COURSE 6
Spring 2004

Multiple-Choice Answer Key

Question #	*Answer*		*Question #*	*Answer*
1	C		21	A
2	D		22	C
3	B		23	A
4	B		24	D
5	D		25	E
6	D		26	B
7	B		27	E
8	A		28	D
9	D		29	C
10	Correct for All		30	B
11	D		31	E
12	D		32	D
13	A		33	E
14	D		34	C
15	B			
16	E			
17	A			
18	B			
19	B			
20	D			

Spring 2004 Course 6 Written-Answer Solutions

Question #1 Solution

- Securities Exchange Act of 1933
  Required registration of prospectus with SEC
  Required full disclosure of all relevant information relating to the issuance of new securities
  This does not mean that the security is a "good buy" but only that relevant information is provided to investors

- Securities Exchange Act of 1934
  Established the Securities & Exchange Commission (SEC) in order to administer the 1933 Act
  Gave the SEC the authority to register and regulate securities exchanges, over-the-counter (OTC) markets, brokers, and dealers

- Securities Investment Protection Corporation (SIPC)
  Established in 1970 in order to order protect investors from losses that occur when their brokerage firms fail

- State laws
  Securities trading is also subject to state laws, known as "blue sky" laws, which attempt to prevent false sale and promotion of securities

- Insider Trading
  It is strictly illegal for anyone to profit by trading based on inside information; that is, information that has not yet been released to the public

- Circuit Breakers
  These help regulate the securities exchanges directly
  There are two basic types

  - Trading Halts

If DJIA falls by x% during one day's trading:
- If DJIA falls 10%, trading is halted for one hour
- If DJIA falls 20%, trading is halted for two hours
- If DJIA falls 30%, trading stops for the day

  - Collars
    If DJIA moves either up or down by more than 210 points within the course of a day's trading, all trades are required to pass a "tick test." That is, the trade will only be executed if the last price movement was positive.

Question #2 Solution

(a) Expected return = $\sum r_i p(s)$

Standard deviation = $\sqrt{\sum\left(r_i - E(r_i)\right)^2 p(s)}$

For Stock A

Expected return = $[30\% \times 45\%]+[2\% \times 60\%]+\left[(-10\%)\times 15\%\right]=12.8\%$

Variance =

$$\left[(30\%-12.8\%)^2 \times 45\%\right]+\left[(2\%-12.8\%)^2 \times 40\%\right]+\left[(-10\%-12.8)^2 \times 15\%\right]=257.76$$

Standard Deviation = $\sqrt{257.76} \doteq 16.05\%$

For Stock B

Expected return = $[8\% \times 45\%]+[15\% \times 40\%]+[5\% \times 15\%]=3.15\%$

Variance =

$$\left[(-8-3.15)^2 \times 45\%\right]+\left[(15-3.15)^2 \times 40\%\right]+\left[(5-3.15)^2 \times 15\%\right]=112.6275$$

Standard deviation = $\sqrt{112.6275} \doteq 10.61\%$

For Stock C

Expected return = $[8\% \times 45\%]+[4\% \times 40\%]+\left[(-10\%)\times 15\%\right]=3.7\%$

Variance = $\left[(8-3.7)^2 \times 45\%\right]+\left[(6-3.7)^2 \times 40\%\right]+\left[(-10-3.7)^2 \times 15\%\right]=36.51$

Standard deviation = $\sqrt{36.51}=6.04\%$

For T-bill

Expected return = 3%

Standard deviation = 0%

(b) (i) Condition 1 = invest 3000 in Stock A $\Rightarrow$ 100% invest in Stock A

Expected return = 12.8%

Standard deviation = 16.05%

$$rp = w_A r_A + w_A r_B$$

$$\Rightarrow E(r_p) = w_A E(r_A) + w_B E(r_B)$$

$$\sigma_p{}^2 = w_A{}^2 \sigma_A{}^2 + w_B{}^2 \sigma_B{}^2 + 2 w_A w_B \operatorname{cov}(r_A . r_B)$$

Condition 2 – invest 3000 in Stock B

$\Rightarrow$ 70% in Stock A
30% in Stock B
$rp = 0.7r_A + 0.3r_B$

$$E(r_p) = [0.7 \times 12.8\%] + [0.3 \times 3.15\%] = 9.905\%$$

$$Cov(r_A r_B) = Ep(s)\left(r_A - E(r_A)\right)\left(r_B - E(r_B)\right)$$

$$= 0.45 \times (30\% - 12.8\%) \times (-8 - 3.15\%)$$

$$+0.4 \times (2\% - 12.8\%) \times (15 - 3.15\%)$$

$$+0.15 \times (-10\% - 12.8\%) \times (5 - 3.15\%) = 143.82$$

$$\sigma_p{}^2 = \left[0.7^2 \times 16.05^2\right] + \left[0.3^2 \times 10.61^2\right] + \left[2 \times 0.7 \times 0.3 \times (-143.82)\right] = 75.952314$$

