order to test whether risk preferences affect coordination behavior in *PBC* as predicted by our theory. In part 3, subject had to choose one of the following lotteries:

**Table 3.** Lotteries Choices Used to Elicit Risk Preferences

| Lottery | 50% | 50% | EV | Risk Preference |
|---|---|---|---|---|
| 1 | 4.00 | 4.00 | 4.00 | RA |
| 2 | 3.50 | 5.00 | 4.25 | RA |
| 3 | 3.00 | 6.00 | 4.50 | RA |
| 4 | 2.50 | 7.00 | 4.75 | RA |
| 5 | 2.00 | 8.00 | 5.00 | RA |
| 6 | 1.50 | 9.00 | 5.25 | RA |
| 7 | 1.00 | 10.00 | 5.50 | RA / RN |
| 8 | 0.50 | 10.50 | 5.50 | RN / RS |

*Notes:* EV = expected value; RA = risk averse; RN = risk neutral; RS = risk seeking. In the experiment, subjects only see the first three columns.

At the end session, one of the three parts was drawn by chance to determine the payment. If part 1 or part 2 were drawn, then one item within that part was drawn by chance and it determined the payment of a subject. If part 3 was drawn, then subjects actually played the lottery that they chose.

*3.2. Procedure*

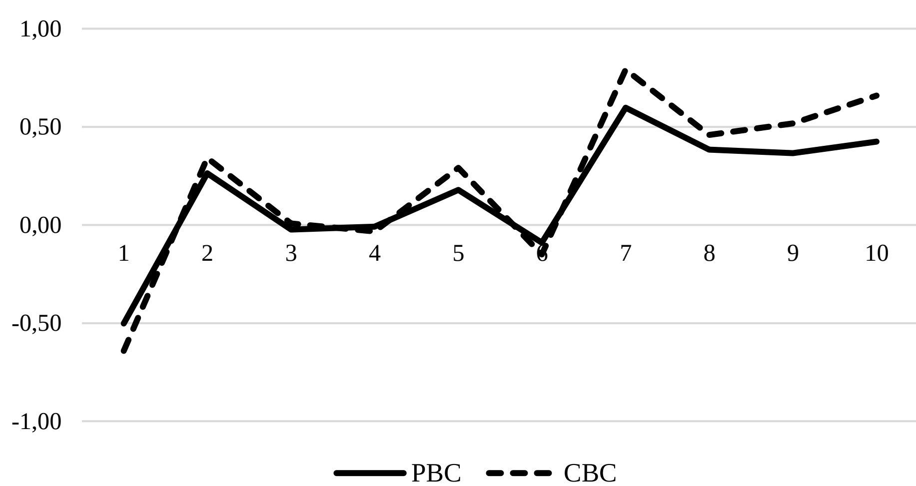
The experiment was programmed in ztree (Fischbacher, 2007) and recruitment was done via hroot (Bock et al., 2014). In total, 158 subjects participated and the sessions were conducted at the experimental lab of Heidelberg University in January and February 2018. We conducted 8 sessions, each with 20 participants (except for one session with 18 participants in *PBC*). 80 subjects participated in the *CBC* and 78 participated in the *PBC*. Participation in either treatment took about 30 minutes and subjects earned on average €9.40 (including a including a show-up fee of €5).

## 4. Results

*4.1. Comparison of Coordination Results*

To analyze coordination results, we quantify choices for injunctive norms (descriptive norms) by assigning a score of 1 for “very appropriate” (“large majority”), 1/3 for “somewhat inappropriate” (“majority”), -1/3 for “somewhat inappropriate” (“minority”) and -1 for “very inappropriate” (“small minority”). Thereby, the choices are normalized between -1 and 1. Figure 1 shows comparison of mean choices between *CBC* and *PBC*. Using t-tests to identify differences between treatments, we find that four items differ on the 5%-level when no correction for multiple testing is conducted (items 1, 7, 9 and 10). When accounting for the inflation of the overall type-I-error rate using the Holm-Bonferroni method (Holm, 1979), differences in two items remain significant (items 9 and 10).

