Econ 165 Stanford University
Winter 2002-03 TA: Kanda Naknoi

Answer for Homework 3
February 26, 2003

Problem 1.a

Let asterisk denote the EU, and double asterisks denote Cuba. Otherwise a variable denotes the U.S. one. E_1 denotes US$/Euro exchange rate, and E_2 denotes Euro/Cuban Peso exchange rate. Absolute PPP between the US and the EU implies:

$$P = E_1 P^* \quad (1)$$

In fact, (1) also implies relative PPP between US and the EU:

$$\pi = e_1 + \pi^* \quad (2)$$

Relative PPP between the EU and Cuba implies:

$$\pi^* = e_2 + \pi^{**} \quad (3)$$

Substitute (3) into (2).

$$\pi = e_1 + e_2 + \pi^{**} \quad (4)$$

Cross US$/Cuban Peso exchange rate is actually E_1E_2. Then, $e_1 + e_2$ in (4) is the expected depreciation of US$ with respect to Cuban Peso. As a result, (4) is in fact relative PPP for the US and Cuba. Between the US and Cuba, relative PPP holds but absolute PPP does not. This question illustrates that absolute PPP implies relative PPP, but not vice versa.

Problem 1.b

What matters for consumers is not nominal income, but real income or "purchasing power." Assume that consumers consume where they work. There are 2 choices: working in Canada or the US. These are the same as choice from the following 2 consumption choices.

(1) Working in Canada allows one to consume aw / Pc unit of Canadian consumption basket.
(2) Working in the US allows one to consume st / Pus unit of US consumption basket.

We can evaluate these 2 consumption choices using gross deviation from PPP or real exchange rate. (In fact, these two concepts are mathematically the same, although they have different meanings in economics.)

(i) Deviation from PPP: $Pus = (1+k) E Pc$,
where k is percentage deviation from PPP. Then,
$aw / Pc = aw (1+k) E / Pus$.
Taking the job in Canada is better off if and only if $aw (1+k) E > st$.

(ii) Real exchange rate: $q = Pus / E Pc$.
Then,
$aw / Pc = aw\ q\ E / Pus$.
Taking the job in Canada is better off if $aw\ q\ E > st$.

This is how we compare purchasing power of income in different countries.

Problem 1.c

The US dollar depreciated by 25 percent vis-à-vis the Euro over the past one year. (In fact, US$/Euro spot rate was 0.8613 on January 31, 2002, and 1.0785 on January 31, 2003, according to http://www.chartflow.com/host/ozforex/historybasic.asp. You can easily verify that the depreciation is indeed 25.22 percent.)

Does relative PPP hold?

Relative PPP predicts relationship of domestic inflation, foreign inflation and depreciation of home currency. The relevant data is a price measure for the U.S. and the Euro area. A widely used price measure is the Consumer Price Index (CPI). It is usually reported as annual percentage change, i.e. annual inflation rate.

(1) The U.S. CPI in January 2003 is 2.6 percent higher than last January (See http://www.bls.gov/news.release/pdf/cpi.pdf).

(2) The Euro area CPI in January 2003 is 2.1 percent higher than last January (See http://www.ecb.int/pub/pdf/mb200302en.pdf).

Relative PPP predicts that, annual depreciation of US$ must equal the gap of the U.S. and the Euro inflation rate. Therefore, annual depreciation of US$ = 2.6 – 2.1 percent = 0.5 percent. The realized appreciation is in fact 50 times of the predicted depreciation! This implies that relative PPP does not hold.

Can we do the same for absolute PPP?

No. The reason is that price measures (CPI, PPI and etc.) are reported as "indices." They do not have any currency unit. To be more precise, the index is computed by setting its value as 100 for the base year. Then inflation rate is reported as annual percentage change of the index. There is no good reason to believe that same indices imply that absolute PPP holds. In order to evaluate absolute PPP, we need to perform more complicated tasks. First, we have to make the commodity basket identical across countries. Second, we have to price each basket in terms of currency units. Then we will be able to compare price in different currency units using bilateral exchange rate.

Problem 2.a

I set maturity as 1 year. The data are current as of February 26, 2003. For money market rates, see http://www.marketprices.ft.com/markets/currencies/international. For forward rates, see http://www.ozforex.com.au/cgi-bin/forwardrates.asp.

(1) Euro 1-year interest rate is "2 7/16 to 2 5/16" percent.

(2) Swiss Franc 1-year interest rate is "19/32 to 1/2" percent.

