University of Southampton School of Social Sciences

Economics Division
University of Southampton
Southampton SO17 1BJ, UK

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By : Christos A. Ioannou (University of Southampton), Miltiadis Makris (University of Southampton)

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An Experimental Study Of Uncertainty In Coordination Games

Christos A. Ioannou *

University of Southampton

Miltiadis Makris †

University of Southampton

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Abstract

Global games and Poisson games have been proposed to address equilibrium indeterminacy in Coordination games. The former assume that agents face idiosyncratic uncertainty about economic fundamentals, whereas the latter, following Myerson (2000), model the number of actual players as a Poisson random variable to capture population uncertainty in large games. Given that their predictions differ, it is imperative to understand which type of uncertainty drives behavior, if any. Recent experimental literature finds that inexperienced (in the sense of limited game-play) subjects' behavior is similar in Global and Common Knowledge Coordination games, thus casting doubts on whether idiosyncratic uncertainty about economic fundamentals is an important determinant of such behavior. We design an experiment to study the behavior of inexperienced subjects in Global, Poisson and Common Knowledge Coordination games. Our findings corroborate the above experimental literature. More importantly, they also suggest that uncertainty about the number of actual players in large games does influence inexperienced subjects' behavior. In addition, inexperienced subjects' behavior under such uncertainty is, in fact, consistent with the theoretical prediction of Poisson Coordination games.

*Mailing Address: Department of Economics, University of Southampton, Southampton, SO17 1BJ, United Kingdom. Email: c.ioannou@soton.ac.uk

†Mailing Address: Department of Economics, University of Southampton, Southampton, SO17 1BJ, United Kingdom. Email: m.makris@soton.ac.uk (Corresponding Author)

1 Introduction

In many situations in macroeconomics, strategic complementarities arise: individual payoffs from taking a certain action are non-decreasing in the number of agents who choose the same action. Examples of such actions include currency short-selling, start-up investments and technology adoption under network externalities, and debt refinancing to name a few. Common Knowledge Coordination games, where "economic fundamentals" (i.e. profitability determinants) and number of agents are assumed to be common knowledge, emphasize that in such environments, equilibrium cannot be pinned down uniquely because beliefs are indeterminate. This lack of predictability poses a serious problem for many academics and practitioners when it comes to predicting, for instance, the onset of speculative attacks.

Global Coordination games constitute the most popular approach to escape the prediction of equilibrium indeterminacy. They assume that agents face idiosyncratic uncertainty about economic fundamentals. A more recent approach, Poisson Coordination games, is motivated by the fact that the number of potential speculators is, by definition, very large in macroeconomic environments, and thus it may be prohibitively expensive to collect the necessary information for who all the stakeholders are. This approach, following Myerson (2000), models the number of actual players as a Poisson random variable. Importantly, Global and Poisson Coordination games lead to drastically different predictions. On one hand, the Global Coordination game prediction about the onset of speculative attacks manifests a threshold level of fundamentals that defines two areas: one in which a successful attack takes place, and another where a successful attack does not materialize. On the other hand, the Poisson Coordination game prediction is that no speculative attack will take place as long as the expected number of players and/or the rewards from a successful attack are sufficiently small (see Section 3 for more details). Therefore, it is imperative to understand the nature of uncertainty that predominantly drives strategic behavior in macroeconomic environments with strategic complementarities.

Cabrales, Nagel, and Armenter (2007) find that inexperienced (in the sense of limited game-play) subjects' behavior in Common Knowledge and Global Coordination games is similar thus, casting doubts on whether idiosyncratic uncertainty about economic fundamentals is an important determinant of the behavior of inexperienced players. Two natural questions are then (a) whether uncertainty about the number of actual players does have an impact on such behavior, and if so, (b) whether the behavior of inexperienced players under such uncertainty is consistent with the prediction of Poisson Coordination games. Investigating these questions is the focus of this paper. In particular, we design an experiment to study the behavior of inexperienced subjects in single-shot, Global, Poisson and Common Knowledge Coordination games (henceforth, for brevity, referred to as *Global*, *Poisson* and *Common Knowledge games*, respectively, unless there is risk of confusion). In the context of macroeconomic situations, our setup captures games between inexperienced players, such as young currency or debt speculators, start-up investors and new technology adopters under network externalities.

The experimental design is formulated around asking subjects to state their intent to buy a cash amount.[1] Registering to buy the cash amount entails paying a fee, which is less than the cash amount. The fee is non-refundable; that is, once a subject registers to buy the cash amount, the fee is subtracted from the subject's initial endowment. Additionally, registering to buy the cash amount does not imply that the cash amount is awarded. In order to get the cash amount, a threshold number of registrations has to be met. If fewer subjects than the number dictated by the threshold register then, the cash amount is not awarded. The experimental sessions were conducted over the internet. Internet is ideal for Poisson experiments as subjects cannot infer the number of participants, which is typically the case in a laboratory experiment. Crucially, in order to circumvent the difficulties that would arise given the (assumed) unfamiliarity of many subjects with Poisson probabilities, we applied the specific probabilities onto a roulette wheel noting that the roulette wheel is not a standard one. In order to maintain consistency with the Poisson experimental sessions, the Global and Common Knowledge sessions were, also, conducted over the internet in an analogous setup to the Poisson sessions, while accommodating the underlying assumptions of each theory. Once all the relevant information was disclosed, subjects were asked to make a decision whether to buy the cash amount. Our approach resembles how managers and investors commit to their decisions nowadays: after contemplating the pros and cons of various alternatives, managers and investors will often place their (short-selling, purchase or investment) orders online.

Contrasting the behavior in Common Knowledge and Poisson games, we find that subjects' behavior across the two games is statistically different. This result implies that uncertainty regarding the number of actual players is an important determinant of inexperienced subjects' behavior. Moreover, subjects in Poisson games forego to register to buy the cash amount, in accordance

[1] In the lingo of the speculative attack model of Morris and Shin (1998), registering to buy the cash amount reward is analogous to attacking the currency peg. Alternatively, in the context of start-up investors and new technology adoption under network externalities, registering to buy the cash amount is analogous to undertaking the investment opportunity and adopting the new technology, respectively.

with the theoretical prediction given the chosen parameters. Motivated by the results in Cabrales, Nagel, and Armenter (2007), we also contrast the empirical findings of Global games to those in Common Knowledge games. In line with existing results, we find that in Global and Common Knowledge games subjects' behavior is statistically similar. Therefore, uncertainty about economic fundamentals does not have an impact on inexperienced subjects' behavior. In particular, we find that, in both games, subjects split almost evenly between foregoing registering to buy the cash amount and registering to buy the cash amount. This result is not theoretically predicted in either informational protocol.

