

homework1_solution

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Quantitative Finance: Homework 1 Solution

Ruoxuan Xiong

Problem 1

Lanni Products is a start-up computer software development firm. It currently owns computer equipment worth \$30,000 and has cash on hand of \$20,000 contributed by Lanni's owners. For each of the following transactions, identify the real and/or financial assets that trade hands. Are any financial assets created or destroyed in the transaction?

- (a) Lanni takes out a bank loan. It receives \$50,000 in cash and signs a note promising to pay back the loan over 3 years.

Suggested solution.

The bank loan \$50,000 is the financial asset. The financial asset is created in this transaction.

- (b) Lanni uses the cash from the bank plus \$20,000 of its own funds to finance the development of new financial planning software.

Suggested solution.

Both the cash from the bank and \$20,000 of its own funds are financial assets. The new financial planning software is the real asset. In this transaction, the financial asset is destroyed, while the real asset is created.

- (c) Lanni sells the software product to Microsoft, which will market it to the public under the Microsoft name. Lanni accepts payment in the form of 1,250 shares of Microsoft stock.

Suggested solution.

The software is the real asset. The 1,250 shares of Microsoft stock are the financial assets. In this transaction, the real asset is destroyed, while the financial asset is created.

- (d) Lanni sells the shares of stock for \$100 per share and uses part of the proceeds to pay off the bank loan.

Suggested solution.

Both the shares of stock and bank loan are financial assets. In this transaction, financial asset is destroyed.

Problem 2

Find the equivalent taxable yield of a short-term municipal bond with a yield of 3% for tax brackets of

- (a) zero

Suggested solution.

$$r_{taxable} = \frac{r_{muni}}{1-t} = \frac{0.03}{1-0} = 0.03$$

(b) 10%

Suggested solution.

$$r_{taxable} = \frac{r_{muni}}{1-t} = \frac{0.03}{1-0.1} = 0.033$$

```
0.03/(1 - 0.1)
[1] 0.03333333
```

(c) 20%

Suggested solution.

$$r_{taxable} = \frac{r_{muni}}{1-t} = \frac{0.03}{1-0.2} = 0.0375$$

```
0.03/(1 - 0.2)
[1] 0.0375
```

(d) 40%

Suggested solution.

$$r_{taxable} = \frac{r_{muni}}{1-t} = \frac{0.03}{1-0.4} = 0.05$$

```
0.03/(1 - 0.4)
[1] 0.05
```

Why are high-tax-bracket investors more inclined to invest in municipal bonds than low-bracket investors?

Suggested solution.

This is because the equivalent taxable yield is higher for the high-tax-bracket investors. Note that the risk tends to increase with the yield. For the high-tax-bracket investors, it is more likely that the taxable investments with the equivalent taxable yield are riskier than the municipal bonds. Then the municipal bonds are more appealing to the high-tax-bracket investors.

LISTING OF TREASURY ISSUES					ASKED YIELD TO MATURITY
MATURITY	COUPON	BID	ASKED	CHANGE	
15-Feb-2019	2.750	100.0391	100.0547	0.0078	2.256
30-Apr-2021	2.250	99.7500	99.7656	0.2344	2.354
15-May-2023	1.750	97.4531	97.4688	0.4766	2.364
15-Aug-2029	6.125	132.7266	132.7891	1.1406	2.575
15-Feb-2036	4.500	125.4688	125.5313	1.5391	2.637
15-Aug-2048	3.000	101.8984	101.9297	1.5391	2.902

Figure 1: BID, ASKED and CHANGE columns are quoted as a percentage of par.

Problem 3

Looking at the Treasury bond maturing in Feb 2036 at the \$1,000 par value in Figure 1

- (a) How much would you have to pay to purchase one of these bonds?

Suggested solution.

You have to pay

$$1,000 \times 125.5313\% = 1255.313$$

to purchase one of these bonds. (b) How much would you get to sell one of these bonds?

Suggested solution.

You can get

$$1,000 \times 125.4688\% = 1254.688$$

to sell one of these bonds.

- (c) What was its ask price the previous day?

Suggested solution.

The ask price on the previous day is

$$125.5313 - 1.5391 = 123.9922.$$

$$125.5313 - 1.5391$$

$$[1] \quad 123.9922$$

- (d) What is its coupon rate? If the bond makes semiannual coupon payments, then how much would you get in each coupon payment?

Suggested solution.

The coupon rate is 1.750%. Each coupon payment is

$$1000 \times 4.5\%/2 = 22.5.$$

Problem 4

Looking at the listing for Hess Midstream Partners in Figure 2

NAME	SYMBOL	CLOSE	NET CHG	VOLUME	52 WK HIGH	52 WK LOW	DIV	YIELD	P/E	YTD %CHG
Herbalife Nutrition	HLF	57.94	-1.39	1,149,773	60.41	34.16	1.20	2.07	47.75	-1.71
Herc Holdings	HRI	26.86	-0.71	389,826	72.99	24.16	3.10	3.35
Heritage Insurance Holdings	HRTG	14.57	-0.38	81,929	19.15	12.85	0.24	1.65	22.01	-1.02
Hersha Hospitality Trust Cl A	HT	16.59	-0.16	732,879	24.16	16.50	1.12	6.75	...dd	-5.42
Hershey	HSY	106.24	0.80	1,145,889	114.63	89.10	2.89	2.72	22.00	-0.88
Hertz Global Holdings	HTZ	13.27	-0.77	2,965,201	25.14	13.01	2.24	-2.78
Hess Corp.	HES	42.39	0.15	5,969,511	74.81	35.59	1.00	2.36	...dd	4.67
Hess Midstream Partners	HESM	17.87	0.25	47,899	24.51	16.17	1.43	8.00	14.60	5.24
Hewlett Packard Enterprise	HPE	13.18	-0.28	11,756,695	19.48	12.09	0.45	3.41	11.46	-0.23

Figure 2: Listing of stocks traded on the New York Stock Exchange.

