University of Heidelberg

Department of Economics

Discussion Paper Series | No. 667

Point Beauty Contest: Measuring the Distribution of Focal Points on the Individual Level

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September 2019

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September 22, 2019

Abstract: We propose the Point Beauty Contest, a mechanism to identify the distribution of focal points on the individual level. By contrast to conventional coordination, subjects coordinate by the distribution of points. This allows for nuanced coordination strategies, as subjects can invest in multiple alternatives at the same time and weigh their choice. A subject´s strategy choice then reveals her perception of the distribution of focal points. In an experiment on the elicitation of social norms, we compare the mechanism with conventional coordination. The data confirms the theoretical predictions regarding coordination behavior and demonstrates that the proposed technique is suited to identify the distribution of focal points on the individual level. Using Monte Carlo simulations, we find that the proposed mechanism identifies focal points on the population level more efficiently than conventional coordination. We point to the possibility of using the mechanism as a simple method to directly measure strategic uncertainty.

Highlights:

- A method to identify the distribution of focal points on the individual level is proposed
- In an experiment, the proposed method is compared to conventional coordination
- The data demonstrates that the technique reveals focal points on the individual level
- On the aggregate level, the proposed technique identifies focal points more efficiently

Keywords: coordination, focal points, games theory, strategic uncertainty, social norms
JEL Classifications: B41, C70, C91

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1. Introduction

Schelling (1960) argues that in coordination games with multiple equilibria, subjects perceive varying degrees of saliences regarding the available alternatives. This renders some of the equilibria more or less "focal" and constitutes an implicit coordination device.[1] Focal points are interesting not only because they help subjects 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 Schelling´s concept, focal points might be induced by prevalent beauty ideals within the guessers´ population. Capitalizing on the same mechanism, Krupka and Weber (2013) propose using coordination games to elicit social norm perception.[2]

In the described settings, however, subjects choose only *one* alternative. As a result, the coordination choice of a single participant only reveals which alternative she considers *most* focal. For example, a subject´s coordination choice in the Keynesian Beauty Contest reveals which picture the respondent considers most salient, but it is not identified which picture is ranked second or third. In order to analyze how one alternative relates to other alternatives in terms of focality and to determine a ranking, it is necessary to combine the choices of many participants.[3] Yet, such a ranking would only emerge on the *population* level, i.e., based on the choices of *many* participants. 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 the *Point Beauty Contest*, a method that allows eliciting the ranking of focal points on the individual level. The Point Beauty Contest allows participants to bet on multiple outcomes

[1] 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; Fehr et al., 2018; 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).

[2] In that approach, subjects are confronted with the description of a particular behavior and they have to coordinate on appropriateness ratings. The method assumes that social norms are constituted through shared perceptions (Crawford and Ostrom, 1995), which thereby determine the focality of alternatives. Consequently, subjects´ coordination choices reveal perceptions about prevailing social norms.

[3] The term *focality* is meant to represent the *degree* to which an alternative appears to be focal to a player.

and to weigh their choices. In contrast to conventional coordination, where subjects coordinate by choosing one alternative, subjects are equipped with a budget of points that they can distribute among multiple alternatives. Like in conventional 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 ranking of focal points on the level of a *single participant*.

Fine-grained coordination is present in many real-world coordination settings. In a bank run, for example, depositors might not only think about withdrawing *none* of their money or *all* of their money from a bank. Instead, due to a conflict of pecuniary incentives (play withdrawal) and social preferences (play no withdrawal), a subject might want to engage in both strategies simultaneously. The proposed mechanism captures two aspects of such a setting. First, subjects can invest in multiple alternatives in a coordination setting. Second, accordingly, the coordination outcome not only depends on the number of subjects choosing a particular alternative, but also on the *weights* that are put on the alternatives. Thus, the Point Beauty Contest provides a framework that reflects the interaction between subjects when nuanced strategy choices are feasible.[4]

We analyze the Point Beauty Contest both theoretically and experimentally. In the theoretical part, we derive predictions for coordination behavior that depend 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. On the aggregate level, we find that the coordination outcomes correspond, i.e., the average ranking produced by the Point Beauty Contest matches the ranking elicited using the conventional approach. Looking at the choices on the subject level confirms the theoretical predictions 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 on the population level more efficiently, as it yields a given level of precision about the underlying distribution with significantly fewer subjects.

[4] Note that such kind of nuanced strategies conceptually differ from mixed strategies, where subjects assign probabilities to every pure strategy. Instead, in the Point Beauty Contest, subjects engage in multiple strategies at the same point in time.

We see several fields of application for the Point Beauty Contest. First, the mechanism is suited to reflect coordination settings where fine-grained coordination is feasible. This allows to study coordination behavior when subjects opt for nuanced coordination strategies that involve engagement in multiple alternatives. Second, the mechanism allows to uncover the distribution of focal points in coordination games on the individual level. That is, subjects not only reveal the most salient alternative in a coordination setting but reveal their ranking of saliences. Third, the mechanism is useful when an experimenter is interested in the identification of focal points on the population level with fewer resources since the Point Beauty Contest yields results that are as precise as the results from conventional coordination with substantially fewer subjects.

The Point Beauty Contest also contributes to the elicitation of social norms using coordination games. As Krupka and Weber (2013) state, their results show that "a social norm is not always a single action that should or should not be taken, but rather a profile of varying degrees of social appropriateness for different available actions".[5] Social norms as such a profile can only be detected on the population level with conventional coordination, while the Point Beauty Contests elicits such profile of social norm perception on the subject level.

Finally, the Point Beauty Contest serves 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 perceive. Controlling for risk preferences thus allows isolating 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 subject´s behavior (i.e., the distribution of points) reflects a direct measure for that kind of uncertainty.

The remainder of the paper is organized as follows. Section 2 contains the theoretical framework to derive predictions for coordination behavior. Section 3 presents the experiment and section 4 the experimental results. Section 5 contains simulations results on efficiency measurement. Section 6 summarizes and concludes.

