Currency markets: Section 5 [1]

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[1] Subset of slides shared from Pasquale Della Corte.

Pset 3 review

1. $PPV = \frac{R \cdot (1-f_n)}{R \cdot (1-f_n) + f_p}$ $\qquad PPV = \frac{R \cdot (1-f_{fn})^4 \cdot f_p}{R_{pn} \cdot (1-f_n)^4 \cdot f_p + f_p}$

   a. $PPV = \frac{0.33 \cdot (1-0.05)}{0.33 \cdot (1-0.05)+0.05} \approx 0.86$

   b. $\mathbb{P}(\text{at least 1 false positive}) = 1 - (1 - f_{fp})^N$

$$\boxed{PPV = \frac{R_{pn} \cdot (1 - f_{fn}^5)}{R_{pn} \cdot (1 - f_{fn}^5) + 1 - (1 - f_{fp})^5} \approx 0.59}$$

3. B will exhibit the higher stock price impact. Its price impact will be 41% higher than that of stock A.
4. OppCost = \$ 50. ExecCost = \$3,950. 0.4% of original trade size.
5. Info. decay eqn & $Cov(h_1, h_2) = h_1^T \cdot V \cdot h_2$

   a. Key step: assume $E\left[\omega_Q^2(t - \Delta t)\right] = E\left[\omega_Q^2(t)\right] = \omega_Q^2$.

   b. Low tcost: $\delta = 0 \Rightarrow \psi = 1 \Rightarrow TC = 1$. High tcost: $\delta = 1 \Rightarrow \psi = 0 \Rightarrow TC = 0$. Low half-life: $HL = 0 \Rightarrow TC = \sqrt{1 - \delta^2}$.

6.

a. $\delta = 0.83, \psi = 0.65$

b. $\frac{1}{\tau_H} = \frac{\hat{\lambda}}{2\lambda} = 0.5$ years.
The result might imply that the amortization horizon equals the halflife. But then you look at the definition of the amortization halflife, and it is independent of γ! Here is the subtlety. You should pick Δt based on the halflife. So if the halflife is a day, you wouldn't rebalance once per year. And so, if for example you adjust Δt to be one-sixth the halflife (as specified in this problem), you tend to find that the amortization horizon is close to the halflife

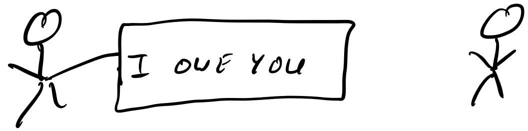
Pset 3 review

7. He is correct that the IR is what matters for value added. We are just not very certain that his IR is truly 1. After 1 year, this observation only has a t-statistic of 1.

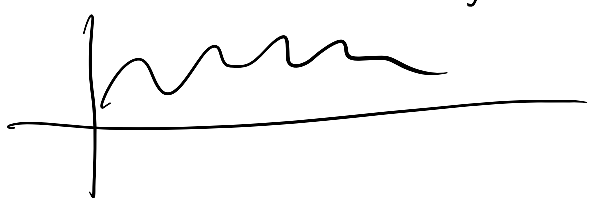
8. After 25 years, the standard error of the IR is $SE(IR) = \frac{1}{\sqrt{Y}} = \frac{1}{\sqrt{25}} = 0.2 \Rightarrow$ we are 95% confident that Jane's $IR > 0$. If Joe has a true $IR = 1$, his can provide higher value added. But we do not yet have much statistical confidence that his $IR = 1$.

9. Defining the information ratio as a monthly number, the shrinkage in standard error is exactly matched by the shrinkage in the magnitude of the IR numbers.

