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Exchange Rates: An Asynchronous Classroom Experiment

This paper describes an asynchronous classroom exchange rate experiment. Students trade foreign currencies at the end of each class with the balances carrying over to the next class. They are introduced to foreign currency markets and how real world political and economic news influences exchange rates. Students struggle with the challenge of extrapolating from current knowledge of the world to make predictions about the future. The time and resources required are modest. No special software is required. Results from running the experiment in economic principles, international economics, and intermediate macroeconomics are discussed.

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1. Introduction

The determination of exchange rates is a standard topic in macroeconomics and international economics courses. However, few students typically have personal experience with trading foreign currency.

This experiment introduces students to exchange rates and the operation of international currency markets by challenging them to predict future exchange rate changes based on developments in the global economy.

Students are immersed in the role of foreign exchange traders. Competing teams trade two currencies with a global banker who buys and sells currencies based on current global market rates. All trades are public and recorded on a spreadsheet for checking and analysis. Students are required to discuss their strategies and their successes or failures in a reflection paper. Pre- and post-test learning can be assessed via short questionaires.

This experiment allows instructors to link international economics with international finance topics including: speculation, financial trading strategies, the efficient markets hypothesis, and the influence of global news on financial markets. It is robust to the unexpected; if a student team is absent for a trading session there is no problem, because its existing balance will simply carry over until the next class period. Actual trading only requires five minutes at the end of each class. In between classes, students track real-world events and prepare for the next trading round, while the instructor records and posts updates of each team's foreign currency balances.[1]

2. Literature Review

Previous classroom exchange rate experiments focused on demonstrating the role of demand and supply in determining an equilibrium exchange rate by having students trade in an internal market where equilibrium prices can be shown to be consistent with the relative supplies of currencies and goods.

In the experiment by Mitchell, Rebelein, Schneider, Simpson, and Fisher (2009), students trade two currencies in an internal market where citizens of "Redlandia" and "Bluestan" trade red and blue cards in order to maximize their holdings of "wheat." Students observe purchasing power parity prevailing in the long run.

Hazlett and Ganje (1999) have students trade a hypothetical home currency, the "whittie", for U.S. dollars. Students are divided into importers and exporters and given trade targets. The teams are required to deal with an official system of parallel exchange rates, where the official rate for U.S. dollars overvalues the home currency. Students learn how foreign exchange controls adversely affect trade in a developing economy, and they experience the operation of black markets with the potential for corruption and favoritism by government officials.

Laury and Holt (1999) create two separate markets for the same good with identical demand conditions but different supply conditions. Initially these operate in parallel. After open

1 At a more general level, there is a benefit from using experiments in the classroom. For institutional accreditation purposes, it is straightforward to demonstrate teaching innovation and a feedback process by making experiment design changes in response to the reflection papers.

ing to trade, selected students acts as traders who (through arbitrage) reduce price disparities between markets. Students learn general principles of arbitrage across markets and the role of traders in establishing consistent prices across markets.

Johnson (2010) sets up a general equilibrium market experiment that allows students to generate goods' prices, exchange rates, and trade flows. The two goods are "blue" and "red," the two currencies are dollars and yen, and all trade quantities and prices are generated within the experiment. Students learn how goods' prices, exchange rates, and consumption levels are generated in general equilibrium and how external shocks affect the equilibrium.

Lypny (2003) creates a market experiment with students trading two assets, one a risky asset and one a safe asset. The students adjust their trading prices for the difference in risk between the assets. Although the assets are not foreign currencies, the principle that risk matters for relative asset prices carries over to the case of exchange rates.

These experiments focus on trading artificial currencies (or assets), allowing comparison and contrast of the relative prices students generate against the theoretical "correct" price. Demand and supply curves are controlled by the instructor. The equilibrating forces of supply and demand can be clearly demonstrated.

There is another, external, dimension to exchange rate markets, however. In real world exchange rate markets, global political and economic "news" affects exchange rates, changing the relative prices of imports and exports, the trade balance, and national income.

The experiment described in this paper aims to inject real-world political and economic news into the classroom discussion of exchange rates by having students trade imaginary holdings of real currencies at prevailing global market rates. Student teams attempt to predict the future path of an exchange rate.