Our results on inexperienced subjects' behavior in Poisson games indicate that, for the chosen parameters, experienced players are also very likely not to register to buy the cash amount. Note that in a repeated setup subjects see the total number of registrations at the end of each period (i.e. there is feedback). The percentage of subjects in the Poisson experiments conducted that do not register is around 95%, which is likely to deter subjects from registering in the next period, and so on and so forth. In light of Heinemann, Nagel, and Ockenfels (2004) and Cabrales, Nagel, and Armenter (2007) we expect that the behavior of experienced subjects in the Common Knowledge games will be different from the above. Therefore, we conjecture that uncertainty about the number of actual players is an important determinant of experienced subjects' behavior as well. Investigating the validity of this reasoning is deferred for future work.

The paper adheres to the following plan. We present next the literature review. In Section 3, we review the theoretical predictions of Global, Poisson and Common Knowledge games. In Section 4, the experimental design is presented. In Section 5, we report the results, and in Section 6, we conduct robustness analysis with smaller and larger sample sizes. Finally, in Section 6, we summarize our results and offer suggestions for future research.

2 Literature Review

An important issue that arises in environments with strategic complementarities is whether beliefs about equilibrium outcomes can be pinned down uniquely. Most of the received theoretical literature has focused on the interaction of heterogeneity in beliefs or preferences/technologies and uncertainty about economic fundamentals to study uniqueness of equilibrium. The ensuing common view is that, in order to escape a prediction of indeterminacy of equilibria, a model needs to have a sufficiently large degree of heterogeneity and/or of asymmetric information.[2] In particular, Global games, probably the most influential of all these approaches, postulate that agents face idiosyncratic uncertainty about economic fundamentals.[3] This equilibrium is in threshold strategies that prescribe the "safe" action (e.g. do not speculate) if and only if the idiosyncratic signal about the unknown state of the economy is a sufficiently strong indication that profitability is low.

Heinemann, Nagel, and Ockenfels (2004) (henceforth referred to as HNO) study an experiment that resembles a speculative attack model with repeated play. In comparing sessions between Common Knowledge and Global games, they find that subjects use threshold strategies in both informational protocols. In Common Knowledge games, the authors find that observed behavior lies between the payoff-dominant and the global game solution. In Global games they find that observed behavior is closer to the global game solution. In their setup, the relevant economic fundamental is the profit from short-selling the currency. The payoff-dominant solution prescribes that all subjects choose the "risky" action (e.g. speculate) regardless of the level of economic fundamental, whereas the global game solution specifies a level of economic fundamental above which enough registrations take place for the cash amount to be awarded. HNO interpret these findings as evidence to suggest that transparent modes of informational disclosure will increase the probability of speculative attacks.

Our study differs in two distinct ways from that of HNO. First, in our experiment, subjects are required to make only one decision based on their information, whereas in the study of HNO, each subject had to make a series of decisions (160 decisions in total) based on a different informational draw each time. Second, the context of a subject's decision differs in this setup compared to the one in HNO. In our setup, a subject has to sacrifice an amount of money from the initial endowment (pay a non-refundable fee) to buy the cash amount. Otherwise, a subject gets to keep the endowed amount. In the study of HNO, subjects are required to decide between the safe and the risky action, before given a monetary payoff.

Cabrales, Nagel, and Armenter (2007) (henceforth referred to as CNA) also investigate subjects' behavior in Common Knowledge and Global games. The authors utilize a discrete state space with five possible states and signals. CNA find that in Global games, subjects' behavior

[2]Morris and Shin (2003) provide an overview of Global games. Herrendorf, Valentinyi, and Waldman (2000), Burdzy, Frankel, and Pauzner (2001), and Frankel and Pauzner (2000) exploit heterogeneity of agents to the same effect.

[3]See Morris and Shin (1998), Heinemann (2000), Heinemann and Illing (2002).

converges towards the global game solution. Moreover, the authors point out that the theoretical results of Carlsson and van Damme (1993) do not hold in situations where players are inexperienced, and in some cases may even not hold after a relatively lengthy interaction (p. 232). CNA also find that in Common Knowledge games, observed behavior can be anywhere (weakly) between the payoff-dominant and the global game solution, and that behavior across Common Knowledge and Global games is similar. Similar to CNA we, also, do not find a statistically significant difference in subjects' behavior across Common Knowledge and Global games. This is a departure from the findings of HNO. Yet echoing the discussion in CNA (p. 232), the difference in results may be driven by the absence of learning effects given that our subjects interact only once.

Crucially the aforementioned literature has not paid particular attention to the potential implications of the fact that in the above strategic environments, the number of economic agents is often very large. As Myerson (2000) points out, in games with a very large number of players, "it is unrealistic to assume that every player knows all the other players in the game; instead, a more realistic model should admit some uncertainty about the number of players in the game" (p. 7). Following this suggestion, Makris (2008) models the coordination problem as a Poisson game, where it is common knowledge that the number of actual players is a Poisson random variable,[4] and shows that the equilibrium is unique if the mean population is less than a well-defined threshold level − with this level being higher, (a) the higher the transaction costs (fees), and (b) the lower the gain from coordination to the risky action. The unique equilibrium prescribes that all players take the safe action.[5] Thus, our contribution to the existing literature rests on providing the first experimental investigation of Poisson *Coordination* games.[6] By doing so, we

[4]This modeling choice is driven, in part, by certain convenient properties associated with the Poisson distribution (see Myerson (1998)). As a complementary justification, suppose that the identity of every stakeholder is indeed common knowledge, but, also, that binding individual orders for new technology or short-sales of a currency, must arrive with the inventor, or central bank, by a given time. Standard theory suggests that each agent will decide on his action by taking the number of orders at the collector's disposal as given. However, the probability that a phone call to a busy switchboard goes through or the webpage of an online site is uploaded successfully at times of high traffic decreases with the number of stakeholders (i.e. with traffic, or the number of trials). As a result, and under the assumption that the average number of successful phone calls or online visits is known, in a large environment, outsiders and stakeholders should actually view the number of actual players in the Coordination game as a Poisson random variable.

[5]The intuition behind (a) and (b) in the main text is the following. Higher transaction costs and/or lower benefits imply that agents are less willing to choose the risky action. Therefore, the range of population means over which the unique equilibrium prescribes that agents choose the safe action is larger.

[6]The only other experimental study of Poisson games we know of is that of Ostling, Wang, Chou, and Camerer

fill an important gap in the literature and help advance the understanding of behavior in setups with inexperienced players, such as young currency or debt speculators, start-up investors and new technology adopters under network externalities.

