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A BANK RUN IN A CLASSROOM: DO SMART DEPOSITORS WITHDRAW ON TIME? [2,3,4]

Abstract: This paper discusses whether being smart makes depositors less prone to get involved in 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 that withdrawing on time is profitable, as the average returns of depositor investments are higher, especially if the other depositors in the bank also withdraw on time. Smarter depositors – those having better academic achievements – choose the 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 a coordination failure in the deposit market. Our results also suggest that panic withdrawals are more probable in markets with poorer economic conditions (liquidity shocks, less profitable or less liquid investments, costly financial information), but depositors show weak sensitivity to the risks of bank investments. Depositors of medium-sized banks withdraw on time more frequently compared to those in small or large banks.

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

JEL: G21, G41, C91

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[2] The paper was prepared within the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) and supported within the framework of a subsidy granted to the HSE by the Government of the Russian Federation for the implementation of the Global Competitiveness Program

The financial support from the Government of the Russian Federation within the framework of the implementation of the 5-100 Program Roadmap of the National Research University Higher School of Economics is acknowledged.

[3] 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.

[4] I'm grateful to Vladimir Sokolov, Leonid Polishchuk and to all the participants of the CInSt Research seminar in March 2017 for the useful comments on the previous version of this paper.

Introduction

Starting with (Diamond & Dybvig 1983) coordination failure in deposit markets has been considered an important source of instability, increasing the risk of bank runs and the subsequent bank defaults. In their model providing insurance against liquidity shock, the standard 2-period on-demand deposit contract adds to the incentives for early withdrawals for those depositors, who are supposed to live for the whole game. A coordination failure appears as the bank is not able to repay to everyone if they come earlier than scheduled in the contract. Being one of the Nash equilibria a bank run appears when the depositors expect others to withdraw earlier and thus withdraw themselves in order not to come to an empty bank at 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 funds from too risky banks to those who are more reliable, 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 considered tools to increase the degree of rationality of unsophisticated market participant behaviour in different financial markets including that for retail bank deposits. Empirical studies show that financial knowledge and skills can increase participation in the market, as they usually make people more prone to saving strategies (Klapper et al. 2013; Semenova 2011; Beck & Brown 2011), but there is no evidence that they influence information-based bank runs (Brown et al. 2014; Semenova 2012). In this paper we extend this literature and ask whether being smart may prevent depositors from withdrawing deposits when only coordination failure is a problem and no financial deterioration appears in any particular bank.

Studying the relationship between financial literacy and depositor behaviour related to withdrawal decisions is a tricky task if empirical data needs to be collected. It seems to be too complicated to collect data about the education of withdrawing depositors, let alone any more complicated measure of financial literacy. As (Dufwenberg 2015) emphasizes, the opportunity to test hypotheses related to this link appears in an experimental set-up, where various situations and economic conditions can be modelled, and decisions are made by real economic agents, maximizing their profit. In this paper we use unique data from 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. We combine this data with the student academic achievement data to examine the relationship between depositor smartness and the propensity to avoid inefficient bank runs.

The rest of the paper is organized as follows. The next section describes the literature on bank runs in the experimental set-up, which we contribute to. Then we introduce the experiment design. The next section describes the data and methodology. Then we present our results and conclude.

Related Literature

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

(Garratt & Keister 2009), on the contrary, found no evidence that the depositors withdraw voluntarily 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 also increase the frequency of bank runs. Having more chances to withdraw and observing the withdrawal history, depositors are more likely to run on a bank.

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

A coordination failure may occur as a result of the complicated coordination process. As (Arifovic et al. 2013) suggest, the higher the coordination parameter (the higher the proportion of the depositors who should not withdraw early needed to ensure higher gains for patient depositors compared to the impatient ones) the higher the probability of a bank run. The nature of these bank runs is not based on sunspots. However people learn over time and, in repeated games with an increasing degree of coordination required, depositors withdraw less frequently.

