Are sunspots effective in a big crowd? Evidence from a large-scale bank run experiment

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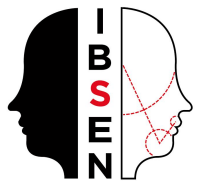
Tenth Workshop on Theoretical and Experimental Macroeconomics



Motivation

- Many economic situations can be described as coordination problems $\rightarrow$ should agents attack the currency? should they withdraw their money from the bank?
- **Financial crises** might not only happen when the state of the economy is bad $\rightarrow$ they can occur as **pure coordination failure** $\rightarrow$ agents simply coordinate on "bad" equilibria
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- With this research we aim to understand under what circumstances **bank runs** are more likely and under which conditions subjects follow **sunspot announcements**
  1. Is coordination on a sunspot equilibrium more or less likely in a large group?
  2. How does it depend on the structure of the sunspot announcements?

Sunspot announcements

- Random extrinsic variable that is independent of the economic outcomes
- In our case: Public announcement (A) that forecasts whether many or few people will choose to withdraw
- Sunspots might serve as coordination device $\rightarrow$ to be effective: language must be meaningful + scarce information should be provided to subjects (Duffy and Fisher, 2005)
- References: Marimon, Spear and Sunder (1993), Duffy and Feltovich (2010), Fehr, Heinemann and Llorente-Saguer (2012), Arifovic, Evans and Kostyshyna (2013),

Evidence so far in bank run

- Arifovic et al. (2013) run bank run experiments in groups of 10 with different short-term return on deposits $\rightarrow$ for more extreme values of return subjects more easily coordinate on one of the pure equilibria of the game
- Arifovic and Jiang (2019) investigated 3 different values of short-term return, as well as sunspot announcements $\rightarrow$ They find that sunspot equilibria are more likely when uncertainty about coordination is higher
- We expand Arifovic and Jiang (2015) to groups e of 70-90, and consider different announcement structures
- Further literature: Madiès (2006), Garrat and Keister (2009), Schotter and Yorulmazer (2009), Kiss et al. (2012), Klos and Sträter (2013), Chakravarty et al. (2014), Brown et al. (2012), Arifovic et al.(2014)

The bank run game I

- N subjects have deposit in the bank (normalized to 1) $\rightarrow$ they can either withdraw their money, or wait $\rightarrow$ payoffs depend on the publicly known fixed short-term rate ($r = 1.54$ or $r = 1.33$) and long-term rate ($R = 2 > r$), and number of withdrawals (e)

$$\begin{aligned} \pi_{\text{withdraw}} &= \min\left\{r, \frac{N}{e}\right\}; \\ \pi_{\text{wait}} &= \max\left\{0, \frac{N - re}{N - e} R\right\}. \end{aligned}$$

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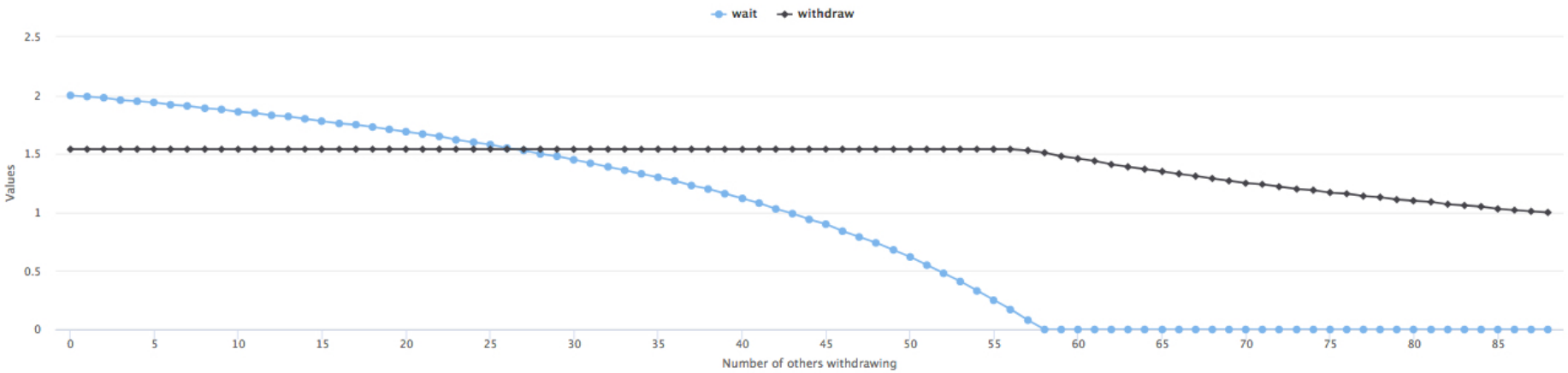
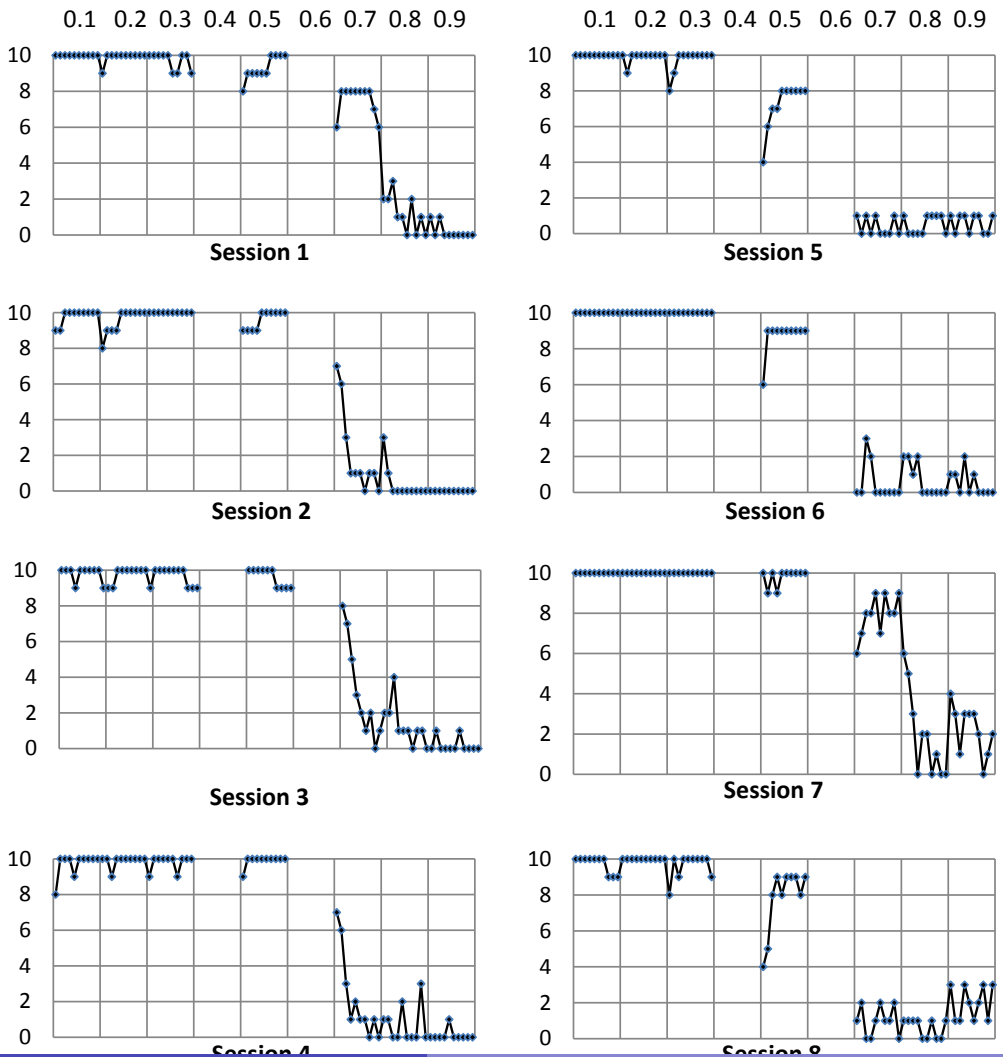


Arifovic, Jiang, and Xu, 2013

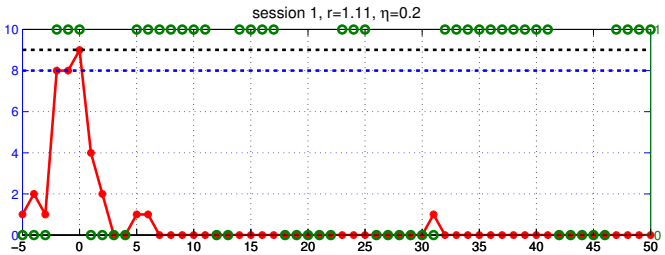
Figure 1a: Experimental Results (Sessions 1-8)

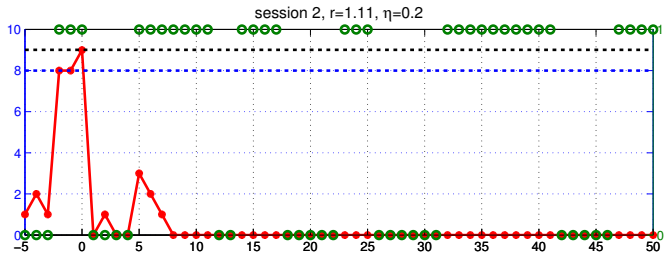


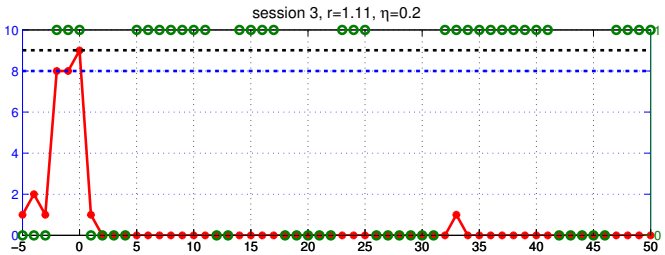
The bank run game II

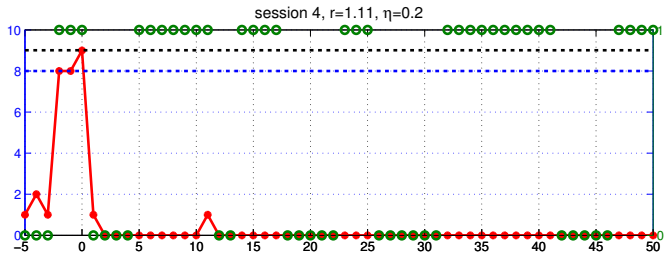
- Two realizations for sunspot announcements:
  - "The forecast is that e^* or **more** people will choose to withdraw."
  - "The forecast is that e^* or **less** people will choose to withdraw."
- Arifovic and Jiang (2019) - N =10, $r = 1.1$, $r = 1.54$, and $r = 1.82$
- persistence parameter $\rho = 0.8$