3 Theoretical Predictions

We deploy the canonical Coordination game used (with different notation) in Morris and Shin (1998). Denote by $N > 1$ the number of players, who decide whether to register to buy a cash award (i.e. attack a currency). Denote by T the registration fee (opportunity cost), Y the state of the economy/economic fundamentals, and $Y/2$ the cash award gross of the fee, with $Y \in [Y_{min}, Y_{max}]$.[7]

The cash amount is awarded if the number of registered players is at least as high as $\alpha(Y)$. Therefore, after letting ν be the number of other players who register, the payoff of each player is

$$\begin{array}{cc} 0 & \text{if he does not register,} \\ -T & \text{if he registers and } \nu < \alpha(Y) - 1, \\ Y/2 - T & \text{if he registers and } \nu \geq \alpha(Y) - 1. \end{array}$$

The function $\alpha(.)$ and the registration fee are common knowledge. The minimum number of contributions needed for the cash amount to be awarded is set as

$$\alpha(Y) = C - \frac{Y}{D}$$

with

$$C > 0, D > 0, \text{ and}$$

$$C - \frac{Y_{max}}{D} \leq 1. \tag{1}$$

(2011) who assume Poisson-distributed uncertainty about the number of players participating in the Swedish *Lowest Unique Positive Integer* (LUPI) game. The behavioral patterns of the field data are consistent with the theoretical predictions.

[7] To map the notation here to that in Morris and Shin (1998) and Heinemann (2000), the interested reader should just use $Y = Y_{max} - (Y_{max} - Y_{min})\theta$, where $\theta \in [0, 1]$ is the state of the economy in these papers. Moreover, $Y_{max}/2$ is the capital gain from short-selling in the worst state ($\theta = 0$), while $Y_{min}/2$ is the short-selling profit in the best state of the economy ($\theta = 1$).

The last condition states that in the worst economic fundamentals ($Y \geq Y_{max}$), the cash amount is awarded even if only one player registers.[8]

Note that for $Y \geq \overline{Y} \equiv \alpha^{-1}(1)$ a single registration is enough for the cash amount to be awarded, while for $Y < \overline{Y}$ more than one registrations will typically be needed. We assume that

$$2T < \overline{Y}$$

to ensure that it is not weakly dominant to abstain from registering for any cash amount $Y < \overline{Y}$. Furthermore, we assume that in the best economic fundamentals ($Y \leq Y_{min}$), the cash amount awarded is smaller than the fee; that is,

$$2T > Y_{min}.$$

Let $\underline{Y}$ denote the supremum of all levels of economic fundamentals for which it is not profitable to register, given that all other $N-1$ players contribute. That is, $\underline{Y}$ is the largest of the economic fundamentals $2T$ and $\alpha^{-1}(N)$. The significance of this state of the economy is that it is (weakly) dominant to abstain from registering for any state $Y < \underline{Y}$ and, if $N \geq \alpha(2T)$, also for $Y = \underline{Y}$.

In what follows, we distinguish between three cases regarding agents' information about economic fundamentals and number of players. Under common knowledge of economic fundamentals and number of players, i.e. in the Common Knowledge game, zero registrations (the maximin outcome) is the unique equilibrium outcome for $Y \leq \underline{Y}$ when $N \geq \alpha(2T)$ (for $Y < \underline{Y}$ when $N < \alpha(2T)$). On the other hand, N registrations (the payoff-dominant outcome) is the unique equilibrium for $Y \geq \overline{Y}$. However, in the "grey area," i.e. in the remaining area of economic fundamentals, there is multiplicity of equilibria. Depending on self-fulfilling beliefs, both the maximin and payoff-dominant outcomes are equilibria.

In the Global games, the cash amount is uncertain and subjects receive idiosyncratic signals/hints on the state of the economy, denoted by x. The unknown state Y is uniformly distributed, and conditional on realized Y, x is uniformly distributed over $[Y - \varepsilon_Y, Y + \varepsilon_Y]$, with

$$2\varepsilon_Y < min\{Y_{max} - (C-1)D, (C-N)D - Y_{min}\}.$$

These distributions are common knowledge. In this case, there is a unique equilibrium where all players register if and only if their signal is at least as high as x^*, where the threshold signal is

[8] Here, to fix ideas, a higher cash award corresponds to worse economic fundamentals. This relationship pertains to the example of speculative attack. For the case of innovation, the converse relationship should be used; that is, a higher cash award would correspond to better economic fundamentals.

part of the solution with respect to x^* and θ^* of the system (see also Heinemann (2000)):

$$\frac{1}{2\varepsilon}\int\limits_{x^*-\varepsilon}^{\theta^*}[Y_{max}-(Y_{max}-Y_{min})\theta]d\theta = T,$$

$$\frac{1}{2\varepsilon}\int\limits_{\theta^*-\varepsilon}^{x^*}d\theta = C-\frac{Y_{max}-(Y_{max}-Y_{min})\theta}{D}.$$

The proportion of players who register is $min\{1, max\{0, \hat{s}\}\}$, where $\hat{s}$ is the left-hand side term in the latter equality.

In the Poisson game, the cash amount is common knowledge. In addition, the number of actual players is a Poisson random variable with the mean n being common knowledge. In this case, as shown in Makris (2008), the predictions for economic fundamentals such that $Y \leq 2T$ or $Y \geq \overline{Y}$ coincide with the corresponding predictions of Common Knowledge games. However, for economic fundamentals within the remaining area, the unique equilibrium is the maximin outcome (where no player registers), if and only if

$$1 - F(\alpha(Y) - 2 \mid n) < 2T/Y.$$

When the above inequality does not hold then multiplicity of equilibria is predicted instead. This result implies either a threshold mean below which uniqueness is guaranteed or a threshold fee per reward above which uniqueness is attained.

In the experiments, we will choose parameters such that the theoretical prediction prescribes that there is equilibrium indeterminacy in the Common Knowledge games, whereas all players do not register under, both, the Poisson games and the Global games regardless of the received signal.

4 Experimental Design

Our experimental setup features a coordination problem that is examined under three informational protocols: Poisson games, Global games, and Common Knowledge games. The experiments were conducted over the internet. Internet is ideal for Poisson experiments as subjects cannot infer the number of participants, which is typically the case in a laboratory experiment. To maintain consistency with the Poisson treatments, the treatments based on Global and Common Knowledge games were also conducted over the internet. A disadvantage of running experiments over the internet is that it becomes very hard to monitor participants' engagement with the game. In particular, there is no control over what participants are doing. For instance, participants could take a break to call someone, to browse the web, to eat pizza, to have a coffee etc. To safeguard against such distractions and to maintain subjects' focus to the game, the screens included timers that allowed a limited but sufficient amount of time to read comfortably the instructions. In addition, the inclusion of timers minimized the possibility of wired or wireless communication. Once the time lapsed, the subjects would concurrently move to the next screen.[9] Finally, subjects were asked to make a decision whether to buy the cash amount. A value-added of this approach is that it mimics how managers and investors commit to their decisions nowadays: after contemplating the pros and cons of various alternatives, managers and investors will often place their (short-selling, purchase or investment) orders online. Next, we provide a detailed description of the experimental design. We then formulate our general hypotheses.

