The U.S.-China Exchange Rate Debate: Using Currency Offer Curves

Jannett Highfill and Raymond Wojcikewych*

Bradley University

Department of Economics

Peoria IL 61625

(309) 677-2304

FAX (309) 677-4174

highfill@bradley.edu

wojo@bradley.edu

Abstract: The paper introduces an innovative graph for teaching bilateral exchange rates. The currency quantities are on the axes, and the exchange rate is the ratio between them, i.e., the slope of a ray from the origin. Behavior is captured by "currency offer curves." The paper uses the model to address the issues surrounding China's export-led growth strategy, i.e., its policy of undervaluing the yuan.

The Fed's recent decision (November 3, 2010) to buy up to $600 billion of long-term Treasury debt (QE2) in an attempt to spur lackluster economic growth has reenergized the foreign currency debate. The second round of quantitative easing is intended to lower longer-term interest rates in the hopes of stimulating business borrowing and investing. However, lower U.S. interest rates make dollar investments less attractive to global investors. This decreases the demand for dollars and causes the dollar to weaken relative to other currencies. Our trading partners are not pleased, accusing the U.S. of trying to export its unemployment problems.

China, in particular, has been vocal in its criticism of the Fed's policies. A weaker dollar implies a stronger yuan, and, this runs counter to China's long standing policy of keeping its currency undervalued in order to drive domestic economic growth through Chinese exports. Well before the recent crisis the large current account deficit of the U.S. with China had been a subject of concern which inevitably raises questions about the dollar-yuan exchange rate. China fixed its exchange rate at 8.28 yuan per dollar until July 2005. The value of the dollar against the yuan as of November 15, 2010 is 6.65, little changed from last year, and about a 20% depreciation since 2005. Derrick (BBC News, 2010) notes that "since the start of 2002, China has sold an astonishing $2.187tn worth of its own currency, in an attempt to stop it gaining in value." Cheung, Chinn, and Fujii (2009), argue, for example, that although considerable uncertainty exists, the yuan is undervalued by about 10% and that Chinese exports should decrease with an appreciation of the yuan. Salvatore (2008) takes a similar view, as does, to mention just one of many examples, Brown, Crowley, McCulloch, and Nakajima, (2005). A dissenting view is articulated by, for example, McKinnon and Schnabl (2008) who argue that the yuan is not undervalued, and that a revaluation would not reduce the U.S. current account deficit with China.

I. Best Practices Using Supply and Demand Curves

As far as we are aware, the major recent innovation in teaching about exchange rates has been to use classroom experiments to get a feel for how the market for foreign exchange works (Mitchell, Rebelein, Schneider, Simpson, and Fisher, 2009; Hazlett and Ganje, 1999). Once students have this valuable hands-on learning experience, it appears that giving students the tools

to further explore foreign exchange markets is the province of traditional supply and demand curves. We examined several economics textbooks (both principles of macroeconomics and intermediate macroeconomics) in order to see how the authors presented the foreign exchange market to students. In the majority of the principles texts (Cowen and Tabarrok 2010; Krugman and Wells 2009; McConnell, Brue, and Flynn 2009; McEachern 2009; Colander 2008) the traditional supply and demand approach was used to determine the equilibrium exchange rate. The market consisted of the supply and demand for a particular currency expressed in terms of the price of some other currency. In all of these texts a linear relationship between the price (exchange rate) and quantity demanded was assumed (although in a few cases the relationship "appeared" on the diagram to be curvilinear). In each of these texts, understanding the exchange rate simply requires students keep track of the price (exchange rate) and quantity of one particular currency being traded.

An exception to the "single-market" approach to exchange rate behavior can be found in Stone's 2008 principles textbook. While the underlying relationships are still assumed linear, his model of the foreign exchange market explicitly recognizes the bilateral nature of foreign exchange transactions. Stone illustrates the market for both currencies (dollars and pounds) side-by-side. This makes it easier, for example, for students to see how economic forces can change the value of both currencies (in opposite directions) and the quantities traded simultaneously. (We will discuss these matters further below.)

