

Homework #1: Interest rates, bonds and FX

FE-620

Due 8 February 2026

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.

$$i) F_0 = S_0 e^{rt}, 5,050 e^{0.035} = 5,229.88/\text{oz.}$$

Yes, Arbitrage opportunity exists.

Forward is Underpriced, reverse cash & carry

Short gold today @ \$5,050/oz. \rightarrow receive cash \rightarrow invest in risk-free (3.5%)

Enter long forward contract to buy gold in 1-year @ \$5,200/oz.

In 1-Year, You have \$5,229.88/oz. cash to cover the \$5,200/oz. forward contract and return the gold initially shorted. profit \$29.88/oz.

ii) Cash & carry

Borrow cash @ risk free rate, buy gold at spot

Enter short forward to sell gold in 1-year @ \$5,300/oz.

In 1-Year deliver gold for \$5,300/oz. and repay \$5,229.88/oz.
Prof. + \$70.12/oz

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.

$$\text{i)} \quad 1 + R_1 = \left(1 + \frac{R_2}{2}\right)^2 = 1.032764$$

$$R_1 = 0.032764 = 3.2764\%$$

$$\text{ii)} \quad \left(1 + \frac{R_4}{4}\right)^4 = \left(1 + \frac{R_2}{2}\right)^2, \quad R_4 = 4 \left[\left(1 + \frac{R_2}{2}\right)^2 \right]^{1/4} - 1 = 0.032369$$

$$R_4 = 0.032369 = 3.2369\%$$

$$\text{iii)} \quad e^{R_c} = \left(1 + \frac{R_2}{2}\right)^2, \quad R_c = \ln \left(\left(1 + \frac{R_2}{2}\right)^2 \right) = 2 \ln \left(1 + \frac{R_2}{2}\right) = 0.032239 = 3.2239\%$$

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?

$$r_d = \frac{APR}{365} = \frac{17.15\%}{365}$$
$$r_d = 0.000469863$$

$$B_{30} = B_0 (1 + r_d)^{30} = 10,000 (1.000469863)^{30} = 10,141.92$$

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%

Problem 1.4

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).

$$1) B_1 = 2.5e^{-0.03(0.5)} + 2.5e^{-0.03(1)} + 2.5e^{-0.035(1.5)} + 102.5e^{-0.035(2)} = 102.83$$

$$2) B_2 = 3e^{-0.03(0.5)} + 3e^{-0.03(1)} + 3e^{-0.035(1.5)} + 3e^{-0.035(2)} + 3e^{-0.0425(2.5)} + \\ 3e^{-0.0425(3)} + 3e^{-0.0425(3.5)} + 3e^{-0.0425(4)} + 3e^{-0.0425(4.5)} + 3e^{-0.0425(5)} + \\ 3e^{-0.045(5.5)} + 3e^{-0.045(6)} + 3e^{-0.045(6.5)} + 3e^{-0.045(7)} + 3e^{-0.045(7.5)} + \\ 3e^{-0.045(8)} + 3e^{-0.045(8.5)} + 3e^{-0.045(9)} + 3e^{-0.045(9.5)} + 3e^{-0.045(10)}$$

$$B_2 = 111.84$$

$$3) 102.83 = 2.5e^{-0.5y} + 2.5e^{-1y} + 2.5e^{-1.5y} + 102e^{-2y}, y_1 = 0.034908 = 3.4908\%$$

$$111.84 = \sum_{k=1}^{19} 3e^{-4(0.5k)} + 103e^{-10y}, y_2 = 0.04465 = 4.465\%$$

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%

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?

$$i) 1,000,000 (1.175 - 1.15) = 25,000 \text{ gain}$$

$$ii) F_0 = X_0 e^{(r_{USD} - r_{EUR})T}, r_{USD} - r_{EUR} = \frac{1}{T} \ln\left(\frac{F_0}{X_0}\right), T = 0.5, F_0 = 1.150, X_0 = 1.100$$
$$r_{USD} - r_{EUR} = \frac{1}{0.5} \ln\left(\frac{1.15}{1.10}\right) = 2 \ln(1.045) = 0.0889 = 8.89\%$$