$$\sigma_p \doteq 8.72\%$$

Condition 3 – invest 3000 in Stock C

$\Rightarrow$ 70% in Stock A
30% in Stock C
$r_p = 0.7r_A + 0.3r_C$

$$E(r_p) = 0.7 \times 12.8\% + 0.3 \times 3.7\% = 10.07\%$$

$$Cov(r_A.r_c) = 0.45 \times (30 - 12.8)(8 - 3.7)$$

$$+0.4 \times (2 - 12.8)(4 - 3.7)$$

$$+0.15 \times (-10 - 12.8)(-10 - 3.7)$$

$$= 78.84$$

$$\sigma^2{}_p = \left[0.7^2 \times 16.05^2\right] + \left[0.3^2 \times 6.04^2\right] + \left[2 \times 0.7 \times 0.3 \times 78.84\right]$$

$$= 162.621369$$

$$\sigma_p \doteq 12.75\%$$

Condition 4 – invest 3000 in T-bill

$\Rightarrow$ 70% in Stock A
30% in T-bill
$r_p = 0.7 r_A + 0.3 r_{T-bill}$

$$E(r_p) = [0.7 \times 12.8\%] + [0.3 \times 3\%] = 9.86\%$$
$$\sigma^2{}_p = 0.7^2 \times 16.05^2 = 126.225225$$

$$\sigma_p = 11.235\%$$

(ii) A = risk aversion = 4 $U = E(r_p) - 0.005 A \sigma_p{}^2$

Condition 1 = All in Stock A
$$U = 12.8 - 0.005 \times 4 \times 16.05^2 = 7.64795$$

Condition 2 = 70% in Stock A, 30% in Stock B
$$U = 9.905 - 0.005 \times 4 \times 75.952314 = 8.38595372$$

Condition 3 = 70% in Stock A, 30% in Stock C
$$U = 10.07 - 0.005 \times 4 \times 162.621369 = 6.81757262$$

Condition 4 = 70% in Stock A, 30% in T-bill
$$U = 9.86 - 0.005 \times 4 \times 126.225225 = 7.3354955$$

Rank by utility: (high $\rightarrow$ low)

Condition 2 = 3000 invest in Stock B
Condition 1 = 3000 invest in Stock A
Condition 4 = 3000 invest in T-bill
Condition 3 = 3000 invest in Stock C

Question #3 Solution

(a) put option payoff = max (0, strike – price)

- right of the investor to sell the bond back to the issuer at a preset price
- pay an upfront premium for this option
- American puts can be exercised at anytime
- European puts can only be exercised at maturity
- it may be optimal to exercise an American put at any time

Call option payoff = max (0, price-strike)

- right to buy the bond back at a preset price
- pay an upfront premium
- American call option can be exercised at any time – may be optimal to exercise right before dividend payment or at maturity
- European calls can only be exercised at maturity

(b) risk

- call risk – risk that bond is called when interest rates decrease (price high) – investor perspective
- reinvestment risk – reinvest cash flows at lower interest rate
- put risk – risk that investor exercises option when interest rates increase (price low) issuer perspective
- credit risk – risk of default of bond – options are worthless

(c) holding period return

investment @ 12/31/03 — 1 callable, strike = 80, bond price =70
1 putable, strike = 40, bond price =50

- strike price for putable bond is lower than price of putable bond at all dates – do not exercise
- only exercise if price falls below strike
- call option – exercise after two years if price above strike
  price after 2 yrs = 90 – issuer may exercise option
- original expenditure = 70+50=120
- receive 80 for called bond = invest in putable bonds @ price = 60 (1 1/3 putable bonds)
- sell bonds at 12/31/06 – put sells for 60
  60 (original putable bond) + 60 (80/60) (bond purchased) = 140
  Holding period return = $\frac{140}{120} - 1 = 16.67\%$
  (since sell before maturity receive market price)

(d) option

- right to buy (call) or sell (put) a bond at preset price and date (maturity if European, earlier if American)
- up front premium paid for this right

futures

- obligation to buy or sell a bond at present price and date
- no upfront premium is required
- back by the exchange
- standardized

(e) Futures could be used to improve holding period return by:

- hedge against price changes that would cause the bond to be called early
- lock in a set return
- enter into a futures contract that sells the bond @12/31/06 at a higher price (each party is betting that interest rates will move in opposite direction $\left(i\uparrow P\downarrow\right)=$ sells short position, $\left(i\downarrow P\uparrow\right)=$ long position)

