

Experimental Instructions

Introduction

Welcome to this experiment in economic decision-making. Please read these instructions carefully as you, and the other participants, will have to successfully answer some questions that check your understanding of the material in these instructions before you can proceed on to the study.

The study consists of a number of rounds. Each round consists of three periods: 1, 2 and 3. Each round is independent of all other rounds; your choices begin anew each new round.

For completing this study you are guaranteed a participation payment of ... and you can earn more depending on the decisions that you and other participants make. Specifically, at the end of the experiment your payoffs from k rounds, randomly selected, will be added to your participation payment. Since you do not know which rounds will be chosen, you will want to do your best in every round.

Overview

There are N participants in this study. You and each of the other $N - 1$ participants play the role of *bankers* that accept deposits from customers in period 1 of each round. Each banker represents one bank. The customers are automated robot players as discussed below.

The N banks are divided up into two “regions”. One half of the banks service customers in Region I while the other half service customers in Region II. The Region that your bank serves, I or II, will be clearly indicated on your computer screen, and your bank will remain in this region for the duration of this study.

At the start of each round you are given an endowment of xx points and you can earn additional payoff points. Your payoff points in each round depend on the allocations you make of your bank’s customer’s deposits between Cash and Assets in period 1, the market price for Assets that will be determined by your choices and the choices of other bankers in period 2, and whether an accounting review indicates that the bank you represent is **Solvent** or **Not Solvent**.

Bankers and the Market for Assets

You and the other bankers make decisions in periods 1 and 2 of each round. At the beginning of period 1, 100 customers, who are all automated robot players, deposit 1 unit of cash in their bank. Therefore, at the beginning of each round, every banker receives 100 units of deposits from customers. Then, in period 1, you and each banker have to decide how many of its 100 deposit units to put into assets, the amount A , with the remaining amount $100 - A$ in cash, C . You make this allocation decision by moving a slider bar on your computer screen for the amount A of deposits you want to put into Assets with 100 minus that choice being the amount C of deposits that remain in Cash (with $C = 100 - A$). You confirm your decision by clicking on a submit button.

Deposits held as Cash earn no interest but they are available for you to meet customer withdrawals of deposits in period 2. Assets, on the other hand, take time to mature. For each unit of deposits that you allocate to Assets in period 1, there is a payoff of 2 units (a 100% return) in

period 3. Assets **MUST** be held until period 3 in order to earn this return. Moreover, as discussed below, there will be a market among bankers for the buying and selling of Assets in period 2 that you and the other $N - 1$ bankers can choose to participate in. Your objective and that of the other bankers is to ensure that your Bank remains Liquid and Solvent as explained below.

You and the other bankers offer their customers the right to withdraw their deposit of 1 unit of cash with no interest or return in period 2. Bankers further offer that if their customers keep their deposit in their bank until period 3 (the last period of the round), then the customer will get an equal share in the profits earned on the Assets and any cash that the bank holds into period 3, provided that the bank is not illiquid or declared insolvent, as explained below.

In making your initial allocation decision, you and the other $N - 1$ bankers face two kinds of uncertainty. The first concerns the number of your customers who are impatient or patient as described in the table below.

State	Region I	Region II
s_1	67 impatient, 33 patient	33 impatient, 67 patient
s_2	33 impatient, 67 patient	67 impatient, 33 patient

There are two “states”, labeled s_1 and s_2 , for the numbers of impatient and patient customers that you and the other $N - 1$ bankers will be dealing with depending on their region. At the start of each new 3-period round, both states are equally likely. You and the other $N - 1$ bankers do not learn the state until period 2, but you have to make your allocation of deposits decision in period 1. If you are in Region I (II) and it is state s_1 , then your bank will have more (less) impatient customers than banks in region II (I). Symmetrically, if you are in Region I (II) and it is state s_2 , then you will have less (more) impatient customers than banks in region II (I). Specifically, 67 impatient customers means that you will definitely face a withdrawal of $w = 67$ units of deposits in period 2, while 33 impatient customers means that you will definitely face a withdrawal of $w = 33$ units of deposits in period 2.

You and the other $N - 1$ bankers also face a second kind of uncertainty about what your *patient* customers will choose to do. While an impatient customer always withdraws his/her deposit in period 2, a patient customer *may wait to withdraw later in period 3 or choose to withdraw early in period 2 along with impatient customers*. Whether your patient customers withdraw later in period 3 or early in period 2 depends on an accounting review of your bank’s solvency (as explained below).

