CHAPTER 27

VALUATION AND ANAL...NDS WITH EMBEDDED OPTIONS

1. (C) Bond B

Explanation

Due to the embedded call option, the upside potential of callable bond B is limited. (Module 27.3, LOS 27.e)

Related Material

SchweserNotes - Book 4

2. (B) bond has lower downside risk.

Explanation

The straight value of the bond forms a floor for the convertible bond's price. This lowers the downside risk. The conversion premium is a disadvantage of owning the convertible bond, and Cr it is the reason the bond has lower upside potential when compared to the stock.

Module 27.8, LOS 27.q)

Related Material

SchweserNotes - Book 4

3. (B) $87.92 0.0446

Explanation

The market conversion price is:

(market price of the bond) / (conversion ratio) = $1,055/12 = $87.92.

The premium over straight price is:

(market price of bond) / (straight value) – 1 = ($1,055 / $1,010) – 1 = 0.0446.

(Module 27.8, LOS 27.o)

Related Material

SchweserNotes - Book 4

4. (B) increase by less than 10%.

Explanation

When the underlying stock price rises, the convertible bond will underperform because of the conversion premium. However, buying convertible bonds in lieu of stocks limits downside risk. The price floor set by the straight bond value causes this downside protection.

(Module 27.8, LOS 27.q)

Related Material

SchweserNotes - Book 4

5. (C) option-free bond value minus the value of the call option.

Explanation

The value of a bond with an embedded call option is simply the value of a noncallable ($V_{noncallable}$) bond minus the value of the option (V_{call}). That is: $V_{callable} = V_{noncallable} - V_{call}$.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

6. (A) MBS-X.

Explanation

MBS-X has the highest OAS relative to the cost of the option embedded in the MBS. Therefore, it is the most attractive of the four alternatives.

(Module 27.4, LOS 27.g)

Related Material

SchweserNotes - Book 4

7. (B) average spreads over the Treasury spot rate curve.

Explanation

OAS is interpreted as the average spread over the Treasury spot rate curve. The nominal spread is measured relative to the Treasury yield curve.

(Module 27.4, LOS 27.g)

Related Material

SchweserNotes - Book 4

8. (C) parallel shift up and down of the yield curve.

Explanation

The usual method is to apply parallel shifts to the yield curve, use those curves to compute new sets of forward rates, and then enter each set of rates into the interest rate tree. The resulting volatility of the present value of the bond is the measure of effective duration.

(Module 27.5, LOS 27.i)

Related Material

SchweserNotes - Book 4

9. (B) plus the value of a call option on the stock.

Explanation

A traditional convertible bond can be viewed as a straight bond plus a call option on the issuer's common stock. The value of a convertible bond would be increased by an investor put option, and decreased by an issuer call option.

(Module 27.8, LOS 27.p)

Related Material

SchweserNotes - Book 4

10. (A) callable bond decreases.

Explanation

Option values are positively related to the volatility of the underlying. Thus, when interest rate volatility increases, the values of both call and put options increase. When interest rate volatility increases, the value of a callable bond (where the investor is short the call option) decreases and the value of a putable bond (where the investor is long the put option) increases. The value of a straight bond is unaffected by changes in the volatility of interest rate, though value is affected by changes in the level of interest rate.

(Module 27.3, LOS 27.d)

Related Material

SchweserNotes - Book 4

11. (B) rise.

Explanation

As volatility increases, so will the option value, which means the value of a putable bond will rise. Remember that with a putable bond, the investor is long the put option.

(Module 27.3, LOS 27.d)

