Problem Set # 1

Answer Key

Answer the following questions. Show your work. As mentioned in class, you are encouraged to work in groups but must write your own answers.

1. **(Data query on exchange rates)** Download the exchange rate data for the following currencies against the US dollar (country currency per dollar): Canada, Mexico, China (i.e., FX Canada-US, México-US, China-US). You can find these data at the St. Louis Fed Federal Reserve Economics Database (FRED) database: https://fred.stlouisfed.org/. The data should be monthly and cover the January 1994-December 2021 period [1]

   (a) Compute the annual growth rates (depreciation rate) for each case. Report the standard deviation of each exchange rate. Report the correlation coefficient for each exchange rate pair (Canada-US vs. México-US, Canada-US vs. China-US, and México-US vs. China-US). [2]

Answer: The annual growth rates based on the 1994.1 to 2021.12 data are available from 1995.1.

The rate is computed as: $(\frac{E_{fcu/\$,t}}{E_{fcu/\$,t-12}} - 1) \times 100$. We use the rate from 12 periods before because our data is monthly and we want to compare this month's growth to the same month from the year before. We multiply times 100 to have a number we can read as a percentage.

Standard deviations: $stdev_{MXN/\$} = 19.19$, $stdev_{CAD/\$} = 7.72$, $stdev_{CNY/\$} = 3.44$

Correlations:
$cor(d_{MXN/\$}, d_{CAD/\$}) = 0.31$, $cor(d_{MXN/\$}, d_{CNY/\$}) = 0.068$, $cor(d_{CAD/\$}, d_{CNY/\$}) = 0.25$

Where $d_{a/b}$ is the depreciation of the a currency units per b exchange rate.

With monthly growth rates: if you wanted to do this analysis with growth rates you would use the formula $(\frac{E_{fcu/\$,t}}{E_{fcu/\$,t-1}} - 1) \times 100$ where t denotes the month-t information.

Standard deviations: $stdev_{MXN/\$} = 3.87$, $stdev_{CAD/\$} = 1.77$, $stdev_{CNY/\$} = 0.61$

[1] Be careful, the data is available in 3 frequencies in most cases, daily, monthly, annually, pick the monthly one. This is the link for one of the rates: https://fred.stlouisfed.org/series/EXCAUS

[2] Feel free to use any software for this, e.g., MS Excel or R. In MS Excel the functions for the standard deviation and correlation are `stdev(data)` and `correl(array1,array2)`. In R the functions are `sd()` and `cor()`

Correlations:

$cor(d_{MXN/\$}, d_{CAD/\$}) = 0.38$, $cor(d_{MXN/\$}, d_{CNY/\$}) = 0.13$, $cor(d_{CAD/\$}, d_{CNY/\$}) = 0.23$

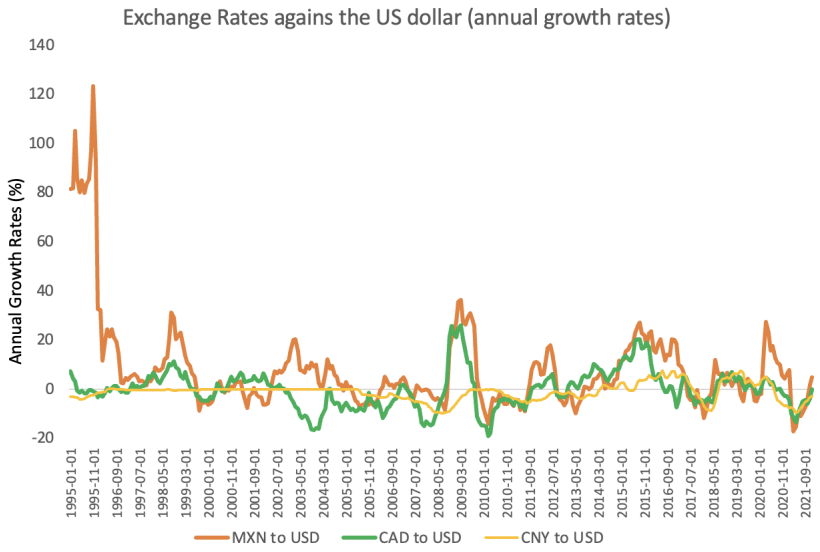
(b) Briefly, summarize the results you found in (a.). Why would the volatilities be different across rates? [Hint: think about the exchange rate regimes in these locations]