In addition to the principles textbooks, we also examined several intermediate texts to see how they presented the foreign exchange market. The analyses were obviously more advanced and each took a slightly different approach to exchange rate determination. Mankiw's 2010 text, for example, explains the exchange rate (on a single diagram) as the relationship between the

flow of capital and the flow of goods between two countries. Abel, Bernanke, and Croushore (2008), on the other hand, look at the market for dollars in terms of the "nominal exchange rate" without identifying the other currency specifically. Froyen (2009), examines the dollar/euro market, but with linear supply and demand curves.

In summary, we would argue that Figure1 below reflects something like best practices in teaching exchange rates when supply and demand curves are used.

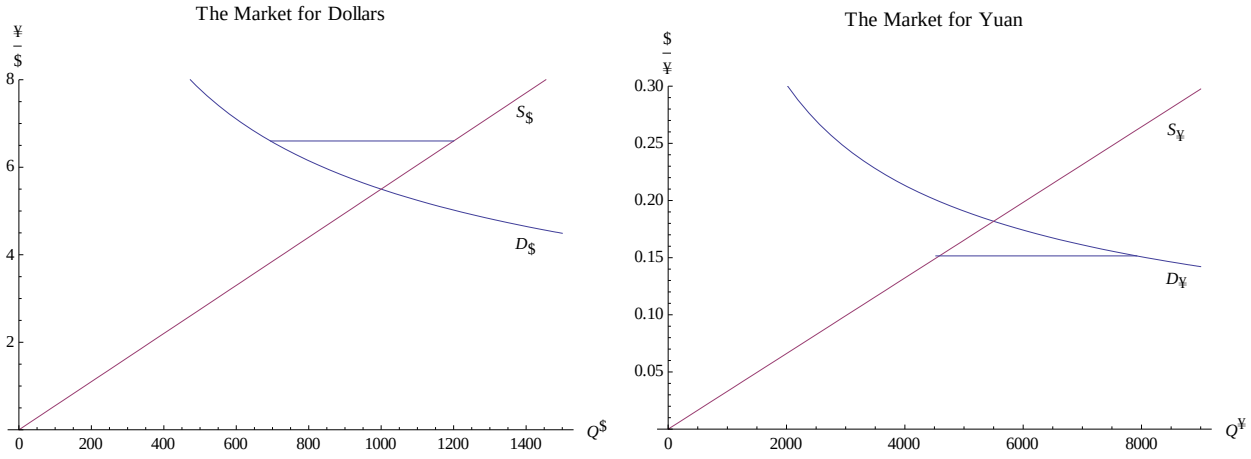

Figure 1: Supply and Demand Approach to Exchange Rates

First, we believe best practices require a currency demand function that is not linear. The problems translating linear demand for one currency into the equivalent supply of the other are so well known we do not need to rehearse them here. As anyone who has sat down with pencil and paper to work the functional forms knows, it is logically inconsistent to draw both the supply and demand curves as straight lines. (A linear demand function for yuan yields a supply of dollars relation that is backward bending, and not even a function.) We prefer iso-elastic demand curves. In the special case when the elasticity is two, the supply curves are linear as shown.

Second, we believe that both the market for dollars and the market for yuan need to be shown. The presentation of exchange rates should not ignore either the U.S.'s or China's point of view. Titles and arrangement matter. Putting the market for yuan side-by-side with the market for dollars sends the message that the two views of the same market are equally valid and important. Only drawing, for example, the market for dollars sends the message that the Chinese point of view, the value of the Chinese currency, is of so little importance that it can literally be invisible. One might argue that the Chinese point of view is really visible in "The Market for Dollars." After all, the value of the dollar is certainly the inverse of the value of the yuan. But quantities are a different matter. If the numbers are chosen as in Figure 1, translating $1000 to 5500 yuan at a given value of the dollar is not difficult, but that is only one point. While the example can be cooked so that one or two translations of quantity of dollars into quantity of yuan are simple, in general making those translations is not so simple. In Figure 1, for example, when the value of the dollar is 6.6, $1200 translates into 7920 yuan—not a calculation everyone can do quickly and easily. Many people do not find it easy to "see" that the left panel contains exactly the same information as the right panel.

