A Classroom Experiment on Exchange Rate Determination With Purchasing Power Parity[*]

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Abstract

We develop a classroom experiment on exchange rate determination appropriate for undergraduate courses in macroeconomics and international economics. Students represent citizens from different countries and need to obtain currency to purchase goods. By participating in an auction to buy currency, students gain a better understanding of currency markets and exchange rates. The implicit framework for exchange rate determination is one in which prices are perfectly flexible (in the long run) so that purchasing power parity (PPP) prevails. Additional treatments allow students to examine the effects of price changes, tariffs and nontradable goods on the exchange rate and to explore the possible resulting deviations from PPP. The experiment is suitable for classes of eight to 50 students and can be run in as little as 30 minutes.

Keywords: Classroom Experiments, Exchange Rates, PPP

JEL Codes: A22, F31

Undergraduate economics students often struggle with the concept of exchange rates. Students have difficulty because the exchange rate between two countries reflects the relative prices of their two currencies. In purely flexible exchange rate systems, exchange rates are determined by market forces. The price of a currency guarantees that the demand and the supply of that currency are equal.[1] If students could better understand the factors associated with the demand and supply of currencies, they would know how exchange rates are determined and could more easily understand the causes of exchange rate fluctuations.

In this article, we describe a classroom experiment that can be used in undergraduate macroeconomics and international economics courses to help students better understand exchange rate determination. We focus on the concept of purchasing power parity (PPP) that offers the basis for discussing the monetary approach to the balance of payments. The experiment can be used as a way to introduce the theory of PPP to students, by allowing them to discover the relationship between prices and exchange rates on their own. It can also be effective in deepening their understanding of some of the factors that affect currency markets.

In the experiment, students represent citizens from one of two countries. Each country produces wheat, where the price of wheat in each country is exogenous. Citizens are initially endowed with currency from their home country, which they can use to buy wheat. Their goal is to obtain as much wheat as possible. If they desire to buy wheat from the other country, they must first obtain that country's currency by purchasing it from an international bank. The price of each currency is determined by having the bank auction off the currency to the highest bidders.[2] The experiment consists of several rounds; in each round, students record the equilibrium exchange rate (i.e., the market price of each currency) and determine how much

wheat they can buy. At the end of the experiment, students can be rewarded for the amount of wheat they buy.

The experiment consists of several independent treatments. Instructors can choose the treatments that are most appropriate for their specific course. For example, one treatment consists of simply changing the relative price of wheat across the two countries. Another treatment imposes tariffs in each country, increasing the cost to import wheat. The final treatment introduces a nontradable good in that wheat must be cooked locally in order to make bread, but the cost of cooking the bread varies by country. In each of these treatments, students observe a change in the equilibrium exchange rate.

The experiment is appropriate for introductory economics courses, as well as intermediate and advanced undergraduate courses such as international economics, open economy macroeconomics and international finance. It is suitable for classes ranging in size from eight to 50 students, and can be run in 30 to 45 minutes, depending on the number of treatments chosen. The discussion following the experiment can be particularly worthwhile to students by linking the results of the experiments to various international economic theories. For example, students observe how the exchange rate reflects the relative prices of goods across countries and that PPP holds in the long run in the absence of trade frictions. The equilibrium exchange rate converges to the ratio of prices as the experiment is run repeatedly. Students notice that changes in relative price levels lead to changes in the exchange rate. The act of trading currencies gives them a hands-on approach to understanding the abstract idea of PPP.

The various treatments of the experiment emphasize several other concepts. First, the experiment demonstrates how inflation in one country reduces the relative value of that country's currency. In class discussion, students could be required to elaborate on the sources of inflation

in various countries and their subsequent effect on the value of the domestic currency. A classroom discussion could also focus on specific barriers to trade that exist in the real world, such as tariffs, transport costs or domestic wage disturbances, and examine their effect on exchange rates. Moreover, students will gain an understanding of the role of nontradable goods in affecting relative prices and hence exchange rates, a complex topic in international economics. Instructors could provide examples of how PPP is applied in the real world, such as analyzing the difference between per capita GDP and PPP-adjusted per capita GDP across countries. A discussion concerning the importance of PPP in these estimates could follow.

