Exercise Sheet 3 (Prices, Exchange Rates, Interest Rates)

Exercise 1

We often use the following approximations:

- Differences in logs are approximately equal to percentage differences. Suppose Y_{t+1} denotes GDP at time $t+1$ and Y_t denotes GDP at time t. Then, if the difference between the two is not too large, $\frac{Y_{t+1}-Y_t}{Y_t} \approx ln(Y_{t+1}) - ln(Y_t)$. (The growth rate of GDP is approximately equal to the log-difference in GDP).

- For any small number i it holds that $ln(1+i) \approx i$. For instance i could denote the nominal interest rate (e.g. $i = 0.03$ if nominal interest is at 3 percent).

a) Show that, for small i, $ln(1+i) \approx i$. Hint: Define a function $f(i) = ln(1+i)$ and make a first order Taylor approximation around $i = 0$. You can now easily verify for yourself that the two approximations discussed above are essentially the same thing.

b) Uncovered interest parity says that the expected return of investing in two currencies must be equal. Denote i_{CH} and i_{EUR} as the (one-year) nominal interest rates on CHF and Euro respectively. The current exchange rate, given in CHF per Euro, is denoted by E, and the expected exchange rate in one year by E^e.

Suppose you are a Swiss investor and you have 1 Swiss Franc available for investment.

- If you invest the Franc today in a CHF-investment, you will get $(1 + i_{CH})$ Francs in one year.

- Alternatively, you can invest in Euro. With one Franc, you can buy $\frac{1}{E}$ Euros, and you will get $\frac{1 + i_{EUR}}{E}$ Euros in one year. You then need to exchange them back into Francs. Your *expected* return expressed in CHF is thus $(1 + i_{EUR})\frac{E^e}{E}$.

Uncovered interest parity (UIP) says that $(1 + i_{CH}) = (1 + i_{EUR})\frac{E^e}{E}$ such that the expected return is equal for both currencies. This is the *exact* version of UIP. We usually use an *approximative* version that is very intuitive (this is the one in the lecture slides). It says that:

$$\underbrace{i_{CH} - i_{EUR}}_{\substack{\text{Difference in nominal interest} \\ \text{rate between CHF and EUR}}} = \underbrace{\frac{E^e - E}{E}}_{\substack{\text{Expected percentage} \\ \text{depreciation/appreciation} \\ \text{of CHF vis-à-vis Euro}}}$$

Using the two approximations given above, show that this version of UIP is approximately identical to the exact version of UIP.

c) Write down the exact version of covered interest parity. Define E as the spot exchange rate given in CHF per Euro, and F as the one-year forward rate given in CHF per Euro. Show that the exact version is approximately equal to the approximate version used in the slides: $i_{CH} - i_{EUR} = \frac{F - E}{E}$.

d) You have seen that the real exchange rate between CHF and USD equals

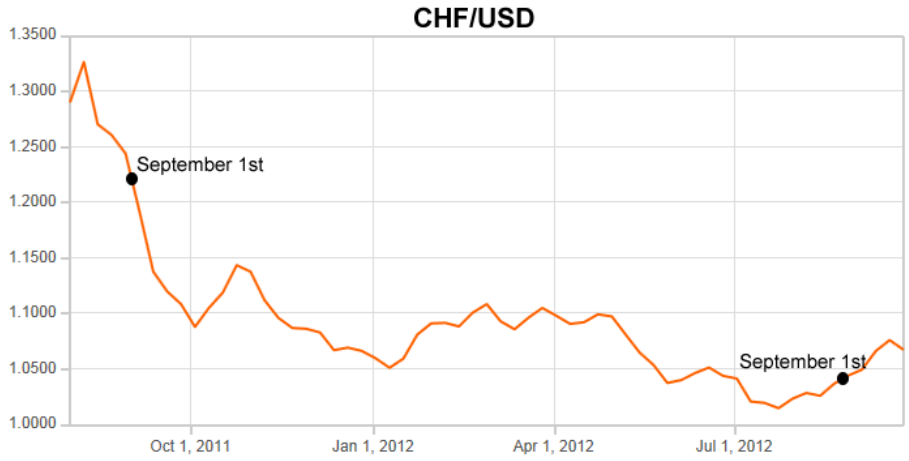
$$E_{real} = \frac{EP^{US}}{P^{CH}}$$

where E is the nominal exchange rate (given in CHF per USD) and P^{US} and P^{CH} denote the price levels in the US and Switzerland respectively. Using the approximations above show that the percentage-change in the real exchange rate $\left(\frac{E_{real,t+1} - E_{real,t}}{E_{real,t}}\right)$ can be computed by comparing the percentage-change in the nominal exchange rate with the difference in inflation between the two countries.

For the remaining exercise sheets, as well as the exam, you can always use either the exact or the approximative formulas. (In the solutions to the exercises the approximative formulas will be used, unless noted otherwise.)

