Bank Run in a Classroom: Do Smart Depositors Withdraw On Time? [1,2]

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Abstract: In this paper we discuss whether being smart makes depositors less prone to get involved into a panic bank run. We conduct a series of experiments with undergraduate and graduate students from Moscow and Saint-Petersburg, modelling the a-la Diamond-Dybvig deposit market with liquidity shocks, changing macroeconomic conditions and risk-based investment technologies. Our results suggest, first of all, that withdrawing on time is profitable, as average returns of the depositor investments are higher, especially if the other depositors in the bank behave rationally. Smarter depositors – those having better academic achievements – choose the rational strategy of avoiding early withdrawals more frequently: each additional grade point (out of ten) adds 9 p.p. to the share of rounds where a depositor withdraws on time. This result adds to the evidence that financial literacy – even measured in a very simple way – may prevent the coordination failure in the deposit market. Our results also suggest that panic withdrawals are more probable in the markets with poorer economic conditions (liquidity shocks, less profitable or less liquid investments, costly financial information), but depositors show weak sensitivity to risks of the bank investments. The depositors of medium-sized banks withdraw rationally more frequently compared to those in small or large banks.

Key words: Banks run, Experiment, Financial literacy, Academic achievements

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[2] In October 2011 the initial idea of the experiment was acknowledged among best teaching practices at the HSE as a winner of the HSE Fund for Educational Innovation contest.
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Introduction

Starting from (Diamond & Dybvig 1983) the coordination failure in the deposit markets is considered an important source of instability, increasing the risk of bank panics and consequent bank defaults. In their model providing the insurance against the liquidity shock the standard 2-period on-demand deposit contract adds the incentives for early withdrawals for those depositors, who are supposed to live for the whole game. The coordination failure appears as the bank is not able to repay to everyone if they come not on time scheduled in the contract. Being one of the Nash equilibria a bank run appears when the depositors expect the others will withdraw earlier and thus withdraw themselves in order not to come to an empty bank in the end of the game. In contrast to information-based bank runs (Jacklin & Bhattacharya 1988; Chen & Hasan 2006), which are usually efficient in terms of redistributing the funds from too risky banks to those who are more reliable, the panic-based bank runs are not related to increased bank risks – and therefore deposit redistribution - and even may ruin a stable bank.

Financial education and financial literacy are usually considered as a tool to generally increase the degree rationality of the unsophisticated market participants' behavior in different financial markets including that for the bank deposits, especially the retail ones. The empirical studies show that financial knowledge and skills can increase the participation in the market, as they usually make people more prone to saving strategies (Klapper et al. 2013; Semenova 2011), but there is no evidence that they can influence much the information-based bank runs (Brown et al. 2014; Semenova 2012). In this paper we extend this literature and ask whether being smart may prevent the depositors from withdrawing the deposits when only coordination failure is a problem and no financial deterioration appears to happen in any particular bank.

Studying the relationship between financial literacy and depositor behavior related to withdrawal decisions is a tricky task if the empirical data needs to be collected. It seems to be too complicated to collect the data about the education of the withdrawn depositors, needless to mention any more complicated measure of financial literacy. The opportunity to test the hypotheses related to this link appears in the experimental set-up, where, on the one hand, several situations can be manually modelled, and, on the other hand, the decisions are made by real economic agents, maximizing their profit. There are several papers studying the depositor behavior via the lens of experiments and providing some proof for the theoretical predictions.

(Madiès 2006) was among the first to provide the evidence of the a-la Diamond-Dybvig bank runs. He conducted an experiment with simultaneous decision-making and 210 participants, who are university of business school students. His results are clearly in line with the theoretical predictions. The bank runs frequently occur as the coordination failure. The suspension of convertibility as well as "narrow banking" proved to be efficient instruments to prevent them. The deposit insurance is also a solution, but only full coverage provides the depositors with necessary confidence.

(Garratt & Keister 2009), on the contrary, found no evidence that the depositors withdraw voluntary if there are no forced withdrawals (or liquidity shocks, in Diamond-Dybvig terminology) in the experiment. They show that macroeconomic instability, which causes more liquidity shocks, may increase the frequency of bank run as well. Having more chances to withdraw and observing the withdrawal history the depositors will run a bank with higher probability.

(Schotter & Yorulmazer 2009) is another paper contradicting to a certain degree to (Madiès 2006), as they prove that the deposit insurance, even being partial, works well preventing early withdrawals. The results of their experiment with undergraduate students show that sequential game provides more stability in the banking sector compared to the simultaneous one, especially provided that the detailed information about withdrawals is available. Introducing insiders – the depositors knowing more about the quality of the bank – also reduces the severity of bank runs, leaving panic runs aside.

The role of sequential decisions and observability of actions is also confirmed in (Kiss et al. 2014a) and their experiment with 48 undergraduate students. Considering 3-period games with depositors being in line to decide whether to withdraw (two real people and one player being a computer simulation), they show that if the second depositor can observe the actions of the first one (and she is not a computer), this reduces the probability of further bank runs significantly. This is particularly true for the first depositor deciding to be patient. Being aware that she is observed by both followers, the first depositor also withdraws less frequently.

(Arifovic et al. 2013) show that the higher degree of coordination is needed to avoid a bank run the lower is the probability that a panic bank run is avoided, however people learn over time and in repeated game with increasing degree of coordination required the depositors withdraw less frequently.

(Davis & Reilly 2016) experimentally model the influence of repayment proportions change (re-contracting) as well as the information about withdrawal behavior on the fragility of distressed banks. The experiment was conducted with the 240 undergraduate students. The authors show that if the contracts are changed in favor of patient depositors the bank stability is undermined to a less degree. However this is not true if the sequential game is introduced and the participants observe the withdrawals in the first stage if they are assigned to decide in the second stage.

There are a few papers focused mostly on modelling the contagion in the deposit markets in the experimental way. The contagion appears as an informational phenomena in several-step games, there some proportion of the depositors receive the signal about the deterioration of bank financial condition and all the rest observe their actions and act according to what they see and what they know about the kind of signal the informed depositors may receive. Using the results of the experiment with 200 undergraduate students in a two-bank set-up (Chakravarty et al. 2014) show that observing the actions of the informed depositors make uninformed ones withdraw even in the case when their bank is unrelated to the bank of informed ones and there exists no correlation in their financial position. In a continuous game the inefficient run is difficult to stop even if the informed depositors do not withdraw intensively.