(a) How many shares could you buy for \$1,000?

Suggested solution.

The number of shares that we could buy for \$1,000 is

$$\frac{1000}{17.87} = 55.96$$

(It is ok to round it to 55 shares)

$1000/17.87$

[1] 55.95971

(b) What would be your annual dividend income from those shares?

Suggested solution.

The annual dividend income from those shares is

$$\frac{1000}{17.87} \cdot 1.43 = 80.02$$

$1000/17.87 * 1.43$

[1] 80.02238

(c) What must be Hewlett Packard's earnings per share?

Suggested solution.

The earnings per share are

$$17.87/14.6 = 1.22$$

	P_0	Q_0	P_1	Q_1	P_2	Q_2
X	100	200	95	200	95	200
Y	200	100	220	100	220	100
Z	180	200	200	200	100	400

17.87 /14.6
[1] 1.223973

(d) What was the firm's closing price on the day before the listing?

Suggested solution.

The closing price on the day before listing is

$$17.87 - (0.25) = 17.62$$

17.87 - (0.25)
[1] 17.62

Problem 5

Consider the three stocks in the following table. P_t represents price at time t , and Q_t represents shares outstanding at time t . Stock Z splits two for one in the last period.

(a) Calculate the rate of return on a price-weighted index of the three stocks for the first period ($t = 0$ to $t = 1$).

Suggested solution.

The price-weighted index on $t = 0$ is

$$I_{pw,0} = \frac{100 + 200 + 180}{3}$$

The price-weighted index on $t = 1$ is

$$I_{pw,1} = \frac{95 + 220 + 200}{3}$$

The rate of return is

$$I_{pw,1}/I_{pw,0} - 1 = \frac{(95 + 220 + 200)/3}{(100 + 200 + 180)/3} - 1 = 7.29\%$$

(95+220+200)/(100+200+180) - 1
[1] 0.07291667

(b) What must happen to the divisor for the price-weighted index in year 2?

Suggested solution.

We solve d using

$$\frac{95 + 220 + 200}{3} = \frac{95 + 220 + 100}{d}$$

or equivalently

$$d = \frac{95 + 220 + 100}{(95 + 220 + 200)/3} = 2.417$$

The new divisor in year 2 is changed to 2.417.

```
d <- (95+220+100)/((95+220+200)/3)
d
[1] 2.417476
```

(c) Calculate the rate of return for the second period ($t = 1$ to $t = 2$).

Suggested solution.

The price-weighted index on $t = 1$ is

$$I_{pw,1} = \frac{95 + 220 + 200}{3} = 171.67.$$

The price-weighted index on $t = 2$ is

$$I_{pw,2} = \frac{95 + 220 + 100}{d} = 171.67.$$

Therefore the rate of return is 0.

```
(95+220+200)/3
[1] 171.6667
(95+220+100)/d
[1] 171.6667
```

Calculate the first-period rates of return on the following indexes of the three stocks:

(d) A market-value-weighted index.

Suggested solution.

Suppose the market-value-weighted index on $t = 0$ is

$$I_{mvw,0} = 1$$

The market-value-weighted index on $t = 1$ is

$$I_{mvw,1} = \frac{95 \cdot 200 + 220 \cdot 100 + 200 \cdot 200}{100 \cdot 200 + 200 \cdot 100 + 180 \cdot 200} = 1.0658$$

The rate of return is

$$I_{mvw,1}/I_{mvw,0} - 1 = 6.58\%$$

```
val0 <- 1
val1 <- (95 * 200 + 220 * 100 + 200 * 200) / (100 * 200 + 200 * 100 + 180 * 200)
val1/val0 - 1
[1] 0.06578947
```

(e) An equally weighted index.

Suggested solution.

Suppose we invest 1 in X , 1 in Y , and 1 in Z on $t = 0$. Then on $t = 0$

The equally weighted index on $t = 0$ is

$$I_{ew,0} = 3$$

The equally weighted index on $t = 1$ is

$$I_{ew,1} = \frac{95}{100} + \frac{220}{200} + \frac{200}{180} = 3.16$$

The rate of return is

$$I_{ew,1}/I_{ew,0} - 1 = 5.37\%$$

```
ew_0 <- 3
ew_1 <- 95/100 + 220/200 + 200/180
ew_1
[1] 3.161111
ew_1/ew_0 - 1
[1] 0.0537037
```

Problem 6

Suppose you buy a February 2023 expiration Apple call option with exercise price \$135.

(a) Suppose the stock price in September is \$140. Will you exercise your call? What is the profit on your position?

Suggested solution.

I will exercise the call because the exercise price is lower than the market price. The profit per share is

$$140 - 135 = 5.$$

If the contract has 100 shares, then the total profit is 500.

(b) What if you had bought the February 2023 call with exercise price \$145?

Suggested solution.

I will not exercise the call as the exercise price is higher than the market price. The profit is 0.

If the contract has 100 shares, then the total profit is 0.

(c) What if you had bought a February 2023 put with exercise price \$145?

Suggested solution.

I will exercise the put as the exercise price is higher than the market price. The profit is

$$145 - 140 = 5.$$

If the contract has 100 shares, then the total profit is 500.