Perhaps more importantly, students are taught in economics classes that technical tools, graphs or equations, are always derived from the behavior of economic agents. Economists are not caught off guard by the fact that the same behaviors by the same agents (i.e., Americans buying toys imported from China at Walmart) is captured by two different curves in two different spaces. But principles students might find it confusing. They have recently only learned the fundamentals of supply and demand: that, for example, in the pizza market the demand function describes the behavior of consumers and the supply function the behavior of firms. They are just learning the corollary, that changes in, for example, the preferences of

consumers affect only the demand curve, not the supply curve. (This is the time-honored "shift versus movement along" discussion that every principles course teaches, precisely because it is not intuitive to all students.) In prior units they have learned that a given shock typically shifts only the supply or demand curve, while in the foreign exchange market shocks shift both a supply and a demand curve.

Some students can grasp the concept that the two panels of Figure 1 are just two different snapshots of the same market, something like looking at the same person in left-profile or right-profile. But even these students do not find it easy to start with one of the functions, say a demand for yuan function as in equation (4) in the appendix and derive the supply of dollars. Our experience with math-econ students suggests that even they need some help and an explicit statement of what we call the exchange rate identity (see equation (3) below). The difficulties with the traditional supply and demand approach are such that we hereby offer an alternative way of teaching exchange rates.

II. Currency Offer Curves

Although elementary to professional economists, students may benefit from a discussion of why agents enter the exchange rate market. The agents and their transactions can be classified a number of ways; equation (1) gives the version we find most useful for summarizing the behavior of agents holding dollars that want to turn them into yuan:

$$Q^{¥} = ChineseExports + InflowsIntoChina\ . \tag{1}$$

Exports includes the usual toys, cars, and software, but also includes such items in the current account as investment income and private remittances. The term "Inflows" refers to the

traditional capital transactions; buying a Chinese stock or bond, making a "green-field" investment, and the like.

The desires of all the private agents holding yuan that would like to exchange them for dollars at the various exchange rates as shown in equation (2).

$$Q^{\$} = USExports + InflowsIntoUS\ . \tag{2}$$

The discussion and examples are similar to that above and will be omitted for brevity.

II.A Turning Dollars into Yuan: Behavior of Agents Holding Dollars

The calculations deriving the offer curve are found in the appendix. The underlying demand function is equation (4) and the resulting offer curve is equation (5). We actually teach them using the following table which captures the behavior of dollar holders. The data is derived from the equations of the appendix which assume iso-elastic demand functions with an elasticity of two and constants $a_{¥} = \frac{2000}{11} \approx 181.82$, and $a_{\$} = 30,250$.

Table 1
DOLLAR INTO YUAN OFFER CURVE DATA

Value of Yuan ($= Q^{\$} / Q^{¥}$)	Quantity of Yuan $Q^{¥}$	Quantity of Dollars $Q^{\$}$	Value of Dollar ($= Q^{¥} / Q^{\$}$)
$\frac{1}{6.6} \approx 0.1515$	7920	1200	6.6
$\frac{1}{5.5} \approx 0.18182$	5500	1000	5.5
$\frac{1}{4.4} \approx 0.227273$	3520	800	4.4

Although we need not dwell on it here, notice that the information can be supplied to students in three different ways. If students are given the value of the yuan and the quantity of yuan, they can derive the value of the dollar and the quantity of dollars. Similarly, if students are given the value of the dollar and the quantity of dollars, they can derive the value of the yuan and the quantity of yuan. Finally, if students are given the quantity of dollars and the quantity of yuan, then they can derive the value of the dollar and the value of the yuan. All these calculations are simple applications of the exchange rate identity:

$$\frac{\$}{¥} \equiv \frac{Q_S^{\$}}{Q_D^{¥}} \ . \tag{3}$$

The "exchange rate" is just the ratio of the quantities of currencies traded. If agents holding dollars offer \$1000 dollars and get 5500 yuan in return they will be satisfied. Equivalently, if the value of the dollar is 5.5 we will offer \$1000. On the other hand, holders of yuan may be satisfied if they offer 5500 yuan and get \$1000 in return. Equivalently, if the value of the yuan is about $0.18182 \approx 1/5.5$ we will offer 5500 yuan.