Related Material

SchweserNotes - Book 4

MediSoft Inc. develops and distributes high-tech medical software used in hospitals and clinics across the United States and Canada. The firm's software provides an integrated solution to monitoring, analyzing, and managing output from a variety of diagnostic medical equipment including MRIs, CT scans, and EKG machines. MediSoft has grown rapidly since its inception ten years ago, averaging 25% growth in sales over the past decade. The company went public three years ago. Twelve months after its IPO, MediSoft made two semiannual coupon bond offerings, the first of which was a convertible bond. At the time of issuance, the convertible bond had a coupon rate of 7.25%, a par value of $1,000, a conversion price of $55.56, and ten years until maturity. Two years after issuance, the bond became callable at 102% of par value. Soon after the issuance of the convertible bond, the company issued another series of bonds, which were putable but contained no conversion or call features. The putable bonds were issued with a coupon of 8.0%, a par value of $1,000, and 15 years until maturity. One year after their issuance, the put feature of the putable bonds became active, allowing the bonds to be put at a price of 95% of par value, and increasing linearly over five years to 100% of par value. MediSoft's convertible bonds are now trading in the market for a price of $947 with an estimated straight value of $917. The company's putable bonds are trading at a price of $1,052. Volatility in the price of MediSoft's common stock has been relatively high over the past few months. Currently, the stock is priced at $50 on the New York Stock Exchange and is expected to continue its annual dividend in the amount of $1.80 per share.

High-tech industry analysts for Brown & Associates, a money management firm specializing in fixed-income investments, have been closely following MediSoft ever since it went public three years ago. In general, portfolio managers at Brown & Associates do not participate in initial offerings of debt investments, preferring instead to see how the issue trades before considering taking a position in the issue. Because MediSoft's bonds have had ample time to trade in the marketplace, analysts and portfolio managers have taken an interest in the company's bonds. At a meeting to discuss the merits of MediSoft's bonds, the following comments were made by various portfolio managers and analysts at Brown & Associates:

"Choosing to invest in MediSoft's convertible bond would benefit our portfolios in many ways, but the primary benefit is the limited downside risk associated with the bond. Because the straight value will provide a floor for the value of the convertible bond, downside risk is limited to the difference between the market price of the bond and the straight value."

"Decreasing volatility in the price of MediSoft's common stock as well as increasing volatility in the level of interest rates are expected in the near future. The combined in effects of these changes in volatility will be a decrease in the price of MediSoft's putable bonds and an increase the price of the convertible bonds. Therefore, only the convertible bonds would be a suitable purchase."

12. (C) **conversion ratio of the convertible bond would be reduced by 50%.**

Explanation

A stock split would affect the market price of the common stock and the conversion ratio of a convertible bond. Since the split is a one-for-two split, the number of shares outstanding in the marketplace will be reduced by one half. Therefore, the stock price will double, keeping the total market value of the stock the same. Upon a stock split (or a reverse stock split), the conversion ratio is adjusted to reflect the split. In this case, the conversion ratio would be reduced by half. The market conversion price would double (the price of the bond is unchanged, but the conversion ratio decreases by 50%).

(Module 27.8, LOS 27.o)

Related Material

SchweserNotes - Book 4

13. (A) **Short-term and long-term interest rates are expected to remain the same.**

Explanation

If interest rates are not expected to change then the straight value of the bond will not change (ignoring the change in value resulting from the passage of time). If the straight value does not change, then downside risk is indeed limited to the difference between the price paid for the bond and the straight value. If, however, interest rates rise as the price of the common stock falls, the conversion value will fall and the straight value will fall, exposing the holder of the convertible bond to more downside risk.

(Module 27.8, LOS 27.O)

Related Material

SchweserNotes - Book 4

14. (C) **Thirty-year Treasury notes with a coupon of 4.5%.**

Explanation

A bond with an embedded soft put is redeemable through the issuance of cash, subordinated notes, common stock, or any combination of these three securities. In contrast, a bond with a hard put is only redeemable using cash.

(Module 27.1, LOS 27.a)

Related Material

SchweserNotes - Book 4

15. (A) **only one feature.**

Explanation

The Black-Scholes model applies to the convertibility feature just as it does to the common stock. The Black-Scholes model is not appropriate for the call feature because the volatility of the bond cannot be assumed constant.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

16. (A) **The price that an investor pays for the common stock if the convertible bond is purchased and then converted into the stock.**

Explanation

The market conversion price, or conversion parity price, is the price that the convertible bondholder would effectively pay for the stock if she bought the bond and immediately converted it.

Market conversion price = market price of convertible bond + conversion ratio.

(Module 27.8, LOS 27.o)

Related Material

SchweserNotes - Book 4

17. (B) **Bond A.**

Explanation

Bond A is option-free and would have a duration that is equal to or greater than the duration of bonds B and C.