(3) Euro/Swiss Franc spot rate is 1.436.

(4) Euro/Swiss Franc 1-year forward bid-rate is 1.435200, and ask-rate is 1.437960.

We can use the average of (1) and (2) and (4) as an approximation. Let the Euro area be home country, and Switzerland be foreign country. As usual, an asterisk denotes foreign variables.

What does covered interest parity (CIP) predict?

From (1) and (2), using average values, the resulting interest rates are as follows: i = 2.3750 and i^* = 0.5469. As a result, i-i^* = 1.8281. According to CIP, the "predicted forward discount" of Euro over Swiss Franc to be 1.8281 percent or 0.018.

What do we observe in the market?

We can compute the "realized forward discount" from (3) and (4). The average of numbers in (4) is 1.4366. Then, the realized forward discount = (1.4366/1.436) – 1 = 0.0004. Obviously CIP does hold in reality.

Problem 2.b

Uncovered interest parity (UIP): $i_t = i_t^* + e$

Uncovered interest parity states that expected return of two assets in a common currency unit must be equal. The LHS of the parity is the expected return of domestic asset, while the RHS is the expected return of foreign asset. In order to keep this parity, expected depreciation of home currency equals to the gap of nominal interest rates in different currencies. The UIP ignores the role of risk and liquidity, and treats two assets as perfect substitutes.

If the expected future exchange rate changes, investors will favor investing in the asset that gives a higher expected return, all else equal. As a result, spot rate will adjust instantaneously to restore equilibrium in asset markets. For example, if our expected future exchange rate rises (i.e. depreciates more), investors will prefer foreign to home asset. This results in depreciation of today spot rate.

In fact, the forward rate is the rate at which market expected return on the two assets are equal. If one's expected future spot rate is higher than the market forward rate, one's subjective expected return on a foreign asset is higher than that on a domestic asset. Hence one will bet on foreign asset if one's expected depreciation is higher than forward discount.

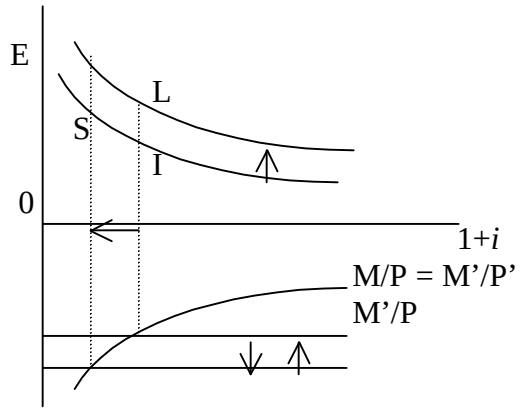
Problem 2.c

Suppose Euro is home currency and Swiss France is foreign current. A source tax on investment income in Euro area reduces expected return on a Euro asset by the size of tax expense. Hence, investors prefer a Swiss Franc asset to a Euro asset and the Euro must depreciate today, in order to reduce expected return of a Swiss Franc asset. The movement of exchange rate conforms the prediction of UIP, once we rewrite UIP as:

$$(1-t)\, i_t = i_t^* + e,$$

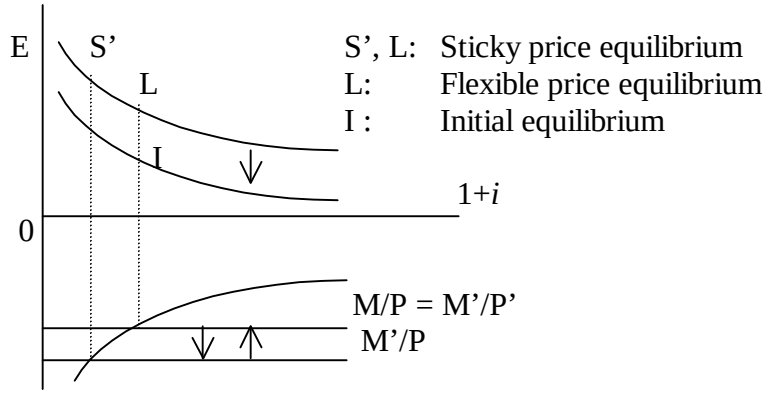
where t is the tax rate.