Question #4 Solution

CMO A

- an increase in interest rates will reduce prepayments
- extension risk will become an issue
- the Z bonds principal and interest payment are used to accelerate principal repayments to the sequential pay classes and reduce their volatility
- the Z bond will only receive payments once the sequential classes have been paid off
- the VADM is protected against extension risk, (as the payments to the VAAM are from the interest accretion of the Z bond, the VADM will follow its schedule until the Z bond begins to paydown)
- the sequential classes will paydown as normal, from the shortest tranche to the longest

CMO B

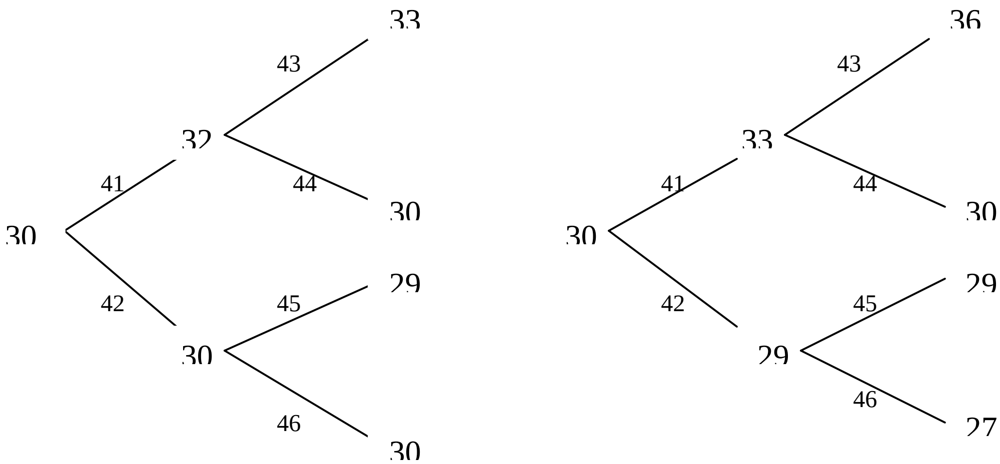
- PAC's have prepayment protection from their companion classes
- The companion classes will absorb any prepayment fluctuations
- As long as the prepayments are within the PAC ranges, the principals received will be stable
- As the prepayment will slow down, the prepayment bands for the PAC's will move
- if the prepayments are below the lower bands
  =) the upper and lower bands will rise
  =) the lower band rises because of built in catch up features
  =) the upper band rises because the companions can accept more prepayment fluctuations
- if prepayments are above the lower bond but below the upper bands
  =) both bands will move up
  =) the lower band because the remaining outstanding principal is less so the prepayments have to increase to maintain previous prepayment levels

CMO C

- the principal payments will slow down due to prepayments
- for sequential clapses the principal is paid to the shortest tranche first (in this case the year tranche); once that tranche is paid off the next shortest tranche will receive principals
- due to lower prepayments, the tranches will receive their principal payments later
- interest payments are to all tranches, based on outstanding principal (will be higher as payment of principal is slower)

Question #5 Solution

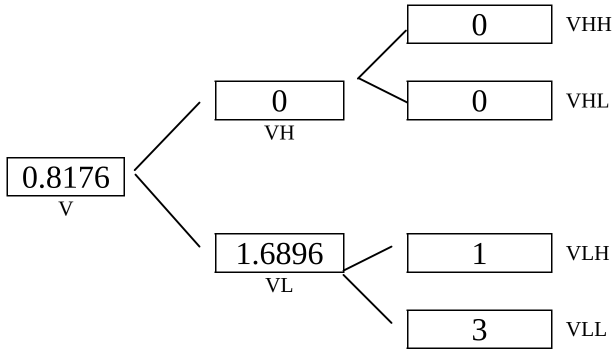
(a)



$$32\varphi_1 + 30\varphi_2 = 30 \rightarrow 32\varphi_1 = 30 - 30\varphi_2 \rightarrow \varphi_1 = 0.9375 - 0.9375\varphi_2$$
$$33\varphi_1 + 29\varphi_2 = 30$$
$$33(0.9375 - 0.9375\varphi_2) + 29\varphi_2 = 30$$
$$30.9375 - 30.9375\varphi_2 + 29\varphi_2 = 30 \qquad \varphi_2 = 0.4839 \qquad \varphi_1 = 0.4838$$
$$33\varphi_3 + 30\varphi_4 = 32 \rightarrow 33\varphi_3 = 32 - 30\varphi_4 \rightarrow \varphi_3 = 0.9697 - 0.9091\varphi_4$$
$$36\varphi_3 + 30\varphi_4 = 33$$
$$36(0.9697 - 0.9091\varphi_4) + 30\varphi_4 = 33$$
$$34.9092 - 32.7276\varphi_4 + 30\varphi_4 = 33 \qquad \varphi_4 = 0.70 \qquad \varphi_3 = 0.3333$$
$$29\varphi_5 + 30\phi_6 = 30 \rightarrow 29\varphi_5 = 30 - 30\varphi_6 \rightarrow \varphi_5 = 1.0345 - 1.0345\varphi_6$$
$$29\varphi_5 + 27\varphi_6 = 29$$
$$29(1.0345 - 1.0345\varphi_6) + 27\varphi_6 = 29$$
$$30 - 30\varphi_6 + 27\varphi_6 = 29$$
$$-3\varphi_6 = -1 \qquad \varphi_6 = 1/3 \qquad \varphi_5 = 0.6897$$

Because there is a state price vector, no arbitrage exists.