(Module 27.5, LOS 27.j)

Related Material

SchweserNotes - Book 4

18. (A) **higher than 50bps.**

Explanation

The OAS of the three bonds should be same as they are given to be identical bonds except for the embedded options (OAS is after removing the option feature and hence would not be affected by embedded options). Hence the OAS of bond B would be 50 bps absent any changes in assumed level of volatility.

When the assumed level of volatility in the tree is decreased, the value of the call option would decrease and the computed value of the callable bond would increase. The constant spread now needed to force the computed value to be equal to the market price is therefore higher than before. Hence a decrease in the volatility estimate increases the computed OAS for a callable bond.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

19. (A) **The issuer can decide when to convert the bonds to stock.**

Explanation

All of these are true except the possibility of the issuer to force conversion. The bondholder has the option to convert.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

20. (B) **stock price rises.**

Explanation

A convertible bond underperforms the underlying common stock when that stock increases in value. This is because of the conversion premium which means that the bond will increase less than the increase in stock price. If the stock price falls, the convertible bond should outperform the stock because of the floor created by the straight-value. If the stock is stable, the bond is likely to outperform the stock because of the higher current yield of the bond. If the bond is upgraded, the bond should increase in value. There is no reason that upgrading the bond should lead to the bond underperforming the stock.

(Module 27.8, LOS 27.q)

Related Material

SchweserNotes - Book 4

21. (B) **lower than 50bps.**

Explanation

The OAS of the three bonds should be same as they are given to be identical bonds except for the embedded options (OAS is after removing the option feature and hence would not be affected by embedded options). Hence the OAS of bond B would be 50 bps absent any changes in assumed level of volatility.

When the assumed level of volatility in the tree is increased, the value of the embedded call option would increase and the computed value of the callable bond would decrease. The constant spread now needed to force the computed value to be equal to the market price is therefore lower than before. Hence an increase in volatility estimate reduces the computed OAS for a callable bond.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

22. (B) **Max(put price, discounted value).**

Explanation

When valuing a putable bond using the backward induction methodology, the relevant cash flow to use at each nodal period is the coupon to be received during that nodal period plus the computed value or exercise price, whichever is greater.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

23. (C) **straight bond plus the value of the call option on the stock.**

Explanation

The value of a noncallable/nonputable convertible bond can be expressed as:

Option-free convertible bond value = straight value + value of the call option on the stock.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

24. (A) **$0, embedded call, callable bond, option-free bond.**

Explanation

The embedded call will always have a positive value prior to expiration, and this is especially true if the callable bond trades at par value. Since investors must be compensated for the call feature, the value of the option-free bond must exceed that of a callable bond with the same coupon and maturity and rating.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

25. (A) $100.00.

Explanation

The value of the callable bond at node A is obtained as follows:

Bond Value = the lesser of the Call Price or {0.5 x [Bond $Value_{up}$ + Coupon/2] + 0.5 x [Bond $Value_{down}$ + Coupon/2])/(1 + Interest Rate/2)]

So we have

Bond Value at node A = the lesser of either $100 or {0.5 x [$100.00 + $6.25/2] + 0.5 x [$100.00+ $6.25/2]}/(1+ 3.15%/2) = $101.52. Since the call price of $100 is less than the computed value of $101.52 the bond price would be $100 because once the price of the bond reached this value it would be called.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

26. (C) common stock at the option of the investor.

Explanation

The owner of a convertible bond can exchange the bond for the common shares of the issuer.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

27. (B) lower.

Explanation

Since the issuer has the option to call the bonds before maturity, he is able to call the bonds when their coupon rate is high relative to the market interest rate and obtain cheaper financing through a new bond issue. This, however, is not in the interest of the bond holders who would like to continue receiving the high coupon rates. Therefore, they will only pay a lower price for callable bonds.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

28. (C) cause negative convexity.

Explanation

Negative convexity is caused by the bond being callable where the issuer has the embedded call option. Negative convexity does not apply to convertible bonds. The convertibility feature gives the bondholder a call option on the shares of common stock of the issuer. This increases the price of the bond and places a lower limit on the possible values of the bond. However, that lower limit will change with the price of the common stock.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

29. (A) not be higher than the call price or lower than the put price.