(Brown et al. 2016) wonder, what the channels of the contagion transmission are, when the new information on bank fundamentals is revealed and is not promising. Basing on the results of the experiment with 264 undergraduate students participating and sequential game, they show that if a signal on withdrawals in the first stage is quite informative the depositors withdraw later as well mostly because they afraid the others will withdraw, not because the expectations about bank stability suggest doing that (the coordination failure described in (Diamond & Dybvig 1983)).

Although quite a few studies dealt with students in their experiment, up to my knowledge there is no paper trying to incorporate the students' academic achievements into the models of bank runs. However, being useful for the students themselves in their understanding of the bank runs' nature, as (Balkenborg et al. 2011) suggest, this type of participants provide the excellent opportunity to add the proxy of financial literacy into analysis. We aim to fill the gap in the literature in this study. Leaving the use of complicated financial literacy measures for further research, we use a very simple proxy for it – the academic achievements.

Experiment design

The experiment was run during the course "Microeconomics of banking" or the research seminar in different groups of students of the Departments of Economics at the National Research University Higher School of Economics (HSE, Moscow) and the European University at Saint Petersburg (EUSPb). Table 1 shows the number of students participating in each wave of the experiment each year and season as well as their year of study and the city where the university is based. Moscow stands for the HSE and SPb marks the waves in the EUSPb. Our database covers 9 waves and four years. The students are diverse in terms of the years of study, varying from 2nd year undergrads to 2nd year grads. All the students participated in the classes where both theory and empirics of the bank runs and market discipline were discussed.

Table 1. Number of participants in each experiment wave

Year	Season	Year of study	City	Number of students
2013	Autumn	2nd year ungrad	Moscow	19
		2nd year grad	SPb	5
2014	Autumn	2nd year grad	SPb	3
2015	Spring	3d year undergrad	Moscow	5
		2nd year ungrad	Moscow	26
	Autumn	2nd year grad	Moscow	10
		4th year undergrad	Moscow	22
2016	Spring	1st year grad	Moscow	15
2017*	Spring	4th year undergrad	Moscow	30

**Only rounds 1 and 3-6*

The each wave of the experiment is scheduled for 40-60 min. during one of the scheduled seminars. The participants are warned that the seminar will be organized in an unusual format. They are advised to come as this activity will provide some bonuses for their final grade for the course. Those who come late are not allowed to join the group as the instructions are already begun to be provided. The experiment implies that the group members are distributed over the classroom to minimize the communication.

Before the game is started the participants are randomly assigned with the ID numbers and are provided with the experiment forms they fill in during the experiment to express their decisions. The ID number comes in the form of *AB-C-D-EF-G*, where letters are replaced by certain figures, and contains important information about the participants' characteristics in the game, they will be discussed in the game description. The example of the form is in Appendix.

The instructions and the game round description comes at the PPT slides and are commented accordingly.

The experiment deals with the 2-period deposit market a-la Diamond-Dybvig. All the students are the depositors of some banks. The banks differ in terms of size and may consist of 3, 4 or 5 depositors. The number of banks of different sizes depends on the size of the group and is usually chosen to ensure the diversity within the group. The first figure in the ID number (*A*) stands for the number of depositors in the bank, the second figure (*B*) identifies the bank of this size in the current classroom. For instance "32-" goes for the second bank containing 3 depositors. The students do not know who is in which bank, so the game is purely non-cooperative and implies the opportunity of the coordination failure. To additionally ensure the absence of any cooperation or other strategic influence, the silence is announced to be crucially important to the game. If a student breaks this rule, the game is promised to be stopped and the penalty will reduce the whole groups' grades for the course. They never do, however.

G - the last number in the ID counts the depositors within a bank. It varies from 1 to 3 for small banks, from 1 to 4 for medium banks and from 1 to 5 for large banks.

The game consists of 10 independent rounds. For all the rounds the depositor is attached to the same bank. The rounds are, however, independent, so each round characteristics do not depend on previous history.

Each round implies that the depositors have 100 units in the beginning of each round and open the deposits for 2 periods, investing the whole amount. The bank invests all accumulated funds into a project (or production technology, as in (Diamond & Dybvig 1983)) which in long run is profitable earning $R>1$ in period 2 for each unit invested. The invested funds can, however, be withdrawn from the project earlier, in period 1, but there exists the early withdrawal loss and each invested unit receives $r<1$. The deposit contract is also 2-period long, providing the patient depositors with R per deposited unit in the end of the round. The contact is a standard on-demand deposit contract and implies no loss if the early withdrawal occurs. So in case of withdrawing the deposit in period 1 the depositor receives back her funds. This contract is subject to funds availability. In any period if the funds are not enough to provide the necessary returns all the available funds are distributed equally among those who came for them. Therefore for the number of depositors N, those N_1 of them who withdraw in period 1, receive:

$$Payment_1 = \begin{cases} 1, if \ \ N_1 < N * r \\ r, if \ \ N_1 \geq N * r \end{cases}$$

The rest (N-N_1) receive:

$$Payment_2 = \begin{cases} \frac{N*r-N_1}{N-N_1}*R<R, if\ N_1<N*r \\ 0, if\ N_1 \geq N*r \end{cases}$$

This experiment design implies that in a first-best case of coordination all the depositors will wait for period 2 and earn *R*. However if at least one depositor withdraws earlier this reduces the returns for all waiting till the end of the game. The coordination failure problem stimulates the depositors to withdraw early if they suspect the others within their bank will also withdraw. We call a bank run the situation where at least one depositor who should be waiting till period 2 withdraws in period 1 (which is an analogue of the "partial bank run" introduced by (Madiès 2006)).

The initial conditions of the experiment implies that *R=1.5* and *r=0.8*. Different changes in the market are modelled in other nine rounds, they are described below. For each round the depositor is asked to decide in which period she withdraws. In the form the depositor has a separate table for each round, showing the possible outcomes given different decisions of the other depositors in the bank. Figure 1 shows the table of outcomes for the first round and a depositor in a bank of 4 depositors. The student sees that, for instance, if the bank has 2 depositors who withdraw early those two receive 100 each and the other two receive 112.5 in the second period. So if the depositor decides to withdraw early she will get 100 given another one also came in the period 1. If the depositor withdraws late, given 2 other depositors in the same bank withdrew early, she will receive 112.5. Of course the depositor does not decide on the number of early-withdrawers. The only thing she is asked to choose is the period to withdraw. The students are asked to mark the second or the third column to show their decisions (for example, by putting √).