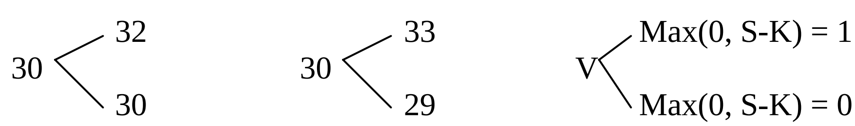
(b) European Put option $\rightarrow$ option to sell stock at 30 at maturity date; will exercise if price less than 30



$$v_{LH} = Max(O, K-S) = Max(0, 30-29) = 1$$
$$v_{LL} = Max(O, K-S) = Max(0, 30-27) = 3$$
$$v_H = 0$$
$$v_L = 1\varphi_5 + 3\varphi_6 = 1(0.6897) + 3(0.3333) = 1.6896$$
$$v = 0\varphi_1 + 1.6896\varphi_2 = 0 + 1.6896(0.48939) = 0.8176$$

(c)

Company A | **Company B** | **Call Option on A**



$$32\theta_1 + 33\theta_2 = 1 \rightarrow 32\theta_1 = 1 - 33\theta_2 \rightarrow \theta_1 = \frac{1-33\theta_2}{32}$$
$$30\theta_1 + 29\theta_2 = 0$$
$$30\left(\frac{1-33\theta_2}{32}\right) + 29\theta_2 = 0$$
$$0.9375 - 30.9375\theta_2 + 29\theta_2 = 0$$
$$0.9375 = 1.9375\theta_2 \qquad \theta_2 = 0.4839$$
$$\theta_1 = -0.4678$$

Can replicate call option by purchasing 0.4839 of Company A stock and selling 0.4678 of Company B stock.

$$\text{Cost } = 30(0.4839) + 30(-0.4678) = 0.483$$

Question #6 Solution

(a) Impact of Maturity

- all other factors constant, the longer the bond's maturity, the greater the bond's sensitivity to interest rate changes

Impact of Coupon Rate

- all other factors constant, the lower the coupon rate, the greater the bond's sensitivity to changes in interest rates
- zero coupon bonds have a greater price sensitivity to interest rate changes than same-maturity bonds bearing a coupon rate and trading at the same yield

Impact of Embedded Options

- Price of Callable bond = Price of Option-free Bond – Price of Call Option
- when interest rates decline, the price of the Option-free Bond will increase and the price of the Call Option will also increase
- the price of the Callable bond may increase or decrease depending on the relative changes in the Option-free Bond price and the Call Option price
- typically, the price of a Callable Bond will increase in price but not as much as a comparable option-free bond

- Price of Putable bond = Price of Option-free bond + Price of Put Option
- when interest rates decline, the price of the Option-free Bond will increase and the price of the Put Option will decline
- the price of the Putable Bond may increase or decrease depending on the relative changes in the Option-free Bond and the Put Option prices

(b) The candidates should see that there are only combinations of pairs of options that will be high or low interest rate risk.
Maturity 10 or 20 years
Coupon high or low value per maturity
Embedded option or option free

Significant Interest Rate Risk (high or low)?				**Investor A (high risk) or B (low risk)**
Bond	**Maturity**	**Coupon**	**Embedded Options**	
A	10 years LOW	5% HIGH	None HIGH	A (2 of 3 factors high sensitivity)
B	10 years LOW	5% High	Put Option LOW	B (1 of 3 factors high sensitivity)
C	10 years LOW	7% LOW	None HIGH	B (1 of 3 factors high sensitivity)
D	10 years LOW	7% LOW	Call Option LOW	B (0 of 3factors high sensitivity)
W	20 years HIGH	8% HIGH	None HIGH	A (all of 3factors high sensitivity)
X	20 years HIGH	8% HIGH	Put Option LOW	A (2 of 3 factors high sensitivity)
Y	20 years HIGH	10% LOW	None HIGH	A (2 of 3 factors high sensitivity)
Z	20 years HIGH	10% LOW	Call Option LOW	B (1 of 3 factors high sensitivity)

Bond portfolio for Investor A – bonds A, W, X, Y

Question #7 Solution

(a) Advantages of simulation techniques

- It permits the inclusion of path dependency in the cashflow of the instrument being valued
- It allows for more realistic jumps in interest rates of varying amounts along a single path
- It allows for branches that do not have to rejoin at each node
- Easier to use when more than one factor changes at a time

Advantages of using lattice methods

- Can be used to value American style options embedded in financial instruments
- At each node of the lattice, the price of the instrument being valued is known

(b) How many paths?