The design of the experiment includes some theoretical limitations that should be discussed with the students. First, the main objective of this experiment is to teach students about the link between exchange rates and purchasing power; we therefore abstract from other factors that might affect exchange rate determination, such as the role of interest rates or expectations. Second, because we focus on a single good, the price of that good in each country reflects domestic prices. Thus, one might argue that the experiment is primarily related to the law of one price. However, the inclusion of a nontradable good in a later treatment allows domestic prices to be reflected by the prices of both tradable and nontradable goods.

Macroeconomic and international economic concepts are generally more difficult to convey in classroom experiments than are microeconomic concepts. As a result, there is a shortage of experiments in these fields.[3] Exceptions include Haupert (1996), Bergstrom and Miller (1997), Hazlett and Ganje (1999), Laury and Holt (1999), Hazlett (2003), Hazlett and Hill (2003), Hazlett and Wookey (2003), Hazlett (2004) and Ewing, Cruse and Thompson (2004). The experiment developed by Hazlett and Ganje (1999) helps students understand the conditions in which official and parallel foreign exchange markets coexist in developing countries. In their

experiment, the government is directly involved in currency markets in two ways: by setting the official fixed exchange rate and by imposing penalties in the parallel market. We add to their work by analyzing how exchange rates are determined in perfectly flexible exchange rate systems, which applies to most developed countries and an increasing number of developing countries.

Three appendices include all of the handouts for the experiment, a sample set of results for the experiment and a list of possible discussion questions related to the experiment. Electronic copies of the materials for the experiment, including a record-keeping sheet for the instructor, can be obtained by contacting any of the authors.

EXPERIMENT DETAILS

In order to conduct this exercise, you will need printed instructions and record sheets (available in Appendix A), colored paper cards, and some means of random selection, such as dice.

At the beginning of the exercise, students are assigned citizenship in one of two countries, Redlandia or Bluestan, and given an initial endowment of 40 colored cards representing their country's currency (blue cards for Bluestan; red cards for Redlandia). One student can be assigned to help with record keeping.[4] This experiment is easiest to run when there are no more than eight citizens in each country. For classes with more than 20 students, we suggest forming groups of two to three students to represent a single citizen.[5] (Note that the countries need not be of equal size.) Having too many citizens can be more of a problem than having too few citizens; collecting bids and awarding currency to winning bidders becomes cumbersome when there are more than eight citizens in a country. Forming groups has the added

advantage of allowing students within a group to discuss possible strategies, such as currency speculation or diversification.

Each citizen will need 40 cards from their country of citizenship. The instructor should cut and sort the cards prior to class. Using two different colors of regular 8.5"x11" paper and cutting each piece of paper into eight parts suggests the instructor will need five sheets of paper per citizen for the initial endowments. Several additional sheets of paper should be cut up for currency to sell during the exercise.

Once students' roles have been assigned and currency appropriately distributed, the instructor should read the instructions out loud and answer any questions students might have. Citizens are allowed to buy wheat in either country, but sellers in Redlandia accept only red currency, and sellers in Bluestan accept only blue currency. It is important to emphasize that their objective is to purchase as much wheat as possible, no matter where it comes from. Wheat is for sale in unlimited quantities in each country and is exactly the same quality, weight and strain in both countries. To begin, assume wheat can be purchased for two red cards in Redlandia or for one blue card in Bluestan.

The instructor serves as an international bank and has the role of conducting currency exchange transactions. The international bank sells both currencies in the following manner. First, the currency is sold in blocks of four.[6] Red currency is offered only in odd numbered rounds, and blue currency is offered only in even numbered rounds. Prices are expressed in units of the other country's currency. We recommend starting the game by selling three blocks of currency in each round.[7]

Citizens may purchase either currency, but can buy only one block of currency each round. If a citizen wants to bid for a block of currency, they must first decide how much to bid.