4.1 Treatments

Upon logging in, subjects were endowed with £12 in lieu of a show-up fee. The treatments in Poisson and Global games consisted of three stages and accommodated the underlying assumptions of the corresponding theories. In Poisson games, the number of participants followed a Poisson distribution with mean n. The latter and the cash amount were common knowledge. On the other hand, in Global games, subjects received a private signal about the cash amount. Furthermore, in contrast to Poisson games, the number of participants in Global games was common knowledge. The treatments with Common Knowledge games consisted of two stages with the number of participants and the cash amount disseminated as common knowledge. In the last stage of all experimental sessions, subjects were asked to complete a short questionnaire consisting of demographic questions as well as questions revealing their trustworthiness and trust.[10] With the conclusion of the experimental session, subjects claimed their earnings from the school office of the college.

[9] In the questionnaire that followed the game-play stage, none of the subjects reported running out of time while reading the instructions on any of the screens.

[10] These questions were based on a survey given in Glaeser, Laibson, Scheinkman, and Soutter (2000).

We describe first the Poisson treatments. In the first stage of the experiment, subjects were instructed that there would be a computer draw and that the number drawn would correspond to the number of subjects participating in the second stage of the experiment. Subjects were explicitly told that the number drawn would not be revealed to them. In the two Poisson treatments the Poisson process was based on $n = 17$. To circumvent the difficulties that would arise given the (assumed) unfamiliarity of many subjects with Poisson probabilities, we applied the specific probabilities onto a roulette wheel. We showed the roulette wheel pictorially and noted that "the roulette is not a standard roulette; the number drawn can be any number between 8 and 26, but not all numbers are equally likely to be drawn. Numbers closer to 17 (the mean) are more likely to be drawn." The instructions specified that subjects not selected for the second stage of the experiment would be dismissed, but would keep their initial endowment.[11]

In the second stage, subjects had the option to buy a cash amount of £12.50 at a reduced price (fee) of £9 (or £10). Subjects were informed that the cash amount of £12.50 would be issued only if a minimum of $\alpha(Y)$ subjects[12] registered to buy them, and that the fee of £9 (£10) required for the purchase of the cash amount was non-refundable and was collected immediately. That is, if a subject registered to buy the cash amount of £12.50, the £9 (£10) would be subtracted automatically from the initial payment of £12, regardless of the number of subjects registering. The subjects were then asked to indicate whether they would like to register to buy the £12.50 cash amount.

Analogous to the Poisson treatments, Global treatments also included a computer draw in the first stage. The drawn integer (between 5 and 95 inclusive) was referred to as "Y" in the instructions. We forewent indicating the actual Y drawn, yet we provided subjects with a *hint* about the drawn Y. The hint was an integer within a range of $+5$ and -5 from the Y drawn.[13] For example, for $Y = 25$, subjects would receive a hint integer in the set of $\{20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30\}$, where each integer had a probability of $\frac{1}{11}$ of being drawn. The hint integer was indicated in bold. Additionally, the number of subjects participating in the experiment was set at $N = 17$ and was indicated on the screens.

[11]In practice, we did not dismiss any of the subjects. Every subject who logged in at the specified time was allowed to proceed to the second stage of the game. In each of the Poisson sessions, we sent log in information to 28 subjects, in anticipation that some of them would fail to log in at the specified time. The total number of participants in each treatment is shown in Table 1 on p. 12.

[12]In the instructions, $\alpha(Y)$ was either $\{15, 16\}$.

[13]To map the values here to the notation in Section 3, let $Y_{max} = 95$, $Y_{min} = 5$, $\varepsilon_Y = 5$ and thereby $x \in [0, 100]$.

In the second stage of the experiment, subjects had the option to buy a cash amount of £$\frac{Y}{2}$ at a reduced and non-refundable fee of £9 (£10). The cash amount would be awarded conditional on, at least, $\alpha(Y) = C - \frac{Y}{4}$ registering to buy them.[14] In order to circumvent calculation errors we indicated on the screen, the number of subjects that needed to register to win the cash amount for every possible value of Y. To ensure comparability among all treatments, we fixed $Y = 25$. Thus, the cash amount that could be received was £12.50, and the actual thresholds matched the corresponding ones of the other treatments. The subjects had to indicate next whether they would like to register to buy the cash amount.

Finally, in the Common Knowledge treatments subjects were told the number of participants (17), the cash amount (£12.50), the fee (£9 or £10) and the threshold number of registrations $\alpha(Y)$ that needed to be met to earn the cash amount. The latter was set at the same value as the corresponding threshold number of registrations in the Poisson games. The subjects were then asked to make a decision, analogous to Poisson and Global games.

The experimental sessions took place in October of 2012 and May of 2013. We conducted two sessions per treatment. The 220 subjects were recruited from the undergraduate student population of the University of Southampton. We announced our experiments via class presentations. In order to participate, students replied by e-mail. We then indicated to the respondents the date and time of the experiment and asked them to confirm their attendance. Those, who confirmed were subsequently sent log in information (username and password) and the url of the website. Most of the participants majored in business, economics, finance and mathematics. Participants were allowed to participate in *only* one session. Each session lasted approximately 20 minutes. Average earnings per participant were £9.40. In the Common Knowledge games, subjects made on average £7.51. In the Poisson games, subjects made on average £11.51, whereas in the Global games, the average earnings were £7.79. The experimental instructions for all treatments are reported in the Appendix. Some general characteristics of the sessions are shown in Table 1. Note that each treatment is denoted by an acronym. In particular, the acronym (*type*, *threshold*, *fee*) consists of the *type* of game (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the *threshold* (15 or 16), and the *fee* (9 or 10).

At this point and before proceeding to the general hypotheses, we feel compelled to justify our choices with respect to the cash amount (£12.50), (expected) number of players (17), the threshold number of players (15 or 16), the fee (£9 or £10), and the initial endowment (£12). Initially,

[14] In the instructions, C was replaced by $\{21, 22\}$.