The role of sequential decisions and the 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 a 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.

(Davis & Reilly 2016) experimentally model the influence of the change in repayment proportions (re-contracting) and information about withdrawal behaviour on the fragility of distressed banks. The experiment was conducted with 240 undergraduate students. The authors show that if contracts are changed in favour of patient depositors, bank stability is less undermined. However this is not true if a 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 an experimental way. Contagion appears as an informational phenomena in several-step games where some proportion of depositors receive a signal about the deterioration of the bank's 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 have received. 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 makes uninformed ones withdraw even when their bank is unrelated to the bank of informed ones and there is no correlation with 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) study the channels of the contagion transmission when new information on bank fundamentals is revealed and is not promising. Basing on the results of an experiment with 264 undergraduate students participating in a sequential game, they show that if a signal on withdrawals in the first stage is quite informative, depositors withdraw earlier and mostly because they are afraid that others will withdraw, not because their expectations about bank stability suggest doing that (the coordination failure described in (Diamond & Dybvig 1983)).

Quite a few studies dealt with students in their experiment: being useful for the students themselves in their understanding of bank runs, as (Balkenborg et al. 2011) suggest. This type of participant provides an excellent opportunity to add the proxy of financial literacy to the analysis, however, as far as we are able to judge there are no papers incorporating student academic achievements into the models of bank runs. This study fills this gap in the literature. Leaving the use of complicated financial literacy measures for further research, we use a very simple proxy for it – the academic achievements. The paper closest to ours is (Kiss et al. 2016), where the authors introduce the cognitive abilities of the depositors proxied by the results of the standard Cognitive Reflection Test (CRT). In their sequential withdrawal experimental set-up they show that depositors with higher CRT withdraw less frequently in situations of strategic uncertainty (when no information on previous withdrawals is available). Our study is different in several ways. First of all, our set-up implies a simultaneous game with multiple independent rounds, modelling several economic scenarios. We aim to detect the coordination failure under different conditions. Secondly, our proxy for financial literacy measures mostly the overall knowledge of the participants and their degree of smartness, while CRT shows the ability of the respondents to go beyond the first – and incorrect – answer coming to mind and to think a bit more about the correct answer. We therefore appear to be closer to the nature of the financial literacy as a characteristic of depositor financial knowledge and skills.

Experiment design

The experiment was run during the course "The Microeconomics of Banking" or during research seminars with 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, their year of study and the city where the university is based. Moscow stands for the HSE and SPb for EUSPb. Our database covers 9 waves and four years. The students are diverse in terms of their years of study, varying from 2nd year undergraduates to 2nd year graduates. All the students participated in classes where both theory and empirics of bank runs and market discipline were discussed.

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

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*

Before the game started the participants were randomly assigned ID numbers and were provided with forms they were to fill in during the experiment to express their decisions. The ID number was in the form *AB-C-D-EF-G*, with the letters replaced by numbers to give important information about the participant characteristics in the game. These will be discussed in the game description. An exemplar of the form is in Appendix. Instructions were done using PowerPoint presentation.

The experiment deals with a 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 have 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. 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 second figure (*B*) identifies the bank of this size in the current classroom. For instance "32-" is 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 any student had broken this rule, the game would have been stopped and a penalty would have reduced the whole group's grades for the course. They never do, however.

G – the last number in the ID –counts the depositors within a bank. The other numbers are used in different rounds and are explained below.

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's characteristics do not depend on previous history.