- Increased precision can be obtained with more paths, but using more paths slows the simulation process
- Variance reduction techniques can be used to maintain accuracy in pricing calculations with fewer paths

How may periods? How long?

- Monthly time intervals are standard for mortgage-backed securities pricing, since cashflows are usually monthly
- Number of factors and parameter estimation errors
- As more factors are added can obtain closer model fits to prices of reference securities
- Credit Liquidity and Prepayment Risk
- Can add and OAS adjustment to reflect illiquidity
- Initializing the parameter
- General approach: produce a simulation that correctly prices a set of Treasury securities options on Treasury futures, and a set of interest rate caps

(c)

- Assign cashflows to each of the nodes and determine probabilities associated with each of these cashflows
- Discount each cashflow by sequence of short rates that give rise to it, weighing all path dependent present values generated by the probability of occurrence of the paths
- The sum of these discounted present values is the value of the mortgage-backed securities portfolio

Question #8 Solution

Asset allocation optimization should consider both the capital market and the Investor's specific conditions.

(a) Capital Market: Identify the capital market conditions
Prediction Procedure
Calculate the expected return, risk and correlation.

In this step, prediction procedure is always difficult
Identify the capital market conditions, we need to specify the risk/reward
It is not an easy thing. Risk-free rate may change, capital allocation line may change and the efficient frontier may not be easily found.
Additionally, the prediction model depends on inputs/assumptions.

(b) Investor's situation: Investor's assets, liability and net worth
Investor's risk averse function
Investor's risk tolerance

In this part, investor's assets, liability and net worth may not be constant and also the Investor's risk averse function and risk tolerance may change over time. Investor's preference could change over time. Also, the embedded options in a portfolio often make value determination difficult.

(c) Combine the capital Market and Investor's situation together. Determine the optimal portfolio and the characteristics of the optimal portfolio.

- model outputs depend on historic data and assumptions
- must have thorough knowledge on investors' circumstances and preferences.

Also, model needs to be constantly updated and re-optimized. There is a tradeoff between transaction cost and optimal mix.

Generally, there are four types of models:

- Integrated Asset allocation: this model follows all the steps in the above
- Strategic Asset allocation: This is not done very frequently.
  It is done for calculating the benchmark portfolio under normal economic situations. Simulations are done under various portfolio mixes. Investors look at the range and choose. In this model, since simulation is done, no need for the prediction procedures. And also it assures the investor has a constant risk averse function.
- Tactical Asset allocation: it takes advantages of the inefficiencies between assets. Normally sell past winners and buy past losers. It assures the risk averse function constant
- Insured Asset allocation: the investor's risk tolerance changes dramatically when the net worth changes.

Question #9 Solution

(a) the market price of risk is

$$\frac{E(r_M)-r_f}{\sigma^2_M}=\frac{0.07-0.03}{0.045}=0.889$$

(b) the contribution to the variance of the market portfolio for security i are

$W_i \times \sum W_j \operatorname{cov}(r_i \cdot r_j)\ j=1,\cdots$

For B:

$$W_B \operatorname{cov}(r_B \cdot r_M)=0.25\times 0.35\times 2\%+0.25^2\times 12\%+0.25\times 0.25\times 1\%+0.25\times 0.15\times 2\%$$

$$=0.175\%+0.75\%+0.0625\%+0.075\%$$
$$=1.0625\%=0.010625$$

For D:

$$W_D \operatorname{cov}((r_D \cdot r_M)=0.15\times 0.35\times 8\%+0.15\times 0.25\times 2\%+0.15\times 0.25\times 5\%+0.15^2\times 12\%$$

$$=0.42\%+0.075\%+0.1875\%+0.27\%$$
$$=0.9525\%=0.009525$$

For B and D all $=0.0010625+0.009525=0.02015$

(c) For i the expected rate of return

$$E(r_i)=r_f+B_i\left[E(r_M)-r_f\right]=r_f+\frac{\operatorname{cov}(r_i,r_M)}{\sigma_M{}^2}\left[E(r_M)-r_f\right]$$

