

## **A Classroom Experiment on Exchange Rate Determination With Purchasing Power Parity\***

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# **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 a sealed bid auction to buy currency, students gain a better understanding of currency markets and the determination of 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 impact of transport costs, nontradable goods and tariffs on the exchange rate and to explore possible deviations from PPP.

JEL Codes: A22 Economics Education and Teaching of Economics in Higher Education;  
F31 Foreign Exchange

Undergraduate economics students often struggle with the concept of exchange rates. Students have difficulty because the exchange rate between two currencies reflects the relative prices of the 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.<sup>1</sup> 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 paper, 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. 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. Students 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 in a first-price sealed bid auction. 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 treatments that are most appropriate for their specific course. For example, one treatment consists of simply changing the relative price of wheat. Another treatment introduces a

nontradable good in that people must cook their wheat in order to make bread, but the cost of cooking the bread varies by country. The final treatment introduces trade frictions by assuming a war occurs that imposes transportation costs to the shipment of wheat across countries. In each of these treatments, students will observe a change in the equilibrium exchange rate.

The experiment reinforces several important theoretical findings to students. 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 fluctuations in the exchange rate. Specifically, an increase in a country's price level leads to a depreciation in that country's currency. 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, students see the connection between barriers to trade, price of products, and exchange rates. A class discussion could focus on specific barriers to trade that exist in the real world and their effect on exchange rates. Second, students observe how increasing the price of a product results in currency depreciation. An instructor could ask students to discuss the various mechanisms behind price changes and their impact on exchange rates. This sort of discussion would be particularly useful for courses in macroeconomics and open-economy macroeconomics. Students will also gain an understanding of the role of nontradable goods in affecting exchange rates, a topic relevant for international economics courses. Perhaps most importantly, students could be asked a series of questions concerning the policy implications of exchange rate fluctuations now that they have a better understanding some of the sources of these fluctuations.

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, since we focus on a single good (wheat), the price of wheat 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.<sup>2</sup> Exceptions include Hauptert (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). We particularly recommend the experiment developed by Hazlett and Ganje (1999), which 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 the currency markets in two ways: by setting the official fixed exchange rate and by imposing penalties in the parallel market. Our paper adds 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.

In addition to describing the experiment and several possible additional treatments, we also provide a list of possible discussion points related to the experiment. Three appendices include all of the handouts for the experiment and a sample set of results for the experiment.

Electronic copies of the materials for the experiment 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.<sup>3</sup> This experiment is best suited for groups of up to eight citizens in each country. For classes with more than 20 students, we suggest forming groups of two to three students to represent each citizen.<sup>4</sup> (Note that the countries need not be of equal size.) Having too many participants can be more of a problem than having too few participants. Collecting bids and awarding currency to winning bidders becomes cumbersome when there are more than eight bidders 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 student (or group) 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 8 parts suggests the instructor will need five sheets of paper per student (or group) 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. Students 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 that 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.<sup>5</sup> 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. Anyone may purchase either currency. If a citizen (or group of citizens) of either country wants to bid for a block of currency, they must decide how much to bid and then place the appropriate number of cards in a stack against their chest, being careful not to reveal their bid to other players. When everyone is ready, each player is asked to reveal their bid. The three highest bids each win one block of currency.<sup>6</sup> Bidding is best conducted through a sealed-bid auction with the winning bidders paying the actual amount of their bids. This works best since observing other bids can influence a group's bid and simultaneous revelation of bids is difficult to achieve.<sup>7</sup> 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, but doing so would take additional time.)

Because there are only a limited number of blocks of currency available for purchase in each round, ties may 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 ties are easily addressed by rolling a dice, but three-way ties may also occur. One idea is to assign each student (or group of students) a number or letter of the alphabet before the experiment begins, and then use bingo balls or Scrabble® tiles,<sup>8</sup> respectively, as your selection mechanism.

After each round, the winning bids and implied exchange rate should be posted for everyone to see. Students should record the amount of each type of currency they have and the total amount of wheat they can purchase on their individual record sheet (available in Appendix A). With purchasing power driving their bids, the equilibrium exchange rate converges to the ratio of prices as the experiment is run repeatedly.

The instructor should conduct as many rounds as needed until convergence occurs. Our experience shows that convergence occurs quickly, 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 basic treatment has been completed.<sup>9</sup>

At the end of the experiment (i.e., after all of the treatments), students can exchange all their domestic currency and foreign exchange for wheat at the relevant prices in each country.



The instructor can then randomly choose one person and pay her or him 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. Still, we have found, as has 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 will help maintain student interest during the experiment and serves to keep them focused on the objectives of the experiment.