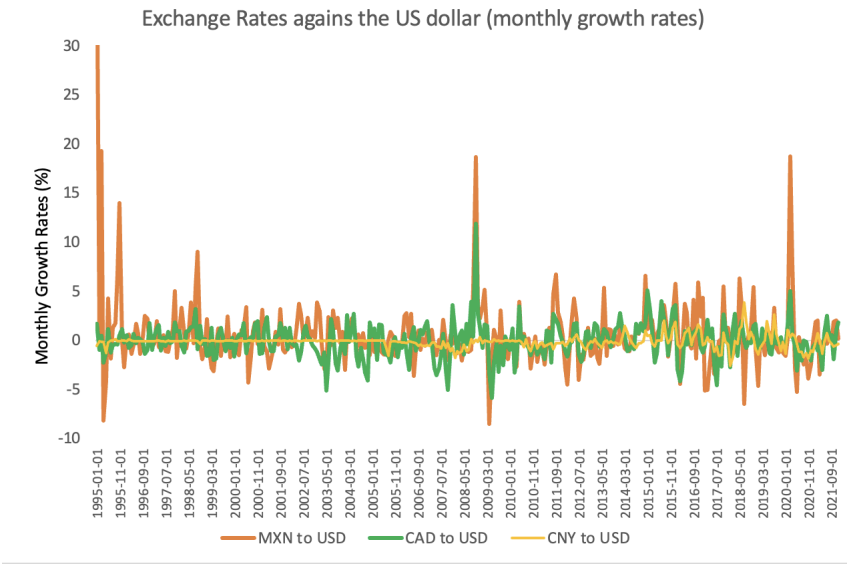
Answer: The exchange rates are all positively correlated. The correlation between the Mexican peso and the Chinese Yuan (or Renminbi) is relatively weak.

The Mexico-US or Canada-US rates are more volatile than the China-US one. This is because China implements a **fixed exchange rate regime** that stabilizes the value of its currency.

(c) Plot the depreciation rates you found in (a). Put the three in the same graph and include labels.

Answer:





Note: for full credits you only needed to report either one the plots. Similarly, you only needed to report your answers before with either type of growth (monthly or annual), not both.

Note: you will usually find the "country currency per dollar" rates. That is because each country's central bank publishes the exchange rate and they do it in the typical home per foreign currency units we saw in class. The only difference is that, from their perspective, the home currency is their currency and the foreign currency is the US dollar. Thus: (1) that's why the data you found in FRED is given in other currencies per dollar, (2) you can always get the dollar price per foreign currency by taking 1/X where X is the currency quoted in foreign currency per dollar.

2. **(Vehicle currencies)** Why would you be able to compute the China-México exchange rate from the data you used in (1)? provide the formula you would use.

Answer: We can compute the implied bilateral exchange rate between the Yuan (China) and the peso (México) if we have each rate with respect to the dollar. For that we use the following formula:

$$E_{CNY/MXN} = \frac{E_{\text{CNY}/\$}}{E_{\text{MXN}/\$}}$$

Or $E_{MXN/CNY} = \frac{E_{\$/\text{CNY}}}{E_{\$/\text{MXN}}}$ if we use the dollar per foreign currency rates.

Where MXN refers to the market label for Mexican pesos, CNY that of the Chinese Yuan, and $E_{a/b}$ to the exchange rate of a against the currency b (or the price of b in units of a).

Notice: the dollar units cancel out leaving only the conversion of Mexican pesos per Chinese Yuan.

3. **(CIP and UIP) - FT problem 6, chapter 13** Consider a Dutch investor with €1000 to place in a bank deposit in either the Netherlands or Great Britain. The 1-year interest rate on bank deposits in Britain is 2% and 4.04% in the Netherlands. The 1-year forward euro-pound is 1.575 euros per pound ($F_{€/£}$) and the spot rate is 1.5 euros per pound. Answer the following questions using the UIP and CIP (exact equations, not the approximations) as necessary:

   (a) What is the euro-denominated return on Dutch deposits for this investor?

   Answer: $i_€ = 4.04\%$

   (b) What is the (riskless) euro-denominated return on British deposits for this investor using a forward cover?