**Figure 1.** Comparison of Coordination Results




*Notes:* Items 1 to 5 are injunctive social norms, items 6-10 are descriptive social norms.

We next compare ordinal rankings (table 4). That is, in the *CBC* alternatives are ranked with regard to the share of subjects that chose a particular alternative. In the *PBC*, alternatives are ranked based on average point assignments. We do not find that the rankings systematically differ. Precisely, the rankings produced by *CBC* and *PBC* correspond in eight of the ten items. In two items (4 and 10), we find that the rankings do marginally differ, as the order of two of the four alternatives is switched. These differences, however, seem to result from noise, as the alternatives that do not correspond are extremely close to one another.[3]

**Table 4.** Comparison of Rankings of Alternatives

| | Point Beauty Contest | | | | | Classical Beauty Contest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | + + | + | - | - - | Mean | + + | + | - | - - | Mean | Ranks identical |
| 1 | 6 | 13 | 29 | 51 | -0,50 | 1 | 5 | 40 | 54 | -0,64 | ✓ |
| 2 | 27 | 42 | 22 | 8 | 0,26 | 15 | 73 | 11 | 1 | 0,34 | ✓ |
| 3 | 14 | 32 | 40 | 14 | -0,02 | 11 | 33 | 53 | 4 | 0,01 | ✓ |
| 4 | (19) | 28 | 35 | (17) | -0,01 | (13) | 34 | 40 | (14) | -0,03 | x |
| 5 | 22 | 42 | 27 | 9 | 0,18 | 25 | 45 | 29 | 1 | 0,29 | ✓ |
| 6 | 13 | 31 | 35 | 21 | -0,09 | 4 | 36 | 44 | 16 | -0,15 | ✓ |
| 7 | 58 | 28 | 10 | 4 | 0,60 | 75 | 20 | 4 | 1 | 0,79 | ✓ |
| 8 | 35 | 43 | 16 | 6 | 0,38 | 26 | 68 | 5 | 1 | 0,46 | ✓ |
| 9 | 37 | 38 | 18 | 7 | 0,37 | 43 | 44 | 13 | 1 | 0,52 | ✓ |
| 10 | (39) | (41) | 14 | 6 | 0,42 | (51) | (46) | 3 | 0 | 0,66 | x |

*Notes:* Items 1-5 are injunctive social norms, items 6-10 are descriptive social norms. For *PBC*, the numbers represent the average numbers of points that have been assigned to the respective alternatives. For *CBC*, the numbers represent the share (in percent) of subjects that chose the respective alternative. The means are calculated according to the above scoring. The numbers in brackets in item 4 and 10 indicate those numbers, where the ranking of alternatives is not identical between the two treatments.

**Result 1.** The coordination outcomes of *PBC* and *CBC* correspond on the aggregate level, both regarding means and rankings.

[3] In item 4, for example, in the *CBC* alternative 1 was chosen by 12.5% and alternative 4 by 13.8%. By contrast, in the *PBC*, alternative 1 received 18.9 points on average and alternative 4 received 17.4 points on average. The two alternatives, however, seem to be equally popular in both treatments, and we therefore conclude that the differences regarding their ranking are not systematic.

*4.2. Coordination Behavior and the Role of Risk Preferences in the PBC*

We look at all 780 decisions made in *PBC* and classify whether subjects apply gambling, ranking or hedging. We observe almost no hedging (<0.1%), but some gambling (9.1%). In most of the decisions, subjects apply ranking, i.e. they assign varying numbers of points to the available alternatives (90.8%). Precisely, in 34.2% subjects fully rank their choices by assigning varying numbers of points to all four alternatives. In 53.2% subjects assign three different numbers to the four alternatives and in 3.3% subjects assign two different numbers to the four alternatives.