At the start of period 2, you and the other $N - 1$ bankers know *precisely* the number of your customers who are impatient and who will withdraw their deposits in period 2 (either $w=33$ or $w=67$), but, you and the other $N - 1$ bankers don’t know what your patient customers will choose to do. Before any period 2 withdrawals are made, you and the other $N - 1$ bankers can choose to participate in a centralized market to buy or sell Assets. Each Asset that you sell yields you immediate payoff in additional Cash according to the market price for Assets, P . Each Asset that you purchase using cash yields you a payoff of 2 if held until period 3. For instance, if given the realized state s_1 or s_2 , you find that you have allocated too many deposits to Assets to meet the period 2 Cash withdrawal demands of your impatient customers, then you can *sell* some of your Assets in exchange for Cash deposits. On the other hand, if, given the state, you find that you have allocated too little to Assets (and too much to Cash) to incentivize your patient customers to wait to

withdraw their deposits until period 3, then you can use some of your Cash deposits to *buy* Assets from other bankers.

If you choose to be a buyer of Assets then you must decide on the amount of Cash you want to bid, b . Your bid can be any amount from zero up to the amount of Cash you have available. If you choose to be a seller of assets, then you choose the quantity q of Assets that you want to sell which can be any quantity from zero up to the number of Assets that you own. After all bankers (participants) have submitted either quantities of Assets to sell or bids of Cash for Assets, the market price of Assets, P , is determined as follows:

$$P = \frac{\text{Total Amount of Cash Bid by all Bankers}}{\text{Total Units of Assets Offered by all Bankers}}$$

If there is no quantity of Assets offered and/or bids of Cash for Assets in the asset market of period 2, then there is no market price and no exchanges take place.

When all you and the other $N - 1$ bankers have confirmed their choices in the asset market, the market price for the round is determined by the formula given above for P .

Assuming there is a market price P , then all exchanges take place at that market price, P . If you bid b units of Cash, then, after the market, you will get b/P Assets that are in addition to the Assets you already hold, but you will have b less Cash. If you sell q Assets, then after the market, you will have $P \times q$ more units of Cash than the Cash balance you started with but q fewer assets.

The decision screen decision screen that you and the other bankers face in the period 2 market for Assets is shown in Figure 1.

In this round, w of your customers are Impatient
Based on your initial allocation, you have A in Assets and 100-A in Cash

You are a buyer:

Amount of cash you want to bid (b)

0

C

OR

You are a seller:

Quantity of assets you want to sell (q)

0

A

Price forecast (P^f)

0.01

5

Based on this information the bank is:

Liquid

Solvent

And your expected payoff is:

Your final choices

$b =$

OR

$q =$

$P^f =$

CONFIRM

Figure 1: Market Decision Screen

At the top of the screen you are informed of the number of impatient customers in your region for this round and how many of your deposits you hold in assets, A , or in cash, $100-A$. Below that is a “sandbox” where, by moving a slider, you can experiment with buying or selling assets that

mature in period 3, but ultimately, you must choose one role or the other and submit a bid of cash, b , to buy assets, or a quantity of assets, q , to sell for cash.

In addition, you must move the market price slider to what you forecast the market price, P^f , will be for this round. Given your forecast for the market price P^f and your bid, b , or your quantity decision, q , the computer program will alert you to whether your bank may face a liquidity or solvency problem.

Your bank is considered *liquid* if you have enough Cash on hand to meet the withdrawal demands ($w=33$ or $w=67$) of your (robot) impatient customers in period 2. That is if $(100 - A) - b \geq w$ provided you have chosen to be a buyer, and if $(100 - A) + P \times q \geq w$ provided you have chosen to be a seller. Your bank is considered *solvent* if you have enough invested in assets to make your patient customers willing to wait to withdraw their funds in period 3, that is if you are likely to be able to offer a payoff higher or equal than 1 to its patient customers. That is if $(100 - A) - b + 2 \times (\frac{b}{P} + A) \geq 100$ provided you have chosen to be a buyer, and if $(100 - A) + 2 \times (A - q) + P \times q \geq 100$ provided you have chosen to be a seller.

Based on the above conditions, the box "Liquid" will turn to "NOT Liquid" if, given your forecast for the market price, P^f and your buy or sell choice, you will be unable to meet the withdrawal needs of your impatient customers in period 2. The box "Solvent" will turn to "NOT Solvent" if, given your forecast for the market price and your buy or sell choice, your patient customers will not earn a return greater than 1, and as a result they will withdraw early in period 2 along with the impatient customers. By adjusting your buy or sell decision and/or your price forecast, P^f you may be able to become either "Liquid" or "Solvent" or both, at least in expectation.