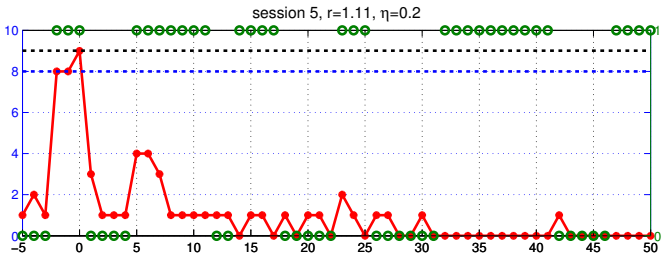
Arifovic and Jiang, 2019, r=1.11

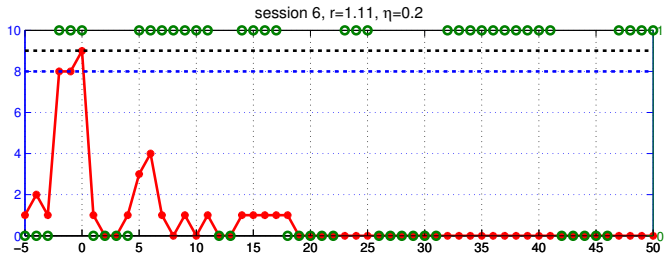




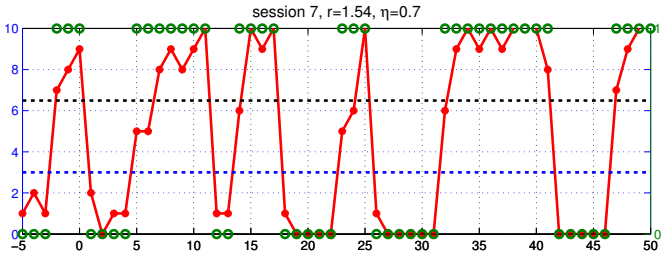


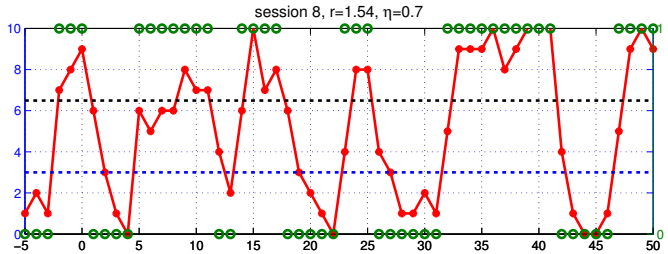


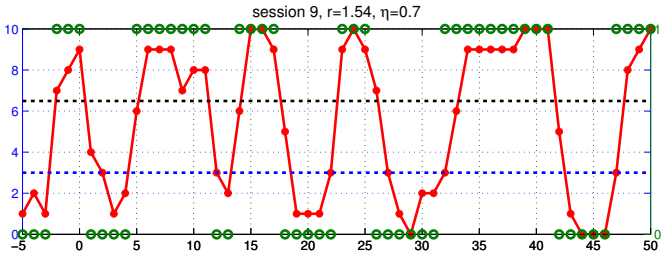


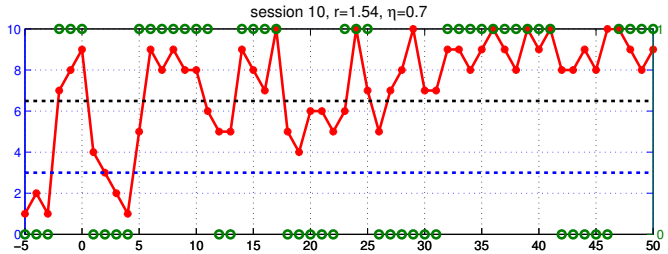


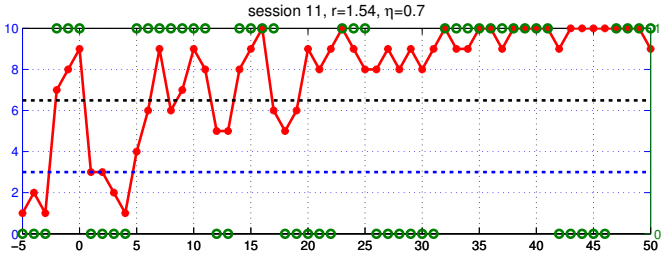
Arifovic and Jiang, 2019, r = 1.54

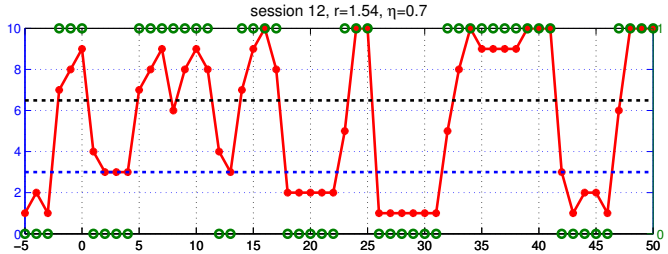




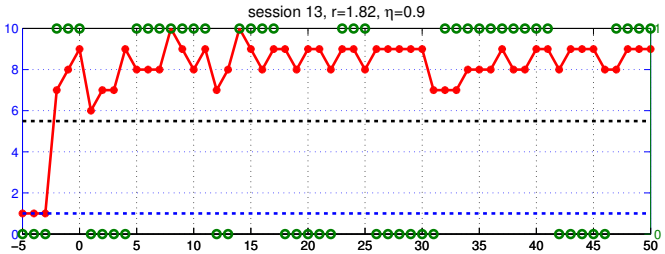


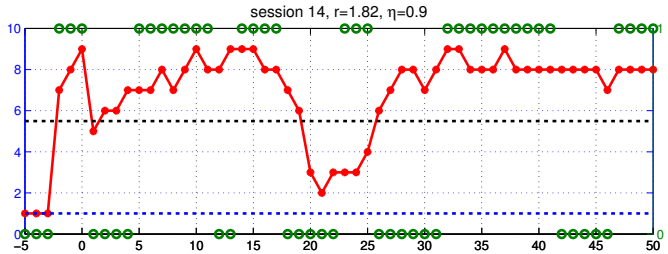


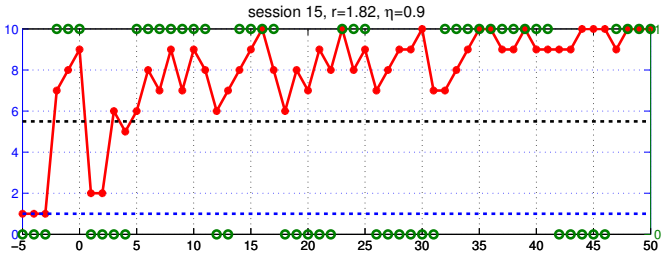


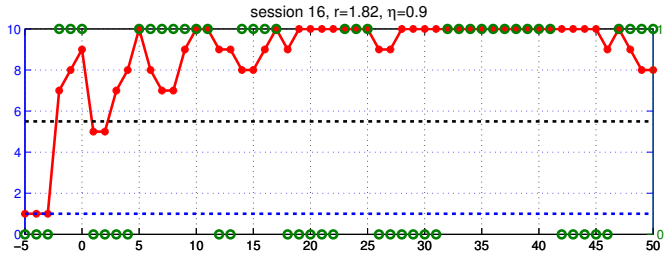


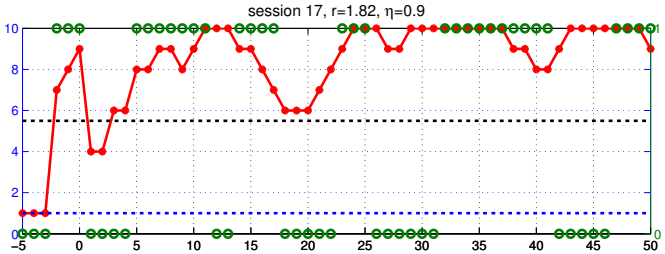
Arifovic and Jiang, 2019, r = 1.82

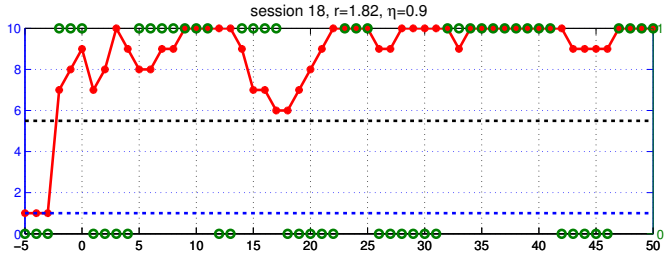












Our paper:

- objective: investigate the behavior in small versus large groups
- we chose the following parameters:
- e^*: number of people withdrawing such that the two strategies result in the same payoff $\Rightarrow$ for $r = 1.54$ ($r = 1.33$) 30% (50%)

- Markov process: A remains same in next period with a given probability, ρ ($\rho = 0.5$ or $\rho = 0.8$) $\rightarrow$ same sequence of extrinsic random variable realizations was used for all sessions

Treatments and procedure

Payoff structure	$r = 1.54$	$r = 1.54$	$r = 1.33$
Persistence parameter	$\rho = 0.5$	$\rho = 0.8$	$\rho = 0.8$
group size			
Small	*SmallVar*	*SmallRun*	*SmallWait*
Large	*LargeVar*	*LargeRun*	*LargeWait*

Table 1: Summary of the experimental treatments

- 56 periods of simultaneous move game: 6 (unpaid) training + 50 formal $\rightarrow$ during training subjects played against robots programmed to follow the sunspot

- The labs in Amsterdam and Valencia connected via internet: 4-4 groups for the large treatments, 6-6 groups in the small treatments (16 sessions in total with 1246 subjects) $\rightarrow$ each session $\approx$ 2 hours with mean earnings $\approx$ 17 euros plus show-up

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3. Sunspot-driven coordination is more likely when $r = 1.54$ than when $r = 1.33$, but does not depend on group size N.

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Main results

5 types of behavior were observed

1. Convergence to **run** equilibrium
2. Convergence to **wait** equilibrium
3. Following the **sunspot** announcements
4. Transient sunspot followed by convergence to **run**
5. Transient sunspot followed by convergence to **wait**

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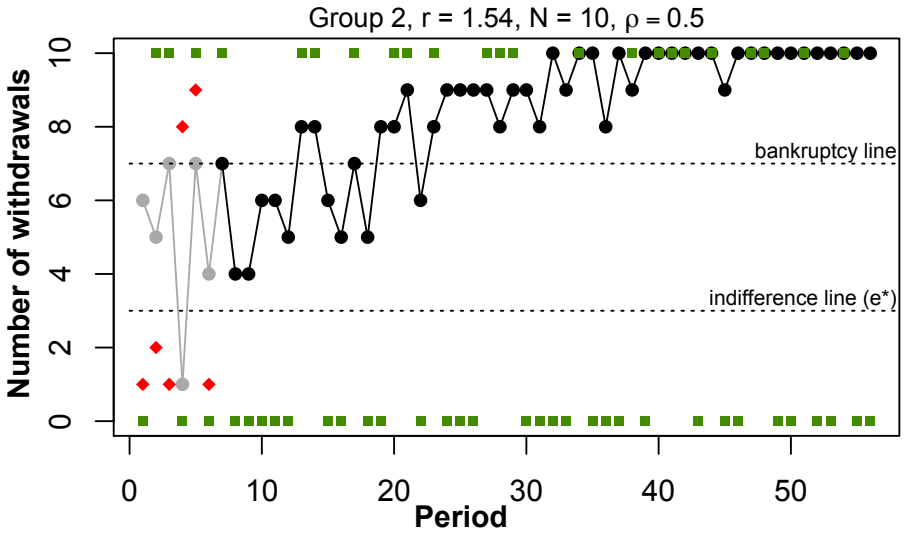
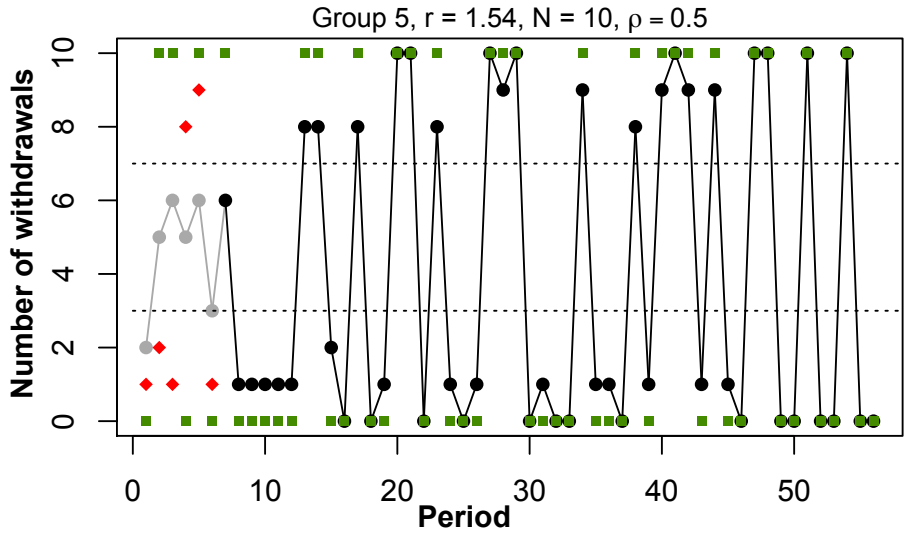
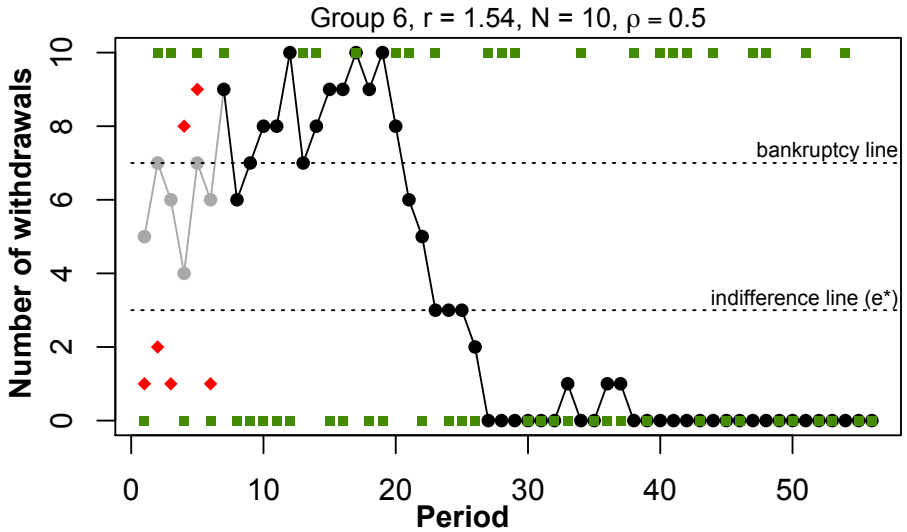
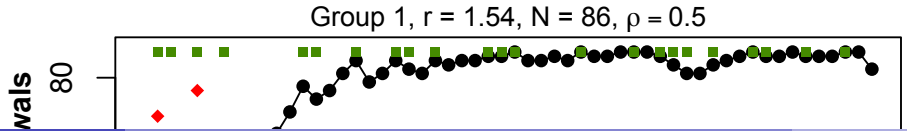
	Small group	Large group
$r = 1.54,\ \rho = 0.5$	**3** type 1, **1** type 2, **2** type 3	**4** type 1
$r = 1.54,\ \rho = 0.8$	**2** type 1, **2** type 2, **2** type 5	**3** type 1, **1** type 4
$r = 1.33,\ \rho = 0.8$	**6** type 2	**4** type 2

$r = 1.54$ and $\rho = 0.5$ (no persistence)

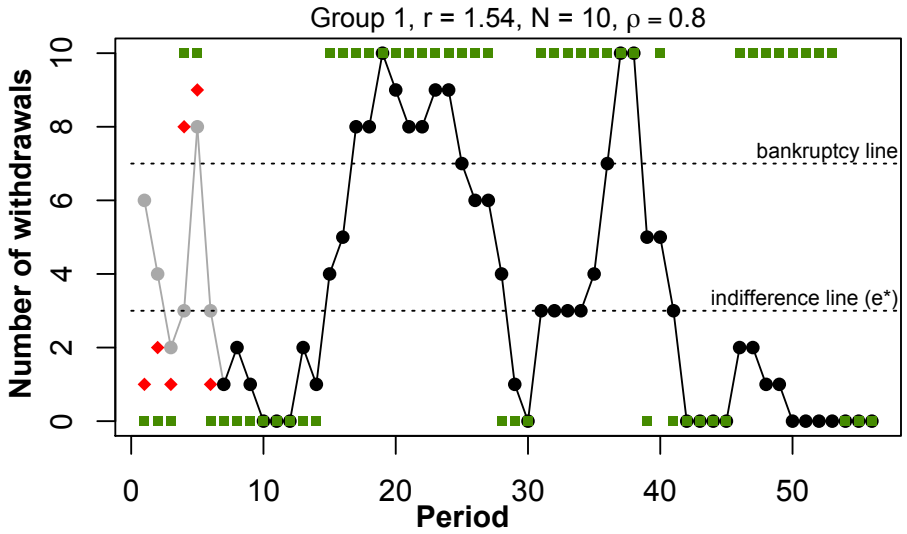


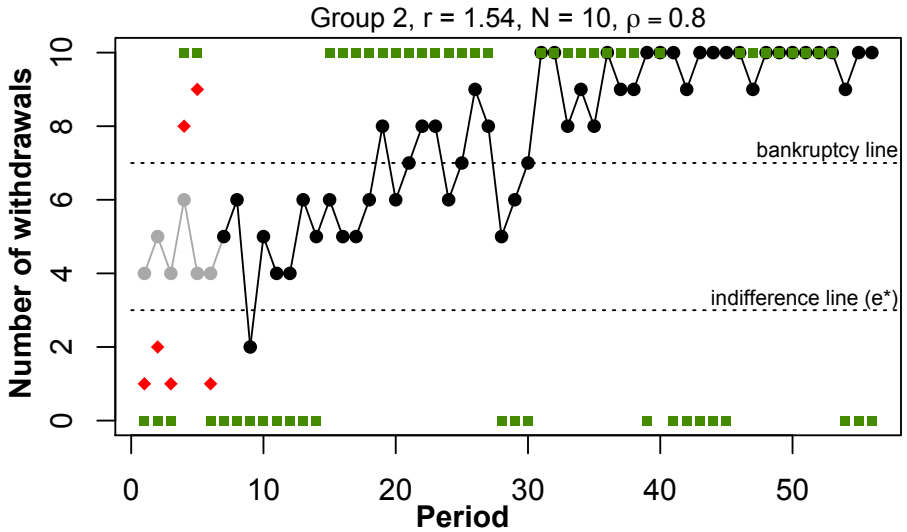


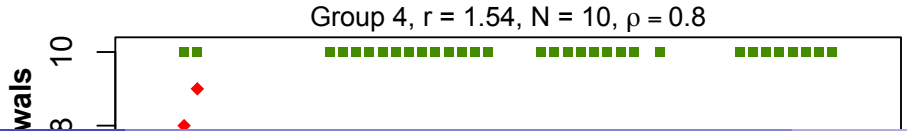




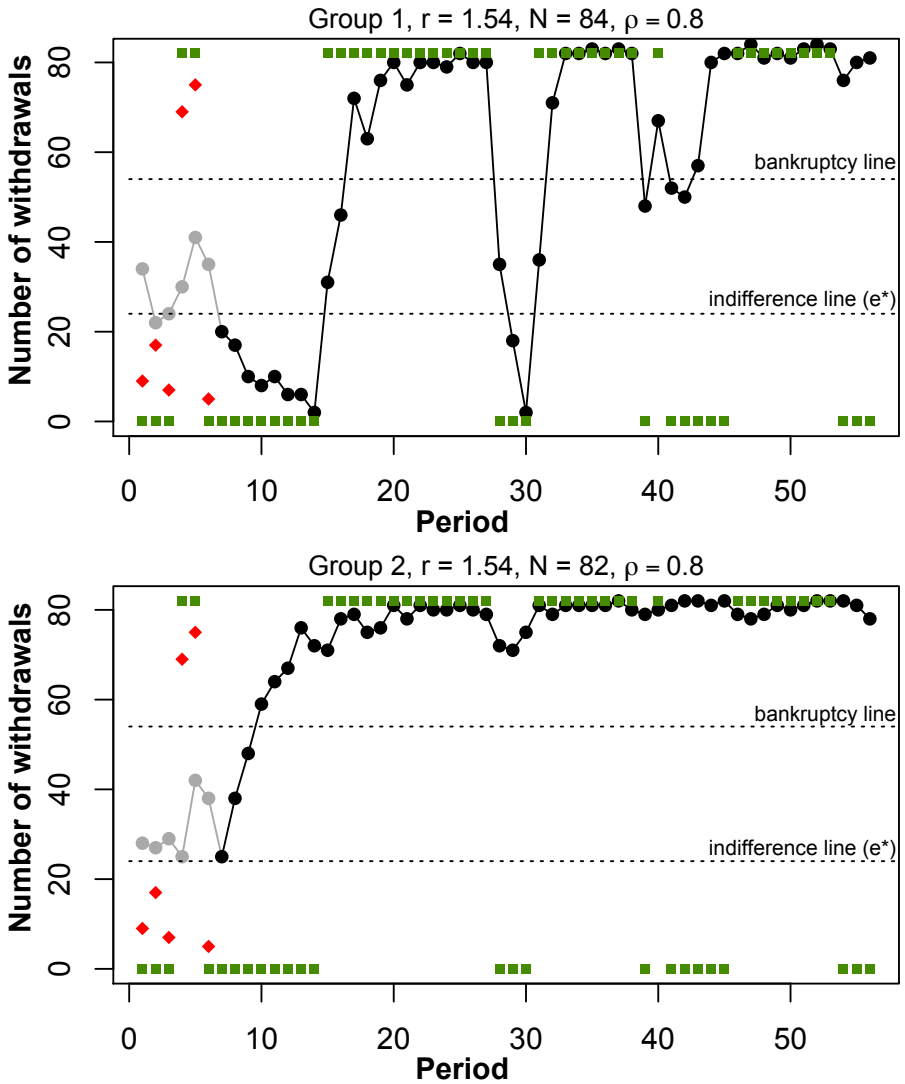
$r = 1.54$ and $\rho = 0.8$, small groups