Our theoretical framework predicts that subjects "manage" the degree of payoff risk, such that it suits their risk preference. We find that the proportion of gambling is driven by participants with low or negative risk aversion. While the share of gambling decisions is 22.4% from subjects that chose lottery 7 or lottery 8, it is only 3.0% from participants that chose lottery 1-6. Moreover, we examine risk induced in coordination choice. Table 5 reports regression results on the standard deviation of the assignment of points. We find that behavior in the risk elicitastion task is significantly related to the standard deviation of the distribution of points. The more risk averse subjects are in the lottery choice, the flatter is the distribution of points, i.e. the lower the standard deviation implied in the coordination choice $X_i$. Also, older subjects are more prone to coordinate in a risky manner in the *PBC*, while a gender effect is observed only when not taking into account risk preferences.

**Table 5.** Risk Induced in Coordination Choice $X_i$

| | Standard deviation of points assigned to alternatives | | |
|---|---|---|---|
| Lottery | 1.830***<br>(0.480) | | 1.792***<br>(0.521) |
| Female | | -5.384***<br>(2.007) | -1.953<br>(1.985) |
| Age | | 0.569**<br>(0.231) | 0.658***<br>(0.186) |
| Economics | | 0.179<br>(0.460) | 0.420<br>(0.429) |
| Constant | 18.609***<br>(1.979) | 15.343***<br>(5.728) | 2.484<br>(5.780) |
| N | 780 | 780 | 780 |

*Notes:* Tobit regressions. *, **, *** indicates significance at the 10%, 5%, and 1% level. The variable "lottery" indicates which of the lotteries (1-8) a subject chose. The higher the number, the less risk averse is a subject. Robust standard errors are clustered on the individual level and reported in parentheses.

**Result 2.** In the *PBC*, most of the subjects rank their alternatives to some degree, by assigning different numbers to the available alternatives. The more risk averse subjects are, the less dispersed is the assignment of points.

## 5. Simulation

We run Monte Carlo simulations in order to test which of the techniques uncovers the underlying ranking more efficiently (i.e. with fewer observations). We consider the realized coordination outcomes from the 78 subjects in *PBC* and the 80 subjects in *CBC* as benchmark (i.e. the results described in section 4.1.). We then run Monte Carlo simulations and mimic our original experiment with varying numbers of *n* participants, with $n = 1, \ldots, 100$. Each *n* is simulated 10.000 times both for the *CBC* and the *PBC*. We then use the simulated data to study how fast the simulated results converge to the benchmark when *n* grows larger. The degree of convergence is measured using convergence of the mean[4] and convergence of the ordinal ranking of the alternatives. Convergence of the mean is measured as realized confidence intervals (50% and 90%) of the simulation means. Convergence of ordinal rankings is measured as the share of simulated items, in which the ordinal ranking corresponds to the benchmark. The more efficient the mechanism, the faster should confidence intervals for means decline and the faster should the share of simulated items rise, in which the ordinal ranking produced by the simulation is identical with the benchmark, when *n* increases. Holding a particular *n* constant thus allows us to compare the efficiency of *PBC* and *CBC*.