[5] See the abstract of Krupka and Weber (2013).

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 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 $X_i = (x_{i1}, \dots, x_{im})$ as a subject´s coordination choice. After all subjects decided about 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^*. If more than one alternative received the maximum number of points, j^* is determined randomly among these alternatives.[6] Finally, each participant receives a payoff π_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 $\Phi_i = (\varphi_{i1}, \dots, \varphi_{im})$ determines a subject´s ranking of focalities. A subject´s Φ_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 Φ_i, a subject derives beliefs p_{ij} which reflect the probability that alternative j becomes the winning alternative j^*. Specifically, stronger focality 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 $P_i = (p_{i1}, \dots, p_{im})$, with $\sum_{j=1}^{m} p_{ij} = 1$, is the perceived probability distribution about the coordination outcome of an individual i.[7] The

[6] 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.

[7] We assume that subjects perceive the probabilities to be exogenous, i.e., they do not strategically assign points in an attempt to influence the probability distribution. This assumption is adequate when the number of participants is sufficiently large.

translation of focalities into actual probabilities allows viewing the agent´s 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 some k and l. A subject is *fully uncertain* if she is clueless concerning the outcome of the game: $p_{ij} = 1/m$ for all j.

Accordingly, we say that a subject is *gambling* if she assigns all points to one alternative: $x_{ij} = X$ for some j. A subject is *ranking* if she assigns more points to one alternative k than to another alternative l: $0 < x_{il} < x_{ik} < X$. A subject is *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 Φ_i. That is, subjects are *gambling* in case of *certainty*, they are *ranking* in case of *partial uncertainty*, and they are *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.[8]

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 she considers more focal.

Proof. See Appendix A.2.

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 cases where a subject's coordination choice fully reflects her beliefs.

3. Experiment

3.1. Design

We experimentally test our predictions by applying the Point Beauty Contest to elicit social norm perception. The idea 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 they are provided with different answer alternatives to evaluate that behavior (e.g., "very appropriate", "somewhat appropriate", "somewhat inappropriate", "very inappropriate"). The subjects´ task is to choose the answer of which they think the majority of participants would choose it. That approach is equivalent to the classical Keynesian Beauty Contest, in which it is not optimal for subjects to state their own opinion, but to anticipate the modal choice of the group. We compare their method, where subjects can only bet on one alternative, with our approach, where subjects can bet on multiple alternatives and weigh their choices. Note that the elicitation of social norm perception is just one context to

[8] This also holds in a game with more than two alternatives, because the predictions apply to all pairwise comparisons of alternatives.

test the proposed mechanism. Any experimental setting, in which participants coordinate, would be suited for an experimental test.

We conduct two treatments: *Classical Beauty Contest (CBC)* and *Point Beauty Contest (PBC)*. In both treatments, we elicit 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 2 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 unfairly a person of which one has been treated unfairly 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 are confronted with a particular item and they are asked, how they evaluate the respective behavior regarding its appropriateness. Subjects then have to coordinate on the answer options: “very appropriate”, “somewhat appropriate”, “somewhat inappropriate”, “very inappropriate”. For the elicitation of descriptive social norms, subjects are confronted with a particular item, and they are then asked how many people would engage in the described behavior. Subjects then coordinate on the answer options: “a large majority”, “a majority”, “a minority”, “a small minority”.

In *CBC*, we employ conventional coordination, as done by Krupka and Weber (2013). That is, for each item, a subject receives 10€ if she manages to pick the answer alternative that is chosen by the majority of the respondents in the session (and zero otherwise). In the *PBC*, subjects are endowed with 100 points in each item, and their task is to distribute the 100 points between the available alternatives. In each item, subjects gain 0.10€ for each point that they assign to the *winning alternative*, i.e., the alternative that receives most points on average. Therefore, the payoff profile of *CBC* is also feasible in *PBC*, since assigning all 100 points to one alternative in *PBC* is equivalent to *CBC* in payoff terms.

In both treatments, subjects receive detailed instructions on the coordination mechanisms in parts 1 and 2 and about how their payment is determined. Specifically, subjects are provided with several examples to illustrate how their payment is calculated depending on their behavior and the behavior of others. Subjects answer several control questions in which they compute profits in a series of hypothetical scenarios. In particular, we pay attention to make clear that subjects are not asked about their own opinion. To make sure that subjects consider this feature, we remind them on each screen, on which they enter a coordination choice, that their task is not to state their own opinion but to coordinate with the remaining participants in the room.

Finally, in part 3, we elicit 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, subjects have to choose one of the lotteries from the menu shown in Table 3.

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 is drawn by chance to determine the payment. If part 1 or part 2 are drawn, then one item within that part is drawn by chance, and it determined the payment of a subject. If part 3 is drawn, then subjects play the lottery that they previously chose.

3.2. Procedure

The experiment was programmed in z-Tree (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 35 minutes, and subjects earned on average 9.40€ (including a show-up fee of 5€).

