ECON 1550 — Problem Set 6 Answer Key

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Submission: Canvas or Gradescope

1. A Conditional Carry Trade

(a) Consider the price level in the United States at time t, $P_{\text{US},t}$, the price level in Korea at time t, $P_{\text{Korea},t}$, and the U.S. Dollar (USD) per Korean Won (KRW) exchange rate at time t, E_t. Write the equation for relative PPP between the United States and Korea.

Solution: As shown in equation (5-2) in the textbook, relative PPP between the United States and Korea is

$$\frac{E_t - E_{t-1}}{E_{t-1}} = \pi_{\text{US},t} - \pi_{\text{Korea},t}$$

where $\pi_{\text{US},t}$ is U.S. inflation and $\pi_{\text{Korea},t}$ is Korean inflation.

(b) When

$$\frac{P_{\text{US},t}}{P_{\text{Korea},t}} - E_t > 0,$$

the theory of absolute PPP suggests that USD is overvalued compared to KRW. Write an analogous condition that suggests that USD is overvalued compared to KRW according to *relative* PPP.

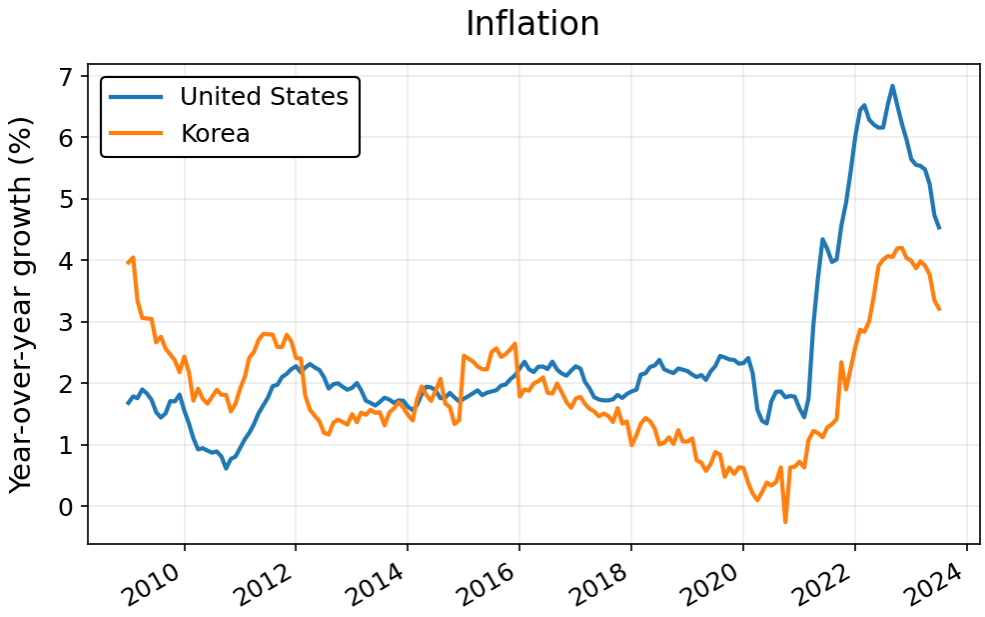
Solution: The condition using relative PPP is

$$\pi_{\text{US},t} - \pi_{\text{Korea},t} - \left(\frac{E_t - E_{t-1}}{E_{t-1}}\right) > 0$$

(c) Download the inflation rate for the United States and the inflation rate for Korea from FRED for all months between February 2009 and July 2023 and show both series in a single plot that has time on the horizontal axis and the inflation rates on the vertical axis.