Table 1: Characteristics of the Experimental Sessions

# of Subj.	# of Ses.	Mean	Threshold	Fee (£)	Amount (£)	Acronym
Common Knowledge Games						
34	2	-	16	9	12.50	CK169
34	2	-	15	10	12.50	CK1510
Poisson Games						
# of Subj.	# of Ses.	Mean	Threshold	Fee (£)	Amount (£)	Acronym
40	2	17	16	9	12.50	P169
44	2	17	15	10	12.50	P1510
Global Games						
# of Subj.	# of Ses.	Mean	Threshold	Fee (£)	Amount (£)	Acronym
34	2	-	$22 - \lfloor \frac{Y}{4} \rceil = 16$	9	$\frac{Y}{2} = 12.50$	G169
34	2	-	$21 - \lfloor \frac{Y}{4} \rceil = 15$	10	$\frac{Y}{2} = 12.50$	G1510

Notes: In the first column, we provide the total number of participants in each treatment. We conducted two sessions per treatment. The number of participants in the Global and Common Knowledge sessions was common knowledge. Notice that the number of participants in *each* session in the Global and Common Knowledge treatments coincides with the mean n of the Poisson treatments. This was done to ensure comparability across the three game types. Moreover, in Global games, we fixed $Y = 25$. Also, in the calculation of the threshold in Global games, the symbolic function $\lfloor \cdot \rceil$ rounds the fraction upwards to the nearest integer. The acronyms in the last column, consist of the game type (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10).

we fixed the cash amount of £12.50 so as to ensure cost-effectiveness while maintaining subjects' monetary incentives. Moreover, the number of players in Global and Common Knowledge games had to be large enough to capture the "largeness" of the games, while being cost-effective. This motivates our choice of the number of players. Next, to ensure comparability across game-types the population mean of the Poisson distribution used in Poisson games had to be equal to the number of players in Global and Common Knowledge games. In addition, the threshold number of registrations should not exceed the number of players in Global and Common Knowledge games (otherwise subjects would have a dominant strategy to not register). Opting for low threshold numbers of registrations would require high fees in order to ensure equilibrium uniqueness in the Poison games. In order to ensure equilibrium uniqueness in Poisson games, given the above parameters, the fee must be at least £9. Considering the duration of the experiment (approximately

20 minutes) and the minimum wage in UK ($\approx$ £6 per hour), we stipulated that no subject should get a compensation below £2. Therefore, the difference between the fee and the endowment must not be less than £2. Cost-effectiveness and the requirement that the fee must be less than the cash amount in the Common Knowledge and Poisson games imply our choice of fee, endowment and threshold registration numbers.

4.2 General Hypotheses

We formulate next six hypotheses. For each game type (Poisson games, Global games, Common Knowledge games), we ran two treatments that differ in the fee incurred and the threshold number of registrations required. The first, second and third hypotheses examine the behavioral differences across the three informational conditions. This is important in order to understand the nature of uncertainty that influences strategic behavior in macroeconomic environments with strategic complementarities. We thus test for differences in subjects' behavior across Common Knowledge and Poisson games, Poisson and Global games, Global and Common Knowledge games.

HYPOTHESIS 1: Subjects' behavior is the same across Common Knowledge and Poisson games.

HYPOTHESIS 2: Subjects' behavior is the same across Poisson and Global games.

HYPOTHESIS 3: Subjects' behavior is the same across Global and Common Knowledge games.

Finally, the last three hypotheses serve as a direct test of the predictions of Poisson, Global and Common Knowledge games, respectively. Recall that on one hand, Poisson and Global games, for the parameters specified, predict that subjects will forego the opportunity to register to buy the cash amount and will keep the endowed payoff. Furthermore, in Global games, the theoretical prediction holds regardless of the private signals that subjects receive on the state of the economy. On the other hand, Common Knowledge games establish that, based on our parameter choices, subjects will either all coordinate on registering to buy the cash amount, or all coordinate on foregoing to resister to buy the cash amount. The last three hypotheses are formulated as follows.

HYPOTHESIS 4: Subjects in Poisson games will choose to forego registering to buy the cash amount, in accordance with the prediction of Poisson games for the parameters specified.

HYPOTHESIS 5: Subjects in Global games will choose to forego registering to buy the cash amount, in accordance with the prediction of Global games for the parameters specified.

HYPOTHESIS 6: Subjects in Common Knowledge games will either all coordinate on registering to buy the cash amount, or all coordinate on foregoing to resister to buy the cash amount, in accordance with the prediction of Common Knowledge games for the parameters specified.

5 Results

All hypotheses are formally tested through pairwise χ^2-tests, where the H_0 states that behavior between treatments is not statistically different (the association between a pair of treatments is random). Each hypothesis is matched with the corresponding result; that is, result i is a report on the test of hypothesis i. Note that the decision of a subject in the game is a binary variable. The subjects who chose not to register to buy the cash amount were assigned a value of 1. The subjects who chose to register were assigned a value of 0. Next, we provide summary statistics based on the raw experimental data.

5.1 Summary Statistics

Table 2 reports descriptive statistics of the raw experimental data. Recall that subjects had to decide whether to register to buy a cash amount at a reduced price or forego this option and keep the endowed payoff of £12. We report in the table the frequency and percentage of subjects who registered to buy the cash amount and the frequency and percentage of subjects who chose to keep their endowment. The summary statistics are classified by treatment. With the exception of treatment CK1510, in all other treatments, the subjects who chose not to register outnumbered the ones that chose to register. In the Common Knowledge and Global treatments, the percentages of those who kept the endowment of £12 range from 47.1% to 58.8%. In sharp contrast, the percentages in the Poisson treatments are substantially higher (95.0% in P169 and 95.5% in P1510). Overall, out of 220 subjects, 68 chose to register to buy the cash amount, whereas 152 subjects chose to keep the endowed payoff of £12. The threshold was not met in any of the treatments, consequently, the cash amount was not awarded.

Table 2: Descriptive Statistics

Common Knowledge Games					
	Registered		Not Registered		Amount
Acronym	Freq.	%	Freq.	%	Awarded?
CK169	16	47.1	18	52.9	No
CK1510	18	52.9	16	47.1	No
Poisson Games					
	Registered		Not Registered		Amount
Acronym	Freq.	%	Freq.	%	Awarded?
P169	2	5.0	38	95.0	No
P1510	2	4.6	42	95.5	No
Global Games					
	Registered		Not Registered		Amount
Acronym	Freq.	%	Freq.	%	Awarded?
G169	14	41.2	20	58.8	No
G1510	16	47.1	18	52.9	No
Total	68		152		

Notes: The table indicates the number of subjects who registered and the number of those who did not register to buy the cash amount in each treatment. In addition, we provide the corresponding percentages. The total number of participants in each treatment is indicated in Table 1. The threshold was not met in any of the treatments. The acronyms consist of the game type (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10).

5.2 Subjects' Behavior Across Game Types

Next, we investigate whether subjects' decisions varied significantly across game types controlling for the parameter choices. In particular, we test for differences in subjects' behavior across Common Knowledge and Poisson games, Poisson and Global games, Global and Common Knowledge games. The results are displayed in Table 3.