This experiment has been implemented at both large universities and small liberal arts colleges. It has been tested in introductory economics, intermediate-level international economics and upper-level international finance (i.e., open-economy macroeconomics) courses. The results of the benchmark experiment (from 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**

Once convergence to PPP is achieved, the instructor can choose the additional treatments best suited to the course being taught, as we describe below. The first treatment (the benchmark experiment) works well in introductory courses, while the other treatments work best in international economics, intermediate macroeconomics or international finance courses. As noted earlier, instructions for subsequent treatments should not be distributed at the beginning of the experiment.<sup>10</sup>

### **Change in Domestic Price Levels**

You can start by changing the price of wheat in each country, while preserving the price ratio. For example, wheat now costs four red cards in Redlandia and two blue cards in Bluestan. This would not change the equilibrium exchange rate and would reinforce the idea that if prices change proportionally in both countries, PPP would predict no change in the equilibrium exchange rate.

A more complex treatment would consist of changing relative prices. For example, wheat costing two red cards in Redlandia and four blue cards in Bluestan would lead to 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. Thus, the experiment is useful in demonstrating the concept of PPP by having students participate in market activities that may or may not change the exchange rate.

### **Transport Costs, Tariffs and Other Barriers to Trade**

Transport costs can be introduced by announcing that a war causes shipping to become difficult. For example, 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 four blue cards in Bluestan and two red cards in Redlandia. Tariffs and other trade barriers could be introduced in a similar fashion, by announcing that each country imposed a tariff of one card per unit of imported wheat. As the sample results in Appendix B show, students have a difficult time determining the appropriate

exchange rate in this case. This gives the instructor the opportunity to discuss in more detail the impact of these frictions on exchange rates and on trade.

### **Nontradable Goods**

Nontradable goods can be introduced by announcing that no one can eat raw wheat, but people can eat bread. Furthermore, 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. This would lead to deviations from PPP since the final product you want to consume is now a basket that consists of a tradable good (wheat) and a nontradable good (cooking). Again, students generally have a difficult time determining the correct exchange rate in this case.

## **DISCUSSION**

The instructor can distribute discussion questions at the end of the experiment; suggested discussion questions are provided in Appendix C and are organized by specific courses. The 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 and make them available to students.

Students are generally quick to understand the basics of PPP theory, i.e., the prediction that the equilibrium exchange rate will reflect the ratio of domestic prices in each country. This can be emphasized in the first part of the experiment by asking students to predict the price of Redlandia's (or Bluestan's) currency in each round. Note that since we focus on a single good

(wheat), the experiment (thus far) captures the law of one price since the price of wheat in each country reflects domestic prices.

The next step is to link changes in relative prices to changes in the equilibrium exchange rate. For example, inflation in Bluestan (an increase in domestic wheat prices from one to four cards) would reduce the purchasing power of its domestic currency. In other words, Bluestan's currency is weaker now and we would expect it to buy less red currency, or to have depreciated. This is equivalent to an increase in the purchasing power, or an appreciation, of Redlandia's currency 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 motivate additional discussion, the instructor can ask (or assign as homework) the following questions: What happened to the exchange rate when Bluestan experienced an increase in its wheat price from one to four cards? What does it mean (in real terms) for Bluestan's currency to become weaker?

The above discussion is suited for introductory courses, where students can be exposed to PPP theory as a basic framework that explains exchange rate determination. 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 is certainly enriched by talking about possible reasons for the exchange rate to deviate from the level predicted by PPP theory. The presence of transport costs, tariffs, or nontradable goods 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 what happened to the exchange rate when there was a nontradable component to wheat consumption (i.e., when it had to be cooked). The instructor could refer the students to Taylor and Taylor (2004) and *The Economist* (2004).

The discussion regarding the experiment can also be enriched by allowing students to apply what they learned to real world scenarios. There is always a fear that students will remember that they had fun doing an experiment but will not be able to apply their knowledge. We like to point out that PPP was used under Bretton Woods to help set the fixed exchange rates after World War II. We also like to point out that some countries, such as China, still have fixed exchange rates. We can use PPP as a rough proxy for determining how over- or undervalued a currency is, such as with the Big Mac index, which looks at the price of a basket of commodities (frozen beef patties, sesame seed bun, lettuce, cheese, pickles, and a secret sauce) across countries. For example, in May 2004, a Big Mac in China cost \$1.26 compared with a U.S. price of \$2.90, which implies that the Chinese Yuan is undervalued by 57%. 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. It is also useful to give students more recent data<sup>11</sup> so that they can check how accurately the index predicts exchange rate fluctuations. After the experiment, however, students should be aware of several reasons PPP often fails to hold.

Students should also be aware that, because prices are not equal across countries, simple cross-country comparisons of wealth are not appropriate. If an economist wants to look at relative wealth or changes in wealth over time, he or she cannot simply look at how many dollars of wealth are in each country. That would not make sense because, for example, while \$2.90 buys only one Big Mac in the U.S., it buys 1.57 Big Macs in China. Economists make adjustments that yield a more accurate measure of purchasing power and hence wealth across

countries. If the average Chinese person earns just one dollar more per day, he or she can purchase  $\$1/1.26 = 0.8$  Big Macs more per day. But if the average American earns one more dollar per day, she can only purchase an extra one-third of a Big Mac per day. This adjustment gives economists a much better understanding of how wealthy the average Chinese person is relative to people in other countries. Practical applications include, for example, using traditional measures of real GDP versus real GDP adjusted by PPP (which can be obtained from the World Bank Development Indicators or from the Penn World Tables).