4. Results

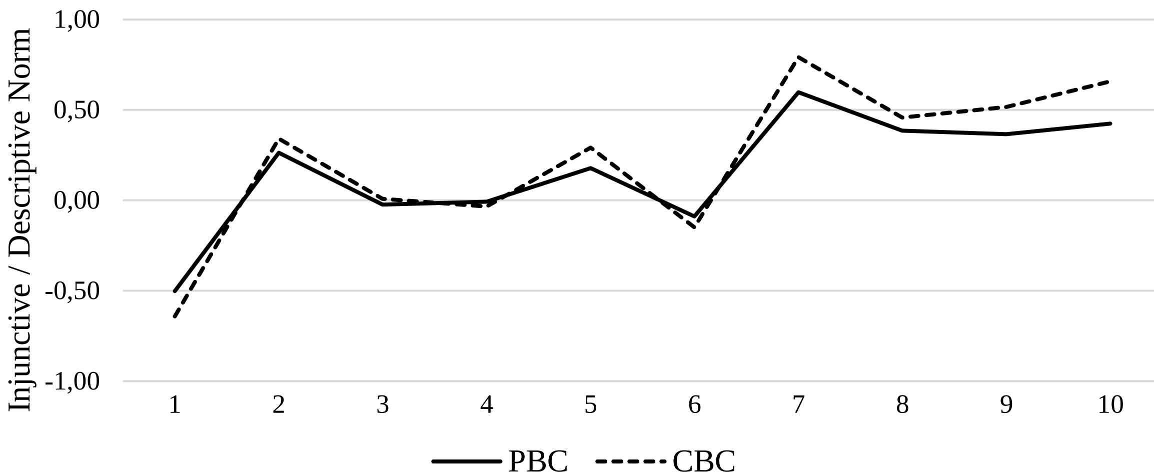
4.1. Comparison of Coordination Outcomes

To analyze coordination choices, we quantify the answers such that the resulting scores are normalized between -1 and 1. Injunctive social norms are quantified as: 1 = " very appropriate", 1/3 = "somewhat appropriate", -1/3 = "somewhat inappropriate", -1 = "very inappropriate". Descriptive social norms are quantified as: 1 = "a large majority", 1/3 = "a majority", -1/3 = "a minority", -1 = "a small minority". Thus, the more positive (negative) the score in part 1, the more appropriate (inappropriate) it is considered to engage in the described behavior. The more positive (negative) the score in module 2, the more common the described behavior is considered to be.

Figure 1 shows a comparison of mean norms elicited in *CBC* and *PBC*. Mann-Whitney-U tests are conducted to test whether mean outcomes differ between the treatments. We find that four items differ on the 5%-level (items 1, 7, 9, and 10). After correcting for multiple testing using the Bonferroni procedure, three items remain significant on the 5%-level (items 1, 7, and 10).[9] Generally, the results in *PBC* tend to be somewhat flatter than the results in *CBC*.

[9] We account for the fact that multiple items are used to detect treatment differences. In order to take care of the inflation of the overall type-I-error rate, we multiply the *p*-values by the number of items (i.e., by ten).

Figure 1. Comparison of Mean Coordination Results



Notes: Items 1 to 5 are injunctive norms from part 1, and items 6-10 are descriptive norms from part 2. The more positive (negative) the score in items 1-5, the more appropriate (inappropriate) it is considered to engage in the described behavior. The more positive (negative) the score in items 6-10, the more common the described behavior is considered to be.

We next compare ordinal rankings (Table 4). In *CBC*, alternatives in each item are ranked with respect to the share of subjects that chose a particular alternative. In *PBC*, alternatives in each item are ranked with respect to the average number of points assigned to the alternatives. 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.[10]

Result 1. One the aggregate level, the coordination outcomes of *PBC* and *CBC* do not differ.

[10] For example, in item 4, in the *CBC* alternative 1 is 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. That is, in the *CBC*, alternative 4 is more popular, while in the *PBC*, alternative 1 is more popular. From a qualitative point of view, however, the two alternatives seem to be equally popular in both treatments. We therefore conclude that the differences concerning their ranking are not systematic, but result from noise.

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, and items 6-10 are descriptive social norms. Responses are: "very appropriate" (+ +), "somewhat appropriate" (+), "somewhat inappropriate" (-), "very inappropriate" (- -) in items 1-5 and "large majority" (+ +), "majority" (+), "minority" (-), "small minority" (- -) in items 6-10. 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 modal response is shaded. Means are calculated using the above-described scoring. The numbers in parentheses in items 4 and 10 indicate those numbers, where the ranking of alternatives is not identical between the two treatments.

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

We look at all 780 decisions made in *PBC* (78 participants times 10 items per subject) and classify whether subjects apply gambling, ranking, or hedging. We observe almost no hedging (less than 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%). More precisely, in 34.2% of cases, subjects fully rank their choices by assigning varying numbers of points to all four alternatives. In 53.4% of cases, subjects assign three different numbers to the four alternatives, and in 3.3% of cases, 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. Indeed, we find that the proportion of gambling is over-proportionally high in 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 (i.e., subjects that are potentially risk-neutral or risk-seeking as measured by the lottery task), it is only 3.0% from participants that chose lottery 1-6 (subjects that are clearly risk-averse as measured by the lottery task). 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 elicitation task is significantly related to the standard deviation of the distribution of points. The more risk-averse subjects are in the lottery choice, the more balanced 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*. By contrast, gender and economics study remain insignificant, once we control for risk-attitude.

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.

Table 5. Risk Induced in Coordination Choice X_i

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

Notes: Tobit regressions. *, **, *** indicates significance at the 10%, 5%, and 1% level. The variable "risk attitude" indicates which of the lotteries (coded as number between 1 and 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. As a robustness check, OLS regressions are conducted that yield the same results.

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, …, 100*. For each of the ten items, 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 and convergence of the ordinal ranking of the alternatives.[11] Convergence of the mean is measured as realized confidence intervals (50% and 90%) of the simulated 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 smaller should the confidence intervals of means become when *n* grows larger. Equivalently, the more efficient the mechanism, the higher should be the share of simulated items 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 degree of efficiency between *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 (see Figure 2).[12] 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.