Correctly predicting future exchange rate movements is a challenge. Standard finance theory holds that, according to "efficient markets" theory as described in Malkiel (2003), an asset price should follow a random walk; it should not be possible to reliably predict an exchange rate without the benefit of insider information. Students face the same dilemma as a real-world investor: should they just "buy and hold" or will they attempt to beat the market?

Malkiel's definition of an efficient market is one that "does not allow investors to earn above average returns without incurring above average risks" (p. 60). In the experiment described in this paper, students who are less risk averse are more likely to take bigger risks by, for example, holding their entire portfolio in one currency. More risk-averse students may diversify by holding a mix of both. However, there is no unique optimal trading strategy or correct solution, especially if we accept the idea of efficient markets. What is interesting is why students choose the strategies they do. Can they defend their strategy even if after the fact it did not work out?

3. Gamification and Simulation

Classroom experiments are a form of "gamification." Gamification has been described as "the application of typical elements of game playing (rules of play, point scoring, competition with others) to other areas of activity, specifically to engage users in problem solving" Hall (2014, p. 1). An appropriate classroom game is a form of active learning that increases motivation, engagement, and social interaction. An economics experiment, like a science classroom lab experiment, has the added benefit of acting as a simple test of the underlying theory being

taught. Though not at the level of rigor of a research experiment, a classroom experiment sends a powerful message that basic economics can in principle be tested against reality.

Experiments are quite different from simulations. Experiments are games of strategy that take theory as their starting point, while simulations teach the operational mechanics. An experiment strips away operational detail to focus on underlying economic forces, while simulations add operational complexity to mimic the day-to-day tasks of a trader. Simulation examples are discussed in Wang and Li (2013), who survey classroom simulation trading platforms, and Flanegin, Zapalska, Rudd, and Litzinger (2010), who present a one-period classroom simulation where students are divided into teams, given supply and demand sheets, and then trade foreign currency on behalf of hypothetical clients.

4. Description of the Experiment

Student teams are given an endowment of the domestic currency and a foreign currency. Over a period of four or more weeks, they make one trade per class, calling out a "sell" order and quantity for their choice of currency. (Because there are only two currencies a sell order is equivalent to a buy order for the other currency.) Alternatively, trade could be set to occur only once a week over a longer period, which would allow more "news" between trades and reduce instructor updating to once per week.

Students can only sell up to the balance of the currency they hold; there is no short selling. Using a sell order rule means that the quantity to be sold can be checked immediately against that team's current holdings of that currency.

The instructor acts as a global banker with an unlimited supply of the currencies. Teams do not trade with each other. There is no transaction fee. A team does not have to trade in a round if it is satisfied with its current portfolio.

Trades occur at the announced current daily real-world global market exchange rate as determined by an exchange rate app on the instructor's cellphone. At the end of the experiment, net profits or losses are determined and compared by converting the balances into the domestic country currency value at the last day's exchange rate.

The benchmark for making a profit is to convert the foreign currency holdings of each team at the very start of the first round into dollars (at that day's exchange rate) for a starting "effective dollar balance." The same calculation is done at the end of the experiment at the final day's exchange rate. If the final day's effective dollar balance exceeds that of the starting day's balance by even one dollar the team has made a profit. That is, U.S. dollars are the standard for measuring profit.

Teams can only make a profit by beating the market in the sense of correctly (on average) anticipating and betting on future exchange rate changes. The reward to profitable teams will be proportional to their share of total class profit (if any.)

As in real financial trading, students are in competition with other teams as well as attempting to beat the global market. It is possible (though unlikely) that no team will make a profit.

5. Administration of the Experiment

First, students are divided into teams of at least two people each, depending on the size of the class. Ideally there should be between ten to fifteen teams. Second, students are given an instruction sheet. A sample is provided in Appendix A.

The sample instruction sheet uses a monetary reward formula to motivate competition. The potential reward for beating the market and the other teams needs to be substantial enough to elicit significant thought and effort. The sample instructions describe the experiment as a "game" to convey the sense of a competition between the teams.