For B: $\operatorname{cov}(r_B,r_M)=\text{contribution for B}/W_B=0.010625/0.25=0.0425$

$$E(r_B)=r_f+\frac{\operatorname{cov}(r_B \cdot r_M)}{\sigma_M{}^2}\left[E(r_M)-r_f\right]$$

$$=0.03+\frac{0.0425}{0.045}\times 0.04=0.0678=6.78\%$$

For D: $\operatorname{cov}(r_D,r_M)=\text{contribution for D}/W_D$

$$=0.009525/0.15=0.0635$$

$$E(r_D)=r_f+\frac{\operatorname{cov}(r_D,r_M)}{\sigma_M{}^2}\left[E(r_M)-r_f\right]$$

$$=0.03+\frac{0.0635}{0.045}\times 0.04=8.64\%$$

Question #10 Solution

(a) Compare forward contracts to futures contracts

1. Futures contracts are more liquid
2. Forward can be traded with dealer or broker but futures are traded in exchange
3. Forward contracts can be customized in size, asset type, delivery date and delivery price but futures contracts are standardized
4. Forward contracts realize gain or loss at delivery while futures contract, are mark-to-market where gain or loss are realized everyday. Futures contract have margin call if maintenance margin is too low.
5. Forward contracts are subject to counterparty risk but futures contracts, have clearing house delinquency
6. Forward have bid-ask spread but futures need commission or fee
7. Futures do not always provide an optimal hedge
8. For forwards, may require a good credit history or deposit as back-up from other party.

(b) 1-month T-bill on Feb 1 2004 quoted spot price = (1-annualized discount yield)x100 = 98.5

4-month T-bill on Feb 1 2004 = 98

Implied price of futures = $\frac{98}{98.5} = 99.49$

(c) On Feb 1 2004, buy 1-month T-bill with par = 97.5
and sell short 4-month T-bill with par = 100

Go long futures contract at 97.5

Cash flows on Feb 1, 2004 = $-97.5\left(\frac{98.5}{100}\right) + 100\frac{98}{100} = 1.9625$

Cash flows of March 1, 2004 = 97.5-97.5=0
because 1-month T-bill matures with proceeds to buy the futures contracts

Cash flows on April 1, 2004 = 0

Cash flows on May 1, 2004 = 100-100=0
because 4-month T-bill matures and is repaid by the redemption of 3-month T-bill under futures contract

Profit = 1.9625

Question #11 Solution

(a) $$S = \frac{\eta S_u + (1-\eta) S_d}{1+r} = \frac{50\%(105) + (1-50\%)\cdot 95}{1+5\%} = 95.23809524$$

(b) market price of risk $\lambda = \dfrac{\mu_s - \gamma}{\sigma}$

$$\sigma^2 = p(1-p)(S_u - S_d)^2 / S^2$$

$$= p(1-p)(105-95)^2 / (95.23809524)^2$$

$$\Rightarrow p(1-p) = \frac{(95.23809524\sigma)^2}{(105-95)^2} = \frac{(95.23809524)^2 \times 0.2755\%}{10^2}$$

=0.249886221

$$\Rightarrow p - p^2 = 0.249886221 \Rightarrow p^2 - p + 0.249886221 = 0$$

$$\Rightarrow p = \frac{1 \pm \sqrt{1 - 4 \times .0249886221}}{2} = 0.51066724$$

$$\mu_s = \left[pS_u + (1-p) S_d - S \right] / S = \left[p105 + (1-p)95 - S \right] / S$$

$$= (10p + 95 - S)/S = 0.051120006$$

$$= \frac{\mu_s - 5\%}{\sqrt{0.2755\%}} = 0.0213328287$$

(c) true probability = 0.510666724

need to know that the true price and the martingale price are the same

Question #12 Solution

(a) Macauley duration = $\frac{1}{A}\sum\frac{tA_t}{(1+y)^t}$

$$A=\sum\frac{A_t}{(1+y)^t}=\frac{7.5}{1.055^{\frac{1}{2}}}+\frac{107.5}{1.055^{\frac{3}{2}}}=106.5060208$$

$$=\frac{1}{A}\left(\frac{0.5(7.5)}{1.055^{\frac{1}{2}}}+\frac{1.5(107.5)}{1.055^{1.5}}\right)$$

$$=1.431441568$$

(b)

Immunization	Cash flow matching
- ensures a positive surplus at the end of holding period	- tries to match timing and amount of asset & liability cashflows as closely as possible to achieve a net accumulated cash flow
- 3 conditions: 1) PV (assets)>PV(liabilities) 2) Duration (assets)=Duration (liabilities) 3) Asset cashflows more disperse than liability cashflows	- limited reinvestment risk
- often need rebalancing; portfolio not immunized after asset default, liability cashflow mature, etc.	- hard to exactly match
- assure flat yield curve	- if successful, eliminates reinvestment and int rate risk
- small, parallel, instantaneous interest rate shifts	- limited asset selection
-asset and liability discounted at same discount factor	- doesn’t take into account option being exercised
- use effective duration, convexity if option embedded securities	