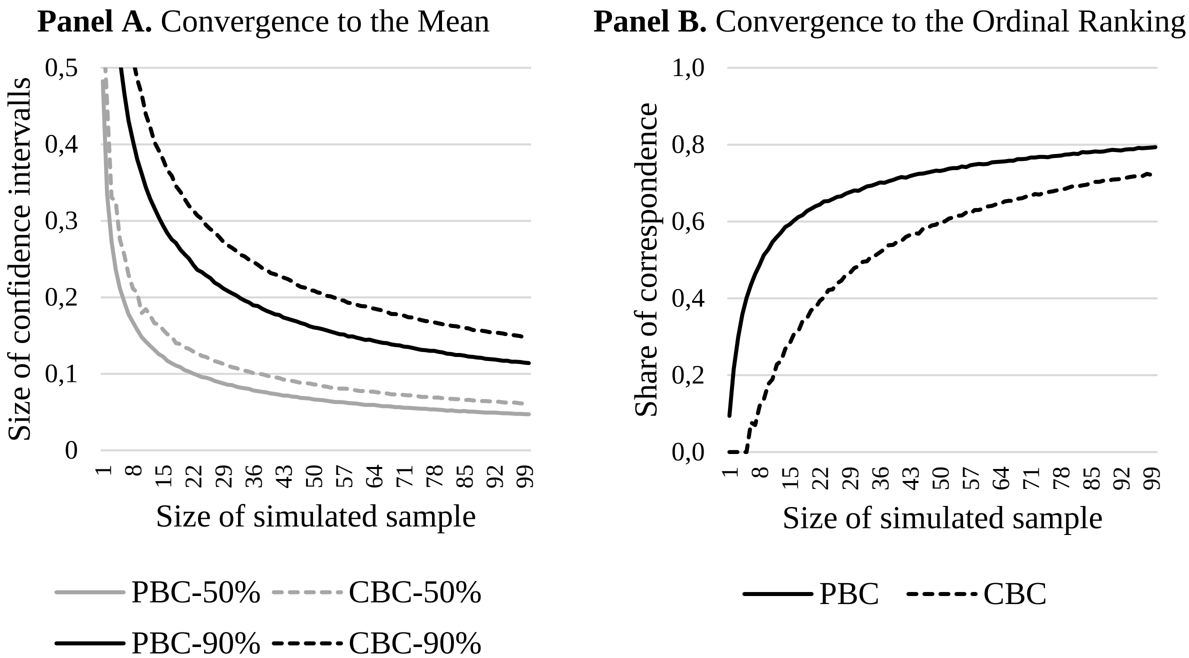
The efficiency gains are particularly strong for the usual numbers of participants used in economic experiments. For example, both the 90%-confidence and the 50%-confidence intervals for the mean that are realized in the *CBC* with *n* = 50 participants are reached in the *PBC* with *n* = 30 participants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

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

[11] 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.

[12] Figure 2 shows the average of all 10 items. In Appendix A.1 the reader finds figures of simulations results separately for each item.

Figure 2. Simulation Results



Notes: The x-axis of both graphs indicates the *n*, i.e., the number of participants that is being simulated. Panel A shows confidence intervals of means. Panel B shows the share of simulation runs in which the ordinal ranking of a simulation run corresponds with the ranking of the benchmark. Both graphs contain the data of 100.000 simulation runs (10.000 simulation runs for each of the ten items). Appendix A.1 contains graphs of simulations separately for each item.

6. Summary and Conclusion

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 alternative, subjects are endowed with points, which they assign to the available alternatives. This enables subjects to bet on multiple outcomes and to weigh their choices. We examine the proposed method both theoretically and experimentally. In the theoretical part, we derive that the assignment of points depends on strategic uncertainty and risk preferences. In an experiment, we find that the mechanism 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. Using Monte Carlo simulations, we find the mechanism to be more efficient regarding the identification of focal points on the population level.

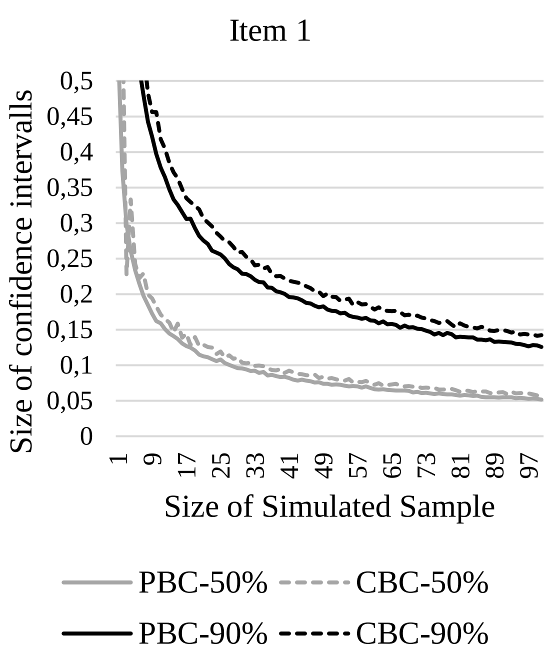
We see four contributions. First, the Point Beauty Contest provides a framework to formally represent coordination settings in which subjects do not coordinate by exclusively choosing one alternative, but in which subjects coordinate in a fine-grained manner by choosing multiple alternatives at the same time. Second, the mechanism allows to uncover the distribution of focal points in coordination games on the individual level. This allows, for example, to measure social norms on the individual level as a profile, i.e., varying degrees of social appropriateness for different available actions (cf. Krupka and Weber, 2013). Third, it provides a possibility to measure focal points on the population level with significantly fewer participants compared to conventional coordination. Fourth, the Point Beauty Contest serves as a simple and direct tool to measure strategic uncertainty in coordination settings (Heinemann et al., 2009), as the assignment of points in the Point Beauty Contest yields a measure that is directly related to that kind of uncertainty.