Explanation

At each node, there will only be two values. At each node, the analyst must determine if the initially calculated values will be below the put price or above the call price. If a calculated value falls below the put price: $V_{i,U}$ = the put price. Likewise, if a calculated value falls above the call price, then $V_{i,L}$ = the call price. Thus the put and call price are lower and upper limits, respectively, of the bond's value at a node.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

30. (A) 98.29.

Explanation

		100.00
	A → 98.67	
98.29		100.00
	99.00	
		100.00

As an example, the price at node A is obtained as follows:

$Price_A$ = min[(prob × (P_{up} + (coupon/2) + prob × (P_{down} + (coupon/2)) / (1/ + (rate/2)), call price] = min[(0.5 × (100 + 2.5) + 0.5 × (100 + 2.5)) / (1 + (0.0776 / 2)), 99} = 98.67. The bond values at the other nodes are obtained in the same way.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

Alnoor Hudda, CFA, is valuing two floaters issued by Mateo Bank. Both floaters have a par value of $100, three year life and pay based on annual MRR. Hudda has generated the following binomial tree for MRR.

1-year forward rates starting in year:

0	1	2
2%	5.7798%	6.0512%
	3.8743%	4.0562%
		2.7190%

31. (A) $98.70

Explanation

The cap will be in the money for nodes 2,UU; 2,UL; and 1,U.

$V_{2,UU}$ = 104/1.060512 = 98.07

$V_{2,UL}$ = 104/1.040562 = 99.95

$V_{2,UL}$ = 102.7190/1.027190 = 100

$$V_{1,U} = \frac{\left(\frac{98.07 + 99.95}{2} + 4\right)}{1.057798} = 97.38$$

$$V_{1,L} = \frac{\left(\frac{100 + 99.95}{2} + 3.8743\right)}{1.038743} = 99.98$$

$$V_0 = \frac{\left(\frac{97.38 + 99.98}{2} + 2\right)}{1.02} = 98.71$$

(Module 27.7, LOS 27.m)

Related Material

SchweserNotes - Book 4

32. (A) $1.29

Explanation

value of the cap = $100 – $98.71 = $1.29

The cap will be in the money for nodes 2,UU; 2,UL; and 1,U.

$V_{2,UU}$ = 104/1.060512 = 98.07

$V_{2,UL}$ = 104/1.040562 = 99.95

$V_{2,UL}$ = 102.7190/1.027190 = 100

$$V_{1,U} = \frac{\left(\frac{98.07 + 99.95}{2} + 4\right)}{1.057798} = 97.38$$

$$V_{1,L} = \frac{\left(\frac{100 + 99.95}{2} + 3.8743\right)}{1.038743} = 99.98$$

$$V_0 = \frac{\left(\frac{97.38 + 99.98}{2} + 2\right)}{1.02} = 98.71$$

(Module 27.7, LOS 27.m)

Related Material

SchweserNotes - Book 4

33. (A) 101.000.

Explanation

The tree will have three nodal periods: 0, 1, and 2. The goal is to find the value at node 0. We know the value for all the nodes in nodal period 2: V_2 = 100. In nodal period 1, there will be two possible prices:

$V_{1,U}$ =[(100 + 8.2)/1.076 + (100 + 8.2)/1.076]/2 = 100.558

$V_{1,L}$ =[(100 + 8.2)/1.068 +(100 + 8.2)/1.068]/2 = 101.311

Since $V_{1,L}$ is greater than the call price, the call price is entered into the formula below:

V_0 = [(100.558 + 8.2)/1.079) + (101 + 8.2)/1.079)]/2 = 101.000.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

34. (C) Bond B.

Explanation

When the underlying option is at (or near) money, callable bonds will have lower one-sided down-duration than one-sided up-duration; the price change of a callable when rates fall is smaller than the price change for an equal increase in rates. In this problem, the coupon rate is given to be equal to the current level of rates and hence the bond should be at par and the underlying option is at-the-money.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

35. (A) **Min(call price, discounted value).**

Explanation

When valuing a callable bond using the backward induction methodology, the relevant cash flow to use at each nodal period is the coupon to be received during that nodal period plus the computed value or the call price, whichever is less.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

36. (B) **A possibility is that the level of interest rates remained constant, but the volatility of interest rates fell.**

Explanation

As volatility declines, so will the option value, which means the value of a callable bond will rise.