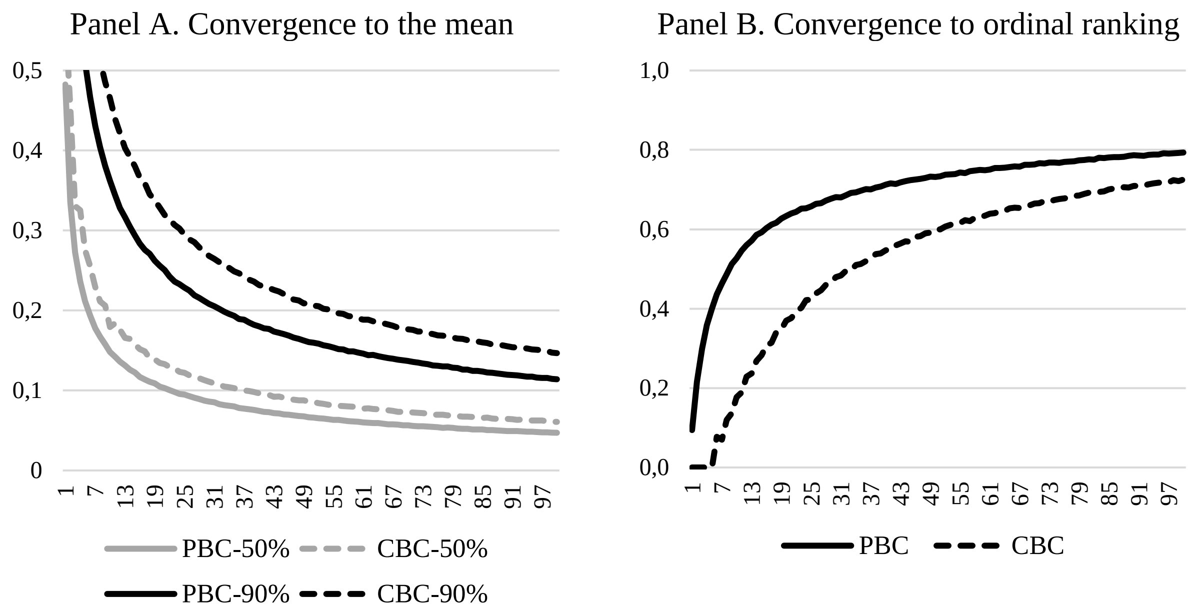
The simulation results show that in the *PBC* the examined confidence intervals are lower for each *n* in either of the 10 items (figure 2 shows the average of all 10 items, in the appendix the reader finds figures of simulations results separately for each item). That is, the precision with which the mean is approached when the number of participants increases is higher for the *PBC* for each size of *n*. Regarding convergence to the ordinal rankings, the *PBC* converges faster to the underlying ranking in 9 of the 10 items, while in one item the *CBC* converges faster.

The efficiency gains are particularly strong for ordinary numbers of participants used in economic experiments. For example, both the 90%-confidence and the 50%-confidence intervals for the mean that are realized in the *CBC* with $n=50$ participants are reached in the *PBC* with $n=30$ participants already. The share of ordinal rankings that corresponds to the benchmark that are produced in the *CBC* with $n=50$

[4] To derive the mean we use the same scoring system as in the results section. That is, the ratings are normalized between -1 and 1.

is reached in the *PBC* already with *n=16*. This indicates that the *PBC* is more efficient as an experimental method, in particular regarding the elicitation of ordinal rankings of focal points.

**Figure 2.** Simulation Results




*Notes:* The x-axis of both graphs indicates the *n*, i.e. the number of participants with which the simulation is conducted. The left figure shows confidence intervals of means. The right figure shows the share of simulation runs in which the ordinal ranking of a simulation run corresponds with the ranking of the benchmark. Both figures contain the data of 100.000 simulation runs (10.000 simulation runs for each of the ten items).

**Result 3.** The *PBC* is significantly more efficient than the *CBC* in identifying the means and the ordinal rankings of coordination choices on the group level.

## 6. Concluding Remarks

We propose a point beauty contest to identify the ranking of focal points in coordination games on the individual level. By contrast to conventional coordination where subjects can only bet on one choice, subjects are endowed with points, which they assign to the available alternatives. This enables the subjects to bet on multiple outcome and to weigh their choices. We examine the proposed method both theoretically and experimentally, and find that it is suited to identify the heterogeneity of focal points on the individual level, as most of the subjects assign varying numbers of points to the different alternatives. Moreover, using Monte Carlo simulations, we find the mechanism to be more efficient regarding the identification of focal points on the group level.