Then, each citizen places the appropriate number of cards in a stack against their chest, being careful not to reveal their bid to other players. Bids must be in discrete amounts, and each citizen can make only one bid each round. When everyone is ready (i.e., has chosen a bid and placed it against their chest), each citizen is asked to reveal their bid. The three highest bidders each win one block of currency (assuming three blocks are auctioned, as suggested above). Requiring each citizen to commit independently to a bid before other bids are revealed works best because observing other citizens' bids can influence one's own bid and simultaneous revelation of bids is difficult to achieve.[8] This auction format can lead to different winning bids, which can make determining the exchange rate difficult; we recommend using the highest winning bid to determine the equilibrium exchange rate. (One could also average the winning bids or use the middle bid, but each of these methods introduces additional complications and would require additional time.)

Because there are only a limited number of blocks of currency available for purchase in each round and because bids must be in discrete amounts, ties tend to occur. If the number of blocks being sold is sufficient to award blocks to all tied bidders, there is no problem. However, if the number of blocks being sold is less than the number of tied bidders, the tie must be broken to determine the winner(s). When ties occur, they should be broken by a random process, and should be broken quickly in order to avoid slowing down the experiment or allowing students to become distracted. Two-way and three-way ties are easily addressed by rolling a six-sided die. An alternative is to assign each citizen a number or letter of the alphabet before the experiment begins and then use bingo balls or Scrabble® tiles,[9] respectively, as the selection mechanism.

After each round, the winning bids and implied exchange rate should be posted for everyone to see. Students should record on their individual record sheet the amount of each type of currency they have and the total amount of wheat they can purchase.

The instructor should conduct as many rounds as needed until the exchange rate converges. Our experience shows that convergence to PPP occurs quickly in this benchmark treatment, but showing the rather obvious equilibrium makes the other treatments more interesting and relevant. Once convergence occurs, then additional treatments appropriate to the class can be implemented. These treatments are discussed in the following section. Note that the instructions for the subsequent treatments should not be distributed beforehand; instead, the instructor should announce them aloud once the benchmark treatment has been completed.[10]

At the end of the experiment (i.e., after all of the treatments), citizens can exchange all of their domestic and foreign currencies for wheat at the relevant prices in each country. The instructor can then randomly choose one citizen and pay a predetermined amount of food, candy, or extra credit for each unit of wheat they bought. Holt (1999) suggests that rewards are not necessary because the appropriate behavior will be forthcoming anyway. However, we found, as did Holt, that a small, randomly selected reward reduces noise in the experiment. For the reward to work of course, students must know in advance that there is a reward for good play. Offering students a tangible reward at the end of the experiment helps maintain student interest during the experiment and serves to keep them focused on the objectives of the experiment.

This experiment has been implemented at large public universities and at small liberal arts colleges, in introductory economics, intermediate-level international economics and upper-level international finance (i.e., open-economy macroeconomics) courses.[11] Class sizes for these

trials have ranged from 18 to 30 students, with most classes divided into groups. In each case the instructors reported an improvement in student learning, based on class discussions and exam outcomes, relative to similar courses in which they did not use the experiment. The results of the benchmark experiment from one of these trials (Simpson's International Finance class in Fall 2005) can be found in Appendix B. In this case, it took six rounds to reach PPP.

ADDITIONAL TREATMENTS

The experiment described above can be used in introductory economics courses by itself, without any additional treatments. We have found it to be an effective way to demonstrate demand and supply in an international context. It exposes students to the concepts of exchange rates and provides them with a basic understanding of how they are determined.