Dollars and euros are used in the sample instruction sheet. Other currencies may be chosen, but they should be major global currencies whose values are affected by world news every day.

6. Theoretical and Actual Outcomes

The efficient markets theory (or hypothesis) is the baseline reference point for beginning a classroom discussion about the actual experiment outcomes. It predicts that all current public information is incorporated into the current exchange rate via "news." In this case, the exchange rate should follow a random walk and it is impossible to systematically beat the market. The theory predicts that, over the long run, final team profits should be approximately equally distributed between teams with half making a profit and half incurring a loss. In this sense, the students are conducting a simple experiment to test the efficient markets hypothesis. However, given the relatively small number of trades over a relatively small number of rounds, actual results can easily vary from the long-run prediction even if the theory holds true.

The experiment was run during 2016 to 2018 with over 250 students in six different semester classes: four sections of principles of macroeconomics, one section of international economics, and one section of intermediate macroeconomics. Students in the principles classes represented a broad range of majors, from nursing to engineering, while there were primarily economics and business majors in the two upper division courses.

The concept of international exchange rates was introduced early in each class to prepare the students for trading. Most of the principles students had never been in an economics classroom experiment (or simulation) and, for these students, the exercise served as an introduction to experimental economics, not just exchange rates.

Five classes traded $US/Euros and one class traded $US/Pounds. In the case of the $US/Euro experiments, when a team sold dollars it was automatically buying euros. When a team sold euros it was automatically buying dollars. The $US/Pound experiment worked in a similar way.[2]

Students' natural propensity for "truck and barter" allowed them to trade easily. Students were reminded every session that world economic and political events were moving exchange rates, but that they had to figure out which events and the direction of effect by checking the news between class meetings and come to class prepared to trade.

Prior to each class, the date, current exchange rate, and team names were written in an area on the classroom whiteboard. When students came into class, they were given updated

2 The $US/Euro design generated more news each day than the $US/Pound. This is not surprising since the Euro Zone includes multiple countries to generate news.

spreadsheets with the latest results for all teams and the full history of past trades (though these results had been available online since the evening of the previous trading day.) During the trading period, only the sell orders for that round remained to be entered, which reduced the use of class time to five minutes. The result was photographed with a cell phone. This data was later used to update a class spreadsheet available online with columns for trading round, trades, the exchange rate, and teams' updated portfolio balances.

Over the six classes there were a total of 63 teams of which 24 earned a profit. Upper division classes did no better than lower division classes in terms of profitable teams as a percentage of the total. Given the diversity and small number of courses and students, this would not satisfy a proper statistical standard for a hypothesis test, but the result at least caused doubt about the teams' ability to beat the market.

7. Sample Results from an Intermediate Macroeconomics Class

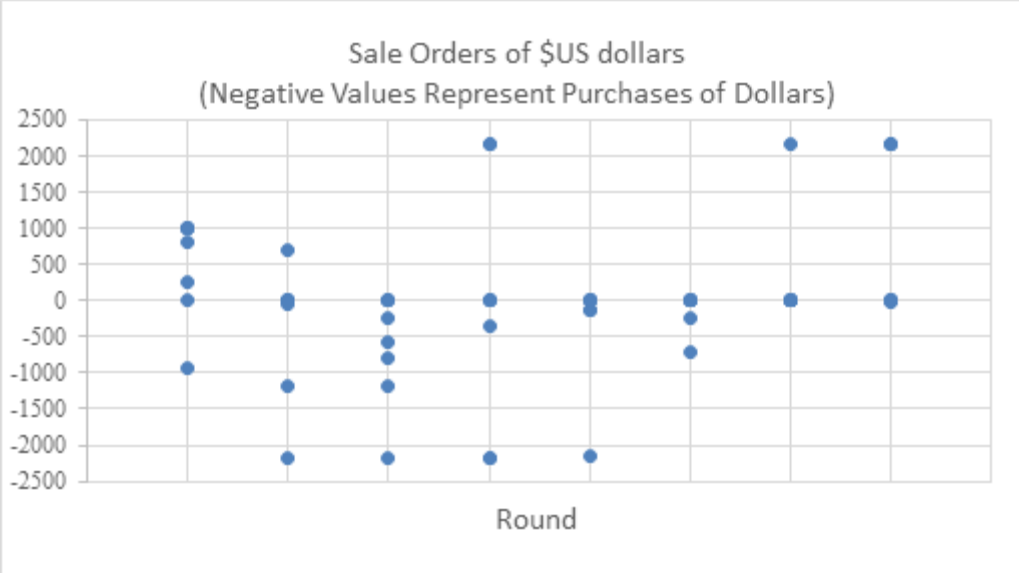
This class had 17 students divided into nine teams (one student was given their own team.) The experiment continued for two months, beginning in the second month of class.