(Module 27.3, LOS 27.d)

Related Material

SchweserNotes - Book 4

37. (A) **Bond C**

Explanation

Bond C is putable and hence has limited downside potential when rates rise. The other two bonds do not have any such protection.

(Module 27.3, LOS 27.e)

Related Material

SchweserNotes - Book 4

38. (B) **ED = 7.801, EC = 80.73.**

Explanation

$ED = (V_{-} - V_{+}) / (2V_0(\Delta Y))$

$= (107.0719 - 99.0409) / (2 \times 102.9525 \times 0.005) = 7.801$

$EC = (V_{-} + V_{+} - 2V_0) / (V_0(\Delta Y)^2)$

$= (107.0719 + 99.0409 - (2 \times 102.9525)) / [(102.9525 \times (0.005)^2)] = 80.73$

(Module 27.5, LOS 27.i)

Related Material

SchweserNotes - Book 4

39. (B) **option-free bond value plus the value of the put option.**

Explanation

The value of a putable bond can be expressed as $V_{putable} = V_{nonputable}\ V_{put}$.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

Philip Bagundang, CFA, is an experienced analyst working for the corporate credit department of a global investment bank.

Bagundang is evaluating the proposed two-year, zero coupon, £100 par Shumensko bond. Using a 2% probability of default assumption, Bagundang calculates the CVA on the bond to be £1.820. Two-year, risk-free zero-coupon bonds currently yield 0.8%.

Bagundang is evaluating a three-year, zero-coupon bond issued by Alligator, Inc. Using a hazard rate of 2% and estimated recovery rate of 70%, and a flat 2.5% benchmark yield curve, a partial table of analysis is completed as shown in Exhibit 1.

Exhibit 1: Alligator, Inc. Bond

Year	Exposure	Loss given default	Probability of survival	Probability of default	Expected loss
1	95.18	28.55	98.00%	2.00%	0.5711
2					
3	100.00	30.00	94.12%		

Bagundang asks his assistant, Diane Monera, to summarize how structural models can be viewed as options on the firm's assets. Monera states that shareholders have limited liability and can, therefore, be viewed as having a long call option on the firm's assets with a strike price equal to the par value of debt. In addition, she adds, debtholders can be viewed as having a long position in a risk-free zero-coupon bond and a position in another instrument she can't quite remember.

Finally, Bagundang asks Monera to prepare a short summary table of structural versus reduced form models. Exhibit 2 shows her summary.

Exhibit 2: Structural vs. Reduced Form Models

	Structural	Reduced Form
Default risk	Exogenous	Endogenous
Parameter estimation	Option pricing theory	Default intensity

40. (C) 0.95%.

Explanation

The credit valuation adjustment is the difference between the value of a risky bond and thevVillii) equivalent risk-free bond (VND).

A two-year risk free bond with a face value of £100 and a yield-to-maturity of 0.8% would have a present value of £98.42.

The CVA on the Shumensko bond is £1.820 per £100 par value.

Bond value = VND – CVA = 98.42 – 1.82 = £96.60

Using TVM Keys:

N = 2; PMT = 0; FV = 100; PV = –96.60; CPT I/Y = ? = 1.75%

The credit spread is the difference between this value and the YTM of the equivalent risk-free bond (0.8%) = 0.95%.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

41. (B) $0.5737.

Explanation

The completed table is shown below:

Exhibit 1: Alligator, Inc. Bond

Year	Exposure	Loss given default	Probability of survival	Probability of default	Expected loss
1	95.18	28.55	98.00%	2.00%	0.5711
2	97.56	29.27	96.04%	1.96%	0.5737
3	100.00	30.00	94.12%	1.92%	0.5762

The exposure in year 2 for a zero-coupon bond is the present value of par discounted at the benchmark (risk-free) rate. $100 / (1.025). The loss given default is the exposure multiplied by 1 – recovery rate. ($97.56 x 0.30). The probability of default is the hazard rate of 2% multiplied by the previous year's probability of survival (2% x 98.00%).