For other economics courses, such as international economics, intermediate macroeconomics or international finance, the instructor can choose one or more of the following treatments to demonstrate to students some of the sources of exchange rate fluctuations. We provide below the details of three additional treatments: a change in domestic price levels, the imposition of bilateral tariffs (or similar barriers to trade) and the introduction of a nontradable good. As noted earlier, instructions for these treatments should not be distributed until after the benchmark treatment has been completed.[12]

Change in Domestic Price Levels

According to PPP, relative prices across countries determine exchange rates. As a simple demonstration of this concept, we suggest first changing the price of wheat in each country while preserving the international price ratio. For example, wheat now costs four red cards in

Redlandia and two blue cards in Bluestan. The instructor could justify such a change by explaining that a higher worldwide oil price makes it more expensive everywhere to operate the machinery required to plant and harvest wheat. Students will realize that the equilibrium exchange rate should not change, although it might take two or three rounds for everyone to reach this conclusion. This treatment reinforces the idea that if prices change proportionally in two countries, PPP predicts there will be no change in the equilibrium exchange rate. This treatment can be run in introductory courses and as a straightforward extension of the benchmark treatment in advanced economics courses.

A more complex treatment would consist of changing relative prices across the two countries. For example, wheat again costs two red cards in Redlandia, but now costs *four* blue cards in Bluestan. The instructor could explain this inflation in Bluestan (an increase in wheat prices from one to four cards) as being caused by bad weather in Bluestan making the local wheat harvest decline. Eventually, students will see that this price change causes a depreciation of Bluestan's currency and an appreciation of Redlandia's currency. In the sample results (in Appendix B), note that students did not initially grasp the concept of PPP under this exogenous price change; it took five rounds for the exchange rate to return to PPP. The combination of these two treatments is useful in demonstrating the concept of PPP by having students participate in market activities that can alter the equilibrium exchange rate.

Tariffs, Transport Costs and Other Barriers to Trade

Most students understand that tariffs are often set to affect trade patterns so that people buy fewer foreign goods and more locally produced goods. However, our experience has been that students seldom take the next step and extend the effects of tariffs to exchange rates. The

purpose of this treatment is to demonstrate for students how PPP breaks down in the presence of tariffs (or other similar trade barriers).

The instructor should announce that each country is imposing a tariff on imported wheat (perhaps as a result of a trade war). It will now cost three red cards to buy wheat from Redlandia if you live in Bluestan, while it will cost five blue cards to buy wheat from Bluestan if you live in Redlandia. For the citizens of each country, however, wheat still costs four blue cards in Bluestan and two red cards in Redlandia. As the sample results in Appendix B show, students have a difficult time determining the appropriate exchange rate in this case.[13] In six rounds, students' bids did not converge to any particular exchange rate. If anything, they appear to be trending towards a one-to-one ratio between the two currencies. The fact that there is not a unique exchange rate at which everyone is willing to trade currency likely contributes to student uncertainty. This gives the instructor an excellent opportunity to discuss in detail the impact of these frictions on exchange rates.

The instructor could extend this treatment by raising tariffs in one country (e.g., it now costs four red cards to buy wheat from Redlandia if you live in Bluestan) so that students comprehend the effects of additional tariffs on the value of the local currency. Other trade barriers, such as transport costs, could be analyzed in a similar fashion.

Nontradable Goods

One of the main reasons PPP fails is the existence of nontradable goods. The inability to arbitrage nontradable goods causes exchange rates to deviate from PPP. The purpose of this treatment is to demonstrate the effect of nontradable goods on determination of the equilibrium exchange rate.

The instructor can introduce a nontradable good by announcing that no one can eat raw wheat, but people can eat bread (i.e., cooked wheat).[14] Specifically, in addition to buying the wheat, you must now pay one unit of your home currency to cook your wheat. The instructor can motivate this treatment by pointing out that bread gets stale after a few days so it is difficult to transport from one country to another; instead, it must be cooked in the country in which it will be consumed. The result is that bread costs three red cards if using wheat from Redlandia and five blue cards if using wheat from Bluestan. The objective for students is now to have each citizen purchase as much bread (instead of wheat) as possible.[15]

The fact that the final product is now a combination of a tradable good (wheat) and a nontradable good (cooking) will lead to a deviation from PPP. Students are generally tempted to view the new equilibrium exchange rate as the ratio of bread prices in the two countries. They fail to realize that, since cooking is not traded, its cost should not influence the exchange rate. Once it is pointed out to them (during discussion of the experiment) that only wheat is being traded and the exchange rate should be based on the relative prices of wheat (and not bread), they are generally quick to accept it. However, it is helpful if the instructor also describes other examples of nontraded goods.