Figure 1. Example of table of outcomes shown before the game starts as an instruction

Round 1

Number of depositors withdrawing in period 1	If you withdraw in period 1, you receive	√ If you withdraw in period 2, you receive
0		150
1	100	137,5
2	100	112,5
3	100	37,5
4	80	

The other rounds involve different changes in the market framework to observe the depositors reaction – and the propensity to withdraw early – to liquidity shocks, economic situation deterioration in both periods, risk appearance and the possibility to cope with the risk paying for the information. In particular these rounds describe the following changes:

Round 2. In this round 1 depositor in each bank faces a liquidity shock. This means that she has to withdraw early. The second figure in the ID number (*C*) equals to 1 for the depositors with the liquidity shock. They mark the first column. All the rest make their choice on their own

Round 3: In this round the number of depositors with liquidity shocks equal to 2 in each bank. The third figure in the ID number (*D*) equals to 1 for the depositors with the liquidity shock. These shocks do not depend on the shocks in the second round. This round is important as this is the only round when the only depositor in a small bank, who has no liquidity shock, should withdraw early as well to get higher output. In case of early withdrawal she gets 80 units back, otherwise she is left with (300-200/0.8)*1.5=75 units.

Round 4 makes us forget about the liquidity shocks. In this round the economy offers worse projects to invest, so *R* is now 1.2 instead of 1.5. The outcomes of the second period are lower but from the social planner's point of view all should keep their money in a bank till the end of the game.

Round 5. In this round R goes back to the basic level, but now the early withdrawal loss is higher and r is 0.7 instead of 0.8. This means that the bank has to withdraw more from the projects to provide the necessary amount to the depositors, who came in period 1, and to retain less funds for the rest of the depositors.

Round 6. This round introduces risk into the market. Now *R* is not fixed: *R*=1.8 (Good scenario) with the probability 0.5 and *R*=1.2 (Bad scenario) with the same probability. The actual R is revealed in the end of the game. Below we describe the process of *R* determining. The student observe additional column AVG in the table of this round. It reflects the expected outcome. They are said they may use these figures if they need them for some purpose.

Round 7. The risk becomes more complicated and R is determined in two steps. With probability 0.5 the probability of high R is 0.9 and R is low with the probability of 0.1. With the same probability of 0.5 the probability of high R is 0.1 and R is low with the probability of 0.9. To make things clearer for students the slide demonstrates the tree of the probabilities. There are two additional columns in the correspondent table, showing the expected outputs for both scenarios (90%-10% or 10%-90%)

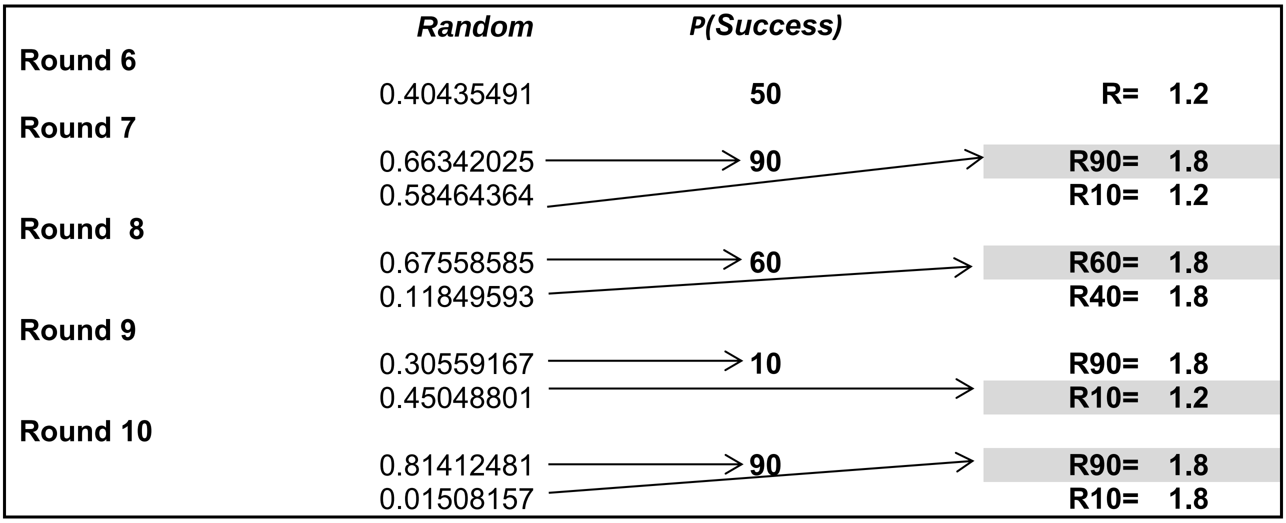
Round 8 is the same as the previous round but the probabilities for different levels of *R* are 60%-40% or 40%-60% correspondingly.

Round 9 is the same as round 7 in terms of risk, but now the students have the opportunity to know, which of the scenarios - 90%-10% or 10%-90% - the economy faces and offer a strategy of withdrawal. The information is costly, they have to pay 10 units each to get it. In this round there are two decisions the students have to make. First of all they have to decide whether they buy the information and mention this in the form. Secondly they describe the withdrawal strategy/ In case they pay, they should choose the withdrawal period for both scenarios. If they do not pay they simply choose the period to withdraw.

Round 10 is the same as the previous round in terms of risk and information availability, but the costs of getting information are now different. Two depositors in each bank have low costs equal to 10, all the rest have higher costs, 15 units. The forth figure (*EF*) in the ID number shows, which costs the depositor has – 10 or 15. The costs are not related to the liquidity shocks in previous rounds. Again the depositors have to make two decisions in this round.