   Answer: we use one of the sides of the CIP to denote the return on British deposits (exchange the euros for pounds, wait a year for the returns, then exchange back to euros with the forward)

   $$\frac{F_{€/£}}{E_{€/£}}(1 + i_£) = \frac{1.575}{1.5}(1.02) = 1.071 \quad (1)$$

   The return is 7.1%

   (c) Is there an arbitrage opportunity here? explain why or why not. Is this an equilibrium in the forward exchange rate market?

   Answer: Yes, there is an opportunity. The return on depositing the euros in Britain is larger than that of the Netherlands ($7.1\% > 4.04\%$). Thus, this is not an equilibrium in the forward market. In equilibrium there is no arbitrage and investors are indifferent between the local or foreign deposits.

   (d) If the spot rate is 1.5 euros per pound, and the interest rates are as stated previously, what is the equilibrium forward rate, according to the CIP?

   Answer: $F_{\text{implied}} = (1 + 0.0404)\frac{1.5}{1.02} = 1.53$

   (e) Suppose the forward rate takes the value given by your answer to (d). Compute the forward premium on the British pound for the Dutch investor (where the exchange rates are in euros per pound). Is it positive or negative? Do investors require a premium/discount in equilibrium? if so, why?

   Answer:

   Premium = Return of investing on Britain − Return of investing on euros = $\frac{1.53}{1.5}(1.02) - 1.0404 = 0$

   With our assumptions here (that CIP is satisfied) which lead to $F_{€/£} = 1.53$ both yield the

same returns, i.e., there is no premium to either option in equilibrium. In this case the investors don't require a premium/discount for opting for the international asset.

(f) If the UIP holds, what is the expected depreciation of the euro (against the pound) over one year?

Answer: From the UIP (rearranging it) we have,

$$\frac{E^e_{€/£}}{E_{€/£}} = \frac{1+i_€}{1+i_£} = \frac{1.0404}{1.02} = 1.02$$

The pound is expected to appreciate 2% against the euro over a year.

For the euro: Remember the appreciation of a currency is not the same (in absolute value) as the depreciation of the other currency. We should obtain the appropriate currency to know by how much the euro depreciates. We first need to get $E^e_{€/£}$ and then flip it (also the spot rate). We can get the expected price of the pound from the formula above

$$E^e_{€/£} = E_{€/£}\frac{1+i_€}{1+i_£} = 1.5\frac{1.0404}{1.02} = 1.53$$

Now we can find the ER pounds per euro (or price of euro): (expected ER) $E^e_{£/€} = \frac{1}{E^e_{€/£}} = 0.653$ and (spot ER) $E_{£/€} = \frac{1}{E_{€/£}} = 0.666$

With this the depreciation of the euro is given by: $d_{£/€} = \frac{0.653}{0.666} - 1 = -0.019$.

That is, the euro is expected to depreciate 1.9% against the euro (almost the same in absolute value given the variations were close to zero)

4. **(Demand and Supply for foreign currency)** Indicate whether each of the following desired transactions would increase the demand for or the supply of foreign currency units (FCU) in the FX market and whether it would constitute upward (UP) or downward (DOWN) pressure on the price of the FCU (in USD terms) [Hint: The U.S. is the home country and demand and supply of FCU are relative to the USD]

Answer:

Desired transaction	Increased Demand or Supply of FCU	Pressure on Price of FCU (USD/FCU)
Example: UK firm, using GBP (pounds), imports software from US	Supply	Down
Belgian brewer, using EUR (euros), buys brewing equipment from US	Supply	Down
Canadian investors sell US stocks and repatriate proceeds to Canada (in CAD)	Demand	Up
Boeing, using USD, buys engines from Rolls Royce, which as a UK firm requires GBP	Demand	Up
French insurance company, using EUR, buys US Treasury bonds	Supply	Down
US share holders of UK firm receive dividend (in GBP) that they repatriate (to USD)	Supply	Down

5. **(Fixed Exchange Rate Regime: China (mainland))** Consider the USD/CNY FX market, where CNY is the Chinese currency, Yuan (also denoted RMB). Assume that China is operating a fixed exchange rate system. Suppose that there is an increase in Chinese exports to the US.

   (a) If the People's Bank of China (PBC), the Chinese central bank, wants the exchange rate to stay at its target level, how should it intervene in the FX market? (indicate which currency PBC buys and which it sells)

Answer: To maintain the exchange rate at its target rate, PBC should buy USD (and sell CNY or RMB).