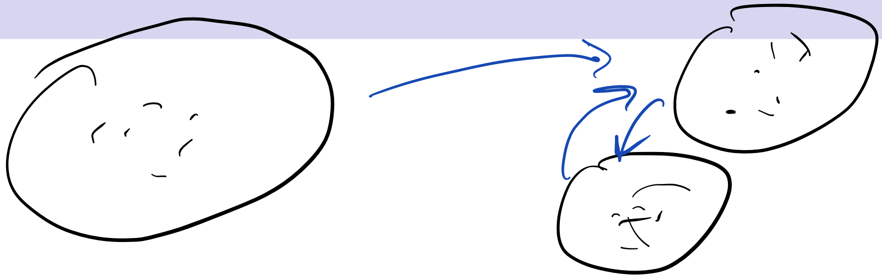
Currencies



- A country's currency is basically a note or an "IOU" backed by something designated by the country.
- This note/"IOU" is recognized by everyone and is transferable.
- This something could be backed by a ~~material~~ (gold), another currency (USD), or a complicated strategy resulting from market forces and central bank policies.
- It represents purchasing power. We use it to buy stuff.
- This value can fluctuate.



Terminology



- Domestic currency is the *quote* currency.
- Foreign currency is the *base* currency.
- Market convention: exchange rate quotes as quote currency per base currency

EUR USD

$$\underbrace{BBB}_{\text{base}}\ \underbrace{QQQ}_{\text{quote}}$$

Terminology

"How many units of domestic currency per 1 unit of foreign currency?"

- Direct terms: $\$/*$
- Indirect terms: $*/\$$
- When direct quotation of the exchange rate $\uparrow$,
    - Foreign currency *appreciates*
    - Domestic currency *depreciates*

$\$1/€1$

$\downarrow$

$\$2/€1$

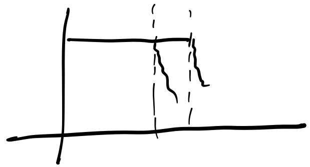
Bilateral vs. cross-exchange rate

Floating

Fixed - pegged

$ / ¥

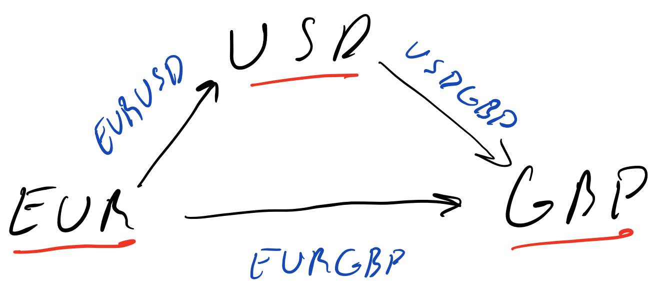
$10/¥



t=0 t=1 t=2

EURUSD

- Bilateral
  - currencies quotes against USD or EUR, GBP, JPY.
- Cross-exchange rate
  - exchange rates between non-USD currencies (for us).
  - EURGBP, EURJPY, GBPJPY, EURCHF



△ Arbitrage

Bid-ask spread

EUR USD

- Counterparty buys base at the ask.
- Counterparty sells base at the bid.
- Consider a dealer's $/* bid-ask quote:

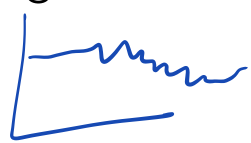
$$\$\underbrace{1.3153}_{\substack{\text{dealer}\\\text{willing}\\\text{to buy}}}-\$\underbrace{1.3158}_{\substack{\text{dealer}\\\text{willing}\\\text{to sell}}}$$

