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FE 620

Pricing and Hedging

Homework 1: Interest Rates, Bonds, FX

1.1

i)	Forward Price (F_0)	?
	spot price (S_0)	$ 5,050.00
	Market Quoted Forward Price (F_m)	$ 5,200.00
	risk free interest rate (r)	3.50%
	time in years (T)	1
	F_0 = S_0*EXP(rT)	$ 5,229.88

i) There is no arbitrage here. The price of the forward today is cheaper than the spot + carry trade. There is no profit that can be made if you decided to short sell gold today and purchase a forward because $5200 < $5229.88. Essentially, buying gold in the future is cheaper than buying gold today and financing it at the risk free rate.

ii) If the Forward Price was $5300 instead, then there would be an arbitrage profit to be made. You would be able to short the forward contract, borrow $5050 at the risk free rate, and buy the gold at it's spot price of $5050. This way, once the forward contract expires you will receive your $5300

1.2

	Semi Annual Compounding Interest Rate (R)	3.25%
	Effective Annual Rate EAR = (1 +R^m/m)^m, where m = number of compounding periods	3.2764%
i)	**Annual Compounding** m=1, equal to the EAR	3.2764%
ii)	**Quarterly Compounding** m = 4, and 1 + (R^4)/4)^4 = 1 + EAR, rearranging and solving for R^4 >>> R^4 = 4 (((1 + EAR)^(1/4)) - 1)	3.2369%
iii)	**Continuous Compounding** solving for r_c, and exp^r_c = 1 + EAR, rearranging and solving for r_c >>> r_c = ln(1+EAR)	3.2239%

i) The annually compounded rate equals the effective annual rate because both represent the total growth of money over one year with interest applied once per year.

ii) The quarterly-compounded rate is lower than the semiannual quoted rate because interest is applied more frequently, and it is chosen so that quarterly compounding produces the same effective annual growth as the EAR.

iii) The continuously compounded rate is obtained by taking the natural logarithm of one plus the EAR so that continuous compounding generates the same one-year growth as discrete compounding.

1.3

APR is an annual rate, but the credit card adds interest every day. Therefore, every day interest accumulated by:

$$1 + (APR / 365 \text{ Days } (1 \text{ Year}))$$

And the daily rate is (APR / 365 Days (1 Year).

Excellent Credit APR (from table)	17.15%
Days	30
Balance	$ 10,000.00
Days in a Year	365
Daily Rate = APR / Days = 17.15% / 365	0.04699%
Total Balance After 30 Days = 10,000 (1 + .0004699)^30	$ 10,141.92

The chart above represents the total balance, **$10,141.92**, including interest after 30 days if the customer has excellent credit.

1.4

Question 4				
B1				
Time in Years (T)	**Cash Flow (CF)**	**Zero Rate (R(T))**	**Discount Factor (D)**	**PV**
0.5	2.5	3.00%	0.98511194	2.46278
1	2.5	3.00%	0.970445534	2.426114
1.5	2.5	3.50%	0.948854321	2.372136
2	102.5	3.50%	0.93239382	95.57037

Price_B1 = ΣCF*exp (-R(T)*(T)) =	**102.831396**

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

$$P = \sum_{i=1}^{n} \frac{CF_i}{(1+\frac{y}{2})^i}$$

Yield B1	**3.5214%**
Yield B2	**4.5152%**

B2				
Time in Years (T)	**Cash Flow (CF)**	**Zero Rate (R(T))**	**Discount Factor (D)**	**PV**
0.5	3	3.00%	0.98511194	2.955336
1	3	3.00%	0.970445534	2.911337
1.5	3	3.50%	0.948854321	2.846563
2	3	3.50%	0.93239382	2.797181
2.5	3	4.25%	0.89919982	2.697599
3	3	4.25%	0.880293416	2.64088
3.5	3	4.25%	0.861784534	2.585354
4	3	4.25%	0.843664817	2.530994
4.5	3	4.25%	0.825926081	2.477778
5	3	4.25%	0.808560316	2.425681
5.5	3	4.50%	0.780750221	2.342251
6	3	4.50%	0.763379494	2.290138
6.5	3	4.50%	0.746395245	2.239186
7	3	4.50%	0.729788874	2.189367
7.5	3	4.50%	0.713551975	2.140656
8	3	4.50%	0.697676326	2.093029
8.5	3	4.50%	0.682153891	2.046462
9	3	4.50%	0.666976811	2.00093
9.5	3	4.50%	0.652137402	1.956412
10	103	4.50%	0.637628152	65.6757

Price_B2 = ΣCF*exp (-R(T)*(T)) =	**111.8428341**

i) Bond B1 is priced by discounting each semiannual cash flow at the zero rate that applies to its maturity, then summing all present values. This gives a fair price of **102.8314** shown in the blue box in the figure above.

ii) Bond B2 is priced the same way: each coupon and the final principal payment are discounted using the corresponding zero-rate "bucket" for that payment date, and all PVs are summed. This gives a fair price of **111.8428** shown in the green box in the figure above.

iii)

The yield to maturity for each bond is the single semiannually compounded rate that makes the present value of its cash flows equal to the bond's price found in parts one and two. Solving for yield of B1 and B2 gives us **3.5214%** and **4.5152%** respectively, shown in the small table on the right hand side of the figure.

1.5

	Notional (Q)	$ 1,000,000.00	
	Spot Rate (S_0)	1.100	
	Forward Rate (F_0)	1.150	
	Spot at Maturity (S_t)	1.175	
	Time to Maturity (t)	0.5	
i)	Payoff = (S_t - F_0) * Q =	(1.175 - 1.150) * $1000000 =	$ 25,000.00
ii)	F_0 = S_0 * exp(r_usd - r_euro)*t =	(1.100) * (e^r_usd - r_euro)*(0.5) rearranging to solve for rate differential: (r_usd - r_euro) = (1/t) * ln(F_0/S_0)	8.8904%

i) The gain on the forward hedge is calculated as the difference between the spot exchange rate at maturity and the forward rate, multiplied by the euro notional. In this example we see a $25,000 gain.

ii) The interest rate differential is implied using covered interest parity under continuous compounding by solving for the rate difference that equates the spot and forward exchange rates over the six-month horizon. In this example the interest rate differential is 8.8904%.