DISCUSSION

An interesting way to introduce the idea of PPP is to run this experiment *before* giving lectures or assigning readings on the topic. That is, have students discover the theoretical relationship between prices and exchange rates on their own via the experiment. Based on our experience, this generates interest in the topic and provides validation for the theory; that is, it makes PPP seem plausible to the students. We have found the experiment to be a relatively easy way to get

students engaged in the topic of exchange rate determination. The discussion following the experiment is especially powerful in getting students to dissect possible sources of exchange rate fluctuation. Several instructors who have run the experiment report that the combination of the experiment and a good, follow-up discussion provides concrete examples an instructor can utilize in lectures and discussions throughout the rest of the semester.

In Appendix C, we provide a list of possible discussion questions. These questions are organized into groups appropriate for different course levels. The instructor should distribute the appropriate discussion questions at the end of the experiment. Students should be given some time to consider their answers to the questions before any classroom discussion occurs. We find that the discussion can even be delayed until the next class period, assuming this occurs within two or three days. If the discussion is postponed to a future class period, the instructor should record the results of the experiment and make them available to students.

Students are generally quick to understand the basics of PPP theory, that is, the prediction that the equilibrium exchange rate will reflect the ratio of domestic prices in each country. The next step is to link changes in relative prices to changes in the equilibrium exchange rate. For example, inflation in Bluestan reduces the purchasing power of its currency. Bluestan's weaker currency will buy less red currency, or has depreciated. Simultaneously, Redlandia's currency appreciates even though the price of wheat in Redlandia did not change. The instructor can point out that the international value of a country's currency depends on conditions in both that country and in other countries.

To help make the experiment applicable to the real world, instructors could have students consider ways in which exchange rates influence decisions, such as traveling abroad or investing in foreign companies. These discussions are well-suited for introductory courses, where students

can be exposed to PPP theory as a basic framework that explains exchange rates. Even at this level, it is important to emphasize that this is a theoretical framework that better applies to long-run situations, where prices are perfectly flexible.

For intermediate-level courses in macroeconomics or international economics, the discussion can be enriched by talking about possible reasons for the exchange rate to deviate from the level predicted by PPP theory (Appendix C offers possible discussion questions). The presence of tariffs, nontradable goods and transport costs are all interesting variations of the basic experiment that offer students a hands-on perspective. Take the inclusion of a nontradable good (cooking), for example, and ask the students to explain what happened to the exchange rate when there was a nontradable component to wheat consumption (i.e., when it had to be cooked). Instructors of international economics courses could relate the findings of the experiment to agricultural products, for example, against which the United States and European Union maintain significant trade barriers. Examples of actual changes in transport costs, such as the increased use of large container ships, can also enhance discussions and make the implications of the experiment more realistic for students.[16]

An interesting discussion of the implications of PPP arises in the context of cross-country comparisons of wealth. Students should be aware that, because prices are not equal across countries, such comparisons are seldom appropriate. PPP gives economists a much better understanding of relative wealth levels; for example, how wealthy the average Chinese person is relative to the average American. Instructors can show students how PPP is used by economists (and others) to make such comparisons. Students could be asked to contrast traditional measures of income (per capita real GDP) to more accurate measures of income (per capita real GDP

adjusted by PPP) for various countries, perhaps using data from the World Bank Development Indicators or the Penn World Tables.

PPP can also serve as a proxy for determining how over- or undervalued a currency is, such as with the Big Mac index. The instructor could ask students whether or not they agree with the predictions of the Big Mac index, and why the index might be misleading.[17]

CONCLUSION

In this article, we develop a classroom experiment where students are participants in currency markets such that their actions have effects on exchange rates. The implicit framework for exchange rate determination is one in which prices are perfectly flexible so that PPP prevails in the long run. Additional treatments separately introduce relative price changes, tariffs and nontradable goods. These treatments allow students to explore some of the reasons behind exchange rate movements and to examine situations in which PPP fails to hold.

