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Homework #1: Interest rates, bonds and FX

FE-620

Due 8 February 2026

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Problem 1.1

Assume that the spot price of gold is \$5,050 per ounce. Suppose that the market quotes a forward contract on gold with delivery in 1 year at \$5,200.00 The risk-free interest rate is $r = 3.5\%$.

i) Is there an arbitrage opportunity? If yes, describe the steps required to realize the arbitrage. What is the profit we can expect to make?

ii) Consider now the case when the forward price is \$5,300.00. Is there an arbitrage opportunity? If yes, describe the steps required to realize the arbitrage.

i) Givens:

$S_0 = \$5{,}050$

$T = 1$ (year)

$r = 3.5\%$ (0.035)

$S_0(1+r) = 5050(1+0.035) = \$5{,}226.75 > \$5{,}200$

For arbitrage:

- Sell 1oz gold at $S_0 = \$5{,}050$
- Invest \$5050 @ $r = 3.5\%$ for $T = 1$yr.
- Enter a forward contract to buy gold in $T = 1$yr @ \$5,200

Arbitrage Profit =

\$5226.75 - \$5200 = \$26.75/oz

the forward price is overvalued

ii) Now that the asset is theoretically overvalued (\$5,300 > \$5,226.75):

For arbitrage:

- Borrow \$5,050 @ $r = 3.5\%$.
- Buy 1oz gold @ $S_0 = \$5{,}050$
- Enter a forward contract to sell gold in $T = 1$yr @ \$5,300

Arbitrage Profit =

\$5300 - \$5226.75 = \$73.25/oz

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Problem 1.2

Assume that an interest rate is quoted as 3.25% with semi-annual compounding. What is the rate when expressed with:

i) annual compounding.

ii) quarterly compounding?

iii) continuous compounding.

i) $(1+R_1)^1 = \left(1+\frac{0.0325}{2}\right)^2$

$1+R_1 = (1.01625)^2$

$1+R_1 \approx 1.032764$

$R_1 = 3.276\%$

correct

ii) $\left(1+\frac{R_4}{4}\right)^4 = (1.01625)^2$

$1+\frac{R_4}{4} = \sqrt{1.01625}$

$1+\frac{R_4}{4} \approx 1.00809$

$R_4 \approx \frac{0.00809}{4}$

$R_4 \approx 3.23168\%$

correct

iii) $e^{R_c} = (1+0.01625)^2$

$R_c = 2\ln(1.01625)$

$R_c = 0.0322238$

$R_c = 3.22238\%$

correct

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Problem 1.3

Credit card companies quote the APR on the outstanding balance. APR means Annual Percentage Rate and is the interest rate with annualized compounding. Typical APRs are shown in the Table below. However, credit card interest rate is compounded *daily*, for 365 days a year.

Suppose the balance on a credit card is \$10,000. Compute the total balance including interest after 30 days, if the customer has Excellent Credit?

Givens:

- $P = \$10{,}000$
- Excellent Credit APR = 17.15%
- $t = 30$ (days)
- Daily compounding

$r_{daily} = 0.1715 / 365 \approx 0.000469863$ this is not the exactly correct daily ra

$A = P(1+r)^n = 10{,}000(1.000469863)^{30} \approx \$10{,}141.94$

Total Interest = \$141.94

Table 1: Current Credit Card Interest Rates. As of Sep 8 2025, from `https://wallethub.com/edu/cc/current-credit-card-interest-rates/128285`.

Category	Interest Rate
Excellent Credit	17.15%
Good Credit	23.33%
Fair Credit	26.55%
Student Credit Cards	19.04%

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We are given the zero rates $R(T)$ for several maturities in Table 2. These zero rates apply for all maturities in the ranges shown.

1) Price a bond B_1 with annual coupon 5.0% paid twice a year with maturity 2Y.

2) Price a bond B_2 with annual coupon 6.0% paid twice a year, with maturity 10Y.

3) Compute the bond yields of the two bonds in points 1) and 2).

1) @ T=0.5 ; \$2.50 discounted @ 3%.
@ T=1 ; \$2.50 discounted @ 3%.
@ T=1.5 ; \$2.50 discounted @ 3.5%.
@ T=2 ; \$102.50 discounted @ 3.5%.

Price of $B_1 = 2.5e^{-0.03(0.5)} + 2.5^{-0.03} + 2.5^{-0.035(1.5)} + 102.5^{-0.035(2)}$
$= \$102.8324$ correct

2) Price of $B_2 = \sum_{t=1}^{2} 3e^{-0.03(0.5t)} + \sum_{t=3}^{4} 3e^{-0.035(0.5t)} + \sum_{t=5}^{9} 3e^{-0.0425(0.5t)} + \sum_{t=10}^{19} 3e^{-0.045(0.5t)} + 103e^{-0.045(10)}$

$= 5.687 + 5.597 + 12.551 + 21.436 + 65.676 \approx \$111.13$ slightly off. should be 111.843

3) B_1: $102.8324 = 2.5e^{-x_1(0.5)} + 2.5^{-x_1} + 2.5^{-x_1(1.5)} + 102.5^{-x_1(2)} \Rightarrow x_1 \approx 3.48\%$ slightly off should be 3.491%

B_2: $111.127 = \sum_{t=1}^{19} 3e^{-x_2(0.5t)} + 103e^{-x_2(10)} \Rightarrow x_2 \approx 4.49\%$ I get 4.465%

Small numerical errors, must be due to truncation to 3 digit:

Math is correct

Table 2: Data for Problem 1.4.

T	$R(T)$
[0,1Y]	3.00%
(1Y,2Y]	3.50%
(2Y,5Y]	4.25%
(5Y,10Y]	4.50%

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Problem 1.5

A US company is due to make a payment of 1.0m Euros in 6 months. They plan to hedge this payment by taking a long position in a forward contract for 1.0m Euros with maturity 6 months, at a forward exchange rate 1.150. The current EUR/USD rate is $X_0 = 1.100$, and the actual exchange rate realized at maturity is $X(6M) = 1.175$.

i) What is the gain or loss of the company at maturity?

ii) What is the interest rate differential $r_{USD} - r_{EUR}$ for maturity $6M$ implied by the quoted forward FX rate?

i) Givens:

$F = 1.15 (USD/EUR)$

$X_T = 1.175 (USD/EUR)$

Gain/Loss $= 1{,}000{,}000(1.175 - 1.15) = \$25{,}000$ correct

ii) $F = X_0 e^{(r_{USD} - r_{EUR})T}$; $T = 0.5$ (years)

$1.15 = 1.1 e^{(r_{USD} - r_{EUR})0.5}$

$1.04545 = e^{(r_{USD} - r_{EUR})0.5}$

$\ln(1.04545) = (r_{USD} - r_{EUR})0.5$

$(r_{USD} - r_{EUR}) = 0.04445 \cdot 2 = 0.0889$

$(r_{USD} - r_{EUR}) = 8.89\%$ correct