The first hypothesis aims to investigate any behavioral differences across Common Knowledge and Poisson games. The findings based on the statistical analysis are formalized in our first result.

RESULT 1: Subjects' behavior differs significantly between Common Knowledge and Poisson games, controlling for the parameter choices of each pairwise comparison.

Table 3: Differences in Subjects' Behavior Across Game Types

Alternative hypothesis:	$decision_i \neq decision_j$
	p-values
Common Knowledge games vs Poisson games	
CK169 & P169	0.000
CK1510 & P1510	0.000
Poisson games vs Global games	
P169 & G169	0.000
P1510 & G1510	0.000
Global games vs Common Knowledge games	
G169 & CK169	0.625
G1510 & CK1510	0.628

Notes: The table utilizes the χ^2-test to determine whether subjects' decisions differ across game types ($i \neq j$) conditional on the same parameters. The acronyms consist of the type of treatment (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10).

Support. All the p-values in the pairwise comparisons are below the 1% level of statistical significance.

The second hypothesis compares subjects' behavior in Poisson and Global games. Result 2 indicates that subjects' behavior differs significantly.

RESULT 2: Subjects' behavior differs significantly between Poisson and Global games, controlling for the parameter choices of each pairwise comparison.

Support. All the p-values in the pairwise comparisons are below the 1% level of statistical significance.

The third hypothesis investigates any behavioral differences across Global and Common Knowledge games. In contrast to Results 1 and 2, there are no differences in subjects' behavior across the two game types when controlling for the parameter choices. This finding is formalized in our third result.

RESULT 3: Subjects' behavior does not differ significantly between Global and Common Knowledge games, controlling for the parameter choices of each pairwise comparison.

Support. All p-values are large enough to infer that there exists a non-random association between the observed distributions; H_0 cannot be rejected.

A possible explanation for the difference in subjects' behavior between Global and Poisson games could be the complicated setup in Global games, which may lead to confounding effects. We rule out this explanation as the results in Global and (the-less-perplex) Common Knowledge games are indistinguishable.

5.3 Theory and Subjects' Behavior

To investigate the consistency of subjects' behavior with the theoretical predictions, the distribution of each treatment is compared to the predicted distribution of the corresponding theory.[15] Panel A, in Table 4, indicates the p-values of the treatments under the H_0 that there exists a non-random association between the observed distribution and the distribution where all subjects choose to not register (recall this is assigned a value of 1). On the other hand, the p-values in Panel B correspond to the distribution where all subjects register to buy the cash amount (this is assigned a value of 0).

The fourth hypothesis was formulated to test the consistency of subjects' behavior with the prediction of Poisson games. The results in Panel A present serious evidence of such consistency for the parameters specified. Given that our sample size is large enough, we also run a probit regression where the dependent variable is a subject's decision and the six treatments are the covariates with Treatment CK169 set as the base. Acknowledging that coefficients in probit models are estimated up to scale and cannot be directly interpreted, we only present marginal effects in Table 5. The standard errors are reported in parentheses. Crucially, the coefficients are statistically significant only in Poisson games. The marginal effects imply an increase in probability of 42.1% (P169) and 42.5% (P1510) in not registering to buy the cash amount in the Poisson treatments, which is consistent with the findings in Panel A of Table 4. We formalize next our fourth result.

RESULT 4: Subjects behave in accordance with the prediction of Poisson games for the parameters specified.

[15] The χ^2-test in this case is analogous to the Kolmogorov-Smirnov test, which compares an empirical distribution function with the cumulative distribution function of the reference distribution. Yet the Kolmogorov-Smirnov test is best suited for testing the equality of continuous probability distributions.

Table 4: Theory and Subjects' Behavior

Panel A		*Panel B*	
Alternative hypothesis:	$decision_i \neq 1$	Alternative hypothesis:	$decision_i \neq 0$
	p-values		p-values
Common Knowledge games		*Common Knowledge games*	
CK169	0.000	CK169	0.000
CK1510	0.000	CK1510	0.000
Poisson games		*Poisson games*	
P169	0.152	P169	-
P1510	0.153	P1510	-
Global games		*Global games*	
G169	0.000	G169	-
G1510	0.000	G1510	-

Notes: The decision of a subject in the game is a binary variable. The subjects who chose not to register to buy the cash amount were assigned a value of 1. The subjects who chose to register were assigned a value of 0. The table utilizes the χ^2-test to determine whether subjects' decisions in Common Knowledge, Poisson, and Global games differ from the theoretical predictions given the parameters specified. Panel A indicates the p-values in the assumption that there exists a non-random association between the observed distribution and the distribution where all subjects choose to not register. In contrast, the p-values in Panel B reflect the distribution where all subjects register to buy the cash amount. The acronyms consist of the type of treatment (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10).

Support. The marginal effects of the two Poisson regressor coefficients highlight that there is an increase in probability of 42.1% (P169) and 42.5% (P1510) in not registering to buy the cash amount, which is also statistically significant at the 1% level.

On the other hand, the fifth hypothesis tests the consistency of subjects' behavior with the prediction of Global games. Result 5 states that such consistency is not verified for the parameters specified. The finding is formalized next.

RESULT 5: Subjects' behavior differs from the prediction of Global games for the parameters specified.

Support. All the p-values in the Global game treatments in Panel A of Table 4 are below the 1% level of statistical significance.

Table 5: Marginal Effects

Dependent variable:	decision
Regressor	dy/dx
CK1510	-0.059
	(0.121)
P169	0.421***
	(0.092)
P1510	0.425***
	(0.091)
G169	0.059
	(0.120)
G1510	0.000
	(0.121)
Number of obs	220

Notes: The table reports marginal effects after probit regression on decision. Treatment CK169 is set as the base against which the estimated parameters are compared. dy/dx for factor levels is the discrete change from the base level. All standard errors are reported in parentheses. The acronyms consist of the game type (*CK* for Common Knowledge games, *P* for Poisson games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10). *** Significant at the 1% level.

We highlight the difference in the results of this study with the results of HNO. A plausible explanation for the difference can be attributed to learning effects. For example, in HNO, the results are based on an aggregation of the data in the last four periods of each treatment.[16] On the contrary, our focus here, is single-shot experiments without inflicting any learning and/or repeated-game effects. Our results confirm the findings of CNA, who point out that the theoretical results of Carlsson and van Damme (1993) do not hold in situations where players are inexperienced, and in some cases may even not hold after a relatively lengthy interaction (p. 232).