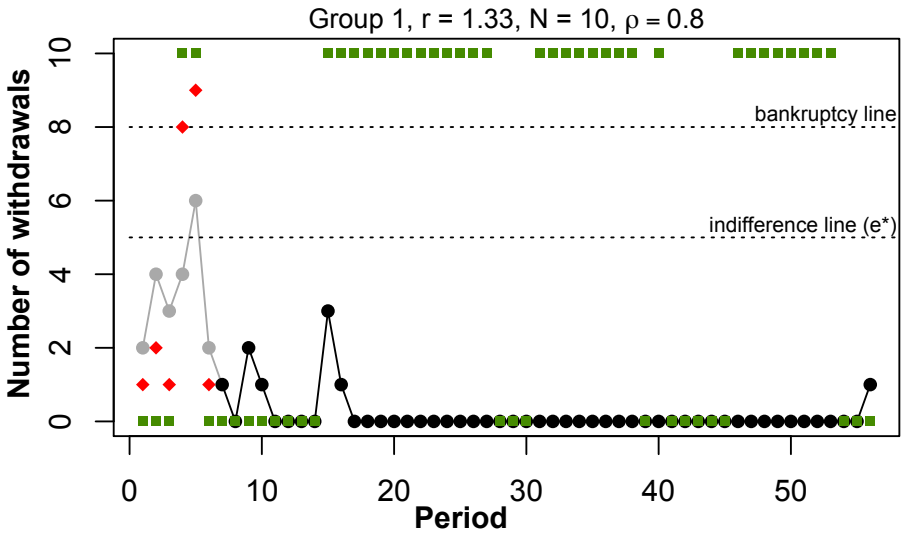


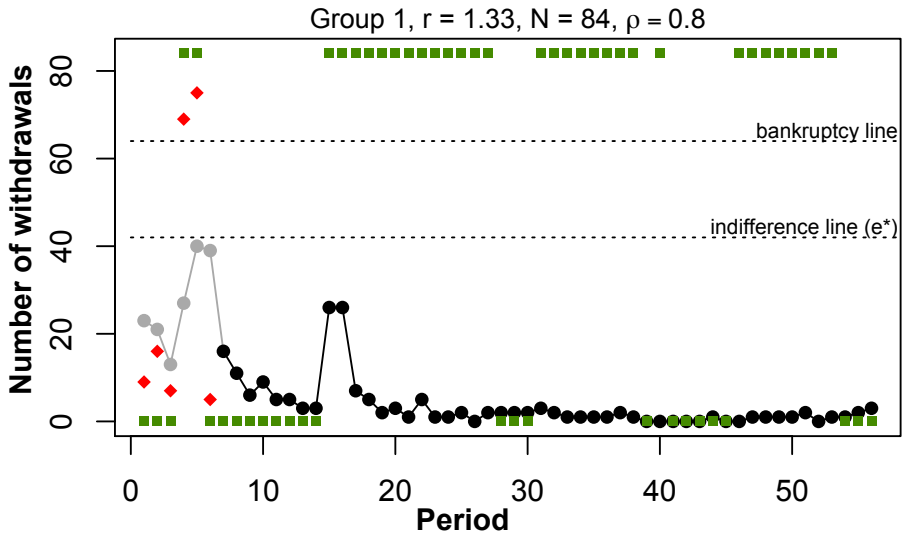


$r = 1.54$ and $\rho = 0.8$, large groups

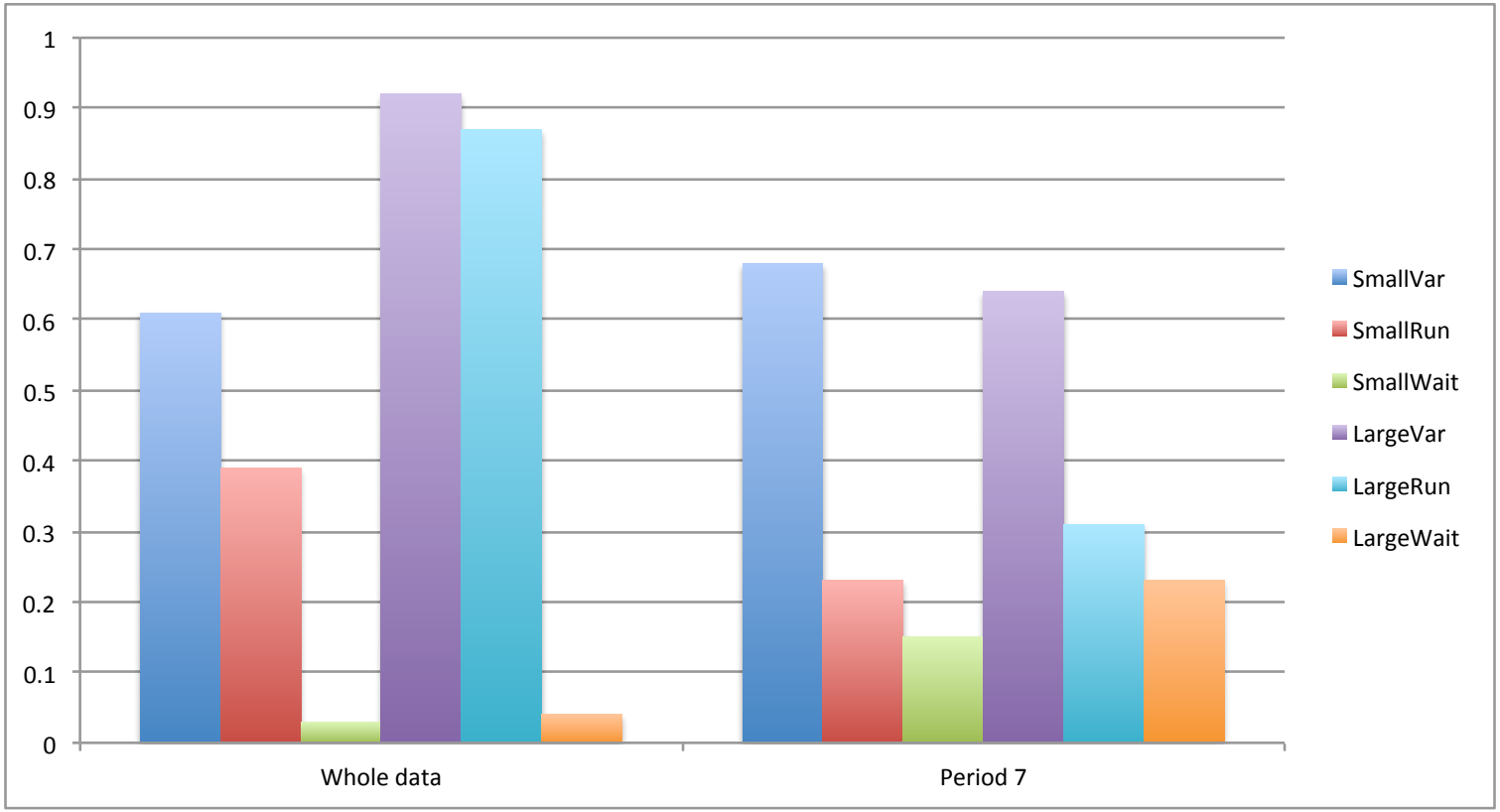


$r = 1.33$ and $\rho = 0.8$





Mean withdrawal rates



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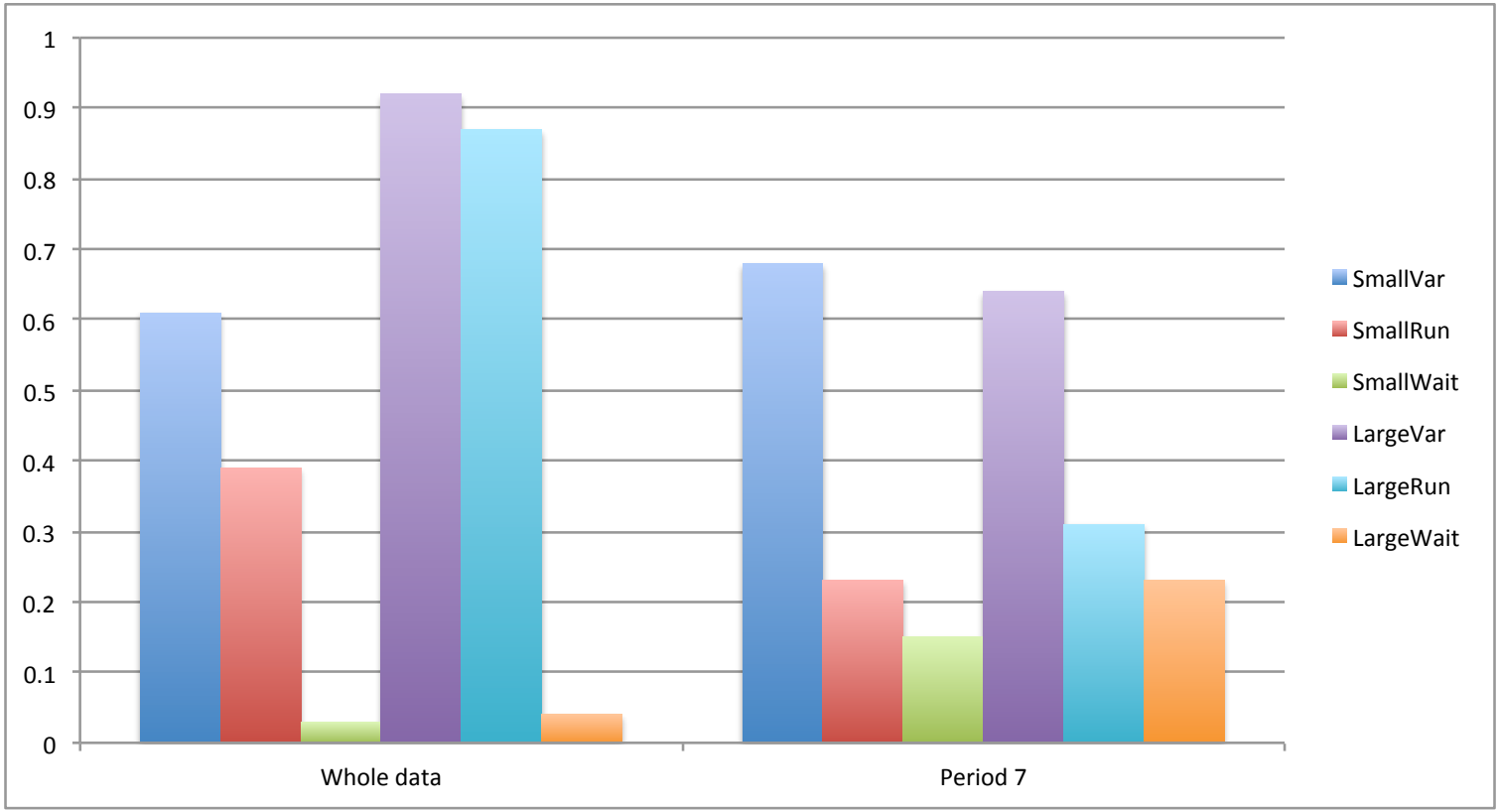
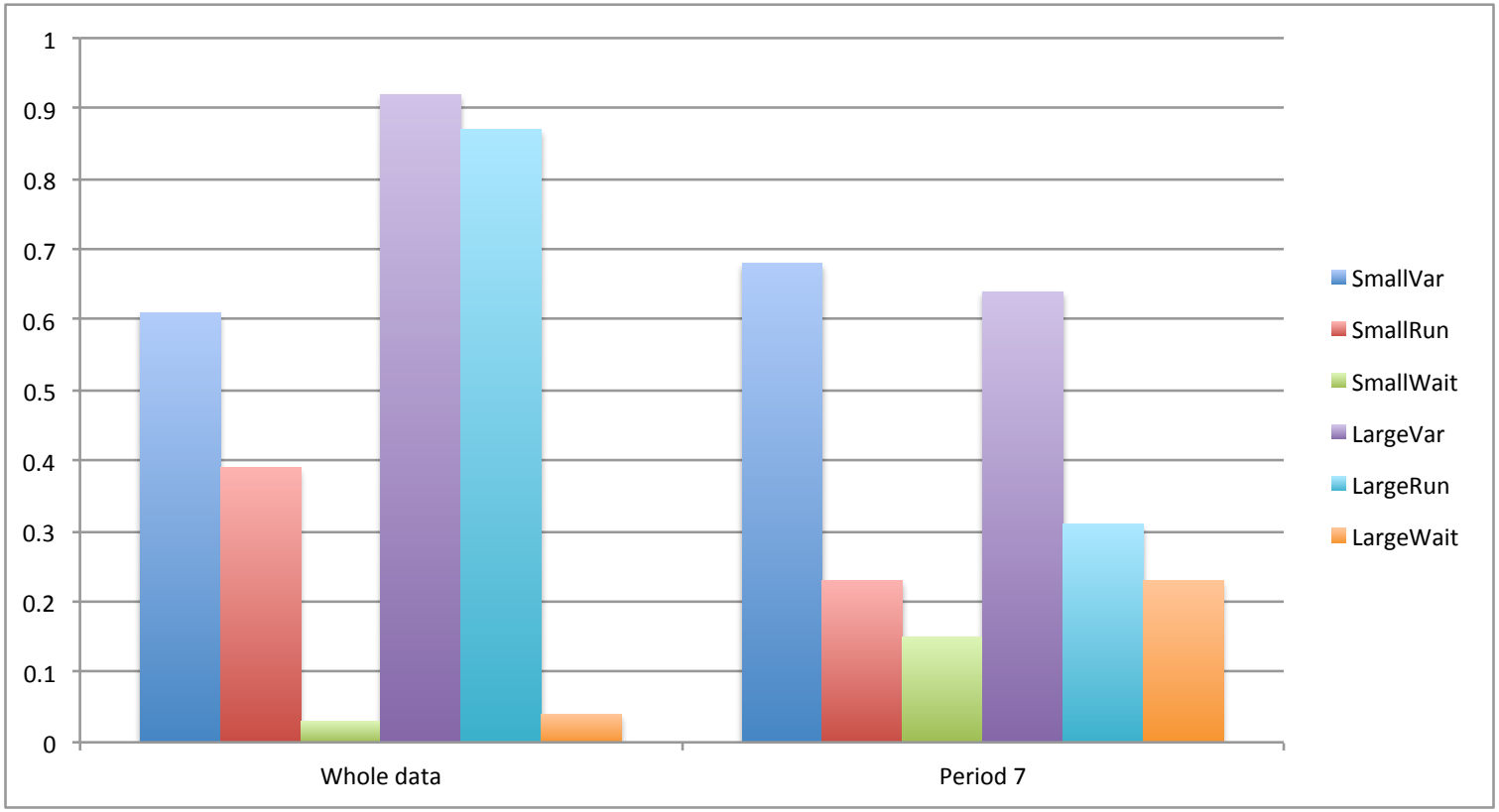