The experiment is a simple in-class exercise that can be implemented in introductory economics courses or extended to intermediate or advanced macroeconomics and international economic courses, using one or more of the various treatments. We fill a void in the current literature on economics pedagogy where there exist very few classroom experiments on these topics. The experiment has been implemented at both small liberal arts colleges and large universities. It can be completed during one class period, providing a low-cost method of bringing some variation to theses courses while having students be active participants in the learning process. We include a full set of discussion questions that can be tailored to specific courses to facilitate learning beyond the in-class experiment. Instructors who have used the experiment in their courses report that students have a much better understanding of how

exchange rates are determined and the sources of their fluctuations. Most importantly, the experiment provides a starting point for discussions on the interesting and complex theories of exchange rates and currency markets that are often abstract for undergraduates. Many instructors find that concepts from the experiment are referenced in class discussions throughout the rest of the semester by both the instructor and students; we have found this to be especially true in international economics courses.

NOTES

[1] For the remainder of the article, we are referring to exchange rates only in purely flexible exchange rate systems.

[2] The specific format of the auction is described in detail in the next section.

[3] For a comprehensive list of classroom experiments in economics, see Brauer and Delemeester (2001) and Holt (2005).

[4] The use of a spreadsheet program and a projector could expedite record keeping and calculations. This would be particularly helpful if you plan to postpone the discussion to a future lecture.

[5] All of our trials were conducted in classes with 18–30 students, although we believe the experiment could comfortably be run with as few as eight students or with as many as 50 students (divided into groups of three students each).

[6] It is convenient to sell currency in blocks to speed up the experiment. However, the size of the blocks is arbitrary. If the blocks are too large they become too expensive for citizens to purchase easily. If the blocks are too small it takes citizens too long to diversify their currency holdings.

[7] The instructor can increase (or decrease) the number of currency blocks offered for sale as needed to maintain an active currency market.

[8] We initially employed a second-price auction format in which all winners pay the lowest winning bid. Although this made computation of the exchange rate easier, it is a format few students are familiar with and therefore required substantial explanation both prior to and during the experiment.

[9] This method was suggested by Anderson and Stafford (2006). A simple way to implement this idea is to give each citizen a numbered (or lettered) tile at the beginning of the experiment. When ties need to be broken, all tied bidders place their tile into a cup. The instructor then draws a tile (or tiles) from the cup to select the winning bidder(s).

[10] Use of a projector to display the instructions for additional treatments will facilitate and expedite running the experiment.

[11] As an indication of the flexibility of this experiment, one instructor used it in her course on Latin America Economics and introduced an additional treatment with a fixed exchange rate.

[12] In addition to the treatments described below we also considered a "helicopter drop" exogenous increase in the money supply and price level in one country. Because of the lack of connection between the money supply and the price level in this model, this type of treatment will not work well for this exercise.

[13] For citizens of Bluestan, it is cheaper to import wheat only if they can purchase red currency for less than 4/3 blue cards per red card. For citizens of Redlandia, it is cheaper to import wheat only if they can purchase blue currency at an exchange rate greater than 5/2 blue cards per red card (i.e., for less than 2/5 red cards per blue card).

[14] We recommend that instructors not try to combine the introduction of a nontraded good with the bilateral tariff treatment. To help make this clear to students, the instructor might want to announce to the students that the tariffs have been rescinded prior to starting this treatment.

[15] In this treatment students earn rewards for pieces of bread cooked rather than for raw wheat purchased.

[16] Possible readings include Taylor and Taylor (2004) and *The Economist* (2007).

[17] Refer to http://www.economist.com/markets/bigmac/ for a collection of articles on the Big Mac Index.

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APPENDIX A: Handouts

Instructions for the International Wheat Purchasing Game

Background:
This is a simple purchasing game. You work for a large food processing company and your goal is to purchase as much wheat as possible either on the domestic market or on the international market. In order to make the experiment run smoothly, I have made some changes to the way markets really work. I will relax some of those assumptions later (there will be a few changes later during this class).