The expected loss is the loss given default multiplied by the probability of default (1.96% x $29.27) = $0.5737.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

42. (B) **short put with a strike price equal to the value of debt.**

Explanation

Debtholders are viewed as having a long position in a riskless bond that pays X at time T and simultaneously a short position in a European put option on company assets with a strike price of X (equal to the face value of debt). In other words, debtholders receive either the face value of debt if the company survives or X – (X – A) = A if the company defaults (where A = the value of the assets of the company).

(Module 27.4, LOS 27.g)

Related Material

SchweserNotes - Book 4

43. (B) **inaccurate in regards to default risk.**

Explanation

Unlike structural models of credit risk, which treat default risk as an endogenous variable (i.e., when the value of the assets is less than the face value of debt), reduced form models do not explain why default occurs, instead they treat default as a randomly-occurring (exogenous) variable. Reduced form models focus on the severity of loss given default.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

44. (C) **$0, embedded call, callable bond, option-free bond.**

Explanation

The embedded call will always have a positive value prior to expiration, and this is especially true if the callable bond trades at par value. Since investors must be compensated for the call feature, the value of the option-free bond must exceed that of a callable bond with the same coupon and maturity and rating.

(Module 27.2, LOS 27.c)

Related Material

SchweserNotes - Book 4

Company Isla has a four-year, 6.5% bond that is callable under the following schedule:

- 102 in one year's time
- 101 in two years' time
- 100 in three years' time

The binomial interest rate assuming a 10% rate volatility is shown in Exhibit 1.

At each of the nodes:

F = the value of the bond obtained by applying the backward induction process (i.e., the expected PV of future cash flows from the bond)

C = the coupon received at the time of the node

V = For the call price depending on whether or not the company is likely to call the bond

Exhibit 1: Binomial Interest Rate Tree

45. (A) A = 99.041 B = 100.000

Explanation

A is 99.041 since the call price is higher at 100 and the issuer will choose the cheapest route.

The missing value F = 106.5 ÷ 1.06166 = 100.315 and hence B is 100 since it is cheaper for the issuer to call.

(Module 27.6, LOS 27.l)

Related Material

SchweserNotes - Book 4

46. (C) 101.000.

Explanation

Lower of F (101.723) and the call price in two years' time of 101.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

47. (C) The binomial tree can be used to calculate the OAS of a callable corporate bond but not a mortgage backed security (MBS), as the MBS value is path dependent.

OAS on callable or putable bonds can be calculated using binomial interest rate trees. MBS has a prepayment risk, and hence has an embedded call option. Binomial interest rate tree cannot be used to value MBS as the prepayment risk (call risk) in MBS is path dependent.

Spot rate curve comprises a single rate for each time period and hence cannot be used to value securities with embedded options. If spot rate curve is used, implicitly you would be assuming zero volatility in rates, and therefore end up valuing the time value component of the option value as zero.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

48. (C) 102.576.

Explanation

Make sure to use the lower of the call price or calculated value for lower node in year 2 (i.e., $101).

G = {(101 + 100.27) / 2 + 6.50) / (1.044448) = 102.57

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

49. (C) Callable bond

Explanation

If a bond is a zero-coupon bond (or if it has a "very low" coupon), key rate durations for maturity points that are shorter than the maturity of the bond being analyzed are generally negative. For example, the five-year key rate duration for a 10-year zero-coupon bond can be expected to be less than zero.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

50. (B) **The spot rate for the maturity of the bond is least important rate affecting the value of the bond.**

Explanation

If an option-free bond is trading at par, the bond's maturity-matched rate (or the spot rate applicable to its maturity) is the only rate that affects the bond's value. Its maturity key rate duration is the same as its effective duration, and all other key rate durations are zero.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

51. (A) **shift the Treasury yield curve, compute the new forward rates, add the OAS to those forward rates, enter the adjusted values into the interest rate tree, and then use the usual convexity formula.**

Explanation

The analyst uses the usual convexity formula, where the upper and lower values of the bonds are determined using the tree.

(Module 27.5, LOS 27.i)

Related Material

SchweserNotes - Book 4

52. (C) 99.00.

