Finance II (441) Paola Sapienza

Homework Assignment 5: Answers

1) Bond covenants and the fine print in bond prospectuses.

A) The bond holders. The fine print restricts the actions of the managers/equity owners, and thus restricts the amount of wealth they can transfer from the bondholders when the firm gets into financial trouble.

B) At the time of issue, the fine print helps the equity holders. The fine print lowers the interest rate required by investors who are buying the bond. This is a common theme in financial contracts. People can sell their liabilities for more, if they agree to restrict their behavior in the future.

2) The cost is the time value of the option that is given to the warrant holders. It is equivalent to giving them a new warrant with a life equal to the time extension. It is unclear why a firm would grant an extension. They are effectively giving investors a new warrant (with a positive time until expiration) and receiving the old warrant (with no time until expiration) in return. Thus, the firm always loses.

$$\text{Loss to firms shareholders} = c(S_t, X, T-t) - c(S_t, X, t-t) = c(S_t, X, T-t) - \text{Max}[S_t - X, 0]$$

However, if the firm grants all shareholders the extension (in proportion to their ownership of the firm), they are effectively taking money out of one pocket and putting it in the other. There aren't any real effects. The shareholders' gain on the warrant is exactly offset by their loss in the value of their shares.

3) Whirlpool has decided to issue some convertible bonds.

A) The expected cash flow from a share of Whirlpool stock is 46. Since the discount rate is 15%, Whirlpool should sell for $40 a share today. The market is correctly valuing the stock. Notice that the expected price change is not zero. This fact does not violate the efficient market hypothesis. The efficient market hypothesis argues that the expected excess return is zero.

B) The expected cash flow from the convertible is 1166. Investors will choose to convert the bond into stock only if the stock price next year is 44 or above (see the table below). Since the convertible has a beta of 0.60, the appropriate discount rate is 13.3% [8.3 + 0.6 (8.4)]. The convertible will thus sell for 1029.6.

Whirlpool Stock Price -- One Year Hence

	Possible Outcomes							E[Value]
Stock Price	40	42	44	46	48	50	52	46
Conversion Value	1000	1050	1100	1150	1200	1250	1300	1150
Convertible Payments	1083	1083	1100	1150	1200	1250	1300	1167

The convertible bond beta is between the stock beta (1.00) and the beta on the straight debt (0.00). Convertible bonds are a hybrid security -- part debt, part equity.

C) The convertible bond can be thought of as a straight bond with a stock option attached. The beta of the convertible bond must be a weighted average of the straight bond beta and the option beta. Use this fact to back out the option beta. Since the straight bond component has a value of 1000, the imbedded option to convert the bond into 25 shares of Whirlpool stock, is worth $29.6. Since the bond is riskfree, the bond beta is zero.

$$\beta_{\text{convertible}} = \beta_{\text{bond}} \left(\frac{\text{Price}_{\text{bond}}}{\text{Price}_{\text{bond}} + \text{Price}_{\text{Option}}} \right) + \beta_{\text{option}} \left(\frac{\text{Price}_{\text{option}}}{\text{Price}_{\text{bond}} + \text{Price}_{\text{option}}} \right)$$

$$0.6 = 0 \frac{1000}{1029.6} + \beta_{\text{option}} \frac{29.6}{1029.6} \quad - \quad \beta_{\text{option}} = 20.9$$

Options are levered equity. They are riskier and have a higher beta than the underlying equity.

D) Based on your inside information, the expected value of Whirlpool stock next year is $50. The correct price for the stock is therefore 43.5. so the stock is undervalued.

To value the convertible bond, first calculate the expected cashflow to the convertible bond. The expected cashflow to the convertible bond is $1250. Next consider the discount rate. Notice that the cashflow to the convertible bond is identical to the conversion value. Investors will always convert their bond. Owning the bond is identical to owning 25 shares of Whirlpool stock. Since the cashflow to the two portfolios is identical, so is the risk (the beta) and the correct discount rate. To value the convertible bond, discount the expected cashflow ($1250) at 15%. The convertible bond should sell for $1087.0 and is therefore undervalued.

Both the stock and the convertible bond are undervalued. However, the stock is more undervalued than the convertible bond. The stock is worth nine percent more than its market price. The convertible bond is worth six percent more than its market value. The stock is a better buy -- but both are positive NPV investments.