The depositors have 100 units at the beginning of each round and open deposits for 2 periods, investing the whole amount. The bank invests all the accumulated funds in 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 is an early withdrawal penalty and each invested unit receives $0<r_0<1$. The deposit contract is also 2-period long, providing patient depositors with R per deposited unit at the end of the round. The contract is a standard on-demand deposit contract and there is no loss for an early withdrawal, withdrawing the deposit in period 1 the depositor receives back her funds. This contract is subject to fund availability. In any period if the funds are not sufficient 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:

$$Payment_1 = \begin{cases} 1, if \ N_1 < N * r_0 \\ r, if \ N_1 \geq N * r_0 \end{cases}$$

The rest (N-N_1) receive:

$$Payment_2 = \begin{cases} \frac{N * r_0 - N_1}{N - N_1} * R < R, if \ 0 < N_1 < N * r_0 \\ 0, if \ N_1 \geq N * r_0 \end{cases}$$

This experiment design means 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 until the end of the game. A coordination failure stimulates depositors to withdraw early if they suspect others within their bank will also withdraw. We call a bank run the situation where at least one depositor who should be waiting until 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 are $R=1.5$ and $r=0.8$. Changes in the market are modelled in other nine rounds, 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 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. She is only asked to choose the period of withdrawal. 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 depositor reactions – and their propensity to withdraw early – to liquidity shocks, deterioration in the economic situation in both periods, the appearance of risk and coping with risk by paying for information. 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 third figure in the ID number (*C*) is 1 for depositors with a liquidity shock. They mark the second column. All the rest make their own choice.

Round 3. In this round the number of depositors with liquidity shocks is 2 in each bank. The fourth figure in the ID number (*D*) is 1 for depositors with a liquidity shock. These shocks do not depend on the shocks in round 2. 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 a 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: There are no more liquidity shocks. In this round the economy offers worse projects to invest in, *R* is 1.2 instead of 1.5. The outcomes of the second period are lower but from the social planner's point of view everyone should keep their money in a bank until the end of the game.

Round 5. In this round *R* goes back to the basic level (1.5), but now the early withdrawal penalty is higher and r_0 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 at the end of the game. Below we describe the process of determining *R*. The students observe an additional column AVG in the table of this round. It reflects the expected outcome. They are told they may use these figures if they need them for any 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 a slide shows the probability tree. There are two additional columns in the correspondent table, showing the expected outputs for both scenarios (90%-10% or 10%-90%)

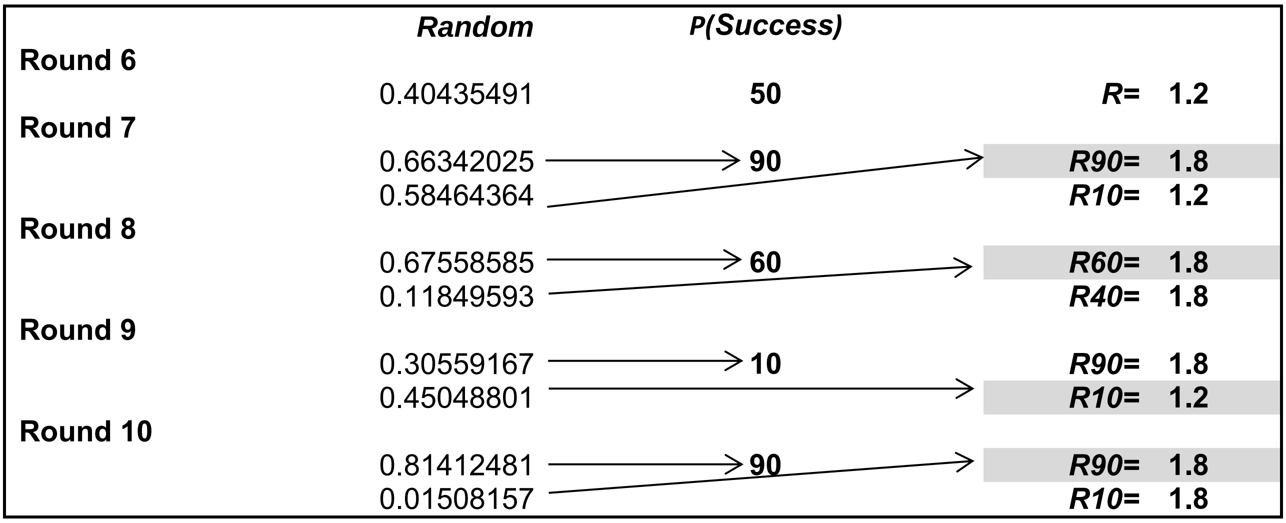
Round 8 is the same as the previous round but the probabilities for different levels of *R* are 60%-40% and 40%-60% respectively.