Please note that the notifications on the decision screen as to whether or not your bank is liquid and/or solvent rely on your forecast of the market price, P^f , and not on the actual realization of the market price, P . If your forecast of P^f is incorrect, then you could be either not liquid or not solvent or both, regardless of what was predicted based on your forecasted market price. Therefore, it is very important that you try to accurately forecast the market price P^f . To better incentivize you to provide an accurate forecast for the market price P^f , you will earn some points each round depending on how close your own price forecast, P^f , is to the actual market price, P as determined by all participants. Specifically, your points for forecast accuracy are determined by the formula:

$$\text{Forecast points} = \frac{zz}{1 + |P^f - P|}.$$

Notice that the maximum points you can earn for forecast accuracy is zz and that your forecast points decrease the greater is the absolute value of the difference $|P^f - P|$ between your forecast, P^f and the actual market price, P ; you get the maximum of zz points only if $P^f = P$. The table below shows the forecast points for a sample of possible forecast errors $|P^f - P|$ you could make.

Forecast error $ P^f - P $	1.8	1.6	1.4	1.2	1.0	0.8	0.6	0.4	0.2	0.0
Forecast points	$\frac{zz}{2.8}$	$\frac{zz}{2.6}$	$\frac{zz}{2.4}$	$\frac{zz}{2.2}$	$\frac{zz}{2.0}$	$\frac{zz}{1.8}$	$\frac{zz}{1.6}$	$\frac{zz}{1.4}$	$\frac{zz}{1.2}$	zz

Once you have settled on a buy or sell decision, enter your bid, b or your offer, q in the buy or sell part of the screen and below that enter your forecast for the market price, P^f . Then click the confirm button. Remember that you can either be a buyer or a seller but not both – that is, once you click confirm your buy/sell choice and price forecast, your decisions for the round are final.

Market Price and the Outcome of a Round

When all N bankers have confirmed their choices in the asset market, the market price for the round is determined by the formula given above for P . Depending on the actual realization of the market price, P , you can earn payoff points, provided that you are *both* liquid and solvent given the actual market price, P .

Using your holdings of cash and assets following the trades in the asset market at price P , the computer program conducts an accounting review of whether or not your bank is both liquid and solvent. If your bank is either not liquid or not solvent or both, then your bank is declared *bankrupt* for the round and you earn zero payoff points. If your bank is both liquid and solvent, then your payoff points will be that earned by a patient customer in your bank.

Your bank is declared *liquid* by the computer's accounting review only if you have enough invested in Assets and Cash to assure that all of your impatient customers are able to withdraw their deposits in period 2 or if $(100 - A) - b \geq w$ if you bought assets and if $(100 - A) + P \times q \geq w$ if you sold assets in the asset market.

Your bank is declared *solvent* by the computer's accounting review if you have enough invested in assets to make your patient customers willing to wait to withdraw in period 3 that is $(100 - A) - b + 2 \times (\frac{b}{P} + A) \geq 100$ if you bought assets, and $(100 - A) + 2 \times (A - q) + P \times q \geq 100$ if you sold assets in the asset market.

To earn payoff points, the accounting review must determine that your bank is *both* liquid and solvent. If that is the case, then you earn a payoff that is equal to the the payoff earned by each of your bank's patient customers, which is your bank's period 3 earnings divided by the number of patient customers $(100 - w)$. This payoff depends on whether you were a buyer or a seller of assets in the asset market:

$$\text{Your payoff if your bank is liquid and solvent} = \begin{cases} \frac{(100-A)-b+2 \times (\frac{b}{P}+A)-w}{100-w} & \text{if you were a buyer} \\ \frac{(100-A)+2 \times (A-q)+P \times q-w}{100-w} & \text{if you were a seller} \end{cases}$$

If the accounting review declares you to be illiquid or insolvent for the round, then your bank is declared *bankrupt* and you earn zero payoff points. In addition to points earned from the decisions you make, you may also earn up to zz points for the accuracy of your price forecast.

At the end of the study, the computer program randomly chooses k rounds for payment. In c of those rounds, you get the payoff points you earned from managing your bank's portfolio, either zero if declared bankrupt or the payoff to a patient customer if not. In $k - c$ rounds, you get the points you earned from forecasting the market price, up to zz points. These points and the xx endowment for each chosen round are summed up and converted into money at the fixed rate of 1 point = money. These earnings will be added to your participation payment. Then you will be paid your total earnings in private.