Prior to the experiment, the students in this class were taught monetary economics and fundamentals of exchange rate theory including arbitrage and parity conditions. Students were not taught about or given advice on currency trading strategies. The efficient markets hypothesis was not mentioned.

Figure 1 is drawn consistent with the fact that teams' trading orders were required to be sell orders. While this has the advantage that data points literally match teams' public sell orders for the domestic currency, it does require some care in interpretation. The graph shows the "effective value" of $US sold by each team that traded in a round. A "sell" order for dollars shows as a dot with a positive value.

A "sell" order for euros on the other hand works the opposite way: it means that the euro value is first converted into dollars at that day's exchange rate, which shows up as a *negative* value for "dollars sold." That is, a *negative* value for *selling* dollars represents a *positive buy* for dollars.

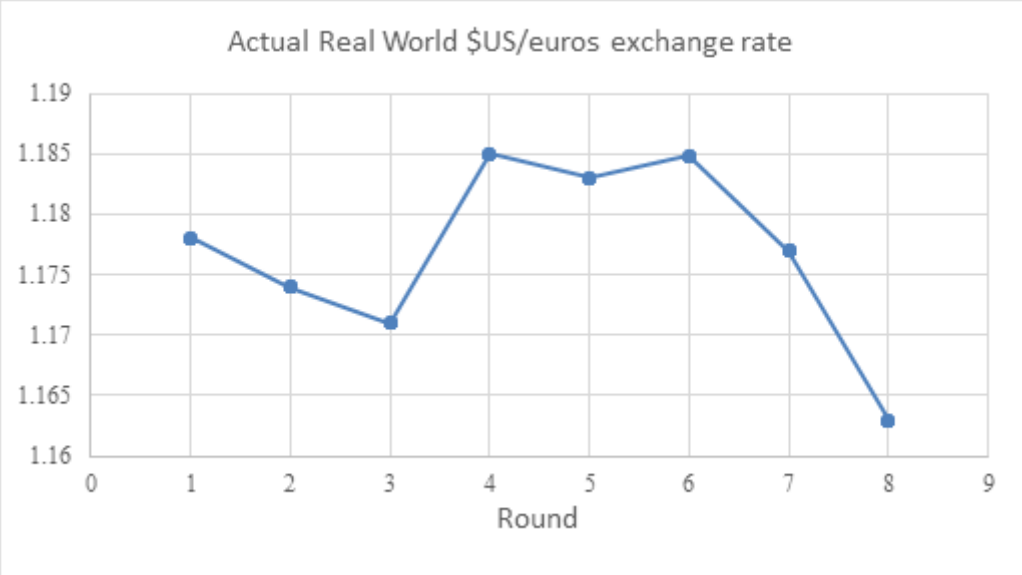
Figure 1 - Intermediate Macroeconomics Class Fall 2017 Trading Results



A shorthand guide for understanding the graph is that positive data points represent pessimism about the future of the dollar while negative data points represent optimism about the future of the dollar.

The graph shows that the strategy of choice was mostly momentum trading (a concept never discussed in class.) In momentum trading teams project past trends in exchange rates into the future and trade accordingly. As you can see in Figure 2, during the first three rounds the $US was appreciating (i.e. $US/euros fell.) The teams reacted by purchasing more dollars. They were surprised when the $US depreciated from Round 3 to Round 4, remained steady, and appreciated again in the last round. One team quickly rebalanced their portfolio in Round 4 by selling dollars.