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 they are offered 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 to buy the information and mention this in the form. Secondly they describe the withdrawal strategy. If 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 of 10 units, the others have costs of 15 units. Figure *EF* in the ID shows which costs the depositor has. 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 round 6 if it is lower than 0.5 the economy shows low project profitability, otherwise *R* is high. For the other 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



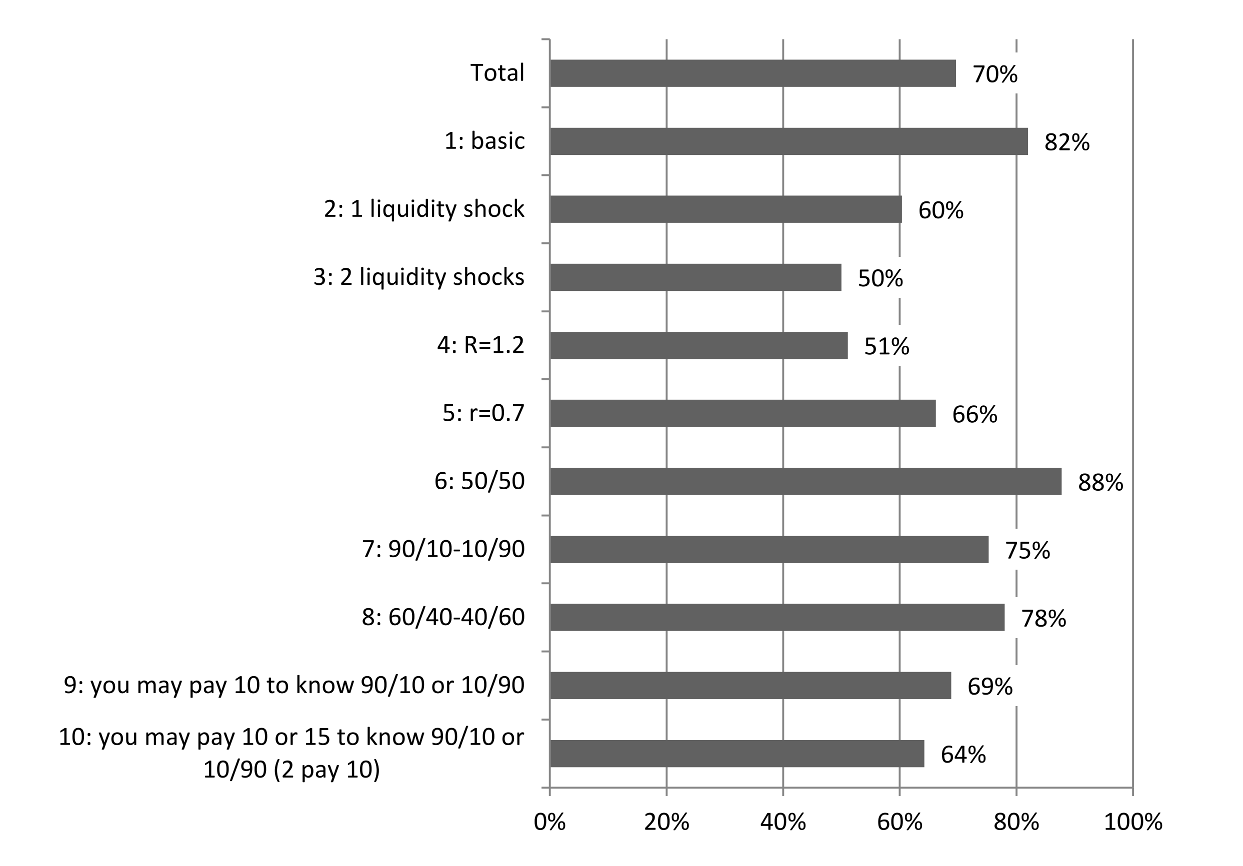
The total gain for a student in this game is her average rate of return for all 10 rounds[5]. To get the results after the last round the forms are collected and all the decisions are aggregated to check how many depositors withdrew early from each bank and each round and what return the depositors get.

