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Experiment with Financial Bubbles

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Abstract

The authors present Kaivik, a free online asset auction classroom experiment platform that works with cellphones. Students use cellphones to trade units of a financial asset (shares in a single company) by submitting bid and ask prices plus the number of asset units they are offering to buy or sell per transaction. In this “order book” system the liquidity of the asset market at any point in time is variable. Trading can generate asset market bubbles. Instructors set key experiment parameters. Results are recorded and can be presented on a screen for discussion. Students are given an experiment report template to complete.

In this article we present a free online cellphone compatible platform for creating and running asset market experiments in the classroom: Kaivik. The behavior of asset markets is a key topic in money and banking, macroeconomics, and finance courses. Kaivik runs on student cellphones and does not assume or require prior knowledge of finance. Kaivik allows students to trade multiple asset units per single trade (an “order book” system). The experiment can be used with online courses, although in-class runs have the advantage that students can work in teams. There is no upper limit of number of students/teams who can participate.

For a baseline consistency in comparing results across different classes, rounds have been set to be a standard fixed length of 90 seconds long. Instructors can vary the number of rounds, the interest rate of cash holdings, the initial endowment of shares per trader, and the initial cash holdings per trader.

Following the experiment students should be required to discuss and report on their strategies and trading experience. Potential learning objectives include acquiring basic knowledge of financial asset trading, learning fundamental differences between the efficiency of real goods markets and financial markets, behavioral aspects of trade in financial markets, the efficiency of financial markets under conditions of uncertainty, and parallels with historical financial asset bubbles such as the US housing bubble of 2007-2009 and the Dutch tulip mania bubble.

The Financial Crisis and Asset Market Bubbles

The fourth issue of Volume 41 (2010) of *The Journal of Economic Education* includes a symposium on *The Financial Crisis and the Teaching of Macroeconomics* in which Robert J. Shiller (Shiller, 2010) discusses challenges for teaching macroeconomics following the 2007 – 2009 financial crisis. Shiller questions the effectiveness of the dominant macro teaching mode which is (still) based on presenting standard models with rational representative agents making optimal efficient choices in an environment with risk (i.e., known probabilities).

Shiller argues that the financial crisis did not conform to the standard rational expectations model. There was no exogenous real shock (such as a pandemic) to explain the crash. Shiller notes students’ dissatisfaction with the disconnect between their standard economics models and the “economic crisis raging outside the halls of academe”. He states that the initial cause of the

crisis was speculative bubbles, and that the psychological dimension of “animal spirits” is important and “should be an important part of what we teach”.

Financial bubbles and behavioral finance are difficult concepts for textbooks to explain. The basic problem is that there is no simple standard graphical model for an instructor to use. Asset market classroom experiments can serve as a substitute that allows students to experience and discuss bubbles, animal spirits, and departures from efficient markets.

Asset Market Experiments

The precursor to classroom finance experiments is the 1988 research “asset market” experiment by Smith, Suchanek, and Williams (1988) which demonstrated that even under conditions of full knowledge of all relevant probabilities of future asset dividends there can be a replicable tendency for a financial asset market price to shoot above the fundamental value, then to crash before the final expiration date.

The financial bubble research experiment result presents a radical contrast with the efficiency and rational behavior of the classic double oral auction real goods demand and supply experiment (Smith, 1962).

There are several classroom versions of the financial bubble experiment. Paper and pencil versions have been created by Bell (1993) and Ball and Holt (1998). Bostian and Holt (2009) created a free web-based version, with students using laptops, with an order book trading system, available for instructors to use, at the Veconlab website at the University of Virginia. Moinas and Pouget (2016) created a variation called the classroom Bubble Game. This experiment is a one-shot paper and pencil strategy game. Moblab.com, the economic games and experiments company, has an online asset market game in its portfolio. The Moblab Asset Market (Bubbles and Crashes) game allows instructors to set parameters and has tools to assist in debriefing and enhancing learning. However Moblab requires that students subscribe to the Moblab site.

Classroom asset market experiments differ in delivery mode but share key common elements:

- Participants (traders/teams) start with an identical endowment of cash, and identical endowments of the asset: company shares which generate dividends every period.
- Every period each unit of the asset generates a random dividend, the dividend being identical for every share regardless of owner.
- The probability distribution for dividends is identical every period and known to traders.
- There is a fixed known number of trading periods, every period of equal length.
- Participants can buy or sell shares every period.
- Shares have zero redemption value at the end of the last period.