In the supply and demand format, the demand for yuan curve is found by mapping the first two columns, the supply of dollars by the second two. The "dollar into yuan" offer curve we use simply maps the middle two columns.

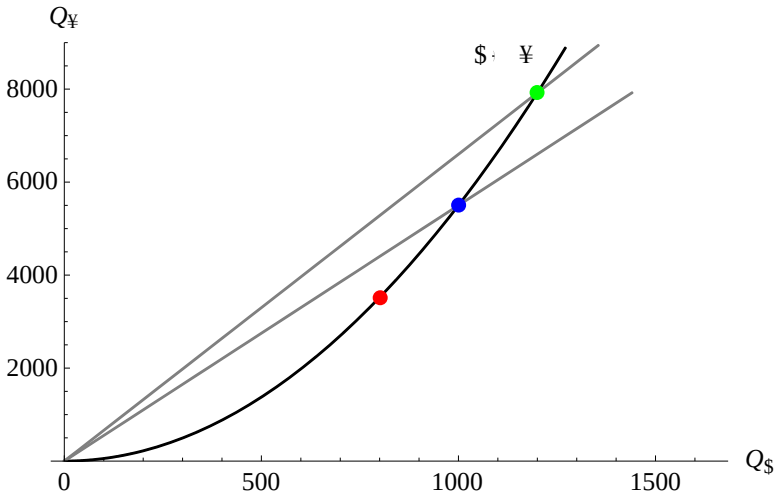

Figure 2: Dollars Into Yuan Offer Curve

The value of the currency on the horizontal axis, the dollar, is the slope of any ray from the origin. A look at the table shows that the two examples given are when the value of the dollar is 5.5 (blue) and 6.6 (green).

II.B Turning Yuan into Dollars: Behavior of Agents Holding Yuan

Also derived in the appendix, the yuan into dollars offer curve is motivated by Table 2 and shown in Figure 3. The underlying demand function is equation (6) and the resulting offer curve is equation (8).

Table 2 **YUAN INTO DOLLAR CURVE DATA**			
Value of Yuan $(= Q^{\$} / Q^{¥})$	Quantity of Yuan $Q^{¥}$	Quantity of Dollars $Q^{\$}$	Value of Dollar $(= Q^{¥} / Q^{\$})$
$\frac{1}{4.4} \approx 0.227273$	6875	1562.5	4.4
$\frac{1}{5.5} \approx 0.18182$	5500	1000	5.5
$\frac{1}{6.6} \approx 0.1515$	4583.33	694.44	6.6