Methodology and Data

The Diamond-Dybvig game means that the optimal choice for every depositor is to wait until the end of the game no matter what the economy shows. The only case when withdrawing early provides higher return is round 3 for a small bank. Two depositors are forced to withdraw so the third one gains more if she withdraws early and receives 80 units instead of 75 units. We call the depositor's withdrawal an *on-time* one if she withdraws in the second period for any case except round 3 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 correctness of their choice as they are forced to withdraw and do not make their own decision.

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

Figure 3. Share of on-time withdrawals by round



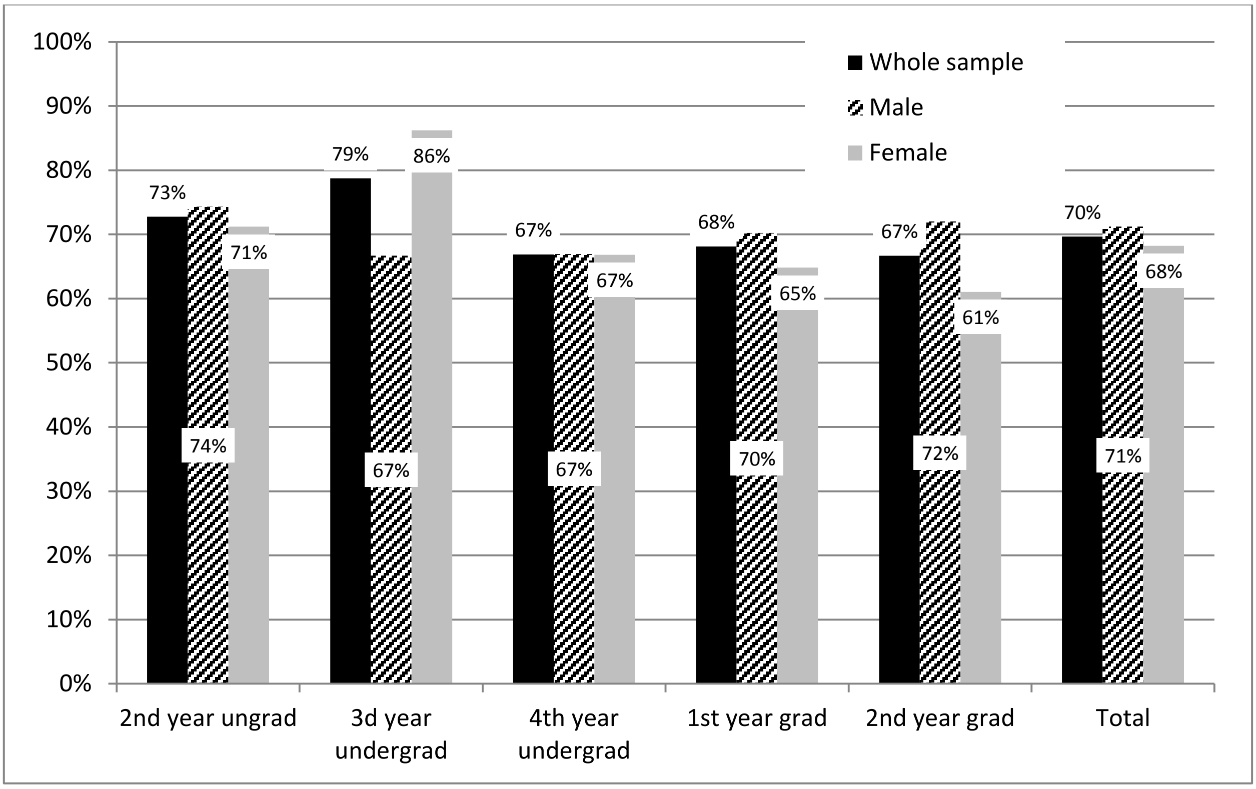
The average share of withdrawals not on time, in our sample is 30% (see Figure 3). Half of the depositors withdraw early in the case of two liquidity shocks among the bank clients and when the second period returns become lower decreasing from 1.5 to 1.2, still ensuring positive net gain for the waiting strategy, though. Surprisingly the introduction of basic risk makes the depositors the most patient: only 12% of them withdraw earlier. The first, basic round is also characterized by rare withdrawals with 82% of the students waiting until the end of the round.