Figure 2 - Fall 2017 Exchange Rate between US$ and Euro



As it turned out the same majors tended to choose to be in the same teams. Trading is taught in the finance major and, in the reflection papers, the finance majors expressed chagrin that they did worse than the economics majors. At a general level, finance majors seemed more focused on trading according to news, while economics majors thought in terms of a strategic game against other teams. The latter were skeptical of trying to beat the market and focused more on reducing their risk relative to what the other teams were doing. Even so, generally there was also some tendency for teams to put weight on the idea of momentum–extrapolating trends.

Looking at the history of trades, the greater confidence (or overconfidence) of finance majors seems to have manifested in a greater willingness to take risk in pursuit of a large profit, whereas economics majors were willing to settle for a guaranteed small profit by locking in a $US balance that at least guaranteed they would have an effective dollar balance exceeding the starting effective dollar balance at the start of the first round. That is, they were guaranteed

to cross the threshold for making a profit.[3]

8. Experiment Reports, Results, and Learning Outcomes

Cartwright and Stepanova (2012) find that experiments must be integrated with a required report to maximize student learning. In that spirit, all students were required to write individual experiment reports as part of their course grade. Grades were assigned based on thoughtfulness and detail, not whether a student was successful in making a profit.

Across all classes, classroom discussion and the students' reflection papers demonstrated learning in the following areas: the correct understanding of exchange rates as relative prices influenced by international monetary and real factors; the ability to read exchange rate quotes and interpret them as reflecting appreciation or depreciation in particular currencies; appreciating the interdependence of national economies and the complexity of global economics appreciation of the difficulty (or even impossibility) of predicting exchange rates and by extension other global financial prices such as interest rates and stock price; scope and nature of global trade and exchange; and what is an economic experiment.

Two of the principles classes with a total of over 60 students were asked to give additional input in the form of answering a single pre- and post-experiment question: "what causes exchange rates to rise and fall?" Compared to the pre-test answers the most common improvements in understanding post-test were: exchange rates change more quickly and rapidly than the students expected (about 50 percent of students said this); political effects were stronger than they expected; any confidence in their ability to predict exchange rates decreased greatly; good economic news makes currencies rise; they have a better idea why we exchange currencies; there is more trading in foreign exchange than they realized; international speculation affects the value of currencies not just import/export trade; there is risk in every currency trade you perform; even small changes in exchange rates affect a whole economy; exchange rates change because of investor trust in the economy; economic principles seem to work in practice after the fact, but that doesn't mean you can predict the future; and exchange rates change because of future expectations.

Overall, the students gained much greater knowledge of: the extent and fluidity of currency markets; how greatly and quickly currency markets can change; the basic economic and political forces underlying the determination of exchange rates; the risks and difficulty of trying to predict exchange rates; and the importance of expectations about the future.

9. Conclusion

This classroom exchange rate experiment places students in the role of competing teams of foreign currency traders. No special software is used, only a spreadsheet to track trades and portfolio balances. Attempting to make maximum profit, teams find themselves following world economic news events and attempting to make correct predictions for future exchange rate movements. In the words of one student, they are "watching macroeconomics in action." The experiment demonstrates the interplay of international monetary and real factors, requires

3 The thinking of finance students will seem contradictory to economists – if they are taught efficient markets theory then why do they simultaneously think they can beat the market? This takes the discussion into the realm of behavioral finance and the psychology of investors, beyond the scope of a typical macroeconomics class.

students to read exchange rate quotes and interpret them correctly, shows the complexity of global economics, and leads to a discussion of the difficulty (or even impossibility) of predicting exchange rates and by extension other global financial prices such as interest rates and stock prices.

Principles of economics students can participate in this experiment as successfully as upper-division students. Upper-division students may adopt different trading strategies depending on their majors. Economics majors tend to think in terms of a strategic game, while finance majors are focused on the effect of "news." Finance majors seem more confident in making risky trades.

Because the experiment is asynchronous, trading rounds are short and simple, requiring only a few minutes at the end of each class over a period of weeks. Team analysis, strategizing, and the instructor's posting and updating results can be done between classes. The competitive game-like nature and relatively simple rules of the experiment elicit a significant degree of interest and engagement from students, even those who are not economics or business majors.