- Often use midrates – average of bid-ask

Forward rates

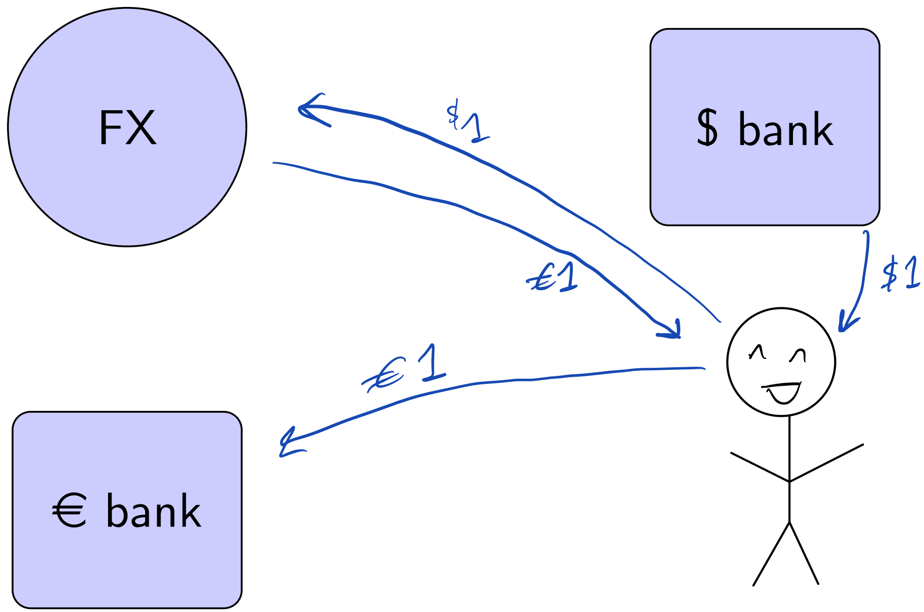
$t = 0$ $t = 1$

- Commit today to swap currencies at specified time in the future at a rate agreed upon today.
- This is a contract.
- Example:
  - EURUSD exchange (spot) rate ≈ 1.1953. Spring 2021
    - Exchange €1 today yields $1.1953.
  - EURUSD 1-year forward rate/contract ≈ 1.2050. Spring 2022
    - Exchange € for $ at $1.2050/euro in 1 year.
    - vs. exchange € for $ at future spot in 1 year.
- Note: A company buying/selling international goods may prefer to use forward contracts, instead of swapping currencies at future spot rates to reduce exchange rate risk.



Investing with forward markets

- Assume F_1 $F_{0,1}$ $= S_0 = 1$, $i_\$ = 2\%$, and $i_€ = 3\%$.
- Borrow \$1 at $i_\$$ 1-year rate (you owe \$1.02 in a year).
- Exchange \$ at S_0 for €1.
- Set up a forward contract to exchange €1.03 at F_1 for \$1.03 in a year.
- Invest €1 at $i_€$ (you receive €1.03 in a year).[2]



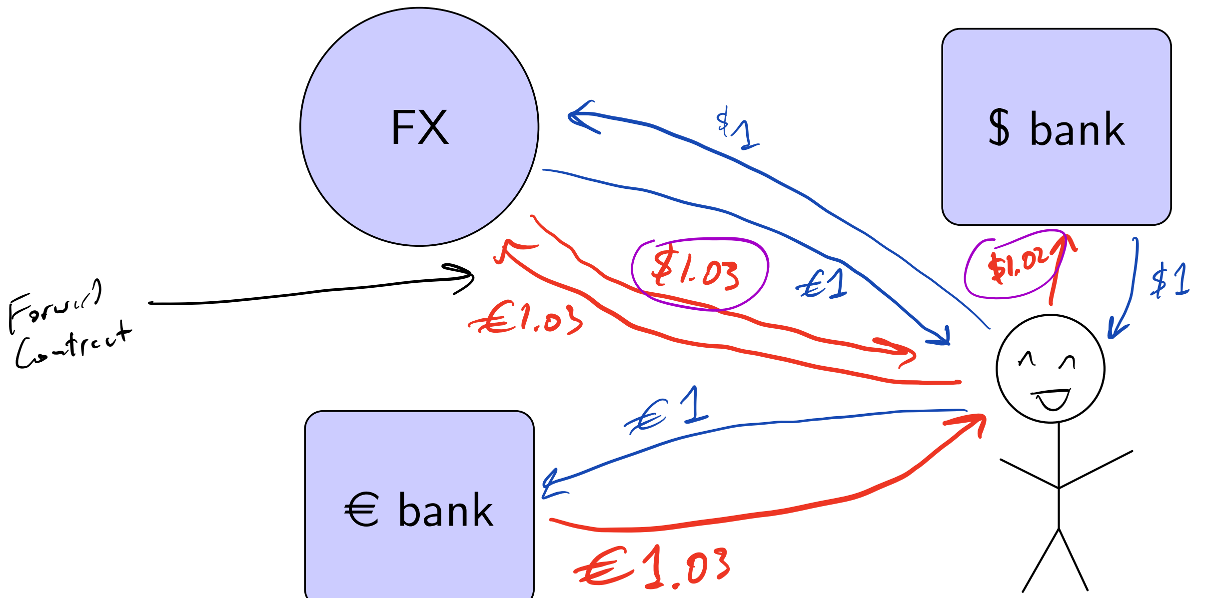
[2] notice all of your actions occur at time 0