Whole data:

- For $r = 1.54$, ρ fixed significant group size difference

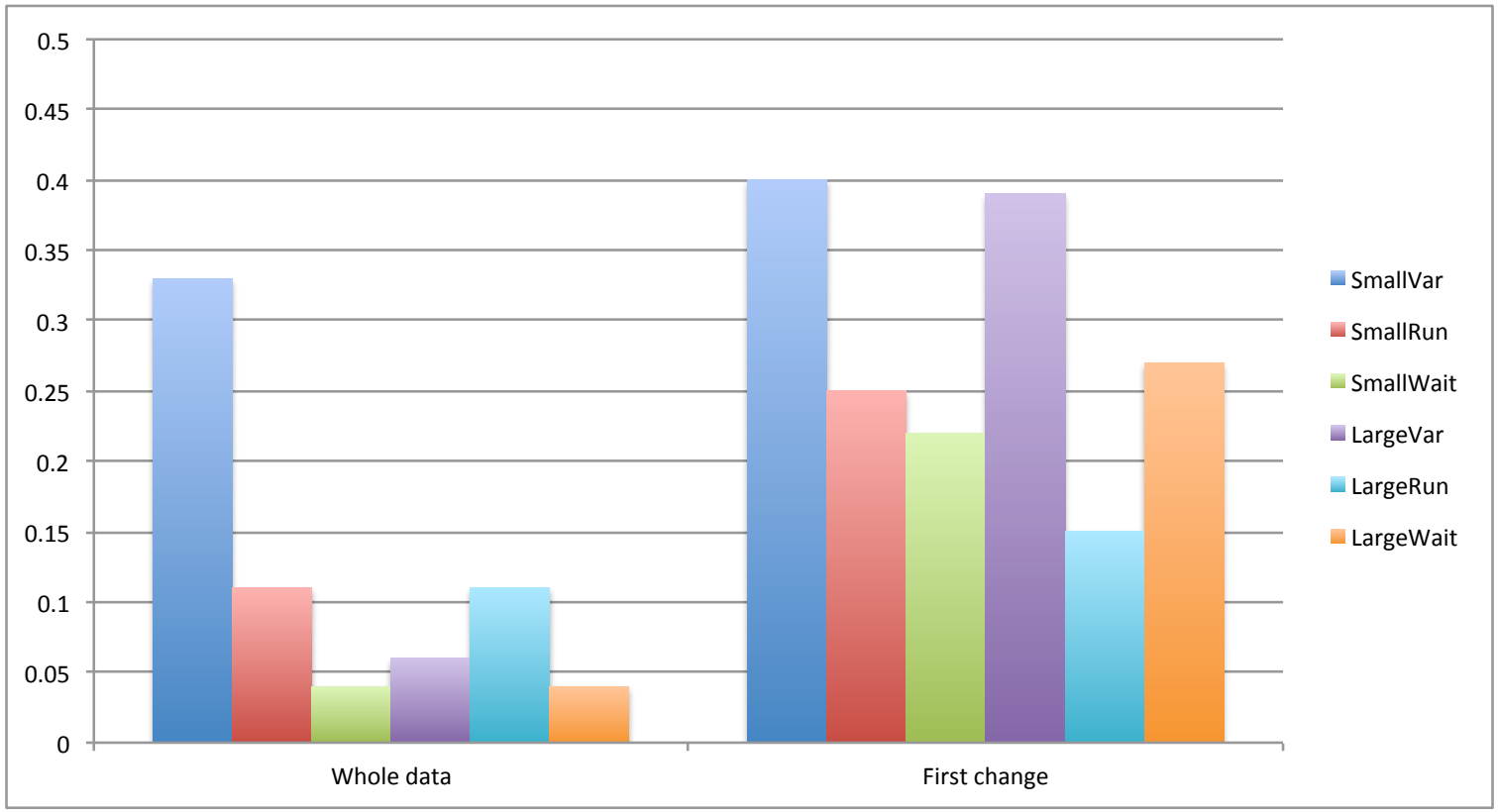
Mean withdrawal rates



Period 7:

- No group size difference
- For r fixed, significant difference when changing $\rho \rightarrow$ effect of the first announcement

Following the announcement



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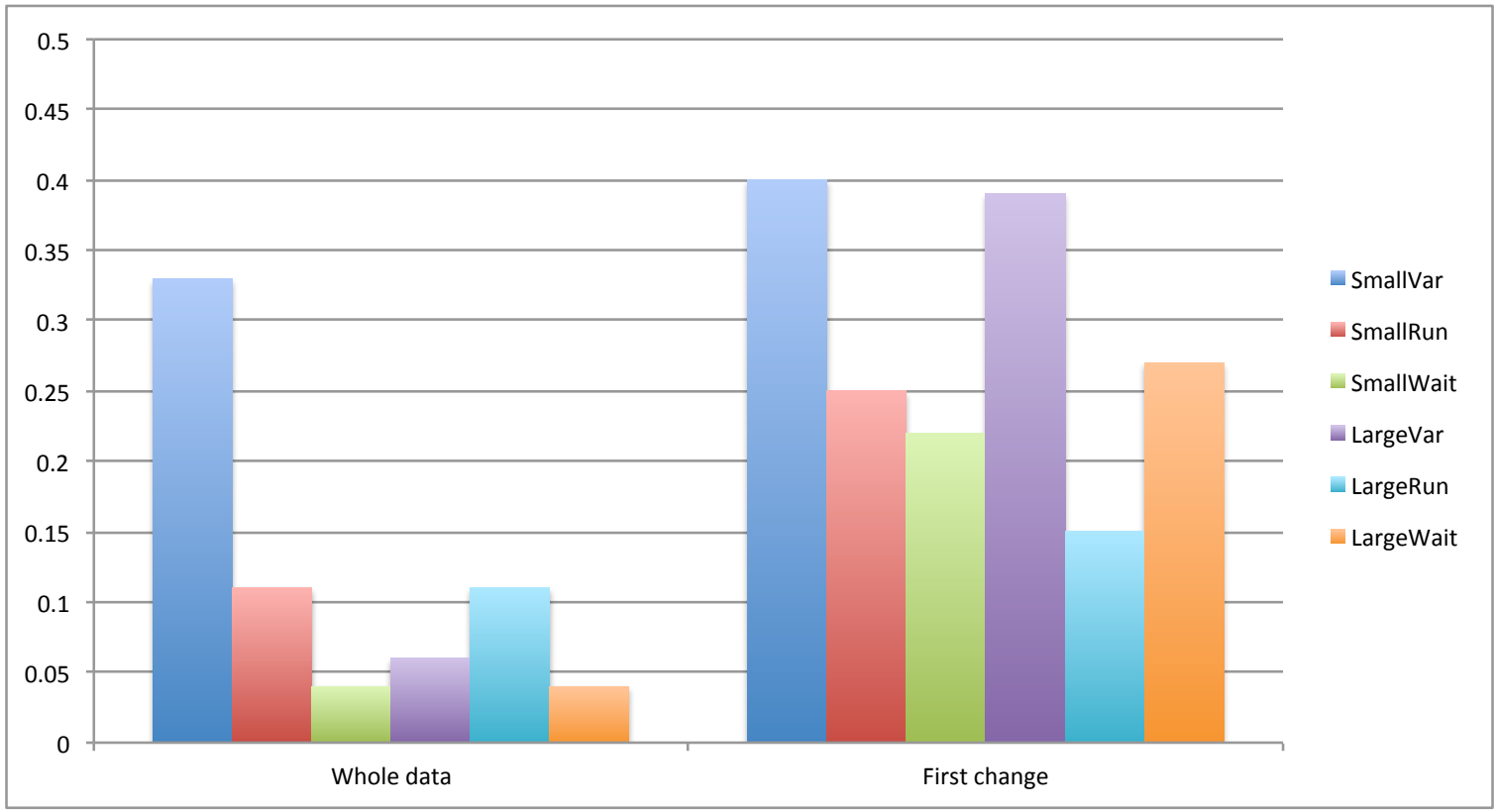
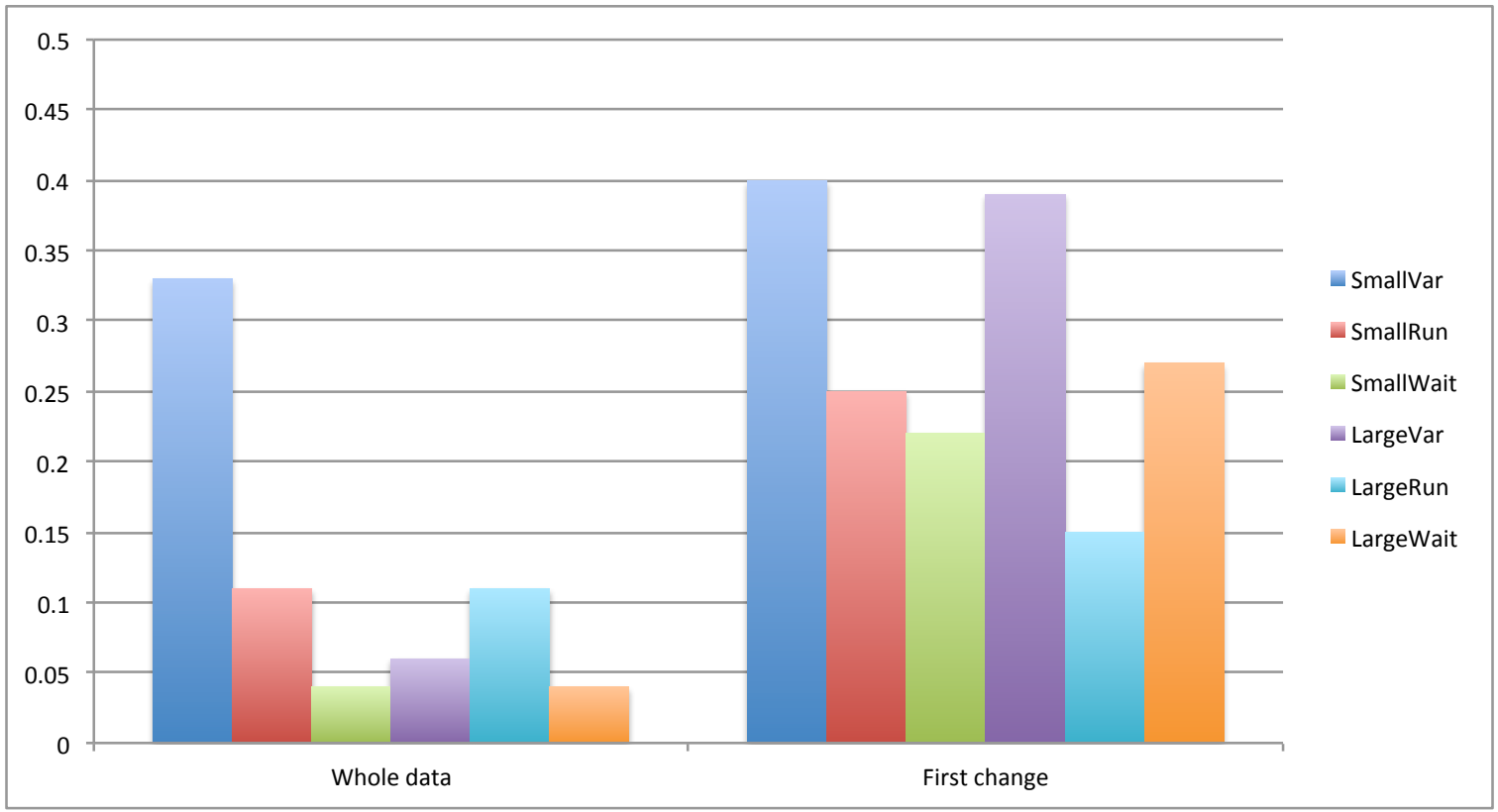


Whole data:

- Weakly significant group size effect in Var treatment ($\rho = 0.5$)

Following the announcement



First change:

- No group size difference

On discarding the announcement

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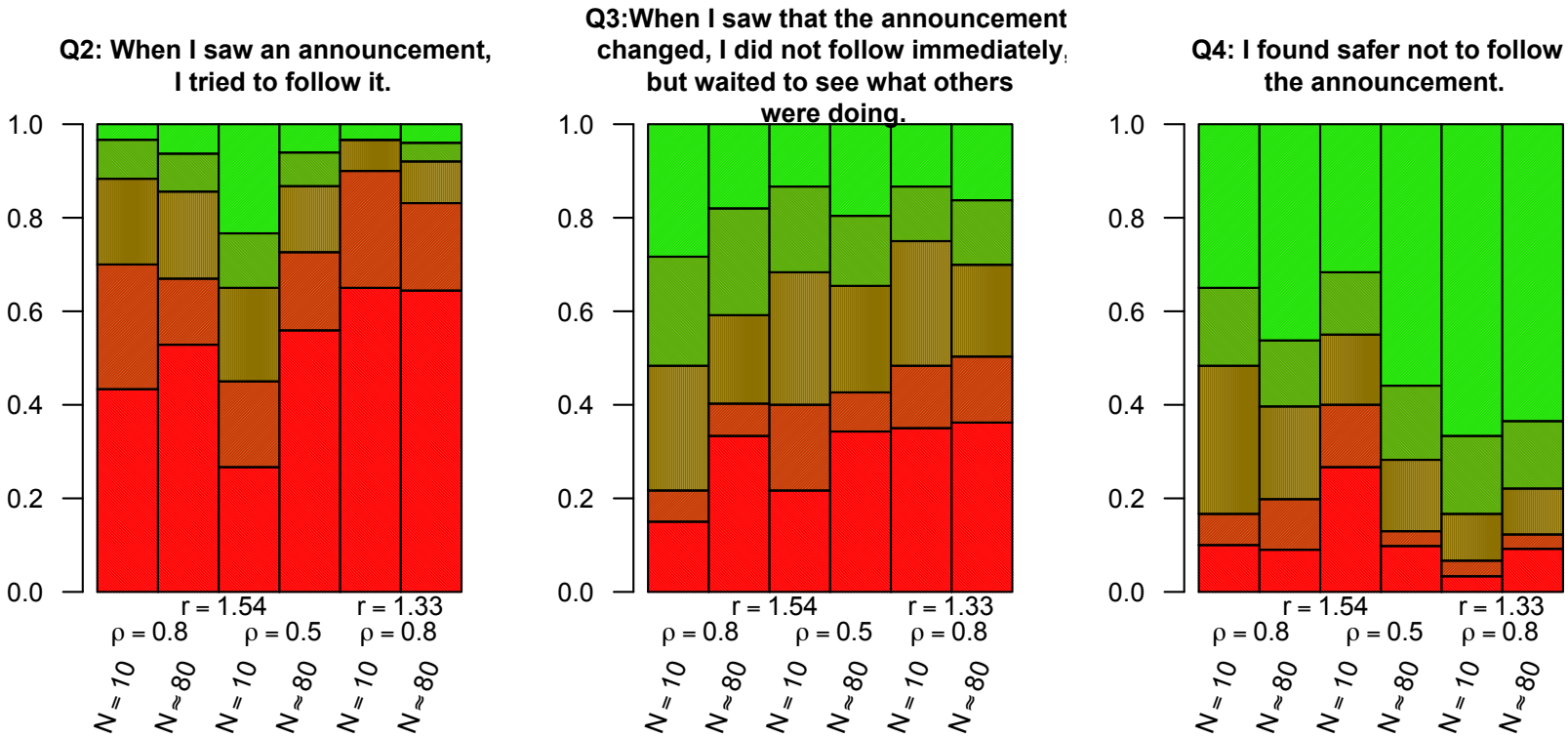
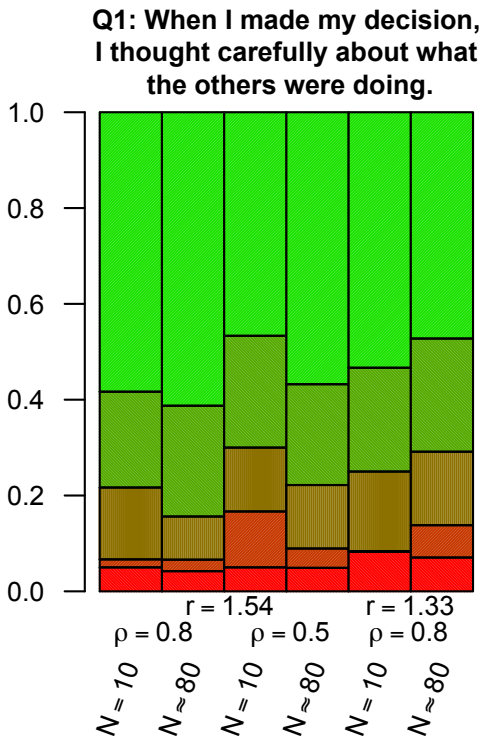


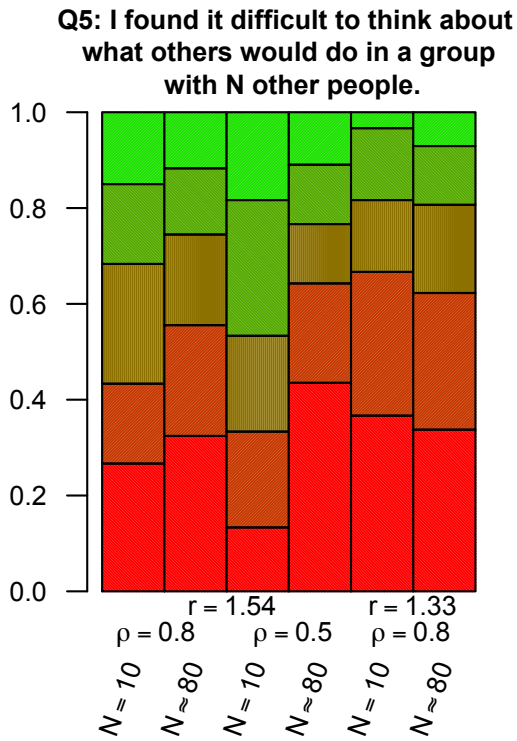
(e) Question 2 (f) Question 3 (g) Question 4

Notes: The answers are scaled from 1, corresponding to 'strongly disagree', to 5, i.e. 'strongly agree', with 3 being a 'neutral' statement.

On strategic uncertainty

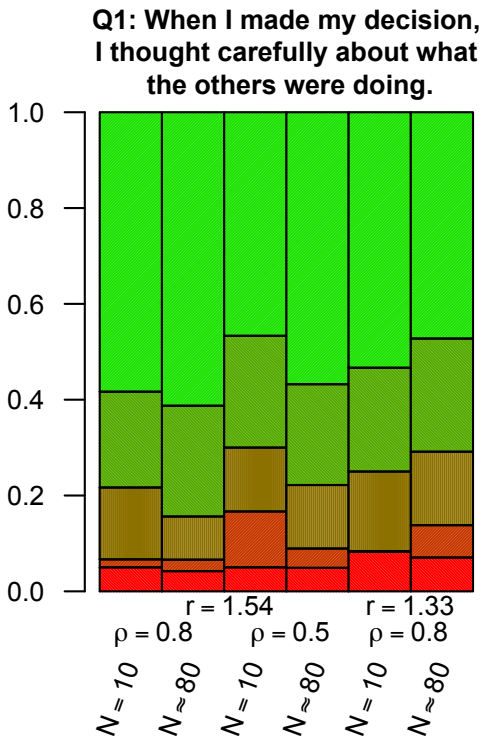


(i) Question 1

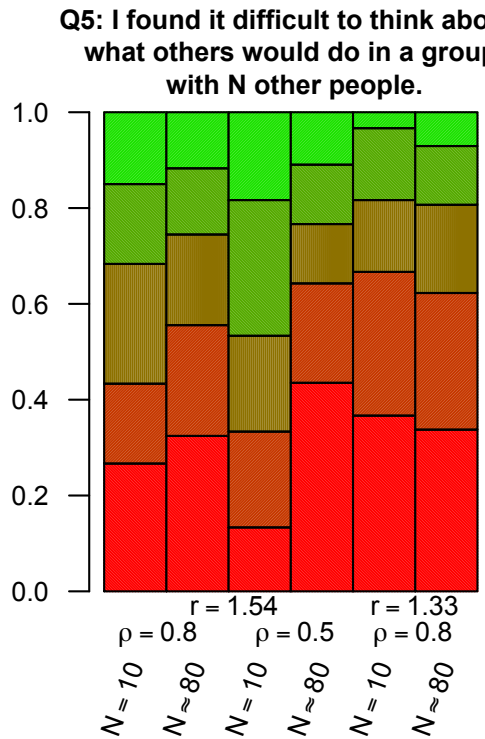


(j) Question 5

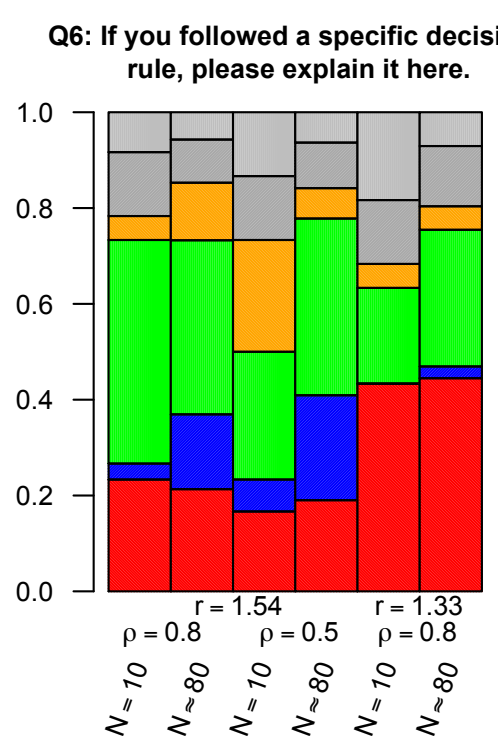
On strategic uncertainty



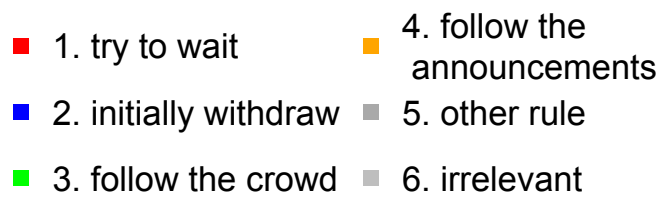
(n) Question 1



(o) Question 5



(p) Question 6



Develop a behavioral model

- Individual evolutionary learning model - adapts to 'no-run' equilbrium for 'low' values of r
- It adapts to 'run' equilibrium for 'high' values of r
- it learns to follow the 'announcements' for intermediate values of r
- no difference in between 'small' and 'large' groups
- we are working on developing a behavioral model that would take this into account

Conclusion

- Large groups are more likely to end up in the run equilibrium than small groups, when 'waiting' is perceived relatively risky
- Group size does not matter when 'wait' is more attractive
- Sunspot announcements have only weak effect for large groups $\rightarrow$ in small groups (close to) sunspot equilibrium was observed in the more volatile environment
- Following the message is viewed more risky in large groups

Thank you for your attention.
Any questions, comments?

Decision screen

TIME: 00:33

Period 2 (training period)

The forecast is that 3 or more people will choose to withdraw

Do you want to withdraw or wait?

wait withdraw

Submit

Payoff calculator

Here you can calculate payoffs from waiting and withdrawing.

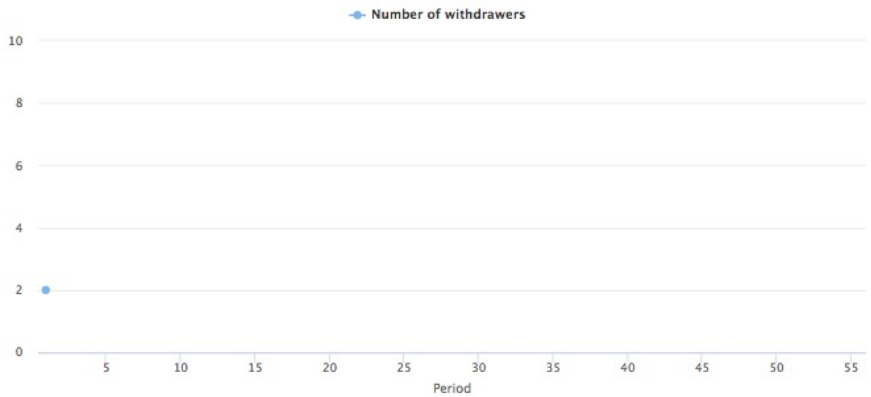
Enter how many **other** people withdraw in your group:

Your payoff if you wait:

Your payoff if you withdraw:

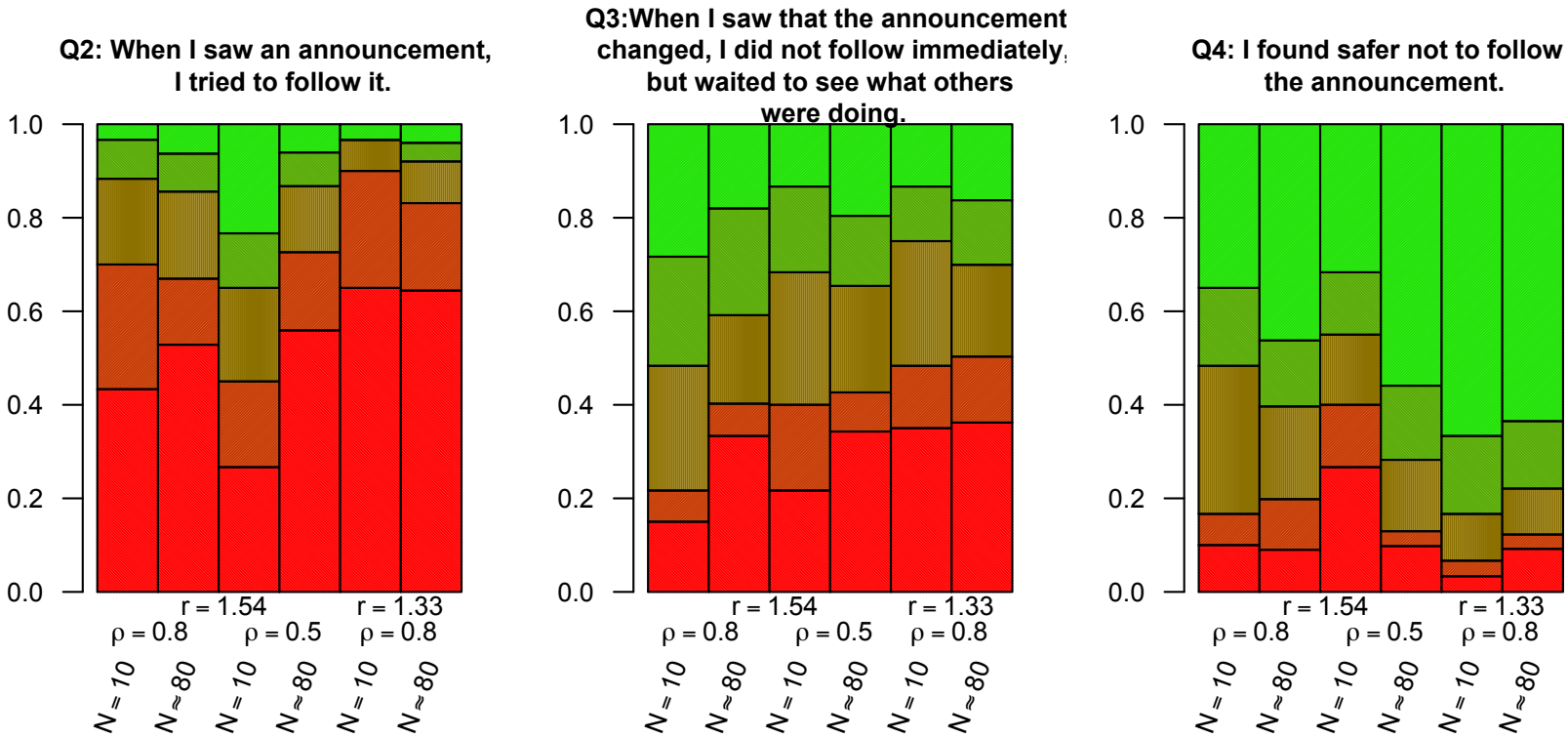
Calculate your payoffs

Past information



Period	Announced withdrawals	Number of withdrawals	Your choice	Period earnings	Total earnings
1	3 or fewer	2	withdraw	1.54	0

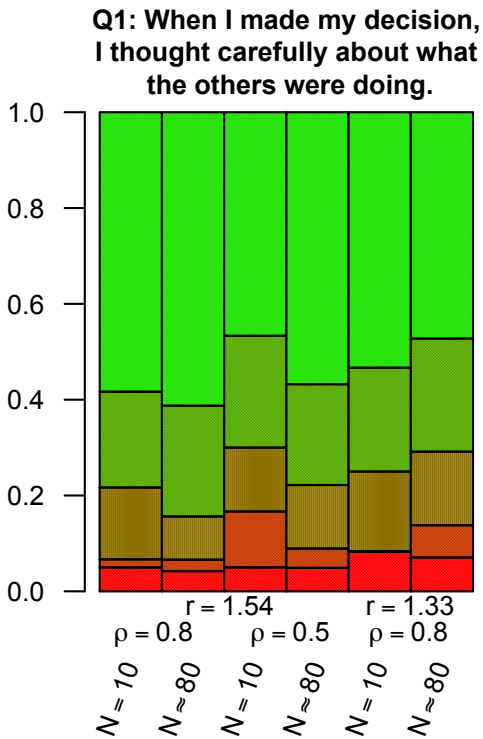
On discarding the announcement



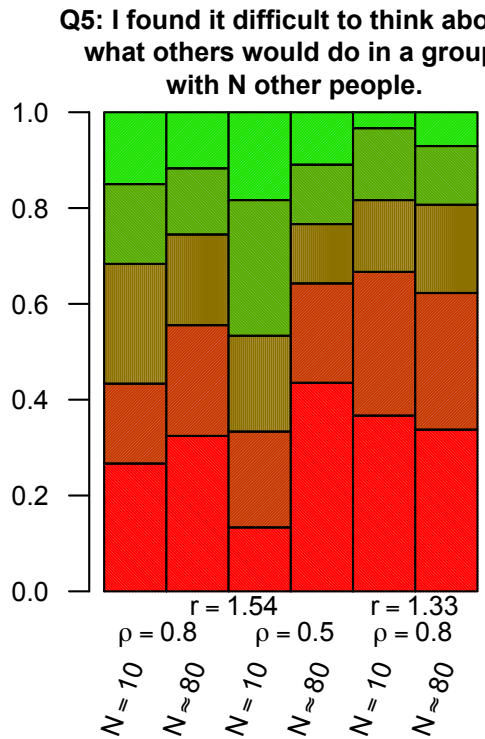
(s) Question 2 (t) Question 3 (u) Question 4

Notes: The answers are scaled from 1, corresponding to 'strongly disagree', to 5, i.e. 'strongly agree', with 3 being a 'neutral' statement.