The risk is modelled with the Random function in Excel, which shows a random figure between 0 and 1. For the round 6 if it is lower than 0.5 the economy shows low project profitability, otherwise *R* is high. For all the rest rounds with risk we need two random figures. If the first one is lower than 0.5, we are in the situation with 10%-90% (40%-60%), otherwise we have 90%-10% (60%-40%). The second random figure determines the value of *R*. If the probability of high *R* is high then this figure being lower than 0.9 (0.6) provides high R, and low R otherwise. If the probability of high *R* is low, then this figure being lower than 0.1 (0.4) provides high R, and low R otherwise. This methodology is explained to the students and then all of them observe on the screen the outcomes the Excel provides, and the results are fixed. Figure 2 shows an example of what the students see.

Figure 2. A snap-shot of *R* determination in rounds with risk

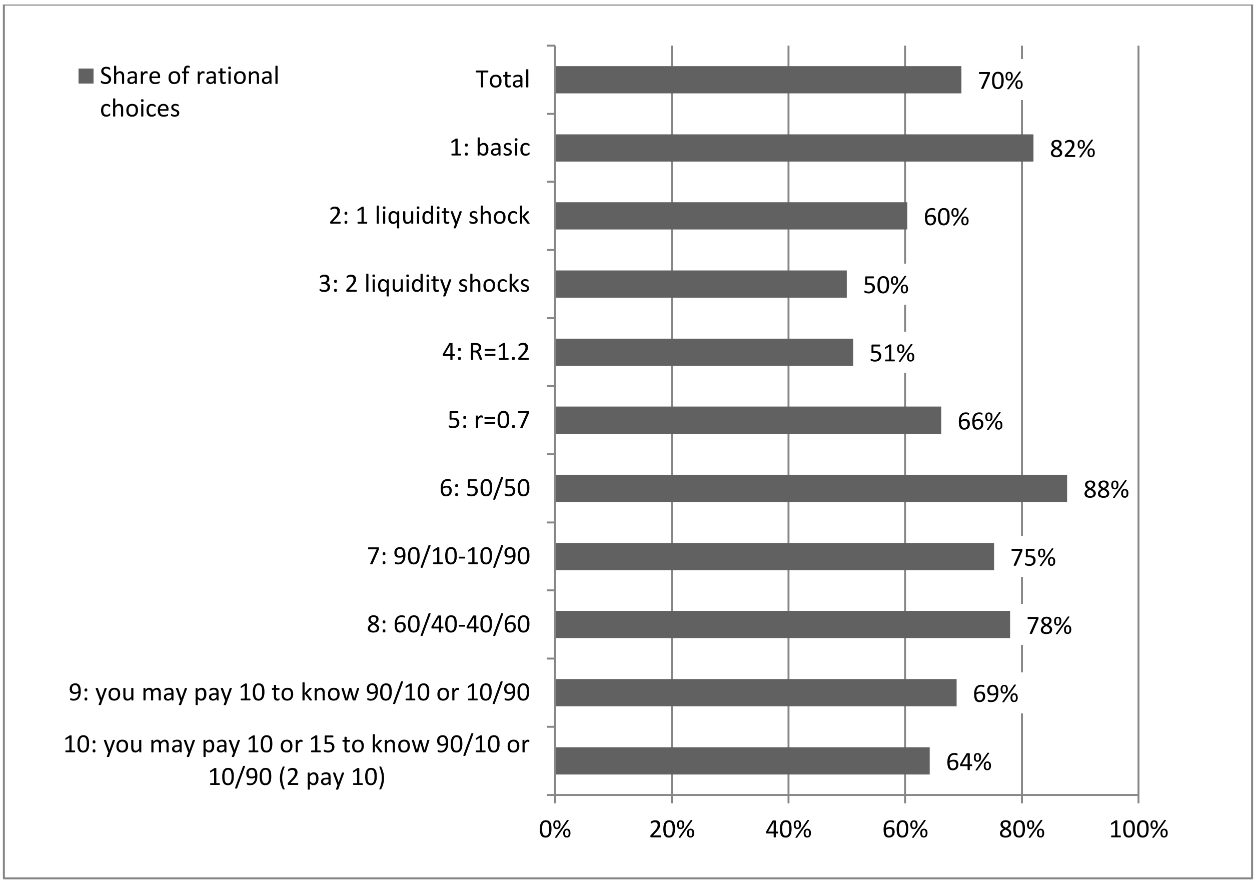


The total gain for a student in this game is her average rate of return for all 10 rounds[4]. To get the results after the last round the forms are collected and all the decisions are aggregated to check how many depositors withdraw early in each bank and each round, and what return depositors get given the withdrawals.

Methodology and Data

The Diamond-Dybvig game implies that the rational choice for everyone is to wait till the end of the game no matter what the economy shows you. The only case when withdrawing early provides more return is the third one for a small bank. Two depositors are forced to withdraw so the third one is rational if she withdraws as well as she receives 80 instead of 75. We call the depositor's choice a *rational* one if she withdraws in the second period for any case except the case of third round and a small bank, and if she withdraws early in this particular case. Those who face a liquidity shock are not considered in terms of rationality as they are forced to withdraw and do not make any own decision.