In this study we are interested in the determinants of the probability of withdrawing on time in the chosen set-up and its gains. We start by asking whether this strategy 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.

Figure 4 shows that there are no extreme differences in the withdrawal rates between male and female depositors or among students of different years of study. However males withdraw on time slightly more frequently than females with the only exception of the 3rd year bachelor students, where females withdraw early only in 14% of observations (males 33%). This year is also specific in terms of the overall proportion of correct choices by the depositors: it is comparatively high amounting up to 79%.

In this study we are interested in the determinants of the probability of withdrawing on time in the chosen set-up and its gains. We start by asking whether this strategy 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.

Figure 4. Share of on-time withdrawals, by year of study and gender



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

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

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

$Ontime_{i,r}$ is a binary variable equal to 1 if the student's decision was to withdraw on time in round r, and 0 otherwise. The gain of a particular student depends on her choice and on the withdrawal choices of all the others in her bank. We introduce $OntimeOther_{i,r}$ measuring the average correctness of the other depositors of student *i*'s bank in round *r*. The average is measured only for students without liquidity shocks.

To check our results for robustness we replace the round-based withdrawal variable with the average one, calculated for the whole game. We introduce it as the share of rounds where a depositor withdrew on time. The same calculations are performed for 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 $Gender_i$, 1 for males and 0 for females;
- campus, introducing SPb_i , 1 for games conducted at EUSPb;
- year of studies, introducing $StudyYear_i$ varying from 2 for 2nd year undergraduate students to 6 for the 2nd year graduate students.

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

We control for the economic conditions in round *r* introducing $Economy_r$, which is equal to 0 for the rounds with no risk, 1 for the rounds where economy was good, providing high second period returns, and (-1) for the rounds where economy was bad. 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 is 1 and 0 otherwise, these games were played in the second semester (mostly in spring).

Our main hypothesis at this stage is that withdrawing on time is profitable: the students withdrawing correctly (and doing that more frequently) gain more and earn a higher average return.

Our next step is to find out whether being smart makes students withdraw on time. We estimate probit models for the probability of on-time withdrawals. First of all we use a model which includes only the characteristics mentioned above:

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

Then we introduce the measures of student academic achievement into the basic model:

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

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 student grades are available only for the Moscow students, so we have to limit our sample to the games conducted at HSE. The grades at HSE vary from 1 to 10. On 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 (grades lower than 4 mean that a student failed 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 available grades for the previous year. The average grade is very close to the previous one and is less dispersed.

We also study the influence of student grades on the share of correct decisions among all the decisions. We estimate with OLS the following regressions again starting with the basic one and then extending it introducing the grades:

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

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

Our main hypothesis at this stage is that smarter students should withdraw on time more frequently as they understand that these withdrawals ensure higher returns in the chosen set-up.