Whirlpool Stock Price -- One Year Hence

	Possible Outcomes							E[Value]
Stock Price	44	46	48	50	52	54	56	50
Conversion Value	1100	1150	1200	1250	1300	1350	1400	1250
Convertible Payments	1100	1150	1200	1250	1300	1350	1400	1250

E) Based on your information, the expected cash flow from the stock is the same as in A). The expected future value of the stock is $46 and the true value is the same as the market price -- $40.

The expected cashflows to the convertible bond drops to $1156.6. The convertible bond beta is 0.7 which means the correct discount rate is 14.2%. Discounting $1156.6 at 14.2% means the true value of the convertible bond is $1012.8. Since the market is over estimating the volatility of Whirlpool stock, it also over estimates the value of the convertible bond. In this case the bond is worth 1.6 percent less than the market believes. The stock is a better buy than the convertible bond. Shorting the convertible bond, however, would be a good investment.

Whirlpool Stock Price -- One Year Hence

	Possible Outcomes					E[Value]
Stock Price	42	44	46	48	50	46
Conversion Value	1050	1100	1150	1200	1250	1150
Convertible Bond Payments	1083	1100	1150	1200	1250	1157

4) Procter & Gamble's Interest Rate Hedge.

A) The spread is the change in P&G's borrowing cost. Negative values of the spread mean they have lowered their borrowing costs. Positive values of the spread means the hedge raised their borrowing costs. To complete the table, calculate the price of the 30 year treasury bond. The bond sells at a discount to face value when rates are above 6.25 percent and at a premium when rates are below 6.25 percent.

P&G Spread	Thirty year rate			
	5 %	6 %	7 %	8%
P30 yr	1.193	1.035	0.906	0.802
Five year rate				
5 %	-0.75%	-0.75%	-0.75%	4.25%
6%	-0.75%	-0.75%	10.85%	21.29%
7%	-0.75%	15.08%	27.89%	38.34%
8%	16.26%	32.12%	44.94%	55.38%

B) P&G bet that interest rates were going to fall or at least stay low. If rates stayed low, then P&G would lower its borrowing costs by 75 basis points. The problem occurs when rates rise. If rates rise from 6 percent on both bonds to 7 percent on both bonds, instead of lowering its borrowing costs by 75 basis points -- it will have raised its borrowing costs by almost 2800 basis points (28 percent). This is a big number. Incidentally, 1994 was the worst year in 35 years for long term bonds, whose value falls when interest rates rise.

Unlike a standard fixed for floating swap -- whose payoffs are linear in the underlying -- this swap's payoffs are non-linear in the underlying. As interest rates rise, P&G's borrowing costs rise exponentially. This non-linear relationship arises because the spread is a difference between a rate and a price. Remember, bond prices move with the reciprocal of rates. Now you know how P&G was able to lose $153 million.

C) The answer to this question follows directly from B). This hedge gives P&G cash when interest rates are low and takes it away (very quickly) when rates are high. For this hedge to make sense, P&G must have expected a high cash flow from operations when interest rates are high (customers purchase more soap when interest rates are high) and a low cash flow from operations when interest rates are low. Alternatively, P&G could have thought that its available investments (positive NPV projects) would be high when interest rates were low and low when interest rates were high.

Justifying the highly non-linear exposure to interest rates is very difficult. Either Procter and Gamble never considered this non-linearity or they received a handsome up-front payment to enter into the swap agreement.

5) VideoServer's PERCS for common equity exchange.

A) The price of VideoServer stock is the value of the firm's equity divided by the number of shares (2000). Since there is no debt, the value of VideoServer's equity is also the value of their assets. The payoff to the option is the max(PS - 150, 0).

VideoServer's Value	100K	200K	300K	400K	500K	600K
Stock Price	50	100	150	200	250	300
Option Payoff (X=150)	0	0	0	50	100	150

B) To calculate the payoff to a PERCS we must convert the number of common shares the PERCS holder will receive to a dollar value. For each PERCS the payoff in shares of common stock is:

$$\text{Min}[\,1, \frac{150}{P_{Stock}}\,]$$

C) Since each share of stock is worth Pstock, the payoff to each PERCS is:

$$P_{Stock} * \text{Min}[\,1, \frac{150}{P_{Stock}}\,] = \text{Min}[\,P_{Stock}, 150\,]$$

The payoff to the PERCS is similar to the payoff to a share of common stock, however, the upside is capped at $150.

D) If VideoServer turns out to be worth less than $300K, the PERCS will have a payoff equal to the stock price. If VideoServer turns out to be worth more than $300K, the PERCS will have a payoff of $150.

2) Since there are 400 PERCS, the total payoff to the PERCS is 400 times the second row.