Figure 3. Share of rational choices by round

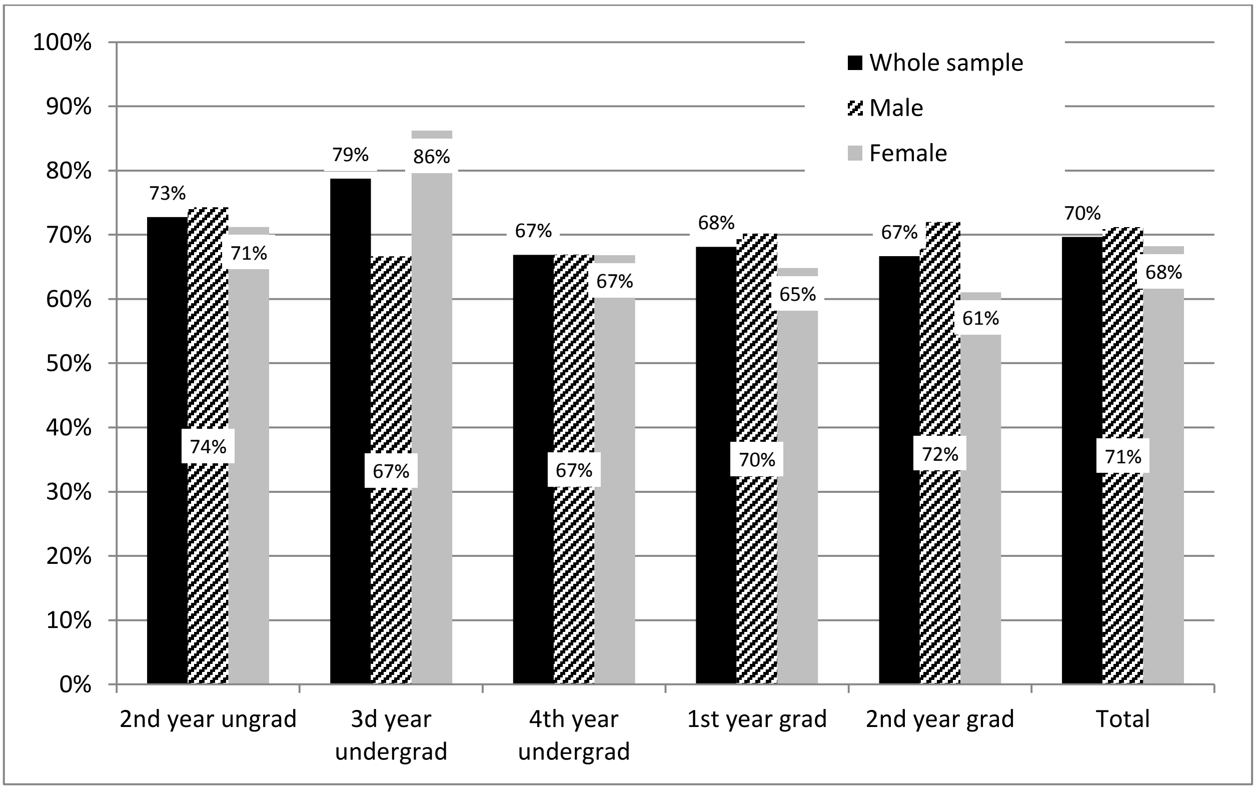


[4] The exception is 2017 wave where students played only 5 rounds from this framework, the others were modified.

The average irrationality rate in our sample amounts up to 30 percent (see Figure 3). Half of the depositors withdraw early in the case of two liquidity shocks among the bank clients as well as in case when the second period returns become lower decreasing from 1.5 to 1.2, still ensuring positive net gain for the waiting strategy, though. Surprisingly the introduction of basic risk makes the depositors the most patient: only 12 percent of them withdraw earlier. The first, basic round is also characterized by rare withdrawals with 82 percent of the students waiting till the end of the round.

Figure **4** shows that there are no extreme differences in the withdrawal rates between male and female depositors as well as among students of different years of study. However males are slightly more rational than females with the only exception of the 3d year bachelors, where females are irrational only in 14 percent of observations while males show 33 percent of decision being irrational. This year is also specific in terms of the overall rate of rationality of the depositors: it is comparatively high amounting up to 79 percent of rational decisions.

Figure 4. Share of rational choices by year of study and gender



In this study we are interested in the determinants of this sort of rationality in the chosen set-up, as well as its gains. We start by asking whether being rational increases the average gain in the game. The average gain determines the bonus a student receives as an add-on to her total accumulative grade for the course.

To shed some light to this relationship we estimate the following regression using OLS with the robust standard errors:

$$AverageReturn_i = \alpha + \beta_1 Rational_{i,r} + \beta_2 RationalOther_{i,r} + \\ + \beta_3 Gender_i + \beta_4 Economy_r + \beta_5 BankSize_b + \beta_6 StudyYear_i + \beta_7 Season + \beta_8 SPb_i + \varepsilon_i$$

In this equation $AverageReturn_i$ stands for the student's *i* average gain in the 10-round game. The average return for the whole sample is more than 16.6 percent and more than 17 percent if we consider the Moscow games only (see Table 2).

$Rational_{i,r}$ is a binary variable equal to 1 if the student's decision was rational in the round *r*, and 0 otherwise. The gain of a particular student depends however not only on her choice but also on how rational were all the rest in her bank. We introduce $RationalOther_{i,r}$ measuring the average rationality of the other depositors of the student's *i* bank in the round *r*. The average is measured only for students without liquidity shocks.

To check our results for the robustness we replace the round-based rationality with the average rationality during the whole game. We introduce the average rationality as the share of rounds where a depositor was rational. The same calculations are performed for the average rationality of the other depositors in the bank.

We also introduce the characteristics of the student, her bank and the state of the economy in the round. We control for the student's

- gender, introducing $Gender_i$ equal to 1 for males and 0 for females,
- campus, introducing SPb_i equal to 1 for the games conducted in the European University at Saint Petersburg,
- year of studies, introducing $StudyYear_i$ varying from 2 for 2nd year undergraduate students to 6 for the 2nd year graduate students.

We include the $BankSize_b$ measuring the size of the bank and varying from 3 for small banks with 3 depositors to 5 for large banks with 5 depositors. A bit less than a half of the depositors in our sample are in large banks, others are quite equally distributed between small and medium banks (see Table 2).

We control for the economic conditions in the round r introducing $Economy_r$, which is equal to 0 for the rounds with no risk, 1 for the rounds where economy happened to be Good, providing high second period returns, and (-1) for the rounds where economy happened to be Bad and ensured only low returns on investment. In our experiment series the bad outcomes appeared a bit more frequently than the good ones (see Table 2).

Finally we control for the season when the experiment took place, introducing Season. Half of the games were played in the first semester (mostly in Autumn), for these games this variable equals to 1. For the rest it equals to 0, these games were played in the second semester (mostly in Spring).

Our main hypothesis at this stage is that being rational is profitable: the students being rational (or being rational more frequently) gain more and earn higher average return.

Our next step is to find out whether being smart makes students more rational. We estimate a Probit models for the probability of being rational. First of all we use the model, which includes only the characteristics mentioned above, as a basic one:

$$\Pr ob(Rational_{i,r} = 1) = \mu_2 Round_r + \mu_3 Gender_i + \mu_4 Economy_r + \mu_5 BankSize_b + \\ + \mu_6 StudyYear_i + \mu_7 Season + \mu_8 SPb_i + \varepsilon_i$$

Then we introduce the measures of students' academic achievements into the basic model:

$$\Pr ob(Rational_{i,r} = 1) = \mu_1 Score_i + \mu_2 Round_r + \mu_3 Gender_i + \mu_4 Economy_r + \mu_5 BankSize_b + \\ + \mu_6 StudyYear_i + \mu_7 Season + \varepsilon_i$$

In this model $Grade_i$ stands for the student's average grade for the semester before the one the experiment is organized in. We use the publicly available student ratings, where the average grades are calculated. The data for the student grades is available only for the Moscow students, so we have to reduce our sample to the games conducted in HSE. The grades in HSE vary from 1 to 10. In average the students in our sample are quite smart, as the average grade exceeds 7 (see Table 2), with minimum being a bit higher than 4 (the grades lower than 4 mean that a student failed with the course).