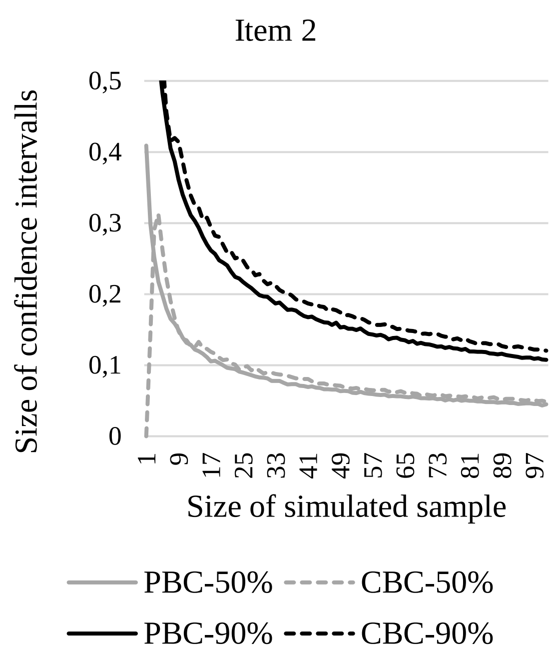
Appendix

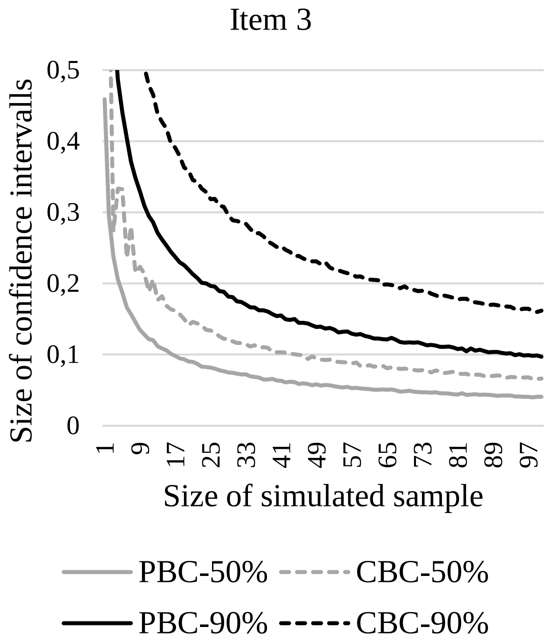
A.1. Simulation Results for each Item

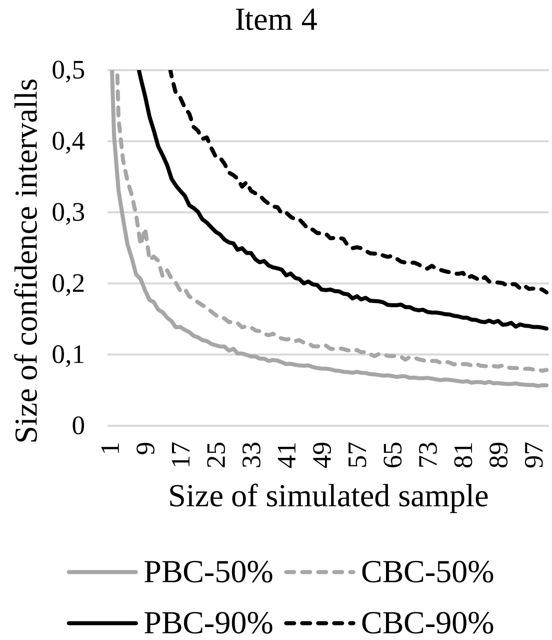
The graphs show simulation results separately for each of the ten items. Each simulation contains 10.000 runs using the Monte Carlo approach.

A.1.1. Convergence to the Mean






Item 3
0,5
0,4
0,3
0,2
0,1
0
Size of confidence intervalls
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50%
CBC-50%
PBC-90%
CBC-90%


Item 4
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0,4
0,3
0,2
0,1
0
Size of confidence intervalls
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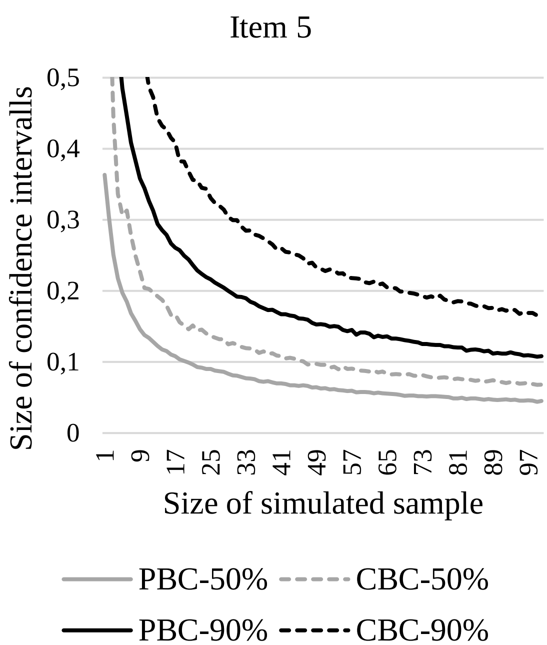
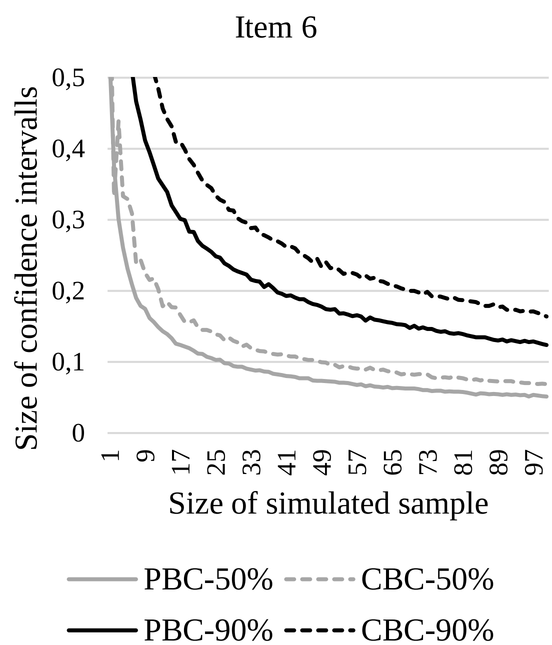
Size of simulated sample
PBC-50%
CBC-50%
PBC-90%
CBC-90%