(c) $A = PV(A) = \frac{110}{1.05^{\frac{1}{2}}} = 107.349008 \qquad D = \frac{1}{A}\left(\frac{0.5x110}{1.05^{\frac{1}{2}}}\right) = 0.5$

$$C = \frac{1}{A}\sum\frac{t(t+1)A_t}{(1+y)^{t+2}} = 0.680272109$$

$$E = PV(E) = \frac{4}{1.065^{0.5}} + \frac{4}{1.065^{1.5}} + \frac{4}{1.065^{2.5}} + \frac{4}{1.065^{3.5}} + \frac{104}{1.065^{4.5}} = 92.47730506$$

$$D = \frac{1}{A}\sum\frac{tA_t}{(1+y)^t} = 4.105678444$$

$$C = \frac{1}{A}\sum\frac{t(t+1)A_t}{(1+y)^{t+2}} = 19.40893555$$

liability: $PV = \frac{25}{1.05^{\frac{1}{2}}} + \frac{20}{1.055^{1.5}} + \frac{15}{1.061^{2.5}} + \frac{10}{1.0625^{3.5}} + \frac{5}{1.065^{4.5}} = 67.64445196$

let w = weight in A, match duration and check PV, dispecion

$D_p = \sum w_i D_i$ -duration

w-weights

i- i^{th} security

$C_p = \sum w_i C_i$ - convexity

0.5w+4.105678444$(1-w) = 1.75$

w = 0.653324605 $\therefore$ 65.33% in A, 34.67% in E $\therefore$ is an immunized portfolio

PV(assets) = 107.349008w+92.47730506(1-w)=102.1933545>PV(liability)

convexity of assets = 0.680272109w+19.40893555(1-w)=1.73>C(liab)=5.5

(d) Match last liability of first

2009: need $\frac{5}{104}$ of bond E

2008: need $\frac{10-\frac{5}{104}x4}{105} = \frac{17}{182}$ of bond D

2007: need $\dfrac{15-\frac{5}{104}x4-\frac{17}{182}x5}{106.5}=0.134654078$ of bond C

2006: need $\dfrac{20-\frac{5}{104}x4-\frac{17}{182}x5-0.134654078x6.5}{107.5}=0.171771236$ of bond B

2005: need

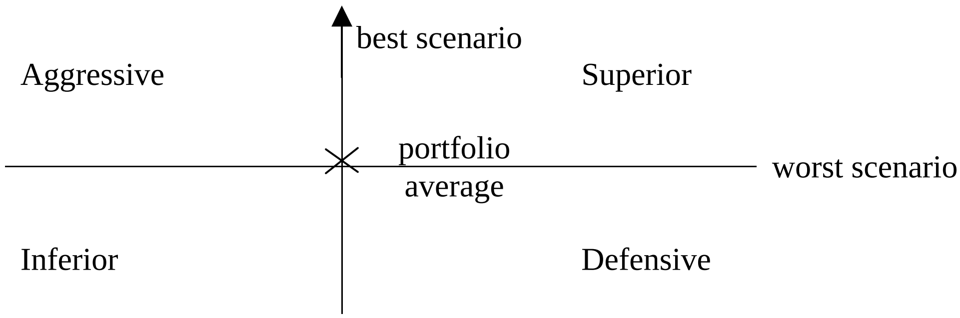
$$\frac{20-\frac{5}{104}x4-\frac{17}{182}x5-0.134654078x6.5-0.171771236x7.5}{110}=0.156155669$$

of bond A

Question #13 Solution

(a) Strategic Frontier Analysis:

- used to evaluate bonds risk characteristics
- graph is split into quadrants
- portfolio average is at center of graph's quadrants