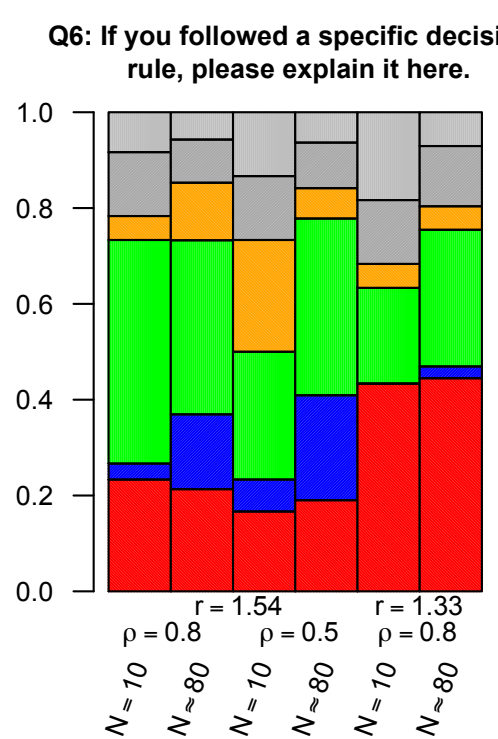
On strategic uncertainty



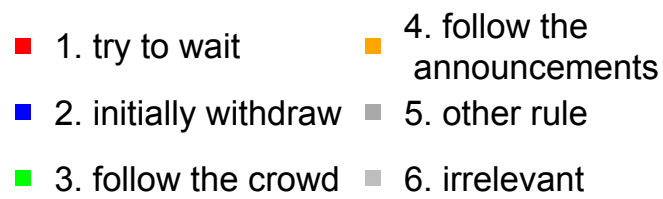
(w) Question 1



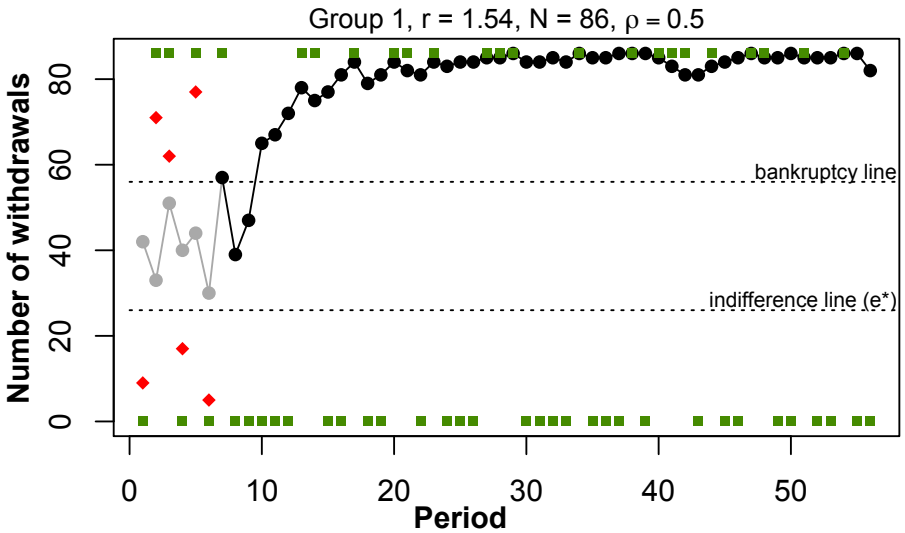
(x) Question 5

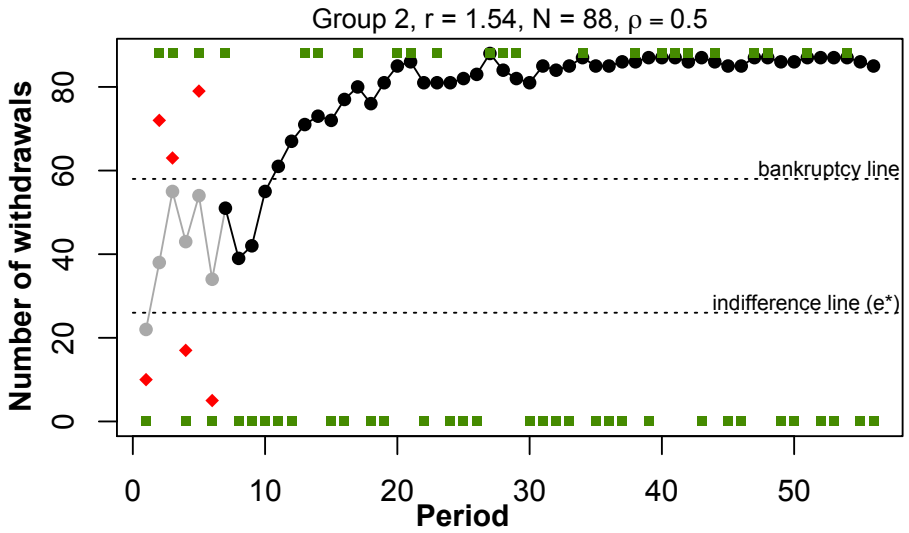


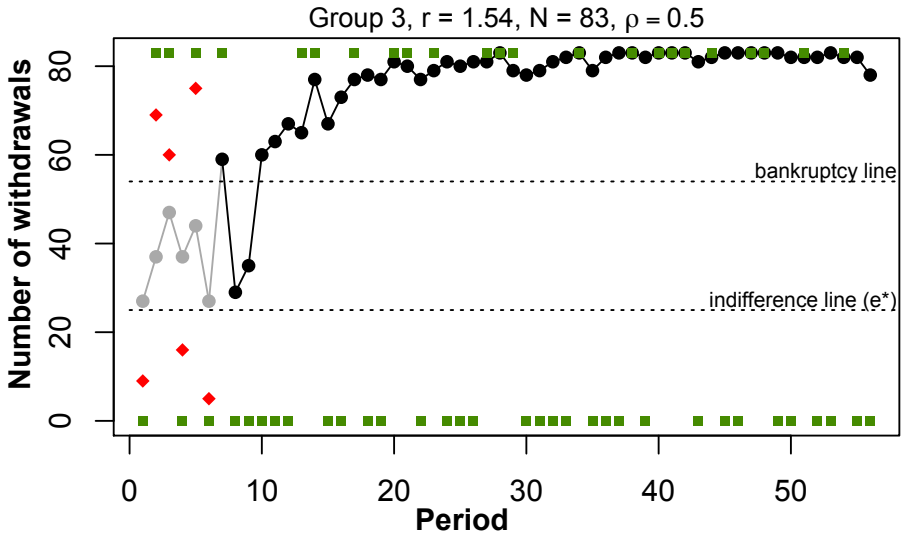
(y) Question 6

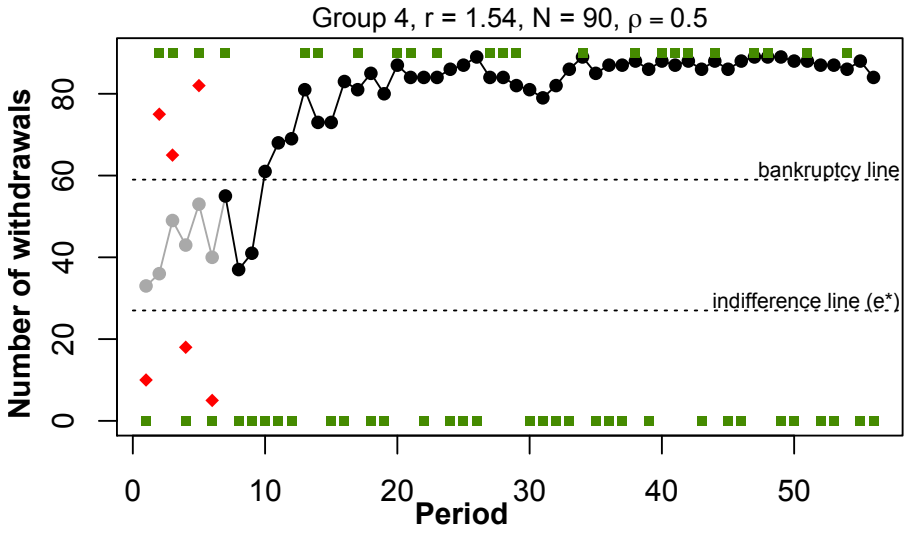


Large groups $r = 1.54$ and $\rho = 0.5$

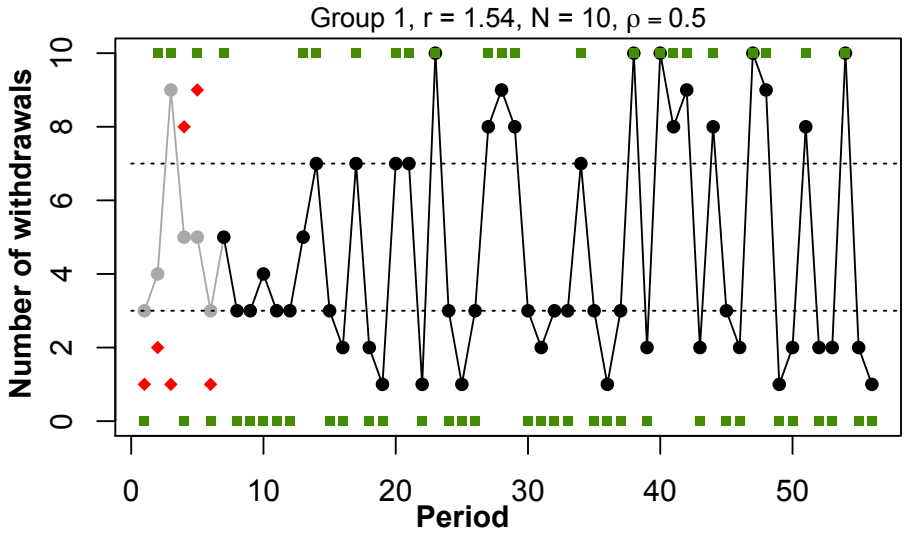


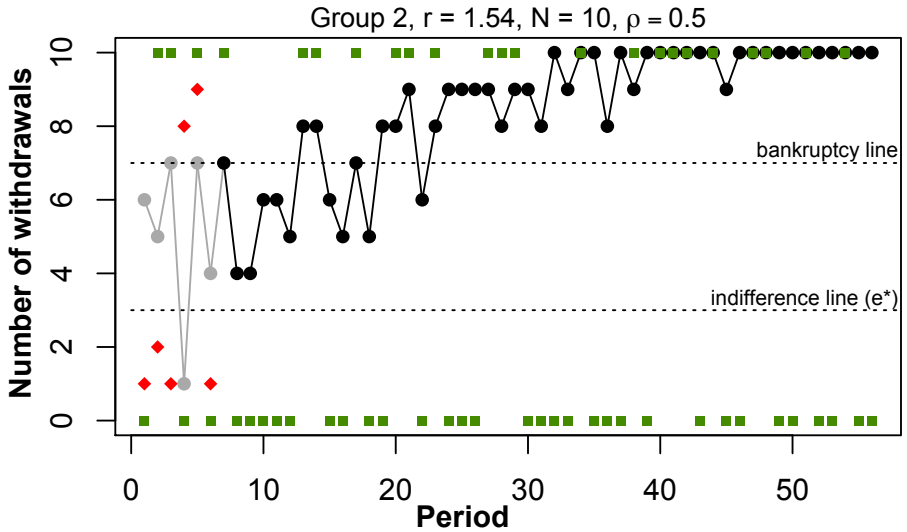


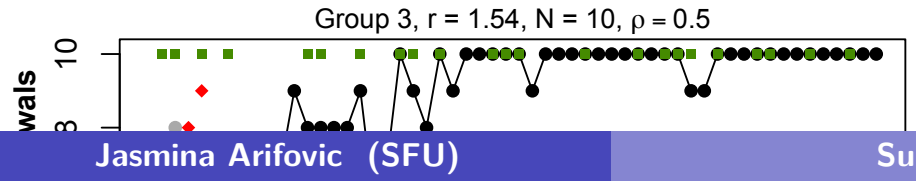


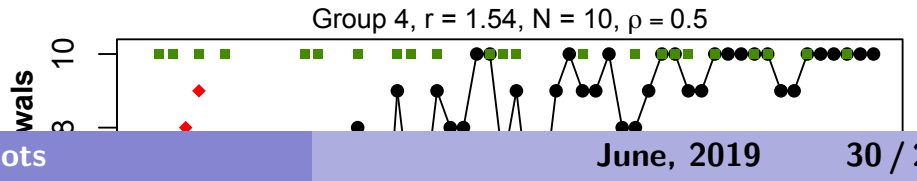


Small groups $r = 1.54$ and $\rho = 0.5$

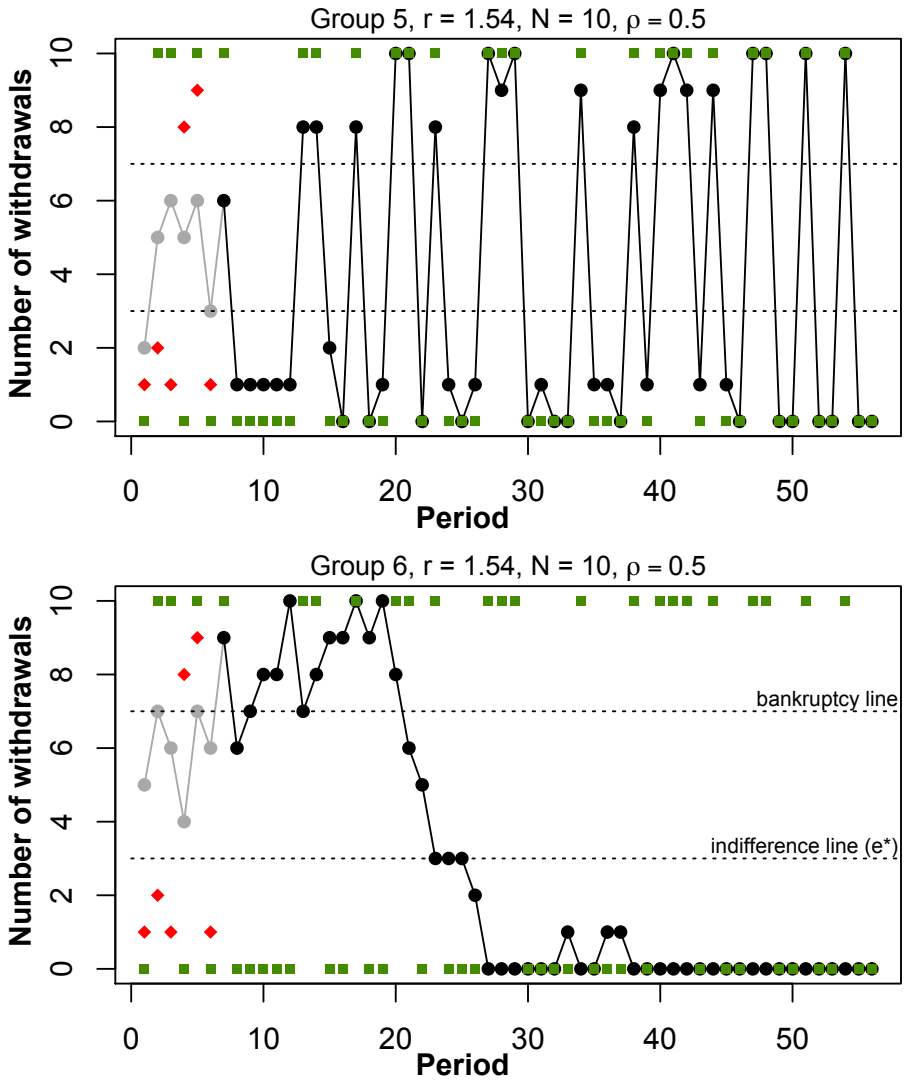




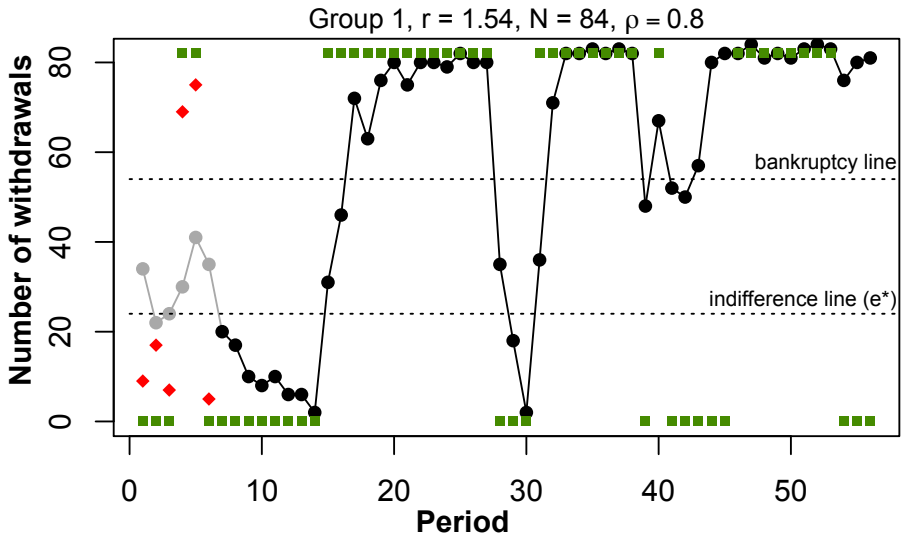


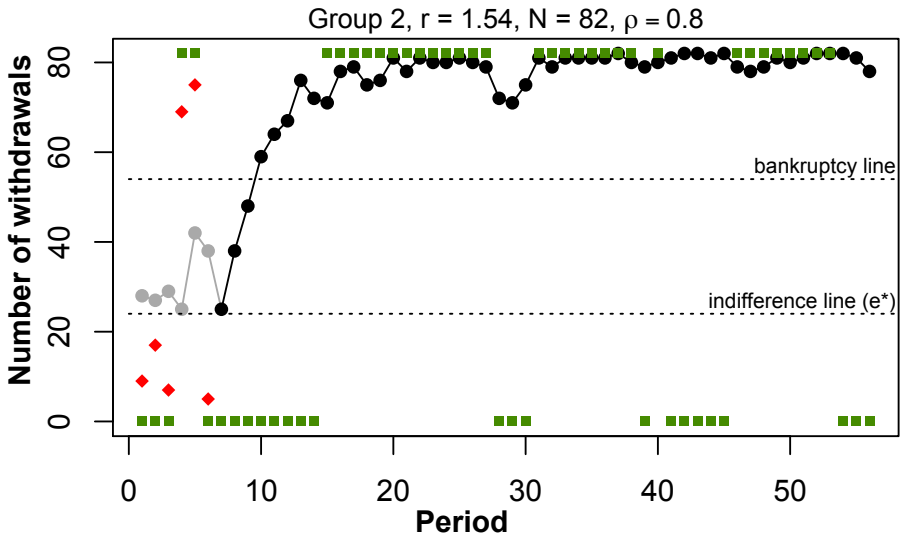


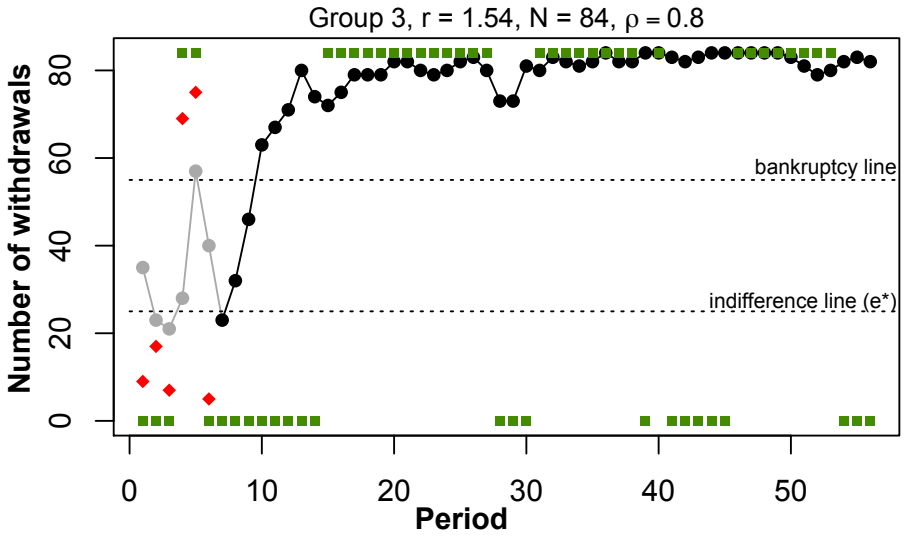
Small groups $r = 1.54$ and $\rho = 0.5$ (cont.)