3) The common equity owners and the PERCS owners, own the entire firm. To calculate the total payoff to the common equity owners, subtract the payoff to the PERCS owners from the value of the firm.

4) The stock price is the total payoff to equity owners divided by the number of common shares outstanding (1600). Notice that for firm values of 300K and below, the payoff to the PERCS and the common equity is identical to the payoff of the common equity before the exchange. All the action occurs for firm values above 300K. For these values of the firm, the payoff to the PERCS is capped. The excess value flows to the equity owners. The excess value is why the stock price is higher in these states than it would be absent the PERCS for common exchange.

To verify the correct stock price, use an alternative method. First calculate the number of shares into which the 400 PERCS convert. When the firm value is less than 300K, the PERCS convert into 400 shares of common stock. For firm values above 300K, the number of shares of common stock into which PERCS convert is:

$$\text{Number of shares PERCS} = \frac{400 * 150}{P_{VS\,stock}}$$

The total number of shares of common stock is equation (8) plus 1600 (see the seventh row of the table). Divide the total value of the firm by the total number of shares to get the stock price. The answer is the same as before.

VideoServer's Value	100K	200K	300K	400K	500K	600K
Payoff to single PERCS	50	100	150	150	150	150
Payoff to all PERCS	20K	40K	60K	60K	60K	60K
Payoff to equity owners	80K	160K	240K	340K	440K	540K
VS Stock price	50	100	150	212.50	275.00	337.50
Number of common equity shares from PERCS	400	400	400	282.35	218.18	177.78
Total number of shares	2000	2000	2000	1882.35	1818.18	1777.78
VS Stock price	50	100	150	212.50	275.00	337.50

C) To know if the option price has risen or fallen, look at the payoffs to the option and compare them to the payoffs calculated in A). The payoff to the option will remain unchanged for firm values of 300K and below and will rise for firm values above 300K. Since the payoffs to the call with PERCS are never smaller and may be larger than the payoffs to the call without PERCS, the value of the call option will increase.

VideoServer's Value	100K	200K	300K	400K	500K	600K
VS Stock Price	50	100	150	212.50	275.00	337.50
Payoff to exchange traded option	0	0	0	62.50	125.00	187.50

D) A PERCS is a portfolio of a share of common stock minus a call option on the underlying common stock. The payoff to a PERCS is capped at $150. Thus a share of stock minus a call option with a strike price of $150 should be equivalent to a PERCS. This portfolio exactly replicates the payoff to one PERCS.

VideoServer's Value	100K	200K	300K	400K	500K	600K
VS Stock Price	50	100	150	212.50	275.00	337.50
- Payoff to option	0	0	0	62.50	125.00	187.50
Combined payoff	50	100	150	150	150	150

E) Replicating portfolios.

1) The Pseudo PERCS (PPERCS). Construct a portfolio which has a payoff equal to the stock price for values of VideoServer of 300K and below and a payoff of 150 if

the value of VideoServer is above 300K. You have two securities to work with -- the stock of VideoServer and a call option on VideoServer. You calculated the payoff of these two securities in A); they are reproduced below. Purchasing a share of stock and selling a call option will produce exactly the payoff you seek. The cost of constructing the PERCS is the price of one share of VideoServer stock minus the price of a call option on VS stock with a strike price of 150. Of course, you want to sell the PERCS for more than your cost.

VideoServer's Value	100K	200K	300K	400K	500K	600K
VS Stock price (no PERCS)	50	100	150	200	250	300
Option on VS stock (X=150)	0	0	0	50	100	150
Pseudo PERCS	50	100	150	150	150	150

2) The PERCed up equity. Construct a portfolio whose payoffs mimic those of the common equity of VideoServer had they issued PERCS. You calculated these payoffs in B) above. There are still just two securities to work with -- the stock and the call option. The portfolio is long one share of stock and long a quarter of an option. The one quarter ratio comes from the number of PERCS (400) divided by the number of common shares outstanding before conversion (1600). When you add up the PERCS and the equity, the net investment in call options must be zero. If the 400 PERCS are each short an option, the 1600 shares of common stock must jointly be long 400 call options. Each one is long one quarter of an option. The cost of the security you constructed for CPTPP is the price of one share of VideoServer stock plus one fourth of the cost of a call option on VS stock with a strike price of 150.

VideoServer's Value	100K	200K	300K	400K	500K	600K
VS Stock price (no PERCS)	50	100	150	200	250	300
3 Option on VS stock (X=150)	0	0	0	12.50	25.00	37.50
Pseudo VS stock with PERCS	50	100	150	212.50	275.00	337.50