### **CONCLUSION**

The classroom experiment described here has demonstrated an ability to help college students at all levels understand how markets determine appropriate values for exchange rates. The implicit framework for exchange rate determination is one in which prices are perfectly flexible (in the long run) so that PPP prevails. Additional treatments allow students to examine some of the reasons behind exchange rate movements and cases in which PPP fails to hold. The experiment is suitable for classes ranging in size from eight to fifty students. It can be run in as little as 30 minutes, if discussion is postponed to the following class period.

## NOTES

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<sup>1</sup> For the remainder of the paper, we are referring to exchange rates only in purely flexible exchange rate systems.

<sup>2</sup> For a comprehensive list of classroom experiments in economics, see Brauer and Delemeester (2001) and Holt (2005).

<sup>3</sup> 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.

<sup>4</sup> Most of our trials were conducted in classes with 16–30 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).

<sup>5</sup> It is convenient to sell currency in blocks to speed up the experiment. However, the size of the blocks is arbitrary.

<sup>6</sup> We recommend starting the game by selling three blocks of currency in each round. The instructor can increase (or decrease) the number of currency blocks offered for sale as needed to maintain an active currency market.

<sup>7</sup> We initially employed a second-price auction format in which all winners pay the lowest winning bid. While 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.

<sup>8</sup> As suggested by Anderson and Stafford (2006).

<sup>9</sup> Use of a projector to display the instructions for additional treatments will facilitate and expedite running the experiment.

<sup>10</sup> 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.

<sup>11</sup> The Economist publishes regular updates of ‘The Big Mac’ index (<http://www.economist.com/markets/bigmac/>).

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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). At the end of class, I will reward one randomly selected student with \_\_\_\_\_ for each unit of wheat.

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.

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. (Normally currency markets do not go through one large buyer and seller, but reducing a bit of realism makes the experiment easier.)

- You may only purchase currency from me.
- I will sell currency in blocks of four. You may buy four Redlandia dollars or four Bluestan dollars. Red currency will be offered for sale only in odd numbered rounds, and blue currency will be offered for sale only in even numbered rounds. Anyone may purchase either 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.
- If you want to bid for a block of currency, first decide how much you want to bid and then place the appropriate number of cards in a stack against your chest. Be careful not to reveal your bid to other players. **The bidding process is very important. Make sure that you fully understand it before we begin.**

- When everyone is ready, I will ask each player 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 (or pieces of paper).
- Ties will be broken by a random process.

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 person at the end of the experiment, and he or she will be paid \_\_\_\_\_ for each unit of wheat they 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 war, and shipping becomes difficult. 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. (This is perhaps the most interesting of the treatments. It works well for an advanced class that wants to see how PPP breaks down.)

**Personal Record Sheet for the International Wheat Purchasing Game**

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

## APPENDIX B: Sample Results

### Results for the International Wheat Purchasing Game

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

| Treatment    | Round | Redlandia<br>Wheat Price | Bluestan<br>Wheat Price | Red<br>Currency<br>Price | Blue<br>Currency<br>Price | Red/Blue<br>Exchange<br>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                             |
| War          | 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, since 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. Did it converge to the expected value? 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?
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?

#### *Additional Questions for International Economics Courses:*

4. 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)?
5. What is the law of one price? What would absolute PPP predict for the equilibrium exchange rate in each part of the experiment?
6. What happens to prices when there are barriers to trade?
  - a. 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.
7. Extra Credit: What would happen if each country imposed a tariff of one card per unit of imported wheat?

#### *Additional Questions for International Economics or Macroeconomics Courses:*

8. The treatments were purposely changed by surprise. What are two reasons to hold foreign exchange? Do foreign exchange traders know the future, or do they trade assets using the best available current information?
9. In the experiment, prices changed, but we did not tell you why they changed. Provide three situations that would cause prices to change. For each case, explain how prices would change and describe its effect on the value of the domestic currency.
10. What are the effects of war on the value of a currency? Why are these effects important? change and describe its effect on the value of the domestic currency.
11. What 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. Does this make sense? Can you think of reasons why countries would not want flexible exchange rates? Since most developed countries have adopted flexible exchange rates, what do you think are the main benefits of flexible exchange rates?

#### *Further Readings:*

“Food for Thought: the Big Mac Index.” *The Economist*, May 27, 2004.

[http://www.economist.com/markets/bigmac/displayStory.cfm?story\\_id=2708584](http://www.economist.com/markets/bigmac/displayStory.cfm?story_id=2708584) .

“The Starbucks index - Burgers or beans? A new theory is percolating through the foreign-exchange markets”. *The Economist*, January 15, 2004.

<http://www.economist.com/search/search.cfm?rv=2&q=starbucks+index&area=1&x=0&y=0>.

Also check <http://www.economist.com/markets/bigmac/> for a collection of articles on the Big Mac Index, including an explanatory video clip.