Standard efficient markets theory predicts that the market price of a share each period should equal the expected value of all future dividends. This prediction is why the game is also an experiment. Will the prediction be confirmed? When drawn on a graph the market price for a

share is predicted to be a downward sloping straight line, reaching zero in the last period when a share has no redemption value.

The surprising and usual result of the asset market experiment is that asset prices for shares start lower than the expected value of all future dividends but increase to a peak well above expected value around the mid-point, then collapse before the end of the experiment.

At the conclusion of the experiment students are debriefed and the class discusses potential explanations and implications of the results. Students can be assigned to write experiment reports. Teams should be rewarded with cash according to a preannounced reward rule: for example, Bostian et al randomly select a student to be rewarded according to a formula. The classroom analysis and discussion can include topics and concepts including: animal spirits; risk; efficient markets theory; probability; liquidity, market strategy, and the concept of financial market fundamentals. The experiment can be linked to episodes in history such as the Dutch tulip bubble mania of the 1600s and more recently the US housing bubble of 2005-2006.

Kaivik

The Kaivik experiment is a free online financial market experiment platform that works with student cellphones. Only the instructor needs to use a computer. It does not require a subscription or personal identifying information from users. Instructors can retrieve data from previous runs for comparison purposes.

Kaivik uses an order book trading system. In an order book system agents submit both a price offer (a “bid” price for buying, an “ask” price for selling) plus a unit quantity offer. The order book system then automatically clears trades, with first priority given to matching by price, and then matching by quantity (buyers never pay more than their bid price and sellers never sell below their ask price).

Order book trading means that market liquidity is a strategic consideration for traders: buyers seeking to buy multiple shares in one trade will have to consider offering a higher bid price than they would if they only wanted to buy a single share, and sellers of multiple shares will have to consider lowering their ask price if they wish to sell multiple shares in one trade.

Order book trading is essential for liquidity in financial markets. It would not be feasible to run a financial market where every trade could only reallocate financial assets one unit at a time.

Setting Up Kaivik: First Time Instructions

The first time an instructor uses Kaivik they will set up a personal free account on the Kaivik server. This allows the creation of financial market experiments by using a Professor Dashboard. The instructor needs to save their personal login email and password for future reference.

The Dashboard will keep a record for each experiment under a unique ten letter upper case run code like “JT BGOHLPDM”.

Each run of the experiment is linked with to a unique “Room” with the ten-letter run code that can be used to retrieve the record of that run. When using Kaivik the word “room” actually means a single specific experiment run. The instructor needs to keep a record of the unique code for each run.

Setting Up Kaivik: Setting Up an Experiment Run

The order of steps for the instructor:

- Navigate to <https://kaivik.us>
- Enter your login email and password
- On the Professor Dashboard, click add new “room” and record the unique new ten letter room identification code (as well the date and course) from the upper left text entry box
- Click “Go to.....” filling in the ten digit code for the new room that was added and now appears in Open Rooms
- The instructor sets the parameter values:
 - Number of rounds
 - Initial cash endowment per team
 - Initial share endowment per team
 - Probability distribution of share dividends each round

Running Kaivik: Running an Experiment

The order of steps for running an experiment are:

- Instruct students to navigate to <https://kaivik.us>
- Tell the students the room code for the run. **Only one student device per team should join the waiting room for the game.**
- The team types in a chosen team name, plus the correct room code, in the two boxes.
- Team names will appear at the bottom of the Professor Dashboard showing teams have joined the game.
- The instructor clicks “Launch Room”.
- **The trading interface will appear automatically on students’ cellphones and teams should begin trading immediately.** Teams can switch between bidding and asking within a round.
- The instructor can monitor the experiment progress via the Professor Dashboard, which projects the order book for the market in real time. The instructor can monitor the behavior of the market (and use recording software if desired for later debriefing).
- **Students cannot see the market order book during trading,** students can only see their cellphone trading screen.

- At the end of the game the instructor will be directed to a room review/debrief screen for projecting to the class. Each team will also see an End of Experiment Student. An optional Student Instruction Sheet is provided in the Appendix, to assist in preparing students to trade.