We see several fields of application for the proposed method. First, the mechanism is useful when an experimenter is interested to study more precisely the heterogeneity of beliefs in coordination games. Second, the mechanism might be useful when an experimenter is interested in the identification of focal points on the group level, but when the number of participants is limited. As shown in the section 5, the point beauty contest yields results that are as precise as the results from ordinary coordination with substantially fewer subjects. Third, the point beauty contest might serve as a simple and direct tool to measure strategic uncertainty in coordination games, as the assignment of points depends on the risk preferences and the degree of strategic uncertainty that the subjects perceives. Controlling for risk preferences would thus allow to isolate the degree of strategic uncertainty on the individual level. For example, Heinemann et al. (2009) propose to measure strategic uncertainty by eliciting certainty equivalents and identify the payment that renders a subject indifferent between the certain payoff and an uncertain payoff that is subject to strategic uncertainty. Our approach would facilitate the elicitation of uncertainty in strategic settings, as the assignment of points in the point beauty contest yields a measure that is directly related to that kind of uncertainty, and it can easily be isolated when controlling for risk preferences.

**References**

Binmore, K., & Samuelson, L. (2006). The evolution of focal points. *Games and Economic Behavior*, *55*(1), 21-42.

Bock, O., Baetge, I., & Nicklisch, A. (2014). hroot: Hamburg registration and organization online tool. *European Economic Review*, *71*, 117-120.

Casajus, A. (2000). Focal points in framed strategic forms. *Games and Economic Behavior*, *32*(2), 263-291.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*(6), 1015.

Crawford, V. P., Gneezy, U., & Rottenstreich, Y. (2008). The power of focal points is limited: Even minute payoff asymmetry may yield large coordination failures. *American Economic Review*, *98*(4), 1443-58.

Crawford, S. E., & Ostrom, E. (1995). A grammar of institutions. *American Political Science Review*, *89*(3), 582-600.

Eckel, C. C., & Grossman, P. J. (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior & Organization*, *68*(1), 1-17.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental economics*, *10*(2), 171-178.

Heinemann, F., Nagel, R., & Ockenfels, P. (2009). Measuring strategic uncertainty in coordination games. *The Review of Economic Studies*, *76*(1), 181-221.

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, 65-70.

Isoni, A., Poulsen, A., Sugden, R., & Tsutsui, K. (2013). Focal points in tacit bargaining problems: Experimental evidence. *European Economic Review*, *59*, 167-188.

Isoni, A., Poulsen, A., Sugden, R., & Tsutsui, K. (2014). Efficiency, equality, and labeling: An experimental investigation of focal points in explicit bargaining. *American Economic Review*, *104*(10), 3256-87.

Isoni, A., Poulsen, A., Sugden, R., & Tsutsui, K. (2019). Focal points and payoff information in tacit bargaining. *Games and Economic Behavior*.

Janssen, M. C. (2001). Rationalizing focal points. *Theory and Decision*, *50*(2), 119-148.

Janssen, M. C. (2006). On the strategic use of focal points in bargaining situations. *Journal of Economic Psychology*, *27*(5), 622-634.

Keynes, J. M., 1936, The General Theory of Employment, Interest and Money, Macmillan, London.

Krupka, E. L., & Weber, R. A. (2013). Identifying social norms using coordination games: Why does dictator game sharing vary?. *Journal of the European Economic Association*, *11*(3), 495-524.

Luce, R. D., & Raiffa, H. (1957). Games & Decisions. John Willey & Sons. *Inc.*, *New York*.

Mehta, J., Starmer, C., & Sugden, R. (1992). An experimental investigation of focal points in coordination and bargaining: some preliminary results. In *Decision Making under Risk and Uncertainty* (pp. 211-219). Springer, Dordrecht.

Mehta, J., Starmer, C., & Sugden, R. (1994). The nature of salience: An experimental investigation of pure coordination games. *The American Economic Review*, *84*(3), 658-673.

Pope, D. G., Pope, J. C., & Sydnor, J. R. (2015). Focal points and bargaining in housing markets. *Games and Economic Behavior*, *93*, 89-107.

Schelling, Thomas C. 1960. The Strategy of Conflict. Cambridge: Harvard University Press.

Sugden, R., & Zamarrón, I. E. (2006). Finding the key: the riddle of focal points. *Journal of Economic Psychology*, *27*(5), 609-621.