To control for the robustness of our results we estimate the model, measuring the academic achievements with the average grade for the previous year. This reduces the sample a little bit, as some 1st year graduate students came from other universities and therefore have no grades for the previous year. The average grade is very close to the previous one and is less dispersed.

We study the influence of students' grades on the share of rational decisions among all the stundent's decisions as well. We estimate with OLS the following regressions again starting with the basic one and then extending it introducing the grades:

$$Rational\_av_{i,r} = \mu_3 Gender_i + \mu_4 Economy_r + \mu_5 BankSize_b + \\ + \mu_6 StudyYear_i + \mu_7 Season + \mu_8 SPb_i + \varepsilon_i$$

$$Rationalal\_av_{i,r} = \mu_1 Score_i + \mu_3 Gender_i + \mu_4 Economy_r + \mu_5 BankSize_b + \\ + \mu_6 StudyYear_i + \mu_7 Season + \varepsilon_i$$

Our main hypothesis at this stage is that smarted students should be more rational other things equal as they understand that late withdrawals ensure higher returns.

Results

We start with discussing the gains the rational behavior can provide for the depositors. Table 3 shows the results of the first step estimations. Each pair of columns demonstrate the results for the full sample and for Moscow sample only, therefore the binary variable for EUSPb is excluded from the second column in each pair. We estimate the regressions only for the observations implying the option to choose the rational decision. This means we exclude those observations with liquidity shocks (columns I, II, V and VI). To check the robustness we do the same estimations for the sample without the whole rounds with liquidity shocks (columns II, IV, VII and VIII). First four columns show the results for per-round rationality of the depositor herself and the rest of the depositors in the same bank, second part of the table includes the results for average per-game rationality of the participant and the same other depositors.

All the specifications provide the evidence of strong and positive relationship between rationality and average returns of the depositor investments. Choosing a rational strategy in a single round adds in average from 1.3 to 2.8 p.p. to the games total result (depending on the model specification). Given that average gain is 16-17 per cent these effects seem to be not only statistically, but also economically significant.

Being rational is good but having rational counterparties is even better. Our results show that the rationality of depositors' unobserved peer-groups is even more important for the deposit profitability. The effects for other depositors' average profitability are in all specifications 2-2.5 times higher than the individual effects. That means that being rational in a bank of irrational depositors is worse in terms of profitability than behaving irrationally when all the rest are rational.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
	Moscow sample					*Moscow and SPb sample*				
Rational	1046	0.7113	0.4534	0	1	1150	0.6965	0.4600	0	1
Grade_s (last sememester)	1040	7.0518	1.2089	4.2000	9.6000					
Grade_y (last year)	960	7.2044	0.9870	5.2857	9.3125					
Average return	1130	1.1722	0.1163	0.9179	1.4500	1240	1.1664	0.1182	0.9064	1.4500
Bank size	1130	4.2124	0.8199	3	5	1240	4.1855	0.8415	3	5
Bank of 3 depositors	1131	0.2522				1241	0.2782			
Bank of 4 depositors	1132	0.2832				1242	0.2581			
Bank of 5 depositors	1133	0.4646				1243	0.4637			
Gender (1 - male; 0 - female)	1130	0.4735	0.4995	0	1	1240	0.4798	0.4998	0	1
2nd year undergrad	1130	0.4071				1240	0.3710			
3d year undergrad	1130	0.0442				1240	0.0403			
4th year undergrad	1130	0.3274				1240	0.2984			
1st year grad	1130	0.1327				1240	0.1210			
2nd year grad	1130	0.0885				1240	0.1694			
Season (1 - Autumn. 0 - Spring)	1130	0.4602	0.4986	0	1	1240	0.5081	0.5001	0	1
State of the economy (-1 - bad. 0 - no risk. 1 - good)	1130	-0.0743	0.6746	-1	1	1240	-0.0750	0.6771	-1	1
Bad	1130	0.2673				1240	0.3020			
No risk	1130	0.5398				1240	0.5072			
Good	1130	0.1929				1240	0.1908			