Item 5
0,5
0,4
0,3
0,2
0,1
0
Size of confidence intervalls
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50%
CBC-50%
PBC-90%
CBC-90%


Item 6
0,5
0,4
0,3
0,2
0,1
0
Size of confidence intervalls
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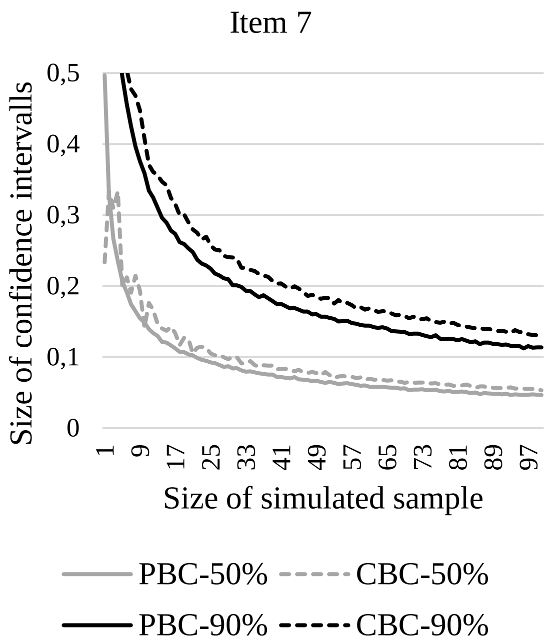
Size of simulated sample
PBC-50%
CBC-50%
PBC-90%
CBC-90%


Item 7
Size of confidence intervalls
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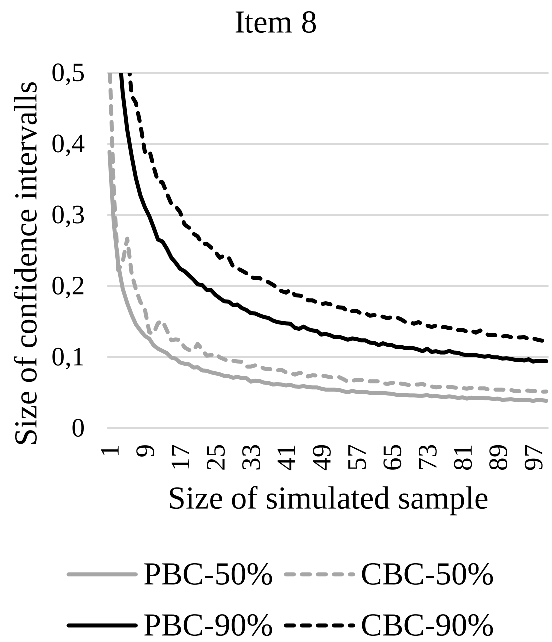
0,4
0,3
0,2
0,1
0
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50% CBC-50%
PBC-90% CBC-90%


Item 8
Size of confidence intervalls
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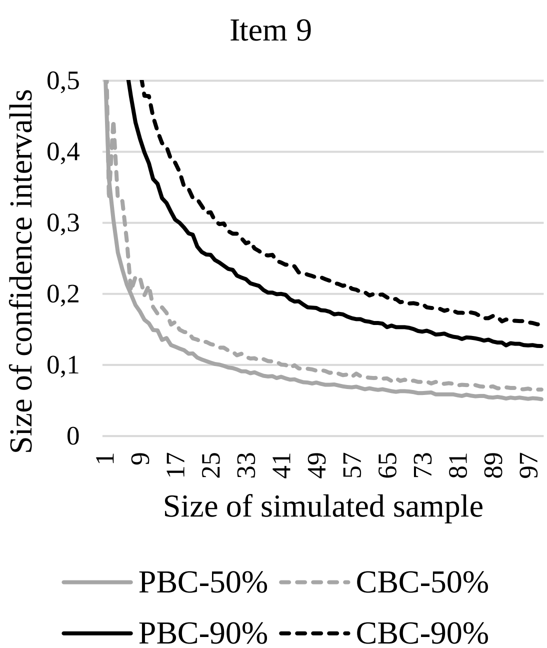
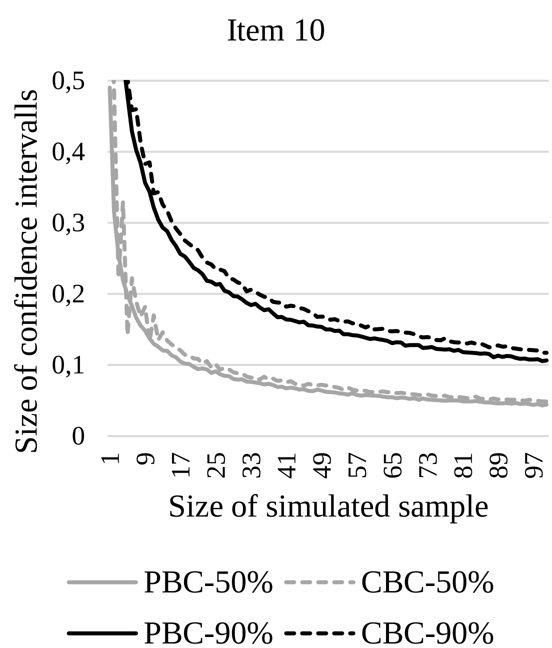
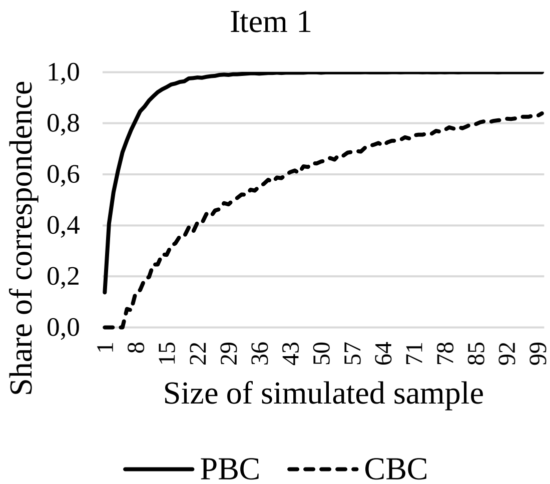
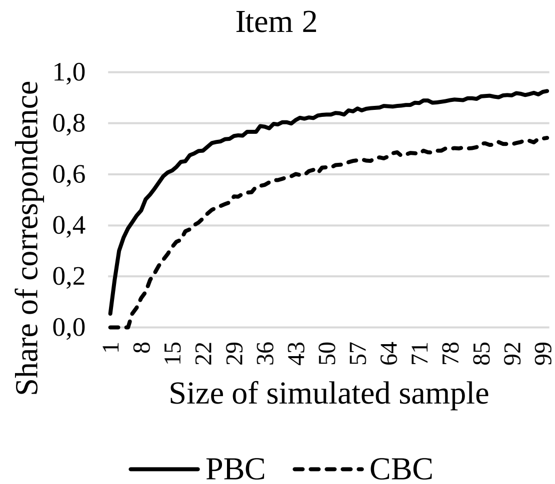
0,4
0,3
0,2
0,1
0
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50% CBC-50%
PBC-90% CBC-90%