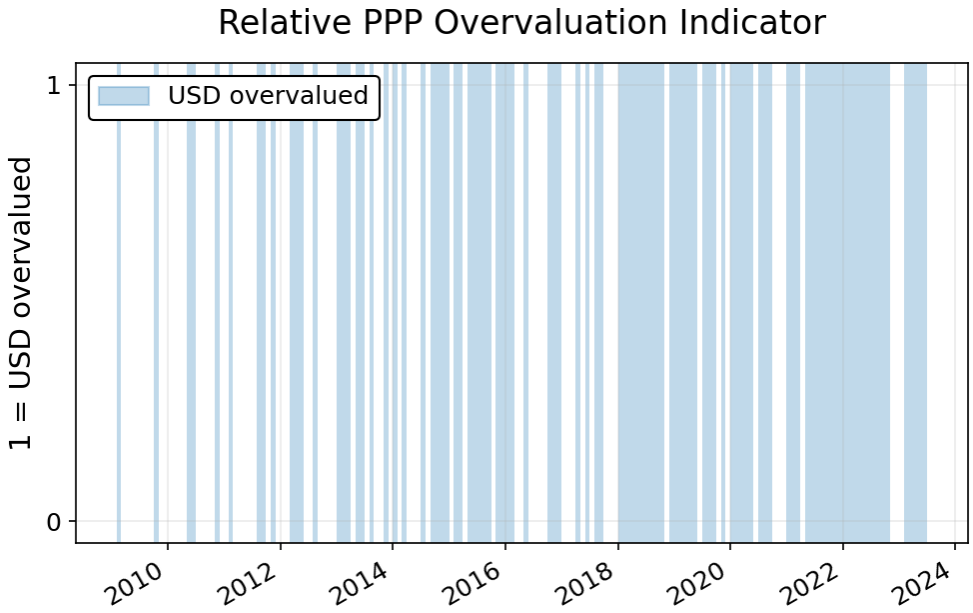
Hint: The links should already display the correct dates, but double check and adjust them if needed. Likewise, the link should already show the consumer price index in units of "Growth rate same period previous year", but make sure it is the case before downloading.

Solution: The plot with both inflation rates is:



(d) Combine the data from (c) with the carry trade data you constructed in Problem Set 3, question 2, part (c), and compute the relative PPP overvaluation condition from part (b). Now construct an indicator variable that is equal to 1 when the overvaluation condition is true, and equal to zero otherwise. Plot this indicator variable with time on the horizontal axis and the indicator on the vertical axis.

Solution: The plot for the indicator variable is:

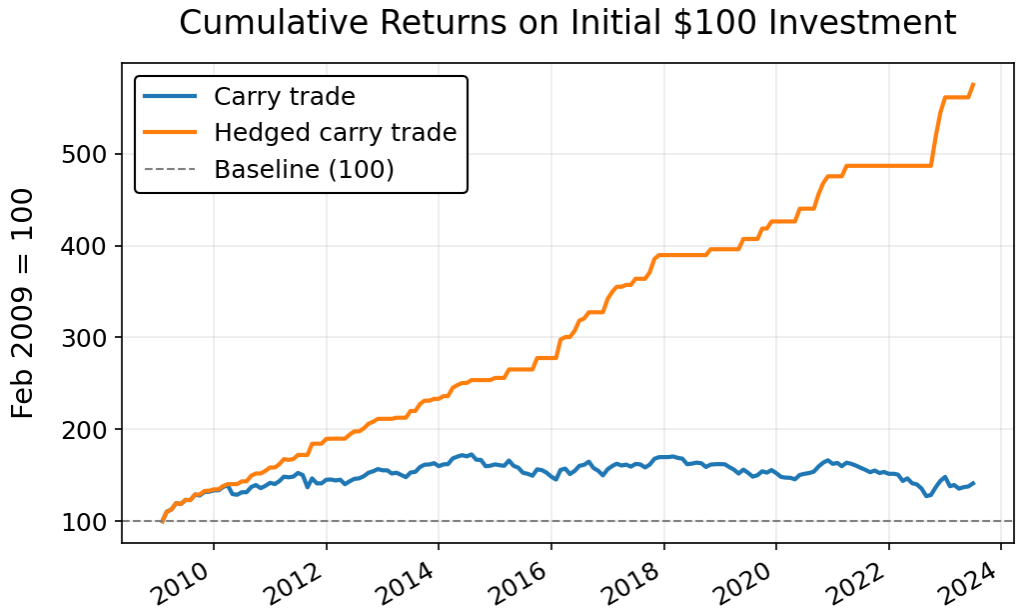


The *hedged carry trade* is a trading strategy where, for each month, you check if the relative PPP overvaluation condition you constructed in (d) signals an overvalued USD. If the signal is for an overvalued USD, invest nothing for that month and earn a monthly return of zero. If the signal is not for an overvalued USD, invest in the standard carry trade and earn the same monthly return that you computed in Problem Set 3, question 2c.

(e) Show the cumulative returns for the hedged carry trade and the standard carry trade together in one plot, with time on the horizontal axis and the cumulative returns on the vertical axis.

By the end of the sample, which strategy has higher cumulative returns? Is the difference in cumulative returns between the two strategies evidence in favor or against the idea that relative PPP holds in the long run?