Table 3. Rational behavior and average gains

Variables	no depositors with liquidity shock		no rounds with liquidity shock		no depositors with liquidity shock		no rounds with liquidity shock	
	I	II	III	IV	V	VI	VII	VIII
rational	0.02813***	0.02867***	0.02933***	0.02867***				
	(0.00636)	(0.00658)	(0.00642)	(0.00658)				
rational_bank$_{-i}$	0.07886***	0.07206***	0.07871***	0.07206***				
	(0.01094)	(0.01115)	(0.01103)	(0.01115)				
rational_av					0.13236***	0.12959***	0.13113***	0.12623***
					(0.01194)	(0.01249)	(0.01246)	(0.01294)
rational_av_bank$_{-i}$					0.31463***	0.25075***	0.31675***	0.25722***
					(0.02483)	(0.02363)	(0.02591)	(0.02489)
Gender (1 - male, 0 - female)	0.02623***	0.02675***	0.02626***	0.02675***	0.01757***	0.02128***	0.01741***	0.02101***
	(0.00527)	(0.00542)	(0.00529)	(0.00542)	(0.00487)	(0.00500)	(0.00511)	(0.00525)
Economy with no risk (compared to Bad)	0.00380	0.00381	0.00301	0.00381	0.00783	0.00787	0.00915	0.00968
	(0.00609)	(0.00625)	(0.00614)	(0.00625)	(0.00542)	(0.00573)	(0.00575)	(0.00605)
Economy is Good (compared to Bad)	-0.01454*	-0.01062	-0.01471*	-0.01062	0.00631	0.00788	0.00689	0.00865
	(0.00773)	(0.00765)	(0.00772)	(0.00765)	(0.00703)	(0.00730)	(0.00707)	(0.00735)
Bank of 4 depositors (compared to 3)	0.04081***	0.03604***	0.04019***	0.03604***	0.05784***	0.04919***	0.05756***	0.04929***
	(0.00773)	(0.00772)	(0.00771)	(0.00772)	(0.00729)	(0.00724)	(0.00760)	(0.00757)
Bank of 5 depositors (compared to 3)	-0.04589***	-0.05623***	-0.04716***	-0.05623***	0.00635	-0.01527*	0.00590	-0.01462*
	(0.00786)	(0.00809)	(0.00778)	(0.00809)	(0.00766)	(0.00792)	(0.00798)	(0.00828)
3d year undergrad	-0.01306	-0.00957	-0.01296	-0.00957	-0.03799***	-0.02961***	-0.03807***	-0.02978***
	(0.00930)	(0.00928)	(0.00930)	(0.00928)	(0.00831)	(0.00830)	(0.00876)	(0.00874)
4th year undergrad	-0.10110***	-0.10554***	-0.10150***	-0.10554***	-0.07545***	-0.08585***	-0.07445***	-0.08433***
	(0.00780)	(0.00781)	(0.00778)	(0.00781)	(0.00758)	(0.00769)	(0.00789)	(0.00801)
1st year grad	-0.14379***	-0.14727***	-0.14416***	-0.14727***	-0.12642***	-0.13481***	-0.12645***	-0.13431***
	(0.00945)	(0.00936)	(0.00942)	(0.00936)	(0.00783)	(0.00796)	(0.00820)	(0.00835)
2nd year grad	0.06029***	0.05274***	0.05934***	0.05274***	0.09535***	0.07971***	0.09400***	0.07932***
	(0.01054)	(0.01050)	(0.01050)	(0.01050)	(0.01155)	(0.01118)	(0.01210)	(0.01174)
Season (1 – Autumn, 0 – Spring)	-0.09752***	-0.09537***	-0.09749***	-0.09537***	-0.11510***	-0.10976***	-0.11420***	-0.10892***
	(0.00728)	(0.00728)	(0.00728)	(0.00728)	(0.00683)	(0.00675)	(0.00710)	(0.00703)
SPb	-0.08927***		-0.09221***		-0.05684***		-0.05690***	
	(0.01409)		(0.01462)		(0.01260)		(0.01346)	
Constant	1.18551***	1.19649***	1.18611***	1.19649***	0.90896***	0.96973***	0.90797***	0.96610***
	(0.01355)	(0.01388)	(0.01350)	(0.01388)	(0.02545)	(0.02617)	(0.02654)	(0.02740)
Observations	1,002	904	992	904	1,092	988	992	904
R-squared	0.504	0.528	0.504	0.528	0.573	0.568	0.572	0.566

*Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Table 4. Being rational and being smart, AME

Variables		All sample	Moscow		
		I	II	III	IV
Grade_y				0.04423*** (0.00665)	
Grade_s					0.04427*** (0.00665)
Rounds (1 –basic round)	2: 1 liquidity shock	-0.21065*** (0.05552)	-0.23256*** (0.05751)	-0.14169** (0.05551)	-0.14169** (0.05551)
	3: 2 liquidity shocks	-0.29502*** (0.06770)	-0.30380*** (0.07122)	-0.23192*** (0.07501)	-0.23192*** (0.07501)
	4: R=1.2	-0.29148*** (0.05027)	-0.29611*** (0.05249)	-0.22297*** (0.05001)	-0.22297*** (0.05001)
	5: r=0.7	-0.16452*** (0.05304)	-0.18729*** (0.05487)	-0.11848** (0.05190)	-0.11848** (0.05190)
	6: 50/50	0.08372 (0.05904)	0.07415 (0.06212)	0.15667*** (0.05921)	0.15667*** (0.05921)
	7: 90/10-10/90	-0.08834 (0.05869)	-0.12698** (0.06032)	-0.02729 (0.05900)	-0.02729 (0.05900)
	8: 60/40-40/60	-0.05497 (0.05839)	-0.03759 (0.06353)	0.04773 (0.06180)	0.04773 (0.06180)
	9: you may pay 10 to know 90/10 or 10/90	-0.14954*** (0.05672)	-0.16584*** (0.05939)	-0.08394 (0.05772)	-0.08394 (0.05772)
	10: you may pay 10 or 15 to know 90/10 or 10/90 (2 pay 10)	-0.19061*** (0.05571)	-0.21957*** (0.05787)	-0.12408** (0.05661)	-0.12408** (0.05661)
Bank of 4 depositors		-0.03062 (0.03723)	-0.03752 (0.03787)	0.04057 (0.03767)	0.00876 (0.03767)
Bank of 5 depositors		-0.16704*** (0.03588)	-0.17932*** (0.03936)	-0.11966*** (0.03972)	-0.11534*** (0.03972)
Gender (1 - male, 0 - female)		0.02311 (0.02600)	0.02389 (0.02685)	0.05227* (0.02718)	0.06007** (0.02718)
3d year undergrad		0.11260 (0.07039)	0.11327 (0.06956)	0.10855 (0.07101)	0.08811 (0.07101)
4th year undergrad		-0.15009*** (0.03680)	-0.15589*** (0.03678)	-0.12889*** (0.03987)	-0.14086*** (0.03987)
1st year grad		-0.11081** (0.04523)	-0.11443** (0.04494)	-0.02788 (0.04756)	-0.05291 (0.04756)
2nd year grad		-0.05404 (0.06217)	-0.06491 (0.06246)	-0.02781 (0.06603)	-0.01452 (0.06603)
Season (1 - Autumn, 0 - Spring)		0.02159 (0.03349)	0.02421 (0.03313)	0.04059 (0.03482)	0.02745 (0.03482)
SPb		-0.17786*** (0.06491)			
Observations		1,150	1,046	890	963

*Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

As for the control variables, the results suggest that male depositors earn 2-2.5 p.p. more than females on average. This contradicts to the experiment results in (Kiss et al. 2014b), where no statistically significant gender difference was found. The highest are returns in medium banks, while the lowest are in large ones. Second year graduate students demonstrate the best results in terms of profitability; the lowest returns are earned by the first year graduates. The games provide higher returns in first semester compared to the second one. This effect may come from the fact that second semester experiments are usually organized in late Spring, when students are less focused on studies and classes. Finally including the EUSPb students into the sample allows showing that they earn less compared to the HSE ones.