Explanation

As an example, the price at node A is obtained as follows:

$Price_A$ = max[par value + coupon / (1 + rate), put price] = max[(100 + 2.5) / (1 + 0.0375) ,99] = 99.00. The bond values at the other nodes are obtained in the same way.

The calculated price at node 0 =

[0.5(99.00 + 2.5) + 0.5(99.84 + 2.5)] / (1 + 0.03175) = $98.78 but since the put price is $99 the price of the bond will not go below $99.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

53. (B) callable.

Explanation

The effective convexity of a callable bond be negative (meaning that the upside for the callable bond is smaller than the downside) when the call option is near the money. Option-free bonds exhibit positive convexity, meaning that the price rises more when interest rates fall than the bond price declines when interest rates rise by the same amount. The convexity of putable bonds is always positive.

(Module 27.6, LOS 27.l)

Related Material

SchweserNotes - Book 4

Mike Diffle has been asked to evaluate the bonds of Hardin, Inc. The specific issue Diffle is considering has an 8% annual coupon and matures in two years. The bonds are currently callable at 101, and beginning in six months, they are callable at par. Bratton Corporation, Hardin's competitor, also has bonds outstanding which are identical to Hardin's except that they are not callable. Diffle believes the AA rating of both bonds is an accurate reflection of their credit risk. Diffle is wondering if the Bratton bonds might be a better investment than the Hardin bonds. Assume that the following 1-year interest rate tree is used to value bonds with a maturity of up to three years (this tree assumes interest rate volatility of 10%).

Today	Year 1	Year 2
		9.324%
	8.530%	
7.250%		7.634%
	6.983%	
		6.250%

Also, assume that the appropriate spot rates for securities maturing in one, two, and three years are 7.25%, 7.5%, and 7.80%, respectively.

Diffle believes he should begin his analysis with the option-free Bratton bonds. He decides to consider two different approaches to valuing the Bratton Bonds—one that uses the current spot rate curve and another that uses the interest rate tree given above.

For the next step in his analysis, Diffle has decided to calculate the value of the Hardin bonds using the interest rate tree. His assumption is that the bond will be called at any node of the tree where the calculated value exceeds the call price. Diffle summarizes the results of his bond valuation analysis in a memo to his supervisor, Luke Puldo. In this memo, Diffle makes the following statements:

Statement 1: The value of the option embedded in the Hardin bonds can be derived by simply subtracting the interest rate tree value of the Hardin bonds from the interest rate tree value of the Bratton bonds.

Statement 2: I am concerned that the 10% volatility assumption used to develop the interest rate tree might be too low. A higher volatility assumption would result in a lower value for the Hardin bonds.

After reviewing Diffle's analysis, Puldo notes that Diffle has not included any information on the option adjusted spread (OAS) for the Hardin bonds. Puldo suggests that Diffle should evaluate the OAS in order to get an idea of the liquidity risk of the Hardin bonds. Diffle counters that the OAS may not be very informative in this case, since he is uncertain as to the reliability of the interest rate volatility assumption.

To finish his analysis, Diffle would like to use his binomial model to evaluate the interest rate risk of both the Hardin bonds and the Bratton bonds. Diffle has shocked interest rates by 25 basis points throughout the interest rate tree he has been using to value the two bond issues. Using the new rates, Diffle has calculated values for the bonds assuming a 25–basis-point increase or decrease in rates. He plans to use these values as inputs into the following formulas for duration and convexity:

$$\text{Duration} = \frac{V_- - V_+}{2 \times V_0 \times \Delta y} \qquad \text{convexity} = \frac{V_+ - V_+ - 2V_0}{2 \times V_0 \times (\Delta y)^2}$$

54. (B) use on-the-run interest rates for other callable Hardin bonds as a benchmark in order to isolate the liquidity risk of the 2-year bond issue.

Explanation

By using on-the-run rates of the issuing company, there will be no difference in credit risk captured in the spread. The only risk left will be liquidity risk. Using on-the-run U.S. Treasury liquidity risk would also be included. Using a benchmark that has no credit risk would not help differentiate the Hardin bonds from the Bratton bonds.