Investing with forward markets

Forward market investing

- After a year passes, you earn €1.03, exchange €1.03 for \$1.03 (since $F_1 = 1$), and pay off your debt of \$1.02.
- Cool you earned \$0.01 ☺

1.03 − 1.02 = \$0.01



Arbitrage Opportunity

This is an Example of Covered Interest Arbitrage

Covered Interest Parity (CIP) Condition

$$(1 + i_\$) = \frac{F}{S}(1 + i_*)$$

$-(1 + i_*) \quad -(1 + i_*)$

$\Rightarrow i_\$ - i_* = \frac{F}{S}(1+i_*) - \frac{S}{S}(1+i_*)$

$= \frac{F-S}{S}(1+i_*)$

- Interest rate difference should equal the difference between forward and spot exchange rates.
- $F_{0,1}$ = Today's 1-period forward rate in \$/*.
- Approximate version: $i_\$ - i_* = \frac{F_{0,1} - S_0}{S_0}(1 + i_*) \approx \frac{F_{0,1} - S_0}{S_0}$.
- % forward discount on the \$ is approximately $\frac{F_{0,1} - S_0}{S_0}$.
    - If $> 0 \Rightarrow$ \$ at forward discount.
    - If $< 0 \Rightarrow$ \$ at forward premium.
- This is an arbitrage condition. Why?

Covered Interest Parity (CIP)

What if

$$(1 + i_{\$}) > \frac{F}{S}(1 + i_{£})$$

would you be better off investing in the US or in UK? US

Covered Interest Parity (CIP)

$1 + i_\$ = \frac{F}{S}(1 + i_*)$

- When CIP holds (ignoring any adjustments),

insert algebra here

$$B_t = \overbrace{i_t^{\$}}^{\substack{\text{cash}\\ \text{rate}}} - \underbrace{\left[\frac{F_t}{S_t}(1 + i_t^*) - 1\right]}_{\substack{\text{synthetic}\\ \text{cash rate}}} = 0$$

$X_{t,t+\tau}$

$+ \tau$

- B_t is the cross-currency basis
- When CIP holds (with adjustments),

$$B_{t,t+\tau} = \frac{1}{\tau}\left[\left(1 + i_{t,t+\tau}^{\$}\right) - \frac{F_{t,t+\tau}}{S_t}\left(1 + i_{t,t+\tau}^*\right)\right] = 0$$

- τ is the adjustment factor measured as $\frac{1}{100} \cdot \frac{\text{days}}{\text{basis}}$.

Swap transactions

- Forward (FX) swap
  - Dealer/player makes a spot transaction against a forward transaction.
  - Quoted in forward or swap points.
  - Reduce currency exposures from a forward trade.
- Buy-and-sell FX swap
  - Buy the base currency and simultaneously sell it forward against the quote currency.
- Sell-and-buy FX swap
  - Sell the base currency and simultaneously buy it forward against the quote currency.