So our answer for the question in the first hypothesis is positive: being rational makes depositors richer in our experiment, especially if the others are rational as well.

What increases the depositors' propensity to withdraw on time? Our quite natural prediction was that higher grades, measuring the degree of students' knowledge, intuition and smartness, should have the positive influence. Table 4 demonstrates the results of the second step estimations (average marginal effects are calculated). Columns I and II show the basic model estimation results for the whole sample and for the HSE one. Models shown in columns III and IV include the average grades as an explanatory variable. They are available only for the HSE students. Column III covers the results for a model with the previous year average grade, column IV shows the effect for the previous semester average grade. Table 5 shows the results for the degree of rationality for the whole game.

Table 5. Share of rational rounds and being smart

Variables	All sample	Moscow		
	I	II	III	IV
Grade_y			0.08947***	
			(0.00261)	
Grade_s				0.08905***
				(0.00263)
Bank of 4 depositors	0.33780***	0.34972***	0.05980***	0.05276***
	(0.02194)	(0.02186)	(0.01732)	(0.01641)
Bank of 5 depositors	0.35133***	0.40274***	-0.05524**	-0.03231
	(0.01836)	(0.01843)	(0.02234)	(0.02121)
Gender (1 - male, 0 - female)	0.20488***	0.17270***	0.09044***	0.10871***
	(0.01796)	(0.01903)	(0.01293)	(0.01300)
3d year undergrad	0.35346***	0.31438***	0.10950***	0.08488***
	(0.02910)	(0.02803)	(0.02601)	(0.02618)
4th year undergrad	0.27324***	0.28404***	-0.06222***	-0.08777***
	(0.02257)	(0.02301)	(0.02044)	(0.02138)
1st year grad	0.34622***	0.34511***	0.01100	0.05032***
	(0.03215)	(0.03286)	(0.01929)	(0.01813)
2nd year grad	0.38000***	0.41376***	0.04918	0.06932**
	(0.03460)	(0.03470)	(0.03048)	(0.03244)
Season (1 - Autumn, 0 - Spring)	0.18401***	0.16131***	0.07833***	0.06529***
	(0.02091)	(0.02094)	(0.01699)	(0.01710)
SPb	-0.26145***			
	(0.04665)			
R-squared	0.82027	0.83192	0.93154	0.92508
Observations	1,150	1,046	890	963

Both measures of students' academic achievements show the same result: each additional grade point adds 4.4 p.p. to the probability that student prefer rational behavior in the current round. The same is true for the share of rounds where the depositor makes a rational choice. Each additional grade point adds virtually 9 p.p. to this share. That means that a student whose average grade is 1 grade point higher has one additional round with correct withdrawal in our 10-round-long game.

As our preliminary observations already showed, the most stable rounds, in term of irrational withdrawals are the basic one and those with risk, but without any options of reducing information asymmetry by paying for the information. The depositors of medium banks withdraw rationally more frequently, and those in large banks do it with lower probability, however, the latter result is not stable.

The control variables provide the evidence that male depositors withdraw correctly more frequently than female ones. Spring editions of the game show lower rationality rates. Third year undergraduate students as well as second year graduate ones withdraw correctly with higher probability. The students from EUSPb are in average less rational in this experiment.

Conclusion

In this paper we discuss the results of a series of experiments with undergraduate and graduate students from Moscow and Saint-Petersburg, modelling the a-la Diamond-Dybvig deposit market with liquidity shocks, changing macroeconomic conditions and risk-based investment technologies. Our simple experiment provides some evidence that being smart makes depositors less prone to get involved into a panic bank run. The students demonstrating better academic achievements choose the rational strategy of avoiding early withdrawals more frequently, thus reducing the probability of panic-based runs. This result extends those dealing with the importance of making retail depositors less sophisticated and provides the evidence that financial literacy – even measured in a very simple way – may prevent the coordination failure in the deposit market. Our results also suggest that panic withdrawals are more probable in the markets with poorer economic conditions (liquidity shocks, less profitable or less liquid investments, costly financial information), but depositors show weak sensitivity to risks of the bank investments. The depositors of medium-sized banks withdraw rationally more frequently compared to those in small or large banks. Why is it important to choose the correct time to withdraw and not to run a bank? Our answer is that withdrawing on time is profitable, as average returns of the depositor investments are higher. This is particularly true if the other depositors in the bank behave rationally and wait till the end of the game to get their funds back from their banks.

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APPENDIX

The form for depositors in a 4-depositor bank[5]

Name, Surname____№____________________

Round 1

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive
0		150
1	100	137,5
2	100	112,5
3	100	37,5
4	80	

Round 2

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive
0		150
1	100	137,5
2	100	112,5
3	100	37,5
4	80	

Round 3

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive
0		150
1	100	137,5
2	100	112,5
3	100	37,5
4	80	

Round 4

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive
0		120
1	100	110
2	100	90
3	100	30
4	80	

Round 5

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive
0		150
1	100	128,5714286
2	100	85,71428571
3	93	0
4	70	

Round 6

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive		
		Good	Bad	AVG
0		180	120	150
1	100	165	110	137,5
2	100	135	90	112,5
3	100	45	30	37,5
4	80			

[5] Those for small and large banks are available upon request

Round 7

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive			
		Good	Bad	AVG90	AVG10
0		180	120	174	126
1	100	165	110	159,5	115,5
2	100	135	90	130,5	94,5
3	100	45	30	43,5	31,5
4	80				

Round 8

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive			
		Good	Bad	AVG60	AVG40
0		180	120	156	144
1	100	165	110	143	132
2	100	135	90	117	108
3	100	45	30	39	36
4	80				

Round 9 c=10

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive			
		Good	Bad	AVG90	AVG10
0		180	120	174	126
1	100	165	110	159,5	115,5
2	100	135	90	130,5	94,5
3	100	45	30	43,5	31,5
4	80				

Round 10 c=

Number of depositors withdrawing in period 1	If you withdraw in period 1 you receive	If you withdraw in period 2 you receive			
		Good	Bad	AVG90	AVG10
0		180	120	174	126
1	100	165	110	159,5	115,5
2	100	135	90	130,5	94,5
3	100	45	30	43,5	31,5
4	80				