Results

We start with discussing the gains withdrawing on time can provide for 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 giving the option to choose the withdrawal time. 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). The first four columns show the results for the per-round choice of the depositor herself and the rest of the depositors in the same bank, second part of the table includes the results for the average per-game proportion of the on-time withdrawals of the participant and the same for other depositors.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
	Moscow sample					*Whole sample*				
Ontime	1046	0.7113	0.4534	0	1	1150	0.6965	0.4600	0	1
Grade_s (last semester)	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. On-time withdrawals 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
Ontime	0.02813***	0.02867***	0.02933***	0.02867***				
	(0.00636)	(0.00658)	(0.00642)	(0.00658)				
$Ontime\_bank_{-i}$	0.07886***	0.07206***	0.07871***	0.07206***				
	(0.01094)	(0.01115)	(0.01103)	(0.01115)				
Ontime_av					0.13236***	0.12959***	0.13113***	0.12623***
					(0.01194)	(0.01249)	(0.01246)	(0.01294)
$Ontime\_av\_bank_{-i}$					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*

All the specifications provide evidence of a strong and positive relationship between withdrawing on time and average returns of the depositor investments. Choosing this strategy in a single round adds on average from 1.3 to 2.8 p.p. to the game result (depending on the model specification). Given that the average gain the depositor receives is 16-17% these effects are statistically and economically significant.

Withdrawing on time is good but having counterparties withdrawing on time is even better. Our results show that the correct choice of depositors' unobserved peers is even more important for deposit profitability. The effects of other depositors' average profitability are in all specifications 2-2.5 times higher than individual effects. That means that withdrawing on time in a bank, where others do not do the same is worse in terms of profitability than making an incorrect choice when all the rest make the correct ones.

For the control variables, the results suggest that male depositors earn 2-2.5 p.p. more than females on average. This contradicts (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, which ensures that our experiment depicts the realities of the deposit markets, where larger banks usually offer lower interest rates, as do the smallest ones, as they are usually not so exposed to the market, focusing on other types of banking activities, being cooperative banks, captive banks or clearing houses. 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 the 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 in the sample shows that they earn less compared to those at HSE.

Our answer to the question in the first hypothesis is positive: withdrawing on time makes depositors richer in our experiment, especially if the others withdraw on time as well.

What increases depositor propensity to withdraw on time? Our natural prediction was that higher grades, measuring the degree of student knowledge, intuition and smartness, should have a positive influence. **Ошибка! Неверная ссылка закладки.** 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 subsample. The models shown in columns III and IV include the average grades as an explanatory variable. They are available only for HSE students. Column III covers the results for the model with the previous semester average grade, column IV shows the effect for the previous year average grade. Both measures of student academic achievements show the same result: each additional grade point adds 4.4 p.p. to the probability that a student will withdraw on time in the current round. The same is true for the share of rounds where the depositor makes a correct choice. Each additional grade point adds almost 9 p.p. to this share. This 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 have already shown, the most stable rounds, in terms of early withdrawals are the basic one and those with risk, but without any way to reduce information asymmetry by paying for the information. The depositors of medium banks withdraw on time more frequently, and those in large banks do it with lower probability, however, the latter result is not stable.

The control variables provide evidence that male depositors withdraw correctly more frequently than female ones. Spring editions of the game show a lower probability of on-time withdrawals and a lower share of those withdrawals. Third year undergraduate students and second year graduate ones withdraw correctly with higher probability. The students from EUSPb withdraw on time less frequently in this experiment.

Table 5 shows the results for the proportion of the rounds with on-time withdrawals for the whole game.

Table 4. On-time withdrawals and being smart, AME

Variables		Whole 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=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	-0.03752	0.00876	0.04057