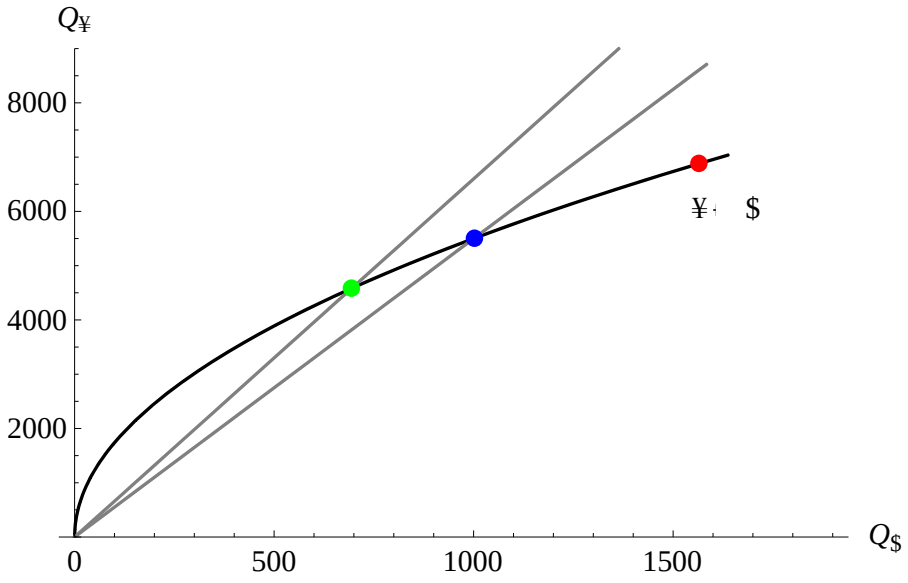

Figure 3: Yuan into Dollars Offer Curve

II.C Equilibrium

As the astute student will have noticed, equilibrium is simply where the offer curves intersect on Figure 4. For this example, the equilibrium value of the dollar is 5.5 and the equilibrium value of the yuan is 1/5.5 or about 0.18182. The appendix gives the equilibrium exchange rates and quantities abstractly, equations (8), (9), and (10).

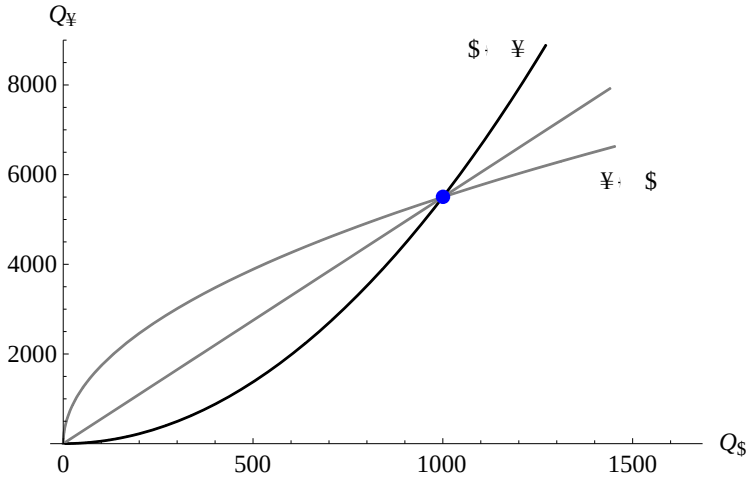

Figure 4: Equilibrium in the Foreign Exchange Market

Although there is more to be said, if the foreign exchange market were always in equilibrium and behavior behind the offer curves unchanging, then the exchange rate unit would not require as much class time. As we argue below, a application of the offer curve methodology is when exchange rates are fixed. Nevertheless it might be useful to explain how the normal comparative statics would be done. For example, suppose U.S. interest rates go down relative to Chinese rates. The yuan into dollar offer curve would rotate down (so that along any given value of the dollar, i.e., ray from the origin) fewer dollars are desired. The intersection of the new yuan into dollar offer curve and the existing dollar into yuan offer curve shows a decline in the value of the

dollar; i.e., a new flatter ray from the origin is needed to go through the new intersection point. (There may also be an effect on the dollar into yuan offer curve, but for class room purposes, one shift is sufficient to illustrate the main ideas. If one did, however, rotate the dollar into yuan curve so that more yuan are desired for a given value of the dollar, the effect on the exchange rate is reinforced.)

III. Fixed Exchange Rates

As shown in the previous section, the equilibrium value of the dollar is 5.5 yuan. The numerical example being developed assumes that China has set the value of the yuan at 0.1515 so that the dollar is overvalued, the fixed value of the dollar being 6.6 as compared to an equilibrium rate of 5.5.