Hypothesis 6 aims to examine whether all subjects coordinate on foregoing registering to buy the cash amount or all coordinate on registering to buy the cash amount in the Common Knowledge treatments. The p-values of the Common Knowledge treatments in Panel A of Table 4 serve to determine whether subjects coordinate on foregoing registering to buy the cash amount.

[16]HNO note that "[e]stimates based on single periods do not show much variation after the first three periods of each treatment. Therefore, we can improve the quality of estimates by combining data of the last four rounds of each treatment (p. 1590)."

On the other hand, the p-values of the corresponding Common Knowledge treatments in Panel B serve to determine whether subjects coordinate on registering to buy the cash amount. Result 6 formalizes our findings.

RESULT 6: Subjects' behavior in Common Knowledge games differs from the multiplicity of equilibria prediction for the parameters specified.

Support. All the p-values in the Common Knowledge treatments of Panel A and B are below the 1% level of statistical significance.

5.3.1 Consistency in Subjects' Behavior Within Game Types

The last three results suggest that only the theoretical prediction of Poisson games is supported. On the other hand, the theoretical predictions of Common Knowledge and Global games are not supported for the parameters chosen. Even though the corresponding theoretical predictions for the parameters chosen do not change, it is plausible that subjects' decisions are, in fact, influenced by the specific parameter choices. If this is so, our findings will be compromised by confounding effects caused by parameter sensitivity. It is thus imperative to test whether subjects' behavior within Common Knowledge and Global games is consistent for the specific parameter choices. Table 6 indicates the p-values under the H_0 that there exists a non-random association within the two treatments of Common Knowledge and Global games. The test does not reject the H_0 in any pairwise treatment comparison in the two game types.

Table 6: Differences in Subjects' Behavior Within Game Types

Alternative hypothesis:	$decision_i \neq decision_j$
	p-values
Common Knowledge games	
CK169 & CK1510	0.628
Global games	
G169 & G1510	0.625

Notes: The table utilizes the χ^2-test to determine if the frequencies of subjects' decisions across treatments ($i \neq j$) within Common Knowledge and Global games are statistically different. The acronyms consist of the game type (*CK* for Common Knowledge games, and *G* for Global games), the threshold (15 or 16), and the fee (9 or 10).

6 Robustness Analysis

Contrasting the behavior in Common Knowledge and Poisson games, we find that subjects' behavior across the two game types is statistically different (Result 1). This result implies that uncertainty regarding the number of actual players is an important determinant of inexperienced subjects' behavior. In addition, the data analysis conducted finds support in favor of Poisson games: subjects forego to register to buy the cash amount, in accordance with the prescription of Poisson games (Result 4).

Both results are important findings that deserve further investigation. We thus sought additional experimentation. We first ran four sessions in Common Knowledge games and four sessions in Poisson games with a smaller sample size. After all, these findings may not hold for small samples. In the Common Knowledge games, four subjects participated in each session. The choice of a setup with four subjects was motivated by the extensive literature in the Turnaround games (Brandts and Cooper (2006), Brandts, Cooper, and Fatas (2007), Brandts and Cooper (2007)), which document initial coordination failure in networks of four participants. Consequently, given the choice of $N = 4$, to ensure comparability between Common Knowledge and Poisson games, we set the mean of the Poisson distribution to $n = 4$. Moreover, in both game types, the threshold was set to $\alpha(Y) = 4$. This choice was made for two reasons. First, having a setup where the threshold exceeds the (expected) number of players is problematic, because (a) such setup would invite experimenter effects, and (b) in Common Knowledge games, it would be dominant for subjects to not register. Second, the only value for the threshold level that does not exceed the mean population and ensures equilibrium uniqueness in the Poisson games is, in fact, $\alpha(Y) = 4$, given the parameters specified ($n = 4, \frac{Y}{2} = £12.50,\ T \in \{9, 10\}$). We next experimented with a slightly larger sample size. Our choice was to set $N = 19$ in the Common Knowledge games, and to set $n = 19$ as the mean of the Poisson distribution in the Poisson games. For the larger group size, we decided to run two treatments in an analogous manner to the earlier treatments by varying the fee ($T = £9$ or $T = £10$). The corresponding threshold number of registrations was set at (18 or 17). These choices ensured equilibrium uniqueness in Poisson games in a similar manner to our corresponding choices under the smaller sample sizes. The characteristics of the robustness sessions are displayed in Table 7. The experimental instructions of the robustness checks are included in the Appendix.

Table 7: Characteristics of Robustness Sessions

Common Knowledge Games						
# of Subj.	# of Ses.	Mean	Threshold	Fee (£)	Amount (£)	Acronym
16	4	-	4	10	12.50	CK410
38	2	-	18	9	12.50	CK189
38	2	-	17	10	12.50	CK1710
Poisson Games						
# of Subj.	# of Ses.	Mean	Threshold	Fee (£)	Amount (£)	Acronym
16	4	4	4	10	12.50	P410
48	2	19	18	9	12.50	P189
46	2	19	17	10	12.50	P1710

Notes: In the first column, we provide the total number of participants in each treatment. The number of participants in the Common Knowledge sessions was common knowledge. Notice that the number of participants in *each* session in the Common Knowledge treatments coincides with the mean n of the Poisson treatments. This was done to ensure comparability across the two game types. The acronyms consist of the game type (*CK* for Common Knowledge games, and *P* for Poisson games), the threshold (4, 17, 18), and the fee (9 or 10).

Table 8 reports descriptive statistics on the raw experimental data of the robustness sessions. Similar to the earlier findings, the threshold was not met in any of the treatments; consequently, the cash amount was not awarded. Furthermore, in Common Knowledge games, the number of subjects is split between those choosing to register and those choosing not to register.[17] Finally, in Poisson games, only 6 subjects out of the 110 that participated registered to buy the cash amount. The other 104 subjects forewent registering.

In Table 9 we present the robustness analysis for the smaller sample size. For the analysis, we utilize Fisher's exact test, which is used in the analysis of contingency tables when the sample size is small. Panel A calculates the p-value to determine whether subjects' decisions differ across Common Knowledge and Poisson games ($i \neq j$) conditional on the same parameters. The H_0 states that behavior between the two game types is not statistically different. The p-value in the pairwise comparison is below the 2% level of statistical significance. Therefore, the H_0 is rejected. Furthermore, Panel B indicates the p-value under the H_0 that there exists a non-random

[17]This finding corroborates earlier results documented in Brandts and Cooper (2006), Brandts, Cooper, and Fatas (2007), and Brandts and Cooper (2007)).