I will divide you into two countries: Bluestan and Redlandia. The currencies for these countries are cards: red for Redlandia and blue for Bluestan. You will begin with 40 cards from the country in which you reside. If the class is larger than 20, I will divide you into groups of two or three students. Each group of students represents one citizen from either Bluestan or Redlandia.

Wheat is available for sale in each country. Wheat is exactly the same in both countries. It can be purchased for two red cards in Redlandia or for one blue card in Bluestan. Wheat is available in unlimited supply at these prices. *Your objective is to purchase as much wheat as possible, no matter where it comes from.* You do not care how much wheat other people buy. It is impossible in this experiment to corner the market or to run the other students out of business.

If you only want to purchase wheat in your home country, you do not need to participate in the currency market. You may simply purchase wheat using your home currency. However, if you want to purchase wheat in the other country, you first need to buy foreign currency. Wheat sellers in Redlandia accept only red currency, and sellers in Bluestan accept only blue currency. I (the instructor) am an international bank and will sell both currencies in the following manner.

Foreign Currency Market:
In order to facilitate this experiment, I will offer currency for sale according to the following rules. (Normally currency markets do not go through one large buyer or seller, but reducing a bit of realism makes the experiment easier.)

- You may purchase currency only from me.

- You may purchase either country's currency as long as you have some of the other currency. You need Redlandia dollars to purchase Bluestan dollars and Bluestan dollars to purchase Redlandia dollars

- I will sell currency in blocks of four. In the first round I will sell Redlandia dollars. In the second round I will sell Bluestan dollars. This process will continue, alternating back and forth, with red currency offered for sale only in odd numbered rounds and blue currency offered for sale only in even numbered rounds.

- You may buy only 1 block of currency each round (equivalently, four Redlandia dollars or four Bluestan dollars).

- If you want to bid for a block of currency, you must first decide how much you want to bid. Then, each citizen places the number of cards bid into his or her hand and holds their closed fist against their chest. If working in a group, quietly discuss your bid. Only one person per group should be selected to hold the bid.

- Be careful not to reveal your bid to other citizens! (The goal is to have everyone select their bids before revealing them to other citizens.)

- You must bid in whole numbers. (You may not tear up cards in order to bid in fractions.)

- When everyone is ready, I will ask each citizen to reveal his or her bid. The three highest bids each win one block of currency. Recall that a block of currency is four cards.

- Ties will be broken by a random process.

- **The bidding process is very important. Make sure that you fully understand it before we begin.**

After each round, please record how much of each type of currency you have and how much wheat you can purchase; this will help you keep track of how you are doing. There will be several rounds.

After the final round, you will be able to exchange all of your currency for wheat at the relevant price in each country. I will randomly choose one citizen at the end of the experiment, who will be paid _____ for each unit of wheat they can purchase.

Additional Treatments for International Wheat Purchasing Game

1. Now the prices of wheat have changed. Wheat still costs two red cards in Redlandia, but now costs four blue cards in Bluestan.

2. There is a bilateral tariff on wheat. Now it costs three red cards if you live in Bluestan and want to buy wheat from Redlandia, while it costs five blue cards if you live in Redlandia and want to buy wheat from Bluestan. For local people, wheat still costs two red cards in Redlandia and four blue cards in Bluestan.

3. No one can eat raw wheat, but people can eat bread. If you live in Redlandia, it costs one red card to cook your wheat, and if you live in Bluestan, it costs one blue card to cook your wheat.