Once the trading starts the instructor can monitor trading from the Professor Dashboard

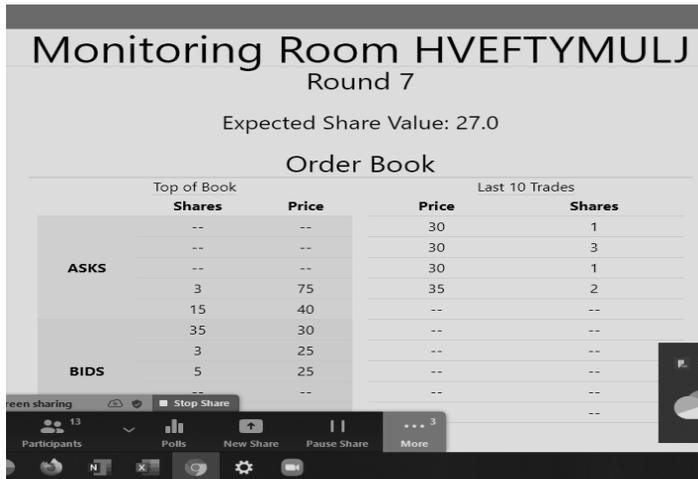


Figure 1. Instructor order book monitoring screen.

The Student Trading Cellphone Interface

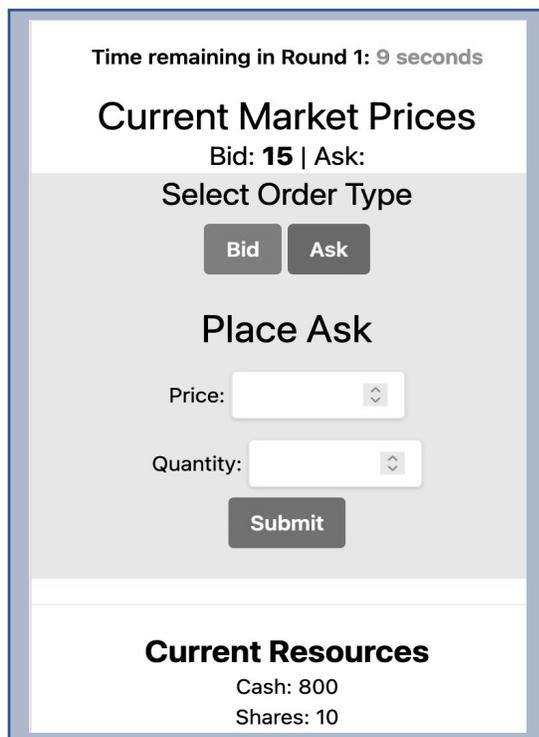


Figure 2. Student cellphone trading screen.

Debrief Screen Sample results

The image below shows a screenshot of an instructor's results presentation screen. The instructor should project this screen for debriefing students on what happened.

In this example there was a clear bubble.