Table 8: Descriptive Statistics of Robustness Sessions

Common Knowledge Games

	Registered		Not Registered		Amount
Acronym	Freq.	%	Freq.	%	Awarded?
CK410	7	43.8	9	56.3	No
CK189	16	42.1	22	57.9	No
CK1710	18	47.4	20	52.6	No

Poisson Games

	Registered		Not Registered		Amount
Acronym	Freq.	%	Freq.	%	Awarded?
P410	1	6.3	15	93.8	No
P189	3	6.3	45	93.8	No
P1710	2	4.4	44	95.7	No

Notes: The table indicates the number of subjects who registered and the number of those who did not register to buy the cash amount in each treatment. In addition, we provide the corresponding percentages. The total number of participants in each treatment is indicated in Table 7. The threshold was not met in any of the treatments. The acronyms consist of the game type (*CK* for Common Knowledge games, and *P* for Poisson games), the threshold (4, 17, 18), and the fee (9 or 10).

association between the observed distribution in Poisson games and the distribution where all subjects choose to not register. The H_0 cannot be rejected (the p-value is 0.500).

Table 10 presents the robustness analysis for the larger sample size. In particular, Panel A tests whether subjects' decisions varied significantly across Common Knowledge and Poisson games controlling for the parameter choices. We find that subjects' behavior differs significantly between the two game types. All the p-values in the pairwise comparisons are below the 1% level of statistical significance. To investigate the consistency of subjects behavior in Poisson games with the respective theoretical prediction, the distribution of each Poisson treatment is compared to the predicted distribution. Panel B indicates the p-values of the treatments under the H_0 that there exists a non-random association between the observed distribution in Poisson games and the distribution where all subjects choose to not register. The results present further evidence of such consistency. Finally, in Panel C, we take advantage of the large sample size to present the marginal

Table 9: Robustness Analysis For Small Samples

Panel A	
Alternative hypothesis:	$decision_i \neq decision_j$
	p-value
Common Knowledge games vs Poisson games	
CK410 & P410	0.019
Panel B	
Alternative hypothesis:	$decision_i \neq 1$
	p-value
Poisson games	
P410	0.500

Notes: The decision of a subject in the game is a binary variable. The subjects who chose not to register to buy the cash amount were assigned a value of 1. The subjects who chose to register were assigned a value of 0. For the analysis, we utilize Fisher's exact test. Panel A calculates the p-value under the H_0 that behavior across Common Knowledge and Poisson games ($i \neq j$) is not statistically different conditional on the same parameters. Panel B indicates the p-value under the H_0 that there exists a non-random association between the observed distribution in Poisson games and the distribution where all subjects choose to not register. The acronyms consist of the game type (*CK* for Common Knowledge games, and *P* for Poisson games), the threshold (4), and the fee (10).

effects. Treatment CK189 is set as the base. The standard errors are reported in parentheses. The coefficients are statistically significant in Poisson games. More specifically, the marginal effects imply an increase in probability of 35.9% in P189 and 37.8% in P1710 in not registering to buy the cash amount in the Poisson treatments, which is consistent with the previous findings.[18]

Overall, the robustness analysis confirms that our results are insensitive to smaller or larger sample sizes in Common Knowledge and Poisson games. We offer next our concluding remarks and direction for future research.

[18] We also ran marginal effects with Treatment CK1710 set as the base. With the latter base, the marginal effects imply an increase in probability in the Poisson treatments of 41.1% in P189 and 43.0% in P1710 in not registering to buy the cash amount. Both results are statistically significant at the 1% level.

Table 10: Robustness Analysis For Large Samples

Panel A	
Alternative hypothesis:	$decision_i \neq decision_j$
	p-values
Common Knowledge games vs Poisson games	
CK189 & P189	0.000
CK1710 & P1710	0.000
Panel B	
Alternative hypothesis:	$decision_i \neq 1$
	p-values
Poisson games	
P189	0.128
P1710	0.153
Panel C	
Dependent variable:	decision
Regressor	dy/dx
P189	0.359***
	(0.087)
P1710	0.378***
	(0.086)
Number of obs	132

Notes: The decision of a subject in the game is a binary variable. The subjects who chose not to register to buy the cash amount were assigned a value of 1. The subjects who chose to register were assigned a value of 0. Panel A utilizes the χ^2-test to determine whether subjects' decisions differ across Common Knowledge and Poisson games ($i \neq j$) conditional on the same parameters. In addition, Panel B indicates the p-values in the assumption that there exists a non-random association between the observed distribution in Poisson games and the distribution where all subjects choose to not register. Panel C reports marginal effects after probit regression on decision. Treatment CK189 is set as the base against which the estimated parameters are compared. dy/dx for factor levels is the discrete change from the base level. All standard errors are reported in parentheses. The acronyms consist of the game type (*CK* for Common Knowledge games, and *P* for Poisson games, the threshold (17 or 18), and the fee (9 or 10). *** Significant at the 1% level.

7 Concluding Remarks

We study experimentally uncertainty in Coordination games, while focusing on the behavior of inexperienced players. We design an experiment to study the behavior of subjects in single-shot, Global, Poisson and Common Knowledge Coordination games. Our study is the first to investigate experimentally Poisson Coordination games. Contrasting the behavior in Common Knowledge and Poisson Coordination games, we find that subjects' behavior across the games is statistically different. This result implies that uncertainty regarding the number of actual players is an important determinant of inexperienced subjects' behavior. Furthermore, we find that subjects' behavior in Poisson Coordination games is indeed consistent with the theoretical prediction. In particular, if potential players perceive that the number of actual players is a Poisson random variable, theory predicts behavior well in online experiments that attempt to capture "large" games between inexperienced players. When we extend our experimental investigation to Global and Common Knowledge games, we corroborate existing experimental results, which suggest that idiosyncratic uncertainty about economic fundamentals does not drive inexperienced subjects' behavior.

In real life, for many applications of Coordination games, there are ample (personal or social) learning opportunities. We know from the received literature (e.g. HNO and CNA) that experience can have a profound impact on behavior. Therefore, an important future direction would be the experimental study of learning in Poisson games. We conjecture, as we have already mentioned in the introduction, that uncertainty about the number of actual players is also an important determinant of experienced subjects' behavior. Another avenue for future research could be the provision of a unified theory of explaining behavior across various treatments. Such fruitful attempts have been undertaken by Heinemann, Nagel, and Ockenfels (2009) and Kneeland (2012). The former study estimates various parameters of a Global game and shows that the estimated model performs well on that front. The latter study utilizes the experimental dataset of HNO to calibrate a model that rests on the limited-depth-of-reasoning solution concept. However, both studies do not incorporate Poisson treatments. An interesting task would be then to see if a Poisson game can be used as a descriptive theory of all treatments, especially in the presence of learning. Finally, an engaging future direction could be the investigation of whether our results on Poisson Coordination games carry over to other important contexts, such as voting games and discrete public good games.

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