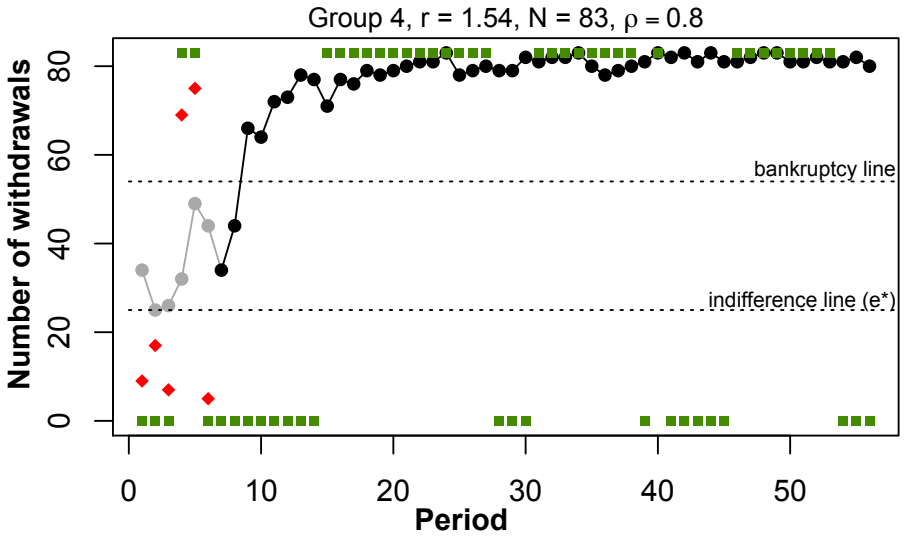


Large groups $r = 1.54$ and $\rho = 0.8$

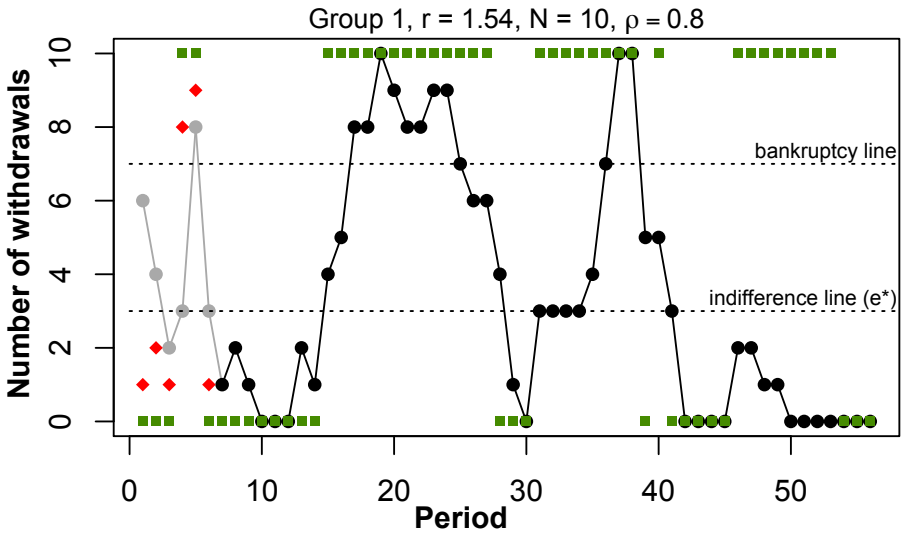


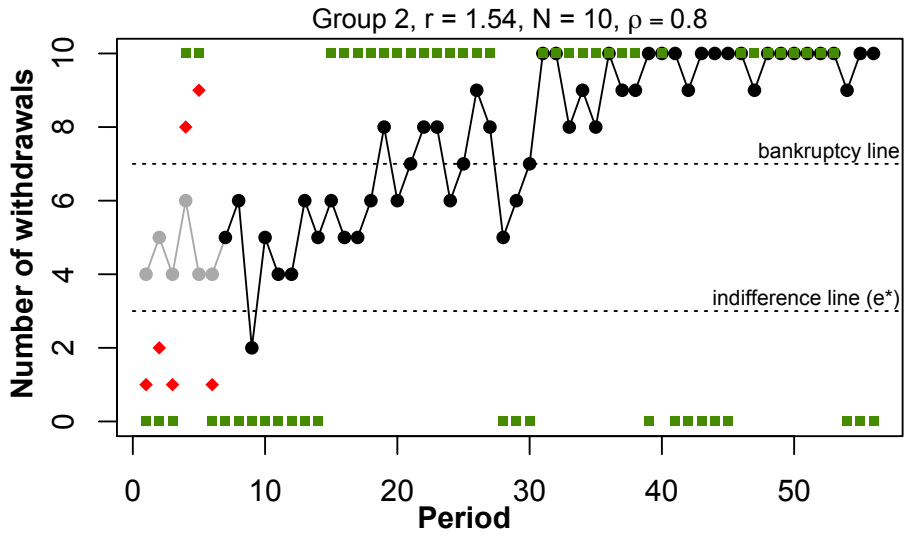


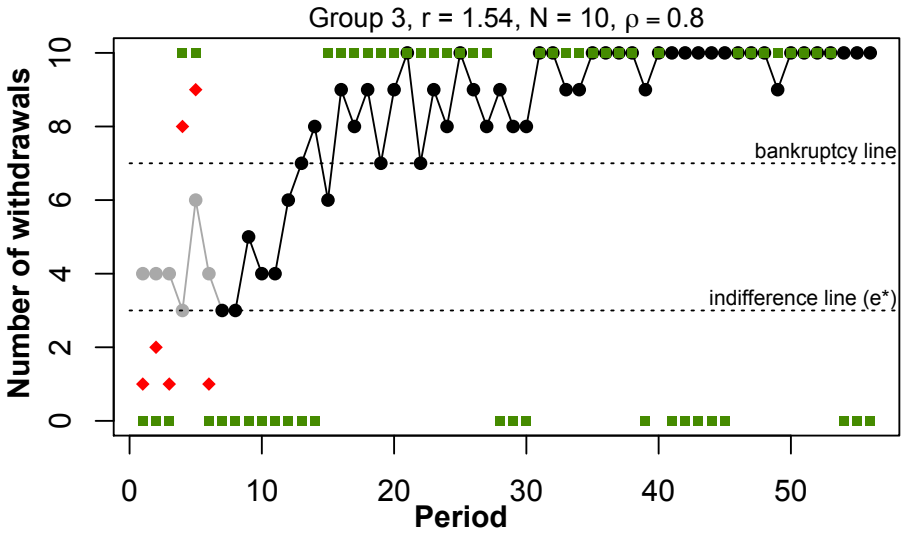


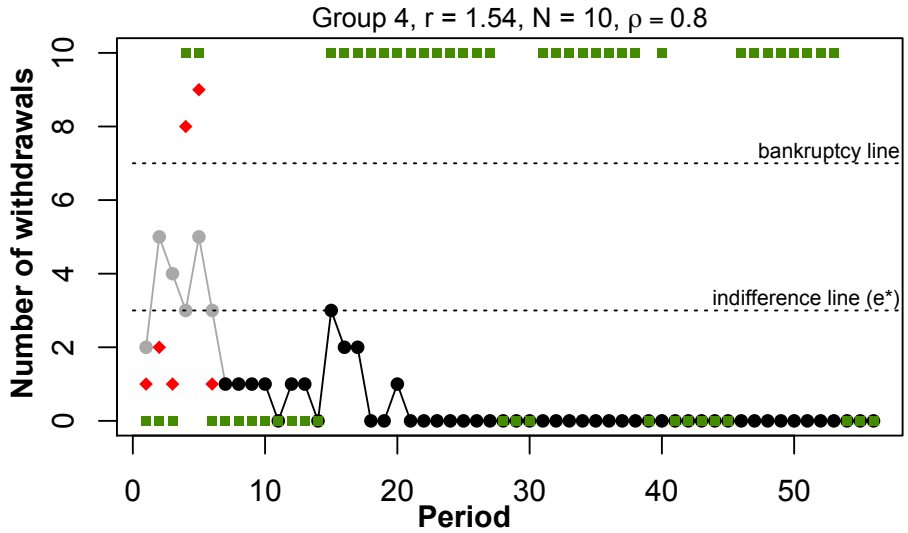


Small groups $r = 1.54$ and $\rho = 0.8$

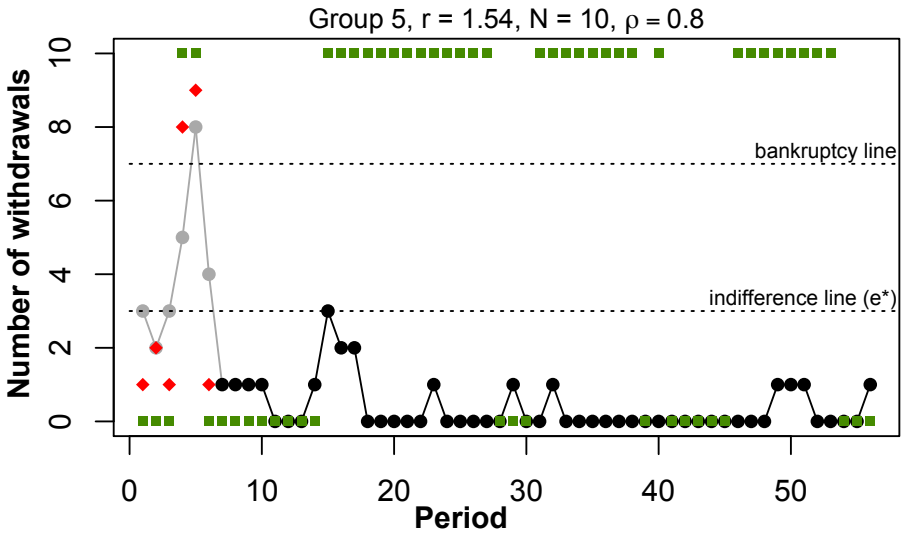


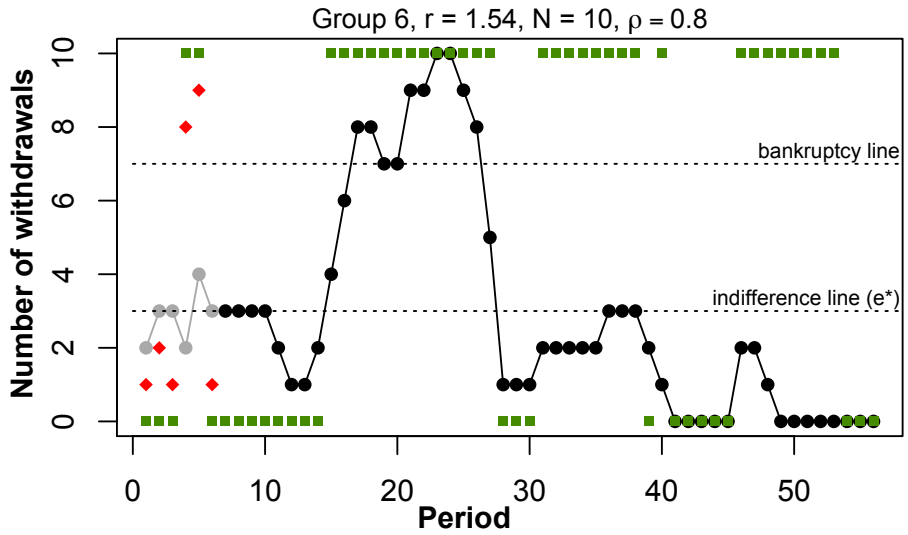




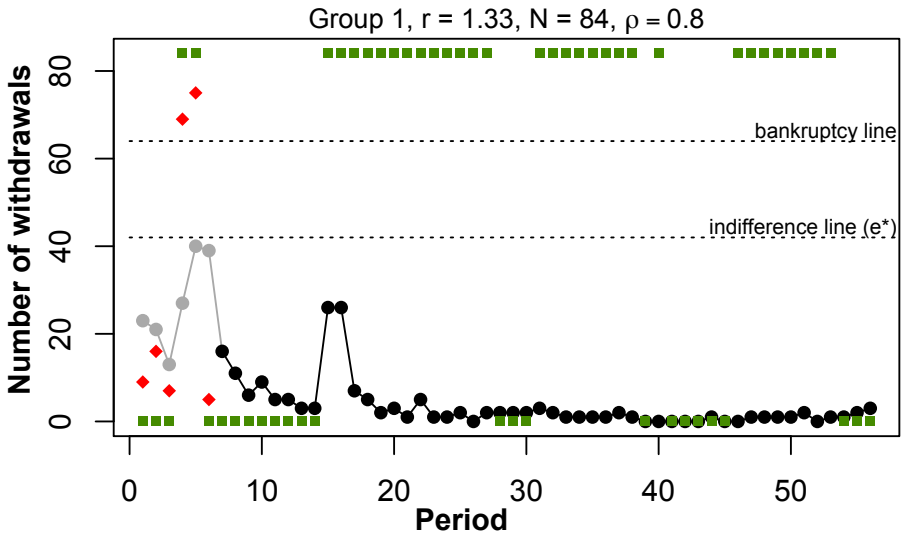


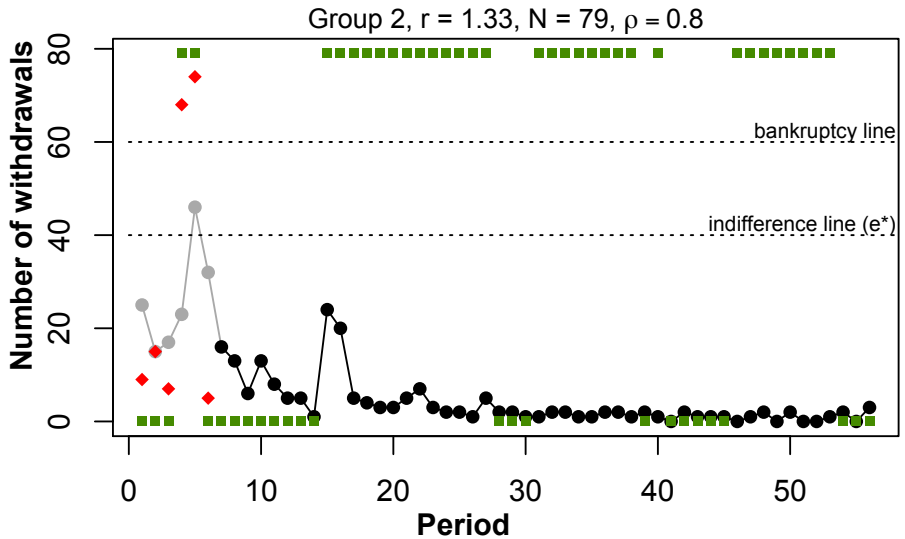