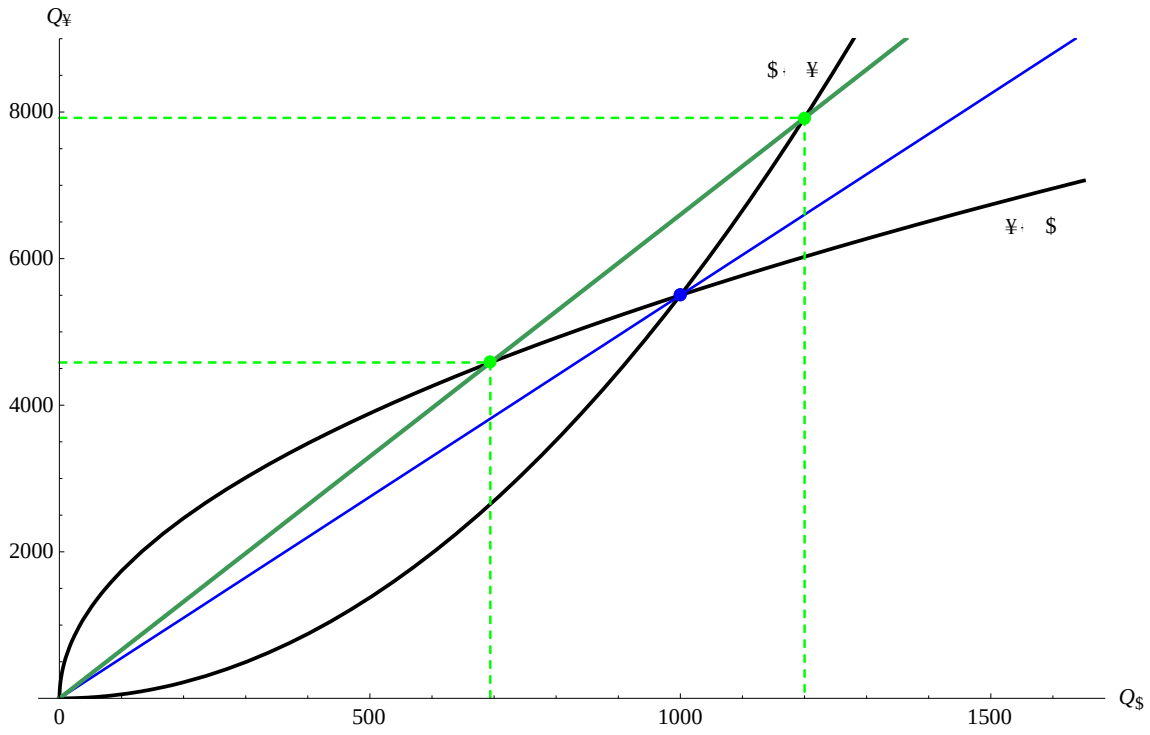

Figure 5: An Overvalued Dollar

When the dollar is at 6.6 yuan, Americans will find (as compared to equilibrium) that their dollars go further and will buy more Chinese goods (or assets etc.). This leads to a desire for 7920 yuan (see Table 1) while the quantity of dollars they need to lay on the table to obtain them is 1200. On the other hand, Chinese agents will find American goods and assets more expensive (compared to equilibrium) and desire only 694 dollars (see Table 2) while they need to put 4583 yuan on the table to get them. So, looking at the yuan axis, Americans desire 7920 yuan, private agents in China will supply 4583 yuan, so the Chinese government will need to supply the difference, i.e., 3337 yuan. This is the vertical distance between the dashed lines in Figure 5. Overvaluing the dollar is a feasible goal for the Chinese government, since they can simply print the yuan with which to support this policy. Looking now at the dollar axis, Americans have put 1200 on the table and private Chinese agents want to pick up only 694 dollars. This difference, 506 dollars, is the amount the Chinese government has to buy. This is the horizontal distance between the dashed lines in Figure 5.

The value of our methodology can now be appreciated. Students can "see" that an export-led growth strategy of overvaluing the dollar is precisely a policy of accumulating dollars—which have to be held somehow. China cannot have an export-led growth/undervalued currency strategy without accumulating vast sums of dollars. The headlines about China's enormous holdings of U.S. government debt and its creation of a Sovereign Wealth Fund to hold the dollars should also mention the value of the dollar, and conversely.