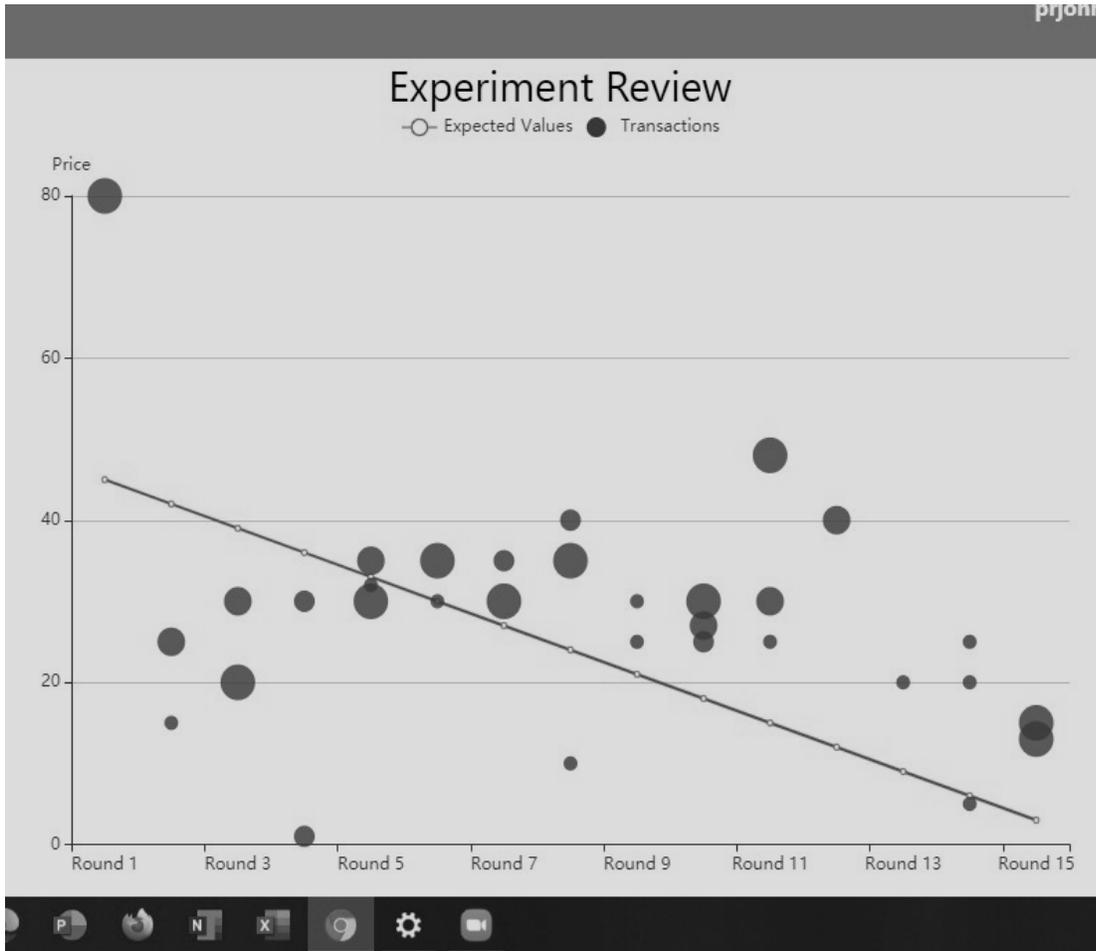


Figure 3. Experiment results presentation screen.

Students also see a record of their team's trade history.

End of Experiment Student Trading Record Screen (visible to students)

Thanks for participating!
You finished the experiment with a final value of **2534** units of currency.

Round Results

Round	Cash	Shares	Interest Earned	Share Dividends
1	796	12	40	26
2	944	11	47	37
3	1022	12	51	36
4	1109	12	55	40
5	1200	12	60	31
6	1301	12	65	35
7	1390	12	70	39
8	1483	13	74	32
9	1590	14	80	39
10	1686	15	84	42
11	1799	17	90	41
12	1881	20	94	51
13	2029	20	101	58
14	2192	20	110	52

Figure 4. Team trading record screen.

Student Reports Template

Students should always complete a graded experiment report. They should be given a template with questions including:

- Name of the experiment?
- Date of the experiment?
- Who was in your team?
- How many rounds in the experiment?
- What were the experiment rules?
- What was your strategy?
- How well did you do?
- If you repeated the game would you change your strategy? How would you change it?
- Describe and explain what happened to share prices. Why did this happen?
- What economics principles does this experiment demonstrate?

Student Sample Reports: summary of results

Students subjects (Intermediate Macroeconomics, and Money and Banking) reported that the main economic principles they learned were: investment risk; how supply and demand predicts prices; what financial bubbles were; and the influence of speculation in financial markets.

The main recurring themes and ideas reported were: the importance of having a strategy; anticipating the actions of other students; the impact of psychology; that the bubble collapse was predictable but each team thought it could exit trading before the collapse. The immersive nature of the experiment was commented on multiple times; “my brain was pretending this situation was in real life.”

Conclusion

In this paper the authors present a free online asset auction classroom experiment platform that works with cellphones. Student teams trade units of shares in a hypothetical company. Trading uses an order book system that allows students to buy or sell multiple shares in one transaction. Instructors can choose key parameter values: number of rounds; initial cash endowment per team; initial share endowment per team; and probability distribution of payouts each round per share.

Following the experiment students should be required to discuss and report on their strategies and trading experience. Potential learning objectives include: acquiring basic knowledge of financial asset trading; learning fundamental differences between the efficiency of real goods markets and financial markets; behavioral aspects of trade in financial market; and the efficiency of financial markets under conditions of uncertainty. The experiment will frequently generate financial bubbles.