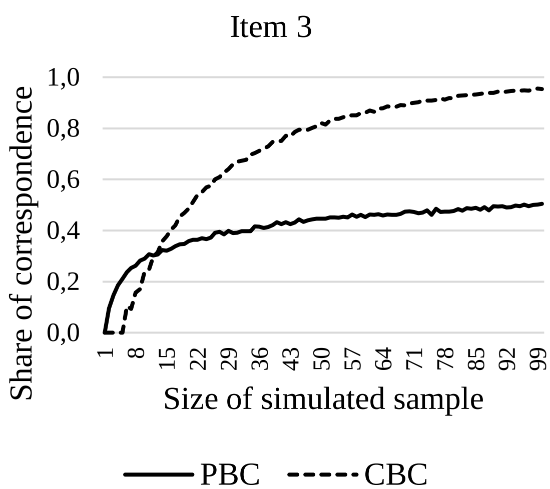

Item 9
Size of confidence intervalls
0,5
0,4
0,3
0,2
0,1
0
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50% CBC-50%
PBC-90% CBC-90%

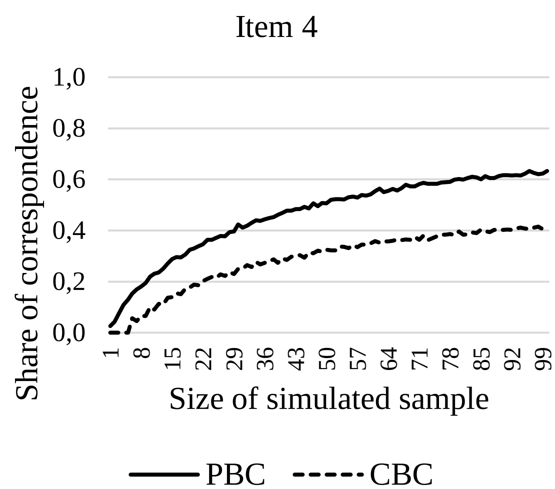

Item 10
Size of confidence intervalls
0,5
0,4
0,3
0,2
0,1
0
1 9 17 25 33 41 49 57 65 73 81 89 97
Size of simulated sample
PBC-50% CBC-50%
PBC-90% CBC-90%

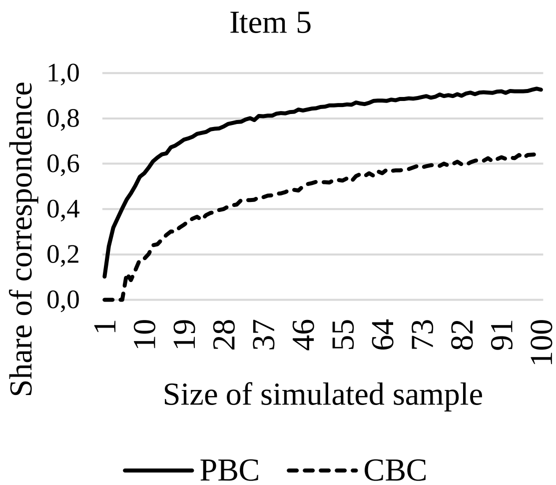
A.1.2. Convergence to the Ordinal Ranking










Item 5
Share of correspondence
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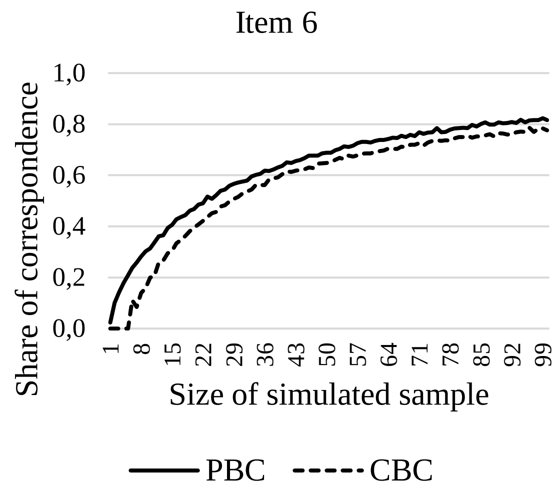
0,8
0,6
0,4
0,2
0,0
1 10 19 28 37 46 55 64 73 82 91 100
Size of simulated sample
PBC
CBC