The problems with running an export-led growth strategy have only been accentuated by the recent global economic crisis. China simply cannot insulate itself from the U.S. economy. Export-led only works when consumers in the U.S. are buying. An overvalued dollar requires that the Chinese government find assets to hold their dollars in, making them vulnerable to forces

in the U.S. economy that weaken either the dollars or the underlying assets denominated in dollars. The very size of China's Sovereign Wealth makes China even more vulnerable to developments in the U.S. economy.

It seems likely that China's policy is to hold its Sovereign Wealth fund for "precautionary reasons," perhaps taking a lesson from its neighbors' troubles during the Asian Crisis. To the extent that China has been a destination for global financial capital, it might be the case that, for whatever reason, those global investors decide to take their funds out of China. Hot money can flee as fast as it can enter. If the Chinese government were willing to accept this devaluation in the yuan, then it would not need to intervene in the foreign exchange market. It might be surprising that the Chinese government does not just let it happen. Falling values of the yuan make Chinese goods even cheaper for Americans, which seems consistent with its export-led growth policy. But perhaps it is a matter of control. Perhaps China wants to set its exchange rate—and not have it subject to market forces, even favorable ones.

Conclusion

China now accuses the U.S. of what it itself has been accused of doing for the past twenty years, i.e., currency manipulation for its own economic advantage. Specifically, China contends that the Fed's actions are intended to drive "hot money" to emerging countries and thereby driving up their currency values. The New York Times (Chan, Stolberg, and Sanger, November 11, 2010) reports that

> At a press briefing in Seoul, Zheng Xiaosong, director general of the Chinese Ministry of Finance's international department, indirectly accused the United States of ignoring its international responsibilities. "The major reserve-currency issuers, while implementing

> their monetary policies, should not only take into account their national circumstances but should also bear in mind the possible impacts on the global economy," he said.

We have found that with a little gentle encouragement, the irony of this situation is not lost on students.

References

Abel, Andrew B., Ben S. Bernanke, and Dean Croushore. 2008. *Macroeconomics*, 6th ed. Boston: Pearson.

Brown, Chad P., Meredith A. Crowley, Rachel McCulloch, and Daisuke J. Nakajima. 2005. The U.S. Trade Deficit: Made in China? *Federal Reserve Bank of Chicago Economic Perspectives*. v29 (n4):2-18.

Chan, Sewell, Sheryl Gay Stolberg, and David E. Sanger. 2010, November 11. Obama's Trade Strategy Runs Into Stiff Resistance. *New York Times*, http://www.nytimes.com/2010/11/12/business/global/12group.html?_r=1&scp=1&sq=Obama's%20Trade%20Strategy%20Runs%20Into%20Stiff%20Resistance&st=cse; accessed November 29, 2010.

Cheung, Yin-Wong, Menzie D. Chinn, and Eiji Fujii. 2009. China's Current Account and Exchange Rate. CESifo GmbH, CESifo Working Paper Series: CESifo Working Paper No. 2587.

Colander, David C. 2008. *Macroeconomics*, 7th ed. Boston: McGraw-Hill.

Cowen, Tyler and Alex Tabarrok 2010. *Modern Principles: Macroeconomics*. New York: Worth.

Derrick, Simon. 2010. Treasury Secretary Geithner in China for Economic Talks, BBC News.

Froyen, Richard T. 2009. *Macroeconomics: Theories and Policies* 9th ed. New Jersey: Pearson.

Hazlett, Denise, and Jeela Ganje. 1999. An Experiment with Official and Parallel Foreign Exchange Markets in a Developing Country. *Journal of Economic Education*. v30 (n4):392-401.

Krugman, Paul R., and Maurice Obstfeld. 2009. *International Economics: Theory and Policy*, 8th ed. Boston: Pearson.

Mankiw, Gregory N. 2010. *Macroeconomics*, 7th ed. New York: Worth.