Appendix: Sample Student Handout (Provided before the Experiment)

Team Instructions

Your team is going to participate in a stock market game.

You will be competing against other teams to make the most money by the end of the game.

The three teams that finish with the most money will each receive \$15 to split among the team members.

You will be trading over 15 rounds. Each round is 45 seconds long.

You will be buying and selling shares in a company.

There is only one company in this game and only one kind of share, so all shares are identical.

You will start the game with an endowment of shares and money.

All teams start out with the same endowment of shares and money.

During every month you can, if you wish, buy or sell shares.

At the end of each month every share that you own will generate a dividend depending on how the company did that round in terms of generating profit from the economy.

There are six possible outcomes for the company at the end of each month, and each outcome is equally likely:

1. There is a 1/6 chance one share will generate a \$1 dividend.
2. There is a 1/6 chance one share will generate a \$2 dividend.
3. There is a 1/6 chance one share will generate a \$3 dividend.
4. There is a 1/6 chance one share will generate a \$4 dividend.
5. There is a 1/6 chance one share will generate a \$5 dividend.
6. There is a 1/6 chance one share will generate a \$6 dividend.

So, for example, if you own 10 shares at the end of a month, and the company has very good business that month, each share might generate \$6. So you will earn (10 shares X \$6 profit per share) = \$60 total profit that month.

But if the company has a very bad month, each share might generate only \$1 profit per share so that would be only \$10 total profit.

In any single month every share owned by every team will generate the same profit.

So a good month is a good month for all shareholders. A bad month is a bad month for all shareholders.

What about your dollar holdings?

Every dollar you have in your account at the end of a round earns monthly interest. The fixed interest rate stays the same for the entire game. The interest rate will be announced before the game begins.

There are no “good” interest rate months or “bad” interest rate months, the interest rate you earn on your dollar holdings never changes.

After the final dividend is paid at the end of round fifteen every share becomes worthless. That is, a share has no redemption value. A share only has value during the game according to the dividends it generates.

How are shares traded?

Every round every team is free to buy or sell shares from other teams.

Trade in shares occurs on a stock market through an interface called an order book.

Each round you can choose to trade shares. You can offer to buy or sell shares. You do this through the order book by entering two numbers.

One is the “bid” or “ask” price. The other is the quantity of shares you wish to trade.

If you are buying you are making a bid.

If you are selling you are making an ask.

Buying shares:

If you want to buy shares you will enter a bid price which is the maximum you are willing to pay for each share. You will also enter the (maximum) number of shares you are willing to buy at that price.

You must enter both numbers: the bid price and number of shares.

Selling shares:

If you want to sell shares you will enter an ask price which is the minimum you are willing to accept for each share. You will also enter the (maximum) number of shares you are willing to sell at that price.

You must enter both numbers: the ask price and number of shares.

What if prices cross?

What if a team is buying and offers to pay a high price per share and simultaneously another team offers to sell at a low price? The team that quoted a price first will set the trading price. In this case the seller will make more profit than they expected. If the selling team offered their price first it would go the other way, the lower price would prevail.

Note that under this rule you will never get a worse deal than you expected if prices cross, and sometimes you might get a better deal.

What if the bid and offer prices work but the quantities don't exactly match?

The system will never make you buy or sell more shares than you requested. In any matching deal you may find that you can buy or sell at the price you quoted but the number of shares changing hands will be fewer than you wanted.

If I am not making any trades can I change my price and or quantity during a round?

Yes, you can change your offer during a round and the order book interface will adjust it immediately.

How does the order book prioritize all the asks and offers coming in simultaneously?

The order book gives first priority according to the quoted price. So the bidder with the highest bid price gets their order filled before any other buyer up to the maximum quantity they requested, then the next highest price bidder gets the priority, and so on. Likewise the seller with the lowest price ask gets priority in having their sale executed, after which the order book goes to the seller asking the next lowest price.

In short, the price you bid or ask is what determines your place in the queue for getting your transaction executed. So for example if you are a seller and you enter trading late but are asking

for the lowest selling price you will bump all the other sellers to be after you. If you are a buyer you can bump all the other buyers to be below you in priority if you offer a higher price than the other buyers.

To repeat: success in getting your trades executed first depends on offering to buy or sell at a price attractive to the other teams and not on the quantity you are offering to buy or sell.

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