Aggressive: high return in best scenario
low return in worst scenario

Superior: high return in best and worst scenarios
want to hold these bonds

Inferior: low return in best and worst scenarios
sell these bonds

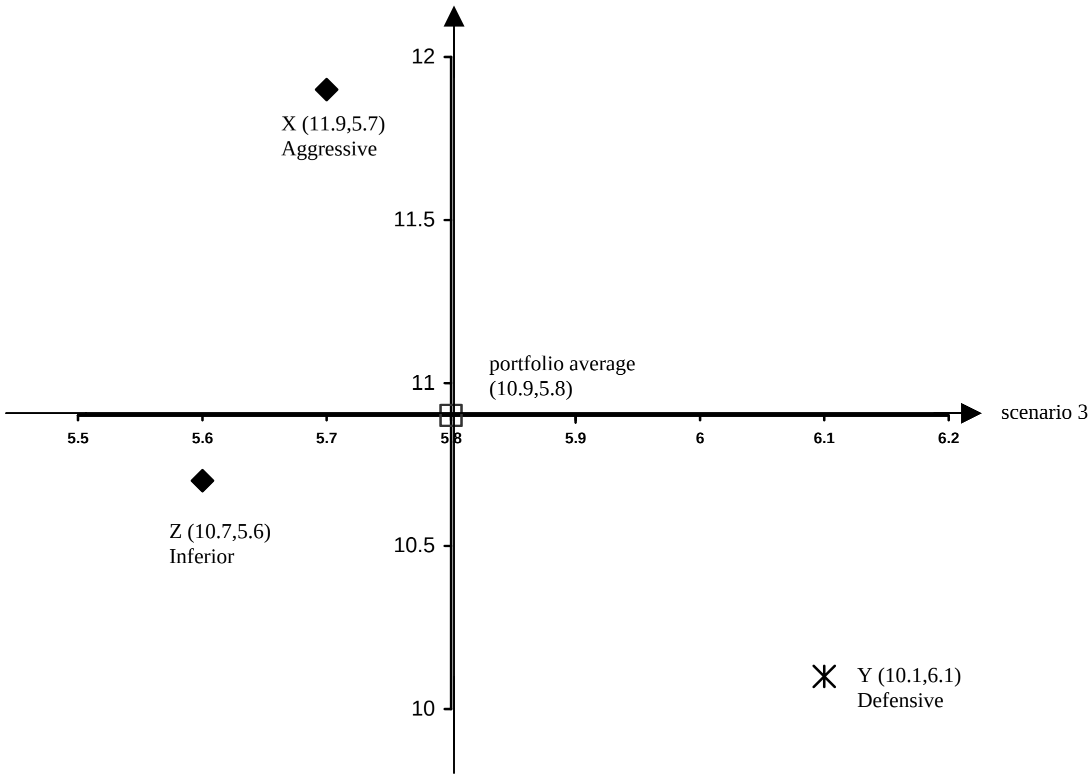
Defensive: high return in worst scenario
low return in best scenario

(b) Scenario #1 average = $\frac{1}{3}(11.9+10.1+10.7)=10.9$

Scenario #2 average = $\frac{1}{3}(8.2+8.4+8.3)=8.3$

Scenario #3 average = $\frac{1}{3}(5.7+6.1+5.6)=5.8$

Scenario 1 is best scenario and scenario 3 is worst scenario



(c) Relative Return Value Analysis:

- plot composite expected return vs. duration
- include regression line
- bonds above regression line have more return per unit of duration than those below regression line

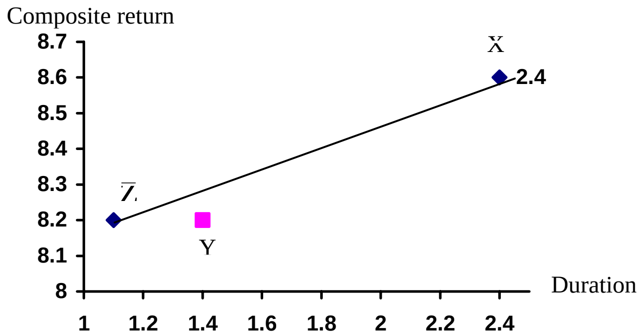
(d) Bond x return = $\frac{1}{3}(11.9+8.2+5.7)=8.6$

Bond y return = $\frac{1}{3}(10.1+8.4+6.1)=8.2$

Bond z return = $\frac{1}{3}(10.7+8.3+5.6)=8.2$

Total expected return = $\frac{1}{3}(8.6+8.2+8.2)=8.3$

Total expected duration = $\frac{1}{3}(2.3+1.4+1.1)=1.6$



Bonds x and z are above regression line and have higher return per unit of duration than bond y.

Question #14 Solution

(a)

i. $r_{bd} = \left(\frac{Par - Price}{Par}\right)\left(\frac{360}{n}\right)$ n = days to maturity

$0.045 = \frac{1000 - P}{1000}\left(\frac{360}{110}\right)$

$Price = 986.25$

ii. $r_{bey} = \left(\frac{Par - Price}{Price}\right)\left(\frac{365}{110}\right)$

$= \left(\frac{1000 - 986.25}{986.25}\right)\left(\frac{365}{110}\right)$

= 4.63%

iii. $r_{eay} = \left(\frac{Par}{Price}\right)^{\frac{365}{n}} - 1$

$= \left(\frac{1000}{98625}\right)^{\frac{365}{n}} - 1$

= 4.70%

(b) T-Bills zero coupon, sold at discount
maturity less than or equal to 1 year

T Notes semi annual coupon
maturity 1-10 years

T Bonds Semi annual coupon
maturity greater than 10 years

Considered a risk free security
Used as a benchmark for other securities
highly liquid
backed by full faith and credit of the US government

Sold by single price auction

- competitive bids made in terms of yield
- non competitive bids also can be made
- All accepted bids award the lowest yield accepted (the stopout yield)

Secondary market is a multi-dealer over the counter market

- highly liquid

(c) Agency Securities

Issued by agencies that all are part of or sponsored by the US Government
Low credit risk

Interest exempt from local and state taxes for most issuers
Distributed through dealers