Summary

Summarizing, the timing of moves in each period is as follows:

Period 1: (a) You receive an endowment of xx points.

- (b) You receive 100 units of deposits and decide on the amount A of deposits to invest in Assets with a payoff of 2 if held until period 3. The amount $C = 100 - A$ goes to Cash on hand earning no return.

- Period 2: (a) You learn the number of impatient customers, w for your Region and bank.
 (b) With knowledge of w and your initial allocation A , you must decide whether to buy or sell assets in the asset market and enter a forecast for the market price P^f .
 (c) When you and the other $N - 1$ bankers have confirmed their buy and sell choices in the asset market, the market price P for the round is determined.

$$P = \frac{\text{Total Amount of Cash Bid by all Bankers}}{\text{Total Units of Assets Offered by all Bankers}}$$

- (d) You and the other $N - 1$ bankers are informed of the market price, P
 (e) Considering the number of impatient customers w , the market price P , and your own bank's cash and asset positions following trades in the asset market, the computerized accounting review determines whether or not your bank is both Liquid and Solvent.

- Period 3: (a) You are informed of the result of the accountancy review. If your bank is both Liquid and Solvent, your payoff points are:

$$\text{Your payoff points if your bank is both liquid and solvent} = \begin{cases} \frac{(100-A)-b+2 \times (\frac{b}{P}+A)-w}{100-w} & \text{if buyer} \\ \frac{(100-A)+2 \times (A-q)+P \times q-w}{100-w} & \text{if seller} \end{cases}$$

If your bank is either Not Liquid or Not Solvent, then you earn zero payoff points.

- (b) You are informed of the amount of points you earned based on the accuracy of your price forecast.

Comprehension Quiz

1. True/False. Which of the following statements is true and which is false?

- When choosing how many deposit units to put into assets (in period 1 of each round) you know that is equally likely that your bank will face 67 or 33 impatient customers in period 2 of that round.

[TRUE]

- Impatient customer can decide to withdraw in period 3 together with patient customers.
- Impatient customers withdrawal demands in period 2 can be paid with assets that mature in period 3.

[FALSE: They can only be paid with Cash in hand]

- After learning the number of impatient customers, bankers can participate in a centralized asset market where they can buy or sell assets for cash.

[TRUE]

2. Single choice. If your bank is in Region II and you learn that the amount of impatient customers your bank will have this round is 67. How many impatient customers any other bank in Region I will have?

- a 67
- b 33
- c 67 or 33
- d none of the above

[Answer: b]

3. If after learning the amount of impatient customers you realize that you have ___ of the deposits allocated to Assets to meet period 2 Cash withdrawal demands, then you can ___ Assets in exchange for Cash deposits from other bankers.

- a too little; buy
- b too little; sell
- c too much; buy
- d too much; sell

[Answer: d]

4. Fill in the blank. If in a given round the total amount of Cash bids is 57 and the total quantity of Assets offered is 75, the market price of Assets, P , will be: ___

[Answer: 0.76]

5. Fill in the blank. If in a given round you bid 24 units of Cash, and after the market exchange takes place P is 1.2 your bank will have ___ Assets in addition to Assets your bank already had.

[Answer: twenty or 20]

6. Fill in the blank. If in a given round you sell 40 Assets, and after the market exchange takes place P is 1.2 then your bank will have ___ units of Cash in addition to the Cash your bank already had.

[Answer: forty-eight or 48]

7. Single choice. The accountancy review will declare your bank insolvent if the computer determines that after the period 2 asset market, the bank will be unable to:

- a meet the withdrawal needs of impatient customers in period 2.

- b meet the withdrawal needs of patient customers in period 2.
- c pay patient customers at least 1 unit in period 3.
- d pay patient customers at least 2 units in period 3.

[Answer: c]

8. Single choice. The accountancy review will declare your bank illiquid if the computer determines that after the period 2 asset market, the bank will be unable to:
- a meet the withdrawal needs of impatient customers in period 2.
 - b meet the withdrawal needs of patient customers in period 3.
 - c pay patient customers at least 1 unit in period 2.
 - d pay patient customers at least 2 units in period 3.

[Answer: a]

9. Fill in the blank. At the end of the study, the computer program randomly chooses [input box 1] rounds for payment. In [input box 2] of those rounds, you get the points earned if your bank is declared liquid and solvent. In [input box 3] of those rounds, you get the points earned from forecasting the market price.

[Answer Box1: k; Box2: c; Box3: k-c]