Exercise 2

The following graph shows a fictional exchange rate between CHF and USD, given as CHF per USD, between August 1st 2011 and October 1st 2012. Suppose inflation in Switzerland between September 2011 and September 2012 was -0.41 %, while inflation in the U.S. in the same period was at 1.99%.



a) From just looking at the graph, do you think relative purchasing power parity (PPP) held between September 2011 and September 2012? Why/why not?

b) At September 1st 2011 the exchange rate was at 1.23 CHF per USD. If relative purchasing power parity holds, what should have been the exchange rate at September 1st 2012?

c) The exact exchange rate at September 1st 2012 was 1.04 CHF per USD. Was there a real appreciation or depreciation of the CHF vis-à-vis the USD? By how many percentage points? (Hint: Use your result from 1c))

d) Given the results above, can you say whether or not absolute PPP holds between Switzerland and the U.S.?

Exercise 3

Consider the same graph as in exercise 2. If not noted otherwise, interest rates are always stated in annual terms. We assume that covered interest parity *always* holds (which is realistic).

a) The exchange rate at September 1st 2012 is 1.04 CHF per USD. Suppose the expected exchange rate for September 1st 2013 is 0.99 CHF per USD. If uncovered interest parity holds, and the nominal interest on Swiss Francs is 1.05 %, what must be the nominal interest on US Dollar?

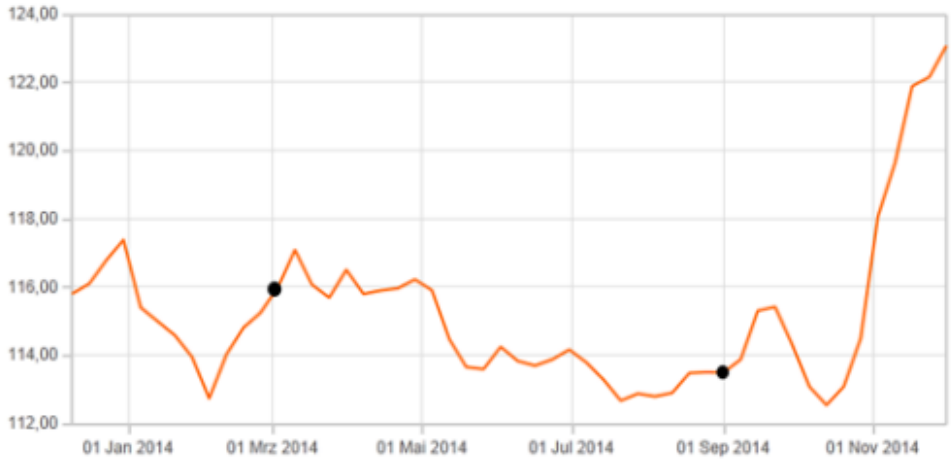
b) The exchange rate at September 1st 2011 was 1.23 CHF per USD. Suppose the nominal interest on Swiss Francs was 0.8% at September 2011 and the 12 months forward rate was 1.18 CHF per USD. What was the nominal (12-months) interest rate on USD in September 2011?

c) Starting from your result in b), what was the realized ex-post nominal return of investing in US Dollar for a Swiss investor who bought a USD bond in September 1st 2011, with maturity at September 1st 2012? Compare this to the realized ex-post nominal return on a bond in Swiss Francs. Note that the Swiss investor is only interested in the return in Swiss Francs.

d) What does your result in c) tell us about whether or not uncovered interest parity holds between USD and CHF?

Exercise 4

The following graph shows the exchange rate between CHF and Japanese Yen (JPY). The exchange rate is given as JPY per CHF. The exchange rate at March 1st was 116 JPY per CHF, at September 1st it was at 113 JPY per CHF.



a) Was there an appreciation or depreciation of the CHF vis-à-vis the Yen between March 1st and September 1st? By how many percentage-points?

b) The exchange rate between CHF and USD at March 1st was 0.9 CHF per USD. What was the exchange rate between USD and Yen at March 1st?

c) Suppose the 6-months forward rate at March 1st between CHF and Yen was at 120 Yen per CHF. Covered interest parity holds. Which currency had the higher effective ex-post return for an investment between March 1st and September 1st? Explain.

d) Inflation in Switzerland between March 1st and September 1st was at -0.5%. If relative purchasing power parity holds between Switzerland and Japan, what should

have been the inflation rate in Japan in the same period?

e) Suppose inflation in Japan was at 0% between March 1st and September 1st. Was there a real appreciation or a real depreciation of the Swiss Franc vis-à-vis the Yen?

Exercise 5

The following table shows (fictional) spot and forward rates for Swiss Francs, given as USD per SFR. Note that returns are usually given in annual units, no matter what the maturity date of the bond. Example: If the 6-months return of a bond with maturity in 6 months is 2%, the (approximate) annual return is 4%.

Spot	3 months	6 months	12 months
1.077	1.081	1.089	1.108

a) Suppose covered interest parity holds. Nominal return on bonds in Swiss Francs is 1% for all maturity dates. What is the nominal return on bonds denoted in US Dollars, maturing in 3 months, 6 months and 12 months respectively?

b) Now suppose nominal interest on 12-months Swiss bonds is at 2% and nominal interest on 12-months USD-bonds is at 3.5% (a violation of covered interest parity). Explain carefully how investors could make a riskless arbitrage profit in this case.

c) What can you say about the term structure of Swiss and US interest rates?

d) Comment on the following statement: If the forward rates equal the expected future spot rates, then if covered interest parity holds, this implies that uncovered

interest parity also holds.