Swap transactions

Pricing of a buy-and-sell FX swap

$$
\begin{aligned}
\text{Swap points} &= (F_t - S_t) \cdot 10,000 \\
&= S_t \cdot \frac{\left(i^{\$}_{t,T} - i^{€}_{i,T}\right) \cdot \tau}{1 + i^{€}_{t,T} \cdot \tau} \cdot 10,000 \\
&\approx S_t \cdot \underbrace{\left(i^{\$}_{t,T} - i^{€}_{i,T}\right)}_{\substack{\text{interest rate} \\ \text{differential}}} \cdot \tau \cdot 10,000 \\
&\propto i^{\$}_{t,T} - i^{€}_{i,T}
\end{aligned}
$$

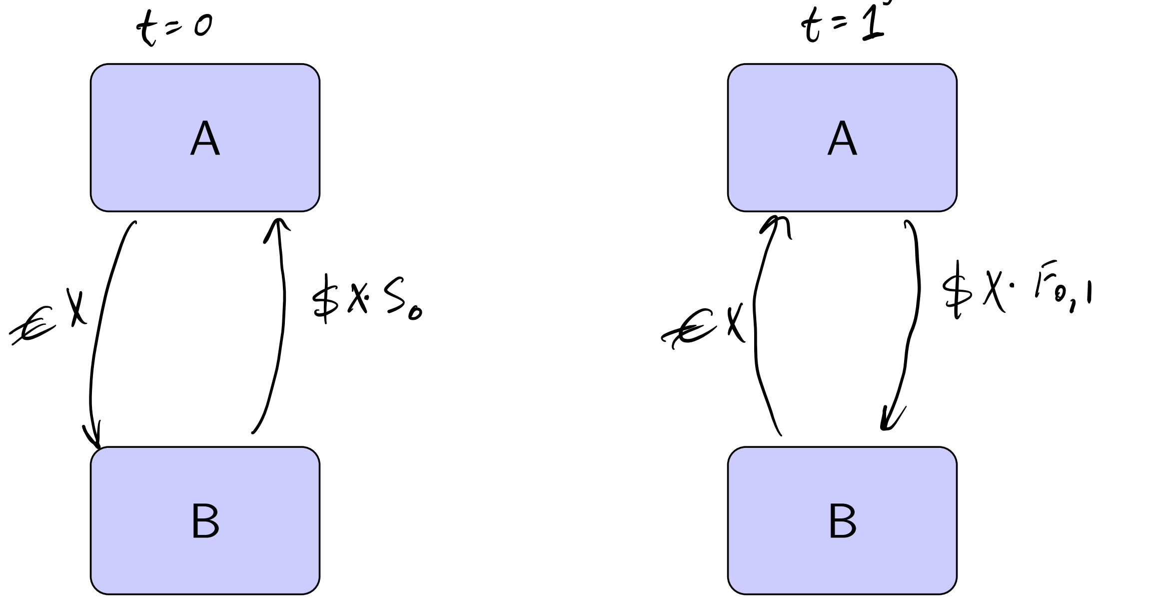
s.t. $\tau = \frac{\text{number calendar days}}{365}$.

Swap transactions

Consider two banks that enter a EURUSD FX swap

- Bank A sells € and buys \$ from bank B at the spot rate at $t = 0$.
- Bank A enters a contract and buys € and sells \$ from bank B at the forward rate at $t = 1$.
- The amount traded is X units of the base currency.

Interbank 50% transactions in FX



Currency swaps

- Currency swap
  - Two parties exchange streams of interest payments in different currencies over a given period and exchange principal amounts in different currencies at a *pre-agreed* exchange rate at maturity.
- Cross-currency basis swap
  - The floating-for-floating currency swap.
  - Most common. Usually 3-month deposit rate in the corresponding currency.
  - Example with EURUSD
    - An investor might pay 3-month USD LIBOR and receive 3-month EUR LIBOR plus a spread.
- This is follows a bond-like structure.

Currency swaps

- $t = 0$: Bank A borrows $\$X \cdot S_0$ and lends €X to bank B, where S_0 is the spot rate at time 0.
- $t \in \{1, 2, 3\}$: Bank A receives 3-month EUR LIBOR $+\alpha$ and pays 3-month USD LIBOR, where α is the basis swap set at time 0.
- $t = 4$: Bank A returns $\$X \cdot S_0$ and receives €X from bank B.