	(0.03723)	(0.03787)	(0.03767)	(0.03767)
Bank of 5 depositors	-0.16704***	-0.17932***	-0.11534***	-0.11966***
	(0.03588)	(0.03936)	(0.03972)	(0.03972)
Gender (1 - male, 0 - female)	0.02311	0.02389	0.06007**	0.05227*
	(0.02600)	(0.02685)	(0.02718)	(0.02718)
3d year undergrad	0.11260	0.11327	0.08811	0.10855
	(0.07039)	(0.06956)	(0.07101)	(0.07101)
4th year undergrad	-0.15009***	-0.15589***	-0.14086***	-0.12889***
	(0.03680)	(0.03678)	(0.03987)	(0.03987)
1st year grad	-0.11081**	-0.11443**	-0.05291	-0.02788
	(0.04523)	(0.04494)	(0.04756)	(0.04756)
2nd year grad	-0.05404	-0.06491	-0.01452	-0.02781
	(0.06217)	(0.06246)	(0.06603)	(0.06603)
Season (1 - Autumn, 0 - Spring)	0.02159	0.02421	0.02745	0.04059
	(0.03349)	(0.03313)	(0.03482)	(0.03482)
SPb	-0.17786***			
	(0.06491)			
Observations	1,150	1,046	963	890

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

Both measures of student academic achievements show the same result: each additional grade point adds 4.4 p.p. to the probability that a student will withdraw on time in the current round. The same is true for the share of rounds where the depositor makes a correct choice. Each additional grade point adds almost 9 p.p. to this share. This 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 have already shown, the most stable rounds, in terms of early withdrawals are the basic one and those with risk, but without any way to reduce information asymmetry by paying for the information. The depositors of medium banks withdraw on time more frequently, and those in large banks do it with lower probability, however, the latter result is not stable.

The control variables provide evidence that male depositors withdraw correctly more frequently than female ones. Spring editions of the game show a lower probability of on-time withdrawals and a lower share of those withdrawals. Third year undergraduate students and second year graduate ones withdraw correctly with higher probability. The students from EUSPb withdraw on time less frequently in this experiment.

Table 5. Share of rounds with on-time withdrawal 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***	0.05276***	0.05980***

	(0.02194)	(0.02186)	(0.01641)	(0.01732)
Bank of 5 depositors	0.35133***	0.40274***	-0.03231	-0.05524**
	(0.01836)	(0.01843)	(0.02121)	(0.02234)
Gender (1 - male, 0 - female)	0.20488***	0.17270***	0.10871***	0.09044***
	(0.01796)	(0.01903)	(0.01300)	(0.01293)
3d year undergrad	0.35346***	0.31438***	0.08488***	0.10950***
	(0.02910)	(0.02803)	(0.02618)	(0.02601)
4th year undergrad	0.27324***	0.28404***	-0.08777***	-0.06222***
	(0.02257)	(0.02301)	(0.02138)	(0.02044)
1st year grad	0.34622***	0.34511***	0.05032***	0.01100
	(0.03215)	(0.03286)	(0.01813)	(0.01929)
2nd year grad	0.38000***	0.41376***	0.06932**	0.04918
	(0.03460)	(0.03470)	(0.03244)	(0.03048)
Season (1 - Autumn, 0 - Spring)	0.18401***	0.16131***	0.06529***	0.07833***
	(0.02091)	(0.02094)	(0.01710)	(0.01699)
SPb	-0.26145***			
	(0.04665)			
R-squared	0.82027	0.83192	0.92508	0.93154
Observations	1,15	1,046	963	890

Conclusion

This paper discusses the results of a series of experiments with undergraduate and graduate students from Moscow and Saint-Petersburg, modelling the 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 getting involved in a bank run. Students demonstrating better academic achievements choose the 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 unsophisticated and provides evidence that financial literacy – even measured in a very simple way – may prevent a coordination failure in the deposit market. Our results also suggest that panic withdrawals are more probable in markets with poorer economic conditions (liquidity shocks, less profitable or less liquid investments, costly financial information), but depositors show weak sensitivity to the risks of bank investments. The depositors of medium-sized banks withdraw on time more frequently compared to those in small or large banks. Why is it important to choose the correct time to withdraw and not to make a run on a bank? Our answer is that withdrawing on time is profitable, as the average returns are higher. This is particularly true if the other depositors in the bank withdraw on time and wait until 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[6]

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			

[6] 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				