Solution: The plot with cumulative returns for both strategies is:



By the end of the sample, the hedged carry trade has cumulative returns that are more than eleven times larger than the standard carry trade. This difference does provide some support to the idea that PPP holds in the long run. When relative PPP signals an overvalued dollar, the standard carry tends to have negative returns over the long run. The hedged carry trade has zero returns on those months. Since the standard carry trade borrows in dollars, the negative returns following the overvaluation signal suggest that the dollar depreciates in those periods, at least on average over our relatively long sample.

On the other hand, it could be possible that the negative returns are not due to a depreciation of the dollar but due to a reduction in the dollar-won interest rate differential. Whether the reduction in interest rate differential is evidence in favor or against relative PPP depends on how interest rates interact with inflation.

A spreadsheet with the data, calculations, and plots can be downloaded here.

2. **Long-Run Theories of the Exchange Rate Determination**

Consider the model of the long run given by:

$(PPP):$	$E = P/P^*$
$(MS = MD):$	$M^s/P = \mathrm{L}(R, Y)$
$(MS^* = MD^*):$	$M^{s*}/P^* = \mathrm{L}(R^*, Y^*)$

In class, we referred to this model as "Model 1".

(a) Explain the name of the equations PPP, $MS = MD$, and $MS^* = MD^*$.

Solution: PPP means purchasing power parity. $MS = MD$ and $MS^* = MD^*$ mean (real) money supply equal to (real) money demand in the domestic and foreign countries, respectively.

(b) Identify the exogenous and endogenous variables.

Hint: Consult these slides if you need a reminder.

Solution: The exogenous variables are: $R, Y, M^s, R^*, Y^*, M^{s*}$. The endogenous variables are: E, P, P^*.

(c) Assume that the function $\mathrm{L}(\cdot, \cdot)$ is given by $\mathrm{L}(R, Y) = Y/R$ and $\mathrm{L}(R^*, Y^*) = Y^*/R^*$. Solve for the endogenous variables as a function of the exogenous variables.

Solution: Solve for P and P^* in the domestic and foreign money market equations to get: $P = M^s R/Y$ $P^* = M^{s*} R^*/Y^*$. Plugging into the PPP equation we get

$$E = \frac{\frac{M^s R}{Y}}{\frac{M^{s*} R^*}{Y^*}} = \frac{M^s}{M^{s*}} \frac{R}{R^*} \frac{Y^*}{Y}$$

(d) Consider a one-time permanent increase in M^s. Explain how all endogenous variables respond immediately when the change in M^s occurs and in the long run.

Solution: After a one-time permanent increase in M^s, P goes up, P^* remains unchanged and E goes up (there is a nominal depreciation). The changes in the short run and long run are identical, that is, immediately after the change in M^s we have a one-time permanent increase in P and E.

To the above monetary model, we add the following equations:

Relative output demand:	$Y/Y^* = q$
Relative output supply:	$Y/Y^* = \bar{Y}$
Definition of real exchange rate:	$q \equiv EP^*/P$

The exogenous variables are the same as before and, in addition, $\bar{Y}$. Assume $\bar{Y} = 1$. The endogenous variables are the same as before and, in addition, q and Y/Y^*.

The first equation, labeled Relative output demand, is a behavioral equation that captures the idea that if domestic goods become cheaper relative to foreign goods (q goes up, a real depreciation), then demand for domestic goods will increase relative to demand for foreign goods (the "relative output demand" Y/Y^* goes up).

The second equation, labeled Relative output supply, says that the relative supply of domestic and foreign goods, Y/Y^*, is equal to an exogenous variable $\bar{Y}$.

The third equation is the definition of the real exchange rate q.

In equilibrium, relative output supply must equal relative output demand.

(e) Consider a one-time permanent increase in M^s. Explain how all endogenous variables respond to the change in M^s in the short run (immediately after the change in M^s) and in the long run.

Hint: If you need help understanding the model, Section 5.6 of Chapter 5 of the textbook has a longer discussion.

Solution: From (d), we know that P^* remains unchanged. We also found that P and E increase permanently in the short run and remain at their new levels in the long run.
In equilibrium, relative output demand equals relative output supply and hence $Y/Y^* = q = \bar{Y}$. Because PPP is imposed in Model 1, $q = EP^*/P = 1$; therefore equilibrium in the added block requires $\bar{Y} = 1$ in levels. The key comparative-static result is that Y/Y^* and the real exchange rate q remain unchanged after the increase in M^s.