Problem 3.a



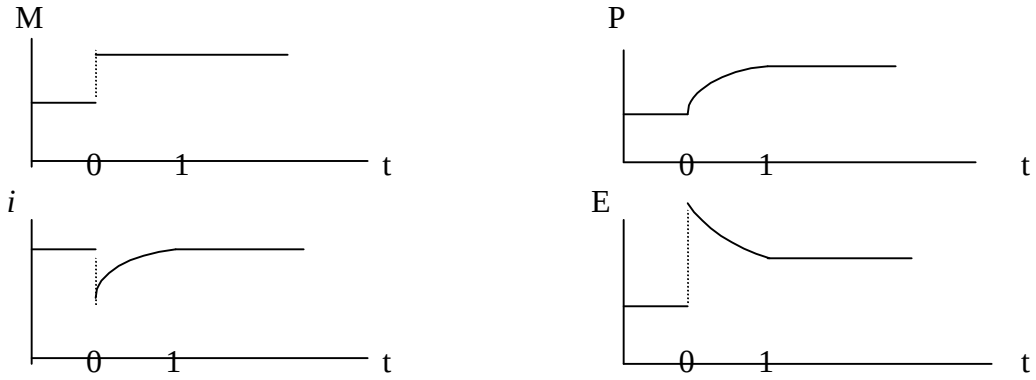
Assume flexible price in goods market. Let I denote the initial equilibrium. The diagram above explains interaction between 3 markets: Goods market, money markets and foreign exchange markets. When money supply increases from M to M', in the short run (before goods price adjusts), real money supply curve shifts downward. As a result, interest falls, but S is NOT the short run equilibrium. In the long run, price adjusts fully to P' and real money supply curve shifts back. Agents know that this will happen, so they expected depreciation. The change in expectation shifts the expected return curve upward. The long run equilibrium is the point L. Since we assume flexible price here, the economy jumps from I to L instantaneously.

Problem 3.b



The exchange rate overshoots because of "difference of speed of adjustment across markets." To be specific, price is sticky in goods market but adjusts instantaneously in financial markets (money markets and foreign exchange markets). Price in goods market will adjust slowly, therefore the economy first jumps to short run equilibrium S'. As price increases slowly, the economy moves along the new expected return curves to the point L. The difference between the short run and the long run equilibrium exchange rate is precisely the size of overshooting.

The diagrams below compare time paths resulting from an unanticipated permanent increase in domestic money supply. Time 0 is when money supply increases and also when it gets to the short run equilibrium. Time 1 is when it gets to the long run equilibrium.

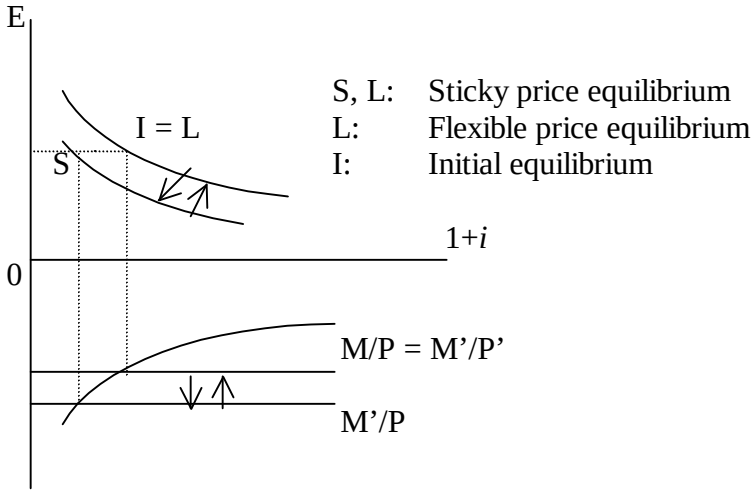


Problem 3.c

In the short run, a joint increase in money supply causes interest rates to fall in two money markets in the same magnitude. While the real money supply curve shift downward, the expected return curve shifts downward too. Then the exchange rate remains the same in the short run. This must be true because the interest rate gaps i-i^* does not change (Recall UIP). In the long run, price adjusts fully. Then interest rates rise back to their initial level. Both curves shifts back to where they were. Everybody knows that the long run exchange rate is the same as the initial level. Therefore they do not change expectation. (Recall that expectation depends on the long run exchange rate.) The shifts in the expected return curve are purely dye to movement in foreign interest rates. If we assume flexible price, the economy actually remains at the initial equilibrium I.

If we assume price-stickiness, there will be slow adjustment in price from S to L.

Therefore the interest rates rise slowly. The expected return curve and the real money supply curve simultaneously moves back to the initial location.



Here are the corresponding time paths.