Personal Record Sheet for the International Wheat Purchasing Game

Round	Red Currency Price	Blue Currency Price	Redlandia Wheat Price	Bluestan Wheat Price	At the End of a Round:		
					Red Currency Held	Blue Currency Held	Wheat You Can Buy
1		----					
2	----						
3		----					
4	----						
5		----					
6	----						
7		----					
8	----						
9		----					
10	----						
11		----					
12	----						
13		----					
14	----						
15		----					
16	----						
17		----					
18	----						
19		----					
20	----						

Results for the International Wheat Purchasing Game

Simpson's International Finance Class, Colgate University, Fall 2005

Treatment	Round	Redlandia Wheat Price	Bluestan Wheat Price	Red Currency Price	Blue Currency Price	Red/Blue Exchange Rate **
Benchmark	1	2 red	1 blue	2 blue	----	2.0
	2	2	1	----	8 red	2.0
	3	2	1	2	----	2.0
	4	2	1	----	9	2.25
	5	2	1	4	----	1.0
	6	2	1	----	8	2.0
Price Change	7	2	4	3	----	1.33
	8	2	4	----	3	0.75
	9	2	4	8	----	0.5
	10	2	4	----	2	0.5
	11	2	4	4	----	1.0
	12	2	4	----	2	0.5
Bilateral Tariff	13	2 or 3 *	4 or 5 *	----	2	0.5
	14	2 or 3 *	4 or 5 *	4	----	1.0
	15	2 or 3 *	4 or 5 *	----	3	0.75
	16	2 or 3 *	4 or 5 *	5	----	0.8
	17	2 or 3 *	4 or 5 *	----	4	1.0
	18	2 or 3 *	4 or 5 *	5	----	0.8

* Price depends on country of origin

** Recall that we sold blocks of four units of currency. Thus, the reported prices reflect how much of one currency it took to purchase 4 units (or one block) of the other currency. In the first round, because 2 units of blue currency were used to buy 4 units of red currency, the red/blue exchange rate is 4/2 = 2.0.

APPENDIX C: Discussion Questions

Discussion Questions for the International Wheat Purchasing Game

For Introductory Courses:
1. What does it mean for Redlandia's currency to get weaker?
2. Plot the value of the red currency in each round in terms of the blue currency. Plot the value of the blue currency (in terms of the red currency). What is the relationship between the values of the blue and red currencies? Did the exchange rate converge to the value predicted by PPP?
3. What happened to the blue/red exchange rate when Redlandia experienced an increase in its price level from one to four? What is the theoretical relationship between prices and exchange rates?
4. How do exchange rates influence decisions such as traveling abroad or investing in foreign companies? What other economic decisions might be affected by exchange rate fluctuations?

Additional Questions for Intermediate Economics Courses:
5. What happened to the blue/red exchange rate when there was a nontradable component to wheat consumption (i.e., when it had to be cooked)?
6. What is the law of one price? What would absolute PPP predict for the equilibrium exchange rate in each part of the experiment?
7. What are the effects of a tariff on the value of a currency? Why are these effects important? What would happen to the blue/red exchange rate if Bluestan doubled its tariff to two cards per unit of wheat but Redlandia kept it at one card?
8. Brian Cudahy, in his book *Box Boats: How Container Ships Changed the World* (2006), argues that large container ships significantly lowered transportation costs. Would you predict that PPP became stronger (prices got closer together) or weaker in the wake of large container ship development? Explain your answer.

Additional Questions for Advanced Economics Courses:
9. The treatments were purposely changed by surprise. What are two reasons to hold foreign currency? Foreign currencies are bought and sold in markets similar to stock markets. Who do you think are the largest participants in these markets? What information do you think foreign exchange traders use in deciding what currencies to buy and sell?
10. In the experiment, wheat prices changed, but we did not tell you why they changed. Provide three examples of situations that would cause the domestic price level in a country to change. For each case, explain how the price level would change and describe the expected effect on the value of the domestic currency.
11. What kinds of things might we expect to happen if the exchange rate between two countries is fixed at a level that is not consistent with PPP? (For example, if 1 blue card = 1 red card in the benchmark treatment.)
12. In this experiment, exchange rates were completely flexible. What does this mean? List three countries that have perfectly flexible exchange rate systems. What do you think are the primary benefits of flexible exchange rates?
13. List three countries that do not have flexible exchange rates. How is the exchange rate for each country determined? Can you think of reasons why a country might not want a flexible exchange rate?