McConnell, Campbell R., Stanley L. Brue, and Sean M. Flynn. 2009. *Macroeconomics* 18th ed. Boston: McGraw-Hill.

McEachern, William A. 2009. *Econ for Macroeconomics*. Mason OH: South-Western.

McKinnon, Ronald Ian, and Gunther Schnabl. 2008. *China's Exchange Rate Impasse and the Weak U.S. Dollar*. CESifo GmbH, CESifo Working Paper Series: CESifo Working Paper No. 2386.

Mitchell, David T., Robert P. Rebelein, Patricia H. Schneider, Nicole B. Simpson, and Eric Fisher. 2009. A Classroom Experiment on Exchange Rate Determination with Purchasing Power Parity. *Journal of Economic Education*. v40 (n2):150-65.

Salvatore, Dominick. 2008. Structural Imbalance and Global Monetary Stability. *Economia Politica*. v25 (n3):441-53.

Stone, Gerald W. 2008. *CoreMacroeconomics*, New York: Worth.

Appendix

Suppose the currency market behavioral assumptions can be captured by iso-elastic demand functions. Consider first agents holding dollars who want to trade them for yuan. Assume a demand function

$$Q_D^{¥} = a_{¥}\left(\frac{\$}{¥}\right)^{-m} \tag{4}$$

where m is the price elasticity, and recall the exchange rate identity, repeating equation (3) from the text

$$\frac{\$}{¥} \equiv \frac{Q_S^{\$}}{Q_D^{¥}} \quad .$$

Combining these

$$Q_D^{¥} = a_{¥}\left(\frac{\$}{¥}\right)^{-m} = a_{¥}\left(\frac{Q_S^{\$}}{Q_D^{¥}}\right)^{-m}$$

and simplifying yields

$$Q_D^{¥} = \left(a_{¥}\right)^{\frac{1}{1-m}}\left(Q_S^{\$}\right)^{\frac{m}{m-1}} \quad . \tag{5}$$

Similarly, for agents holding yuan, the demand function

$$Q_D^{\$} = a_{\$}\left(\frac{¥}{\$}\right)^{-n} \tag{6}$$

and the exchange rate identity yield

$$Q_S^{¥} = a_{\$}^{1/n}\left(Q_D^{\$}\right)^{n-1/n} \quad . \tag{7}$$

The equilibrium condition is $Q_D^{¥} = Q_S^{¥}$ so that

$$a_{¥}\left(\frac{\$}{¥}\right)^{-m} = Q_D^{¥} = Q_S^{¥} = a_{\$}\left(\frac{\$}{¥}\right)^{n-1}$$

which simplifies to

$$a_{\$}\left(\frac{¥}{\$}\right)^{m} = a_{¥}\left(\frac{¥}{\$}\right)^{1-n}$$

or

$$\left(\frac{¥}{\$}\right)_{EQ} = \left(\frac{a_{\$}}{a_{¥}}\right)^{\frac{1}{m+n-1}} \quad . \tag{8}$$

The quantities, which this approach is designed to highlight, are

$$Q_{EQ}^{\$} = a_{\$}\left(\frac{¥}{\$}\right)^{-n} = a_{\$}\left(\frac{a_{\$}}{a_{¥}}\right)^{\frac{-n}{m+n-1}} = \left(a_{\$}\right)^{\frac{m-1}{m+n-1}}\left(a_{¥}\right)^{\frac{n}{m+n-1}} \tag{9}$$

and

$$Q_{EQ}^{¥} = a_{\$}\left(\frac{\$}{¥}\right)^{n-1} = a_{\$}\left(\frac{¥}{\$}\right)^{1-n} = a_{\$}\left(\frac{a_{\$}}{a_{¥}}\right)^{\frac{1-n}{m+n-1}} = \left(a_{\$}\right)^{\frac{m}{m+n-1}}\left(a_{¥}\right)^{\frac{n-1}{m+n-1}} \quad . \tag{10}$$