Small groups $r = 1.54$ and $\rho = 0.8$ (cont.)

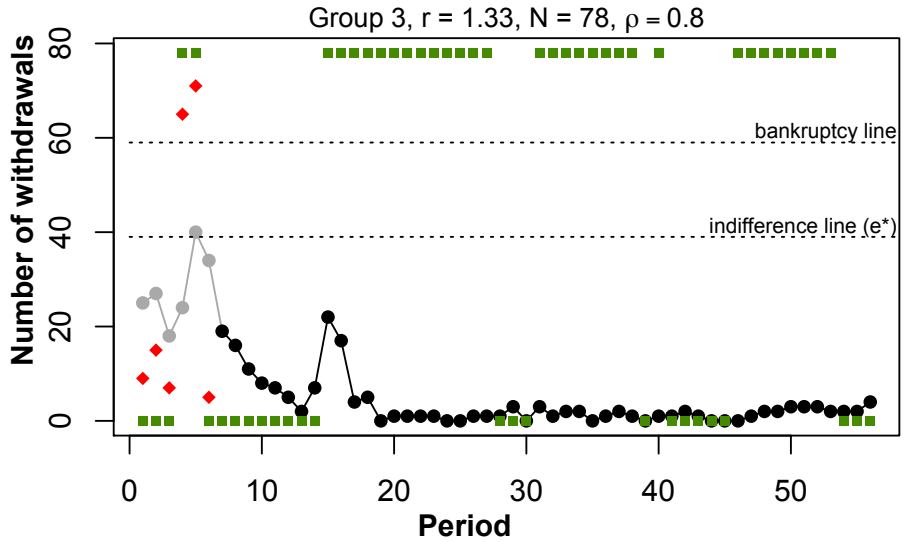


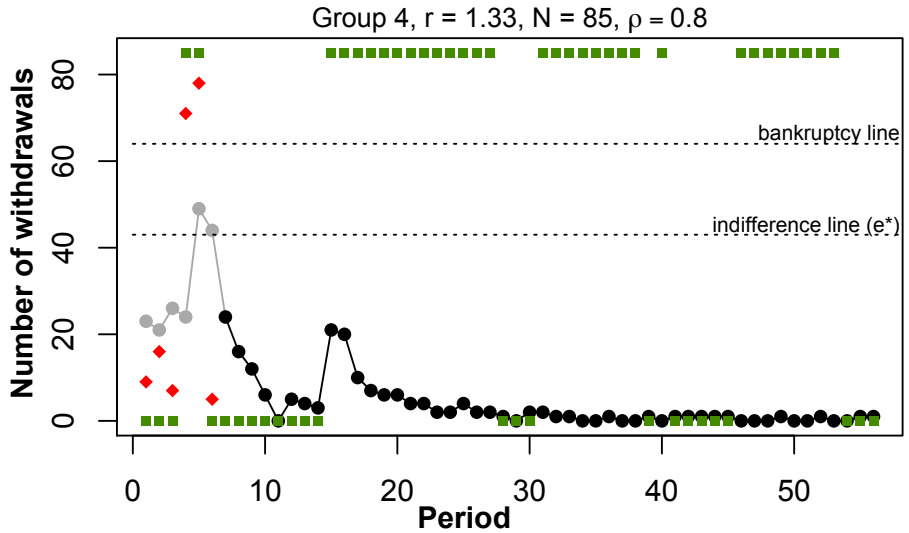


Large groups $r = 1.33$ and $\rho = 0.8$

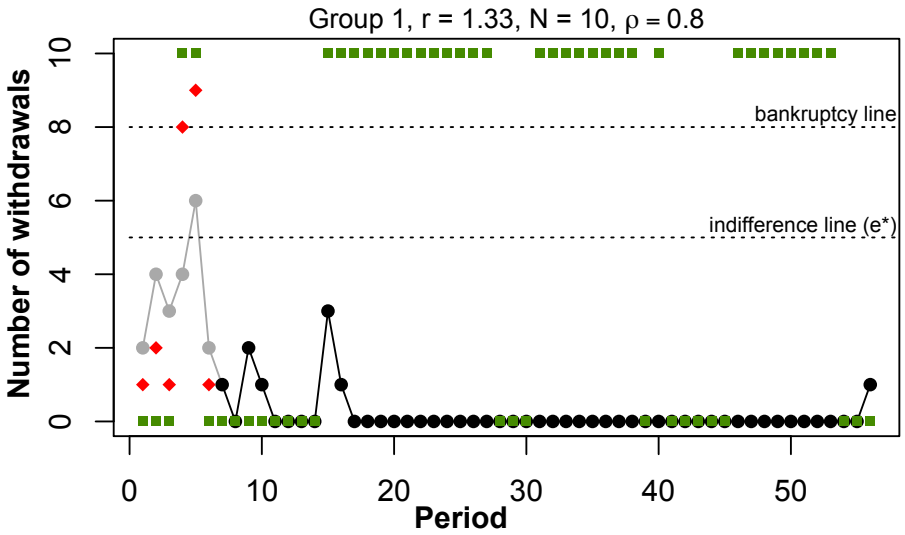


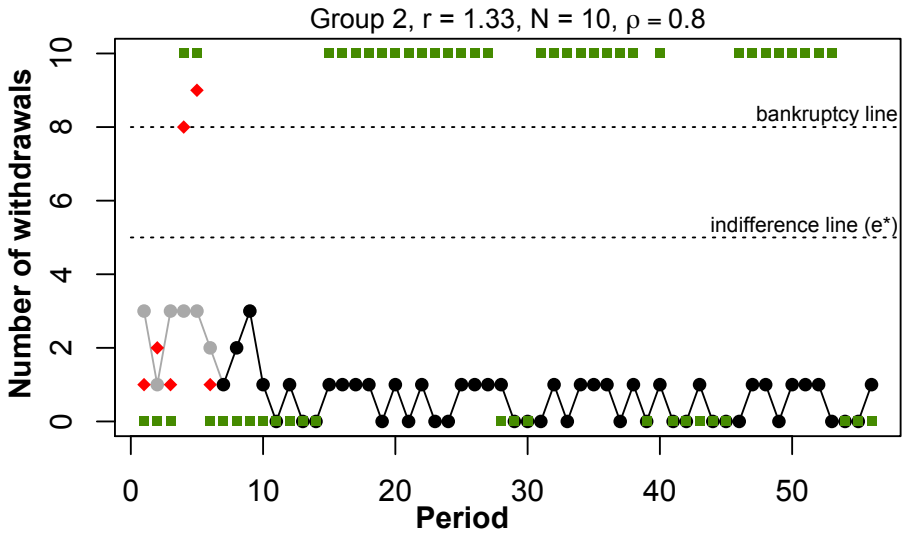


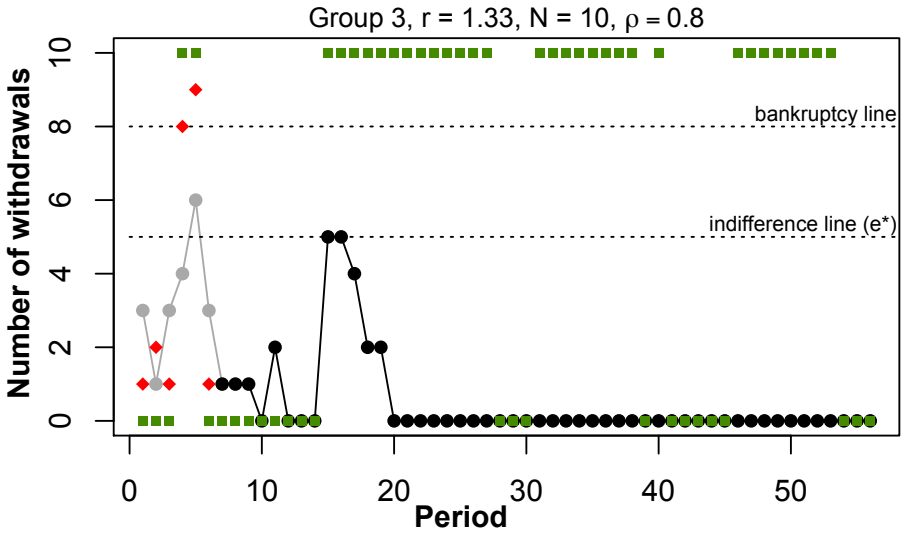


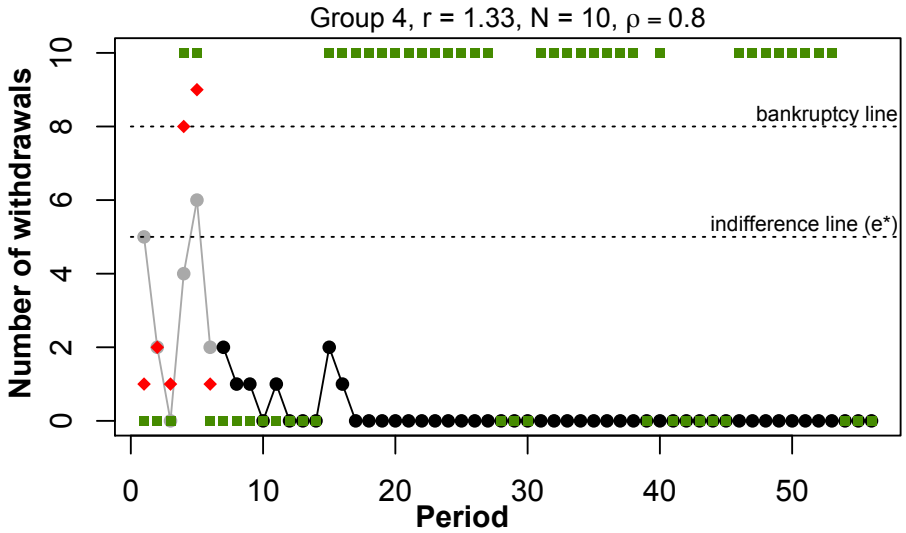


Small groups $r = 1.33$ and $\rho = 0.8$









Small groups $r = 1.33$ and $\rho = 0.8$ (cont.)