References

Cartwright, E. & Stepanova, A. 2012. What do students learn from a classroom experiment: not much, unless they write a report on it. *The Journal of Economic Education 43*(1), 48-57.

Flanegin, F., Zapalska, A., Rudd, D. & Litzinger, P. 2010. Teaching foreign exchange market issues in business education. *Journal of Accountancy and Finance 2*, 1-16.

Hall, M. 2014. What is gamification and why use it in teaching? *https://ii.library.jhu.edu/2014/05/13/what-is-gamification-and-why-use-it-in-teaching/*

Hazlett, D., & Ganje, J. 1999. An experiment with official and parallel foreign exchange markets in a developing country. *The Journal of Economic Education 30*(4), 392-401.

Johnson, P. 2010. An international economics classroom experiment. *Southern Economic Journal 77*(2), 501-513.

Laury, S.K. & Holt, C.A. 1999. Multimarket equilibrium, trade, and the law of one price. *Southern Economic Journal 65*(3), 611-21.

Lypny, G., 2003. A pilot study using an online, experimental, two-asset market." *The Journal of Economic Education 34*(3), 204–213.

Malkiel, B.G. (2003). The efficient markets hypothesis and its critics. *Journal of Economic Perspectives 17*(1), 59-82.

Mitchell, D.T., Rebelein, R.P., Schneider, P.H., Simpson, N.B., & Fisher, E.O. 2009. A classroom experiment on exchange rate determination with purchasing power parity. *The Journal of Economic Education 40*(2), 140-65.

Wang, J. & Li, Q. 2013. The Application of a simulated trading platform in international finance. Unpublished manuscript.

Appendix

(Sample) International Currency Trading Game Instructions

Choose a name for your team. Your team will participate in a currency trading game.

The game will take place over the next 8 weeks.

You will start the game with $1,000 and €1,000 in your foreign exchange account.

At the end of each class you will have the opportunity to sell dollars or euros.

You will be selling to a hypothetical international bank, not to the other teams.

When you sell dollars they are converted into euros and vice versa.

Trades will be converted using that day's exchange rate, according to the XE exchange rate app on my phone, using the rate to the accuracy of three decimal places. I will tell you the rate at the start of class before you decide the trade. You can also check that day's exchange rate before class.

All trades will be recorded on the whiteboard. I will use my phone to take a picture of the completed trades and that day's exchange rate. After class, I will update the spreadsheet tracking our game results and history by adding a new transaction to the ledger record. The spreadsheet will be available online. This allows you to check the record for accuracy and track the pattern of trades over time.

On the first day of the game, I will use the XE exchange rate to convert your 1,000 euros to dollars, and then add that to your existing 1,000 dollars to get a total "effective dollar" value for your total balance. This initial effective dollar starting balance number is the benchmark for calculating the profit you have made at the end of the game. For example, if on the first day one euro sold for 1.2 dollars your starting dollar equivalent balance would be $2,200.

At the class following the last trading day, I will convert your euros to dollars at that day's exchange rate, add it to your dollar balance, and determine if you have made a profit. Therefore, in my example, you must get a "dollar equivalent" balance greater than $2,200 to make a positive profit at the game's end.

$70 will be split between the teams that make a profit, proportional to how much profit they made.

If no teams make a profit, no dollars will be awarded to any team. If only one team makes a profit they keep the entire $70.

You will be required and graded on a final reflection paper describing the rules of the game, what your strategy was, and why your strategy succeeded or failed (as in resulting in a loss). This will count toward your final class grade for a maximum of five percentage points. Thus, even if you do not make a profit, there will be a reward for trying. Why you lost money is just as interesting to me as why you made money, maybe more so. You will have the spreadsheet record available for you to use in your analysis.

I will supply you with a blank template reporting form with prompt questions to get you started with an idea of the kind of information and analysis that will be required.

(Sample) Reflection paper prompt questions

1. Name of the experiment?
2. Who was in your team?
3. Your team name?
4. Dates you participated?
5. How many rounds were there?
6. What where the experiment rules?
7. What was your team's strategy?
8. Why did you choose this strategy?
9. Did you change your strategy and why?
10. How well did your team do?
11. What economic principles and concepts are demonstrated in this experiment?