Item 6
Share of correspondence
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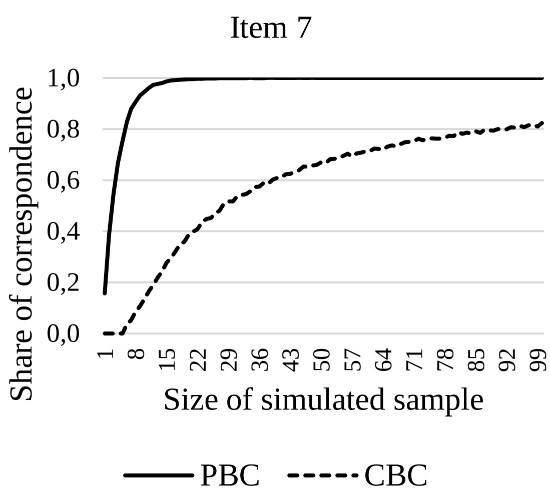
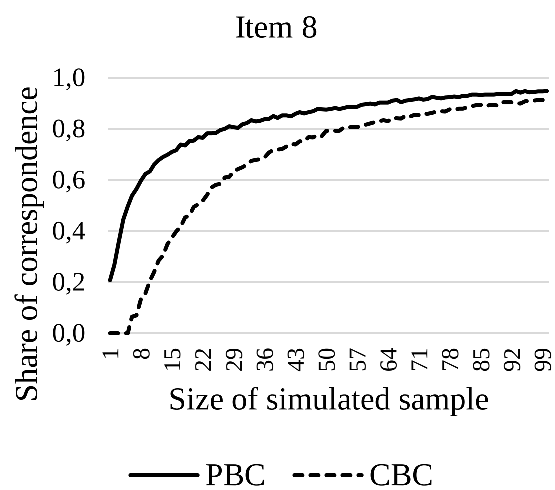
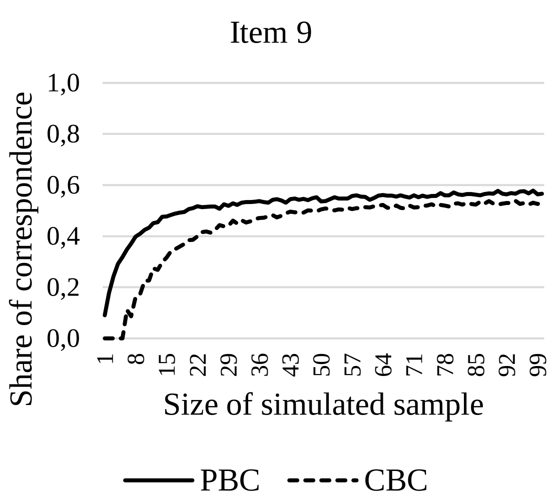
0,6
0,4
0,2
0,0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99
Size of simulated sample
PBC
CBC


Item 7
Share of correspondence
1,0
0,8
0,6
0,4
0,2
0,0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99
Size of simulated sample
PBC
CBC


Item 8
Share of correspondence
1,0
0,8
0,6
0,4
0,2
0,0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99
Size of simulated sample
PBC
CBC


Item 9
Share of correspondence
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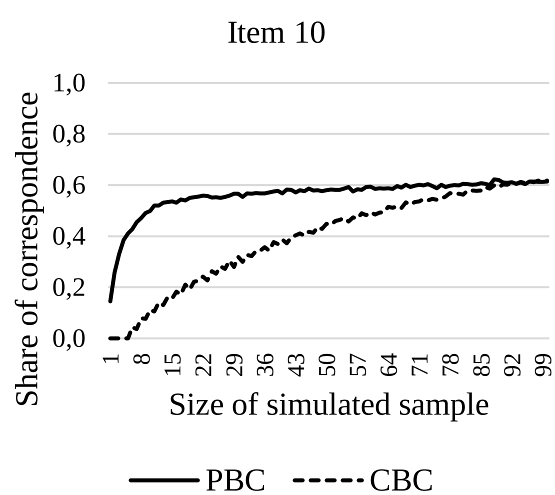
0,8
0,6
0,4
0,2
0,0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99
Size of simulated sample
PBC
CBC


Item 10
Share of correspondence
1,0
0,8
0,6
0,4
0,2
0,0
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99
Size of simulated sample
PBC
CBC

A.2. Proof of Proposition 1

We suppress the script i from now on and analyze a representative individual. If $\pi = x_j^*$, profit equals the number of points assigned to j^*. The utility function in that case is $U = \sum_{j=1}^{m} p_j * u(x_j)$.

Risk aversion. Take two arbitrary alternatives k and l. We assume that $\varphi_k > \varphi_l \Leftrightarrow p_k > p_l$. First-order conditions require that $p_k * u'(x_k) \equiv p_l * u'(x_l)$. If $p_k > p_l$, then it needs to be that $u'(x_k) < u'(x_l)$. Since utility is marginally decreasing in case of risk aversion, it needs to be that $x_k > x_l$. As a result, for each comparison of two arbitrary alternatives and independent from strategic uncertainty, utility maximization requires to assign more points to alternatives that are more focal: $\varphi_{ik} > \varphi_{il} \Leftrightarrow x_{ik} > x_{il}$.

Risk-neutrality. Take two arbitrary alternatives k and l. In case of "certainty", it is the dominant strategy to assign all points to the alternative that is expected to become the winning alternative with certainty. The same reasoning applies to a subject that perceives "partial uncertainty", i.e., assigning all points to the more promising alternative is dominant. Risk-neutral subjects that face "full uncertainty" are indifferent between all possible distributions of points, since they can neither control expected profit nor can they manipulate payoff.

Risk-seeking. Take two arbitrary alternatives k and l. In case of "certainty", it is the dominant strategy to assign all points to the alternative that is expected to become the winning alternative with certainty. This maximizes the expected payoff, while risk cannot be controlled for anyway in case of certainty. The same reasoning applies to a subject that perceives "partial uncertainty". In case of full uncertainty, risk-seeking subjects will invest all points into a random alternative. Although they cannot control expected payoff in case of full uncertainty, gambling will maximize risk, thus maximizing utility.

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