(Module 27.4, LOS 27.g)

Related Material

SchweserNotes - Book 4

55. (A) **The duration estimate for the Bratton bonds will reflect the projected percentage change in price for a 100-basis-point change in interest rates.**

Explanation

The duration formula given will calculate the percentage change in price for a 100 basis point change in yield, regardless of the actual change in rates used to derive BV_ and BV+. The standard backward induction process would ensure that the derived values of BV_ and BV+ reflect any potential change in cash flows due to embedded options.

(Module 27.6, LOS 27.l)

Related Material

SchweserNotes - Book 4

56. (A) **correct that the OAS will provide insight into the liquidity risk of the Hardin bonds, and Diffle is correct that different volatility assumptions would change the OAS.**

Explanation

The OAS accounts for compensation for credit and liquidity risk after the optionality has been removed (i.e., after cash flows have been adjusted). Since in this case the credit risk of the bonds is similar, the OAS could prove helpful in evaluating the relative liquidity risk. OAS will be affected by different assumptions regarding the volatility of interest rates.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

57. (B) **Both statements are correct.**

Explanation

Statement 1 is correct. The value of the option would be the difference between the value calculated with no call feature (the Bratton bonds) and the value calculated assuming the bond is callable (the Hardin bonds). Recall that the vignette stated the Bratton and Hardin bonds were identical except for the call feature in the Hardin bonds. The option value would therefore be: 100.915 – 100.472 = 0.443. Statement 2 is also correct. Increased volatility would increase the value of the option, thus lowering the value of the callable bond.

(Module 27.5, LOS 27.j)

Related Material

SchweserNotes - Book 4

Kate Inka is a new hire for Maya Incorporated, a fixed income fund manager. On her first week on the job, she is asked to prepare a presentation on valuation and analysis of bonds with embedded options.

Inka starts her presentation with the following three statements:

Statement 1: "In times of increased expectations of interest rate volatility the value of callable bonds will fall."

Statement 2: "When trying to analyze the return for credit and liquidity risk on a corporate callable bond relative to a government bond, the Z-spread must be calculated. The Z-spread can be viewed as the constant spread added to treasury spot rates such that the present value of the callable bonds coupons and principal equate to its market price."

Statement 3: "When analyzing the interest rate risk of a callable bond it is worth keeping in mind that its effective convexity will be less than or equal to the equivalent option free bond."

Inka is analyzing a three-year, 6% annual coupon, $100 par callable bond. The bond has a European call feature allowing it to be called at 101% of par in two years' time. Inka uses a binomial tree assuming interest rate volatility of 20% as shown in Exhibit 1.

Exhibit 1: Binomial Lattice

T_0	T_1	T_2
		6.34%
	5.45%	
3%		?????
	3.65%	
		2.85%

Inka makes the following three comments about her binomial tree exercise:

Comment 1: "If the spot and expected future 1-period rates in the binomial tree have been derived from treasury securities we should be aware that the backwardly induced value of a corporate bond would be too high relative to its market price."

Comment 2: "For a corporate callable bond, the option adjusted spread must be added as a fixed margin to all the treasury spot and expected future 1-period rates so that the backwardly induced price converges with market price."

Comment 3: "If we were to increase our assumption of interest rate volatility used to create the binomial tree, the estimated option adjusted spread would be smaller."

Finally, Inka makes three comments on her use of effective duration:

Comment 1: "Given that a corporate callable bond will exhibit negative convexity when yields are low, care must be taken when interpreting effective duration, as essentially the computation averages the impact of the up and down shock on bond price. Perhaps the non-symmetrical price reaction to yield increases and decreases would be better captured by looking at one-sided durations."

Comment 2: "Effective duration is an incomplete measure of interest rate risk as it fails to adequately capture option risk. For example, callable bonds are more sensitive to interest rate risk due to embedded options and as such have a higher effective duration."

Comment 3: "One method of capturing shaping risk is to compute one-sided durations. A 20-year bond callable after 10 years with a low coupon is likely to have the highest one-sided duration corresponding to the call date. If the coupon is increased the one-sided duration corresponding to the call date declines but the maturity matched 20-year one-sided duration increases."

58. (A) Two.

Explanation

Statement 1 is true.

The value of a callable bond = value of an identical straight bond – value of embedded call.

The value of embedded options, (both call and put) will increase in times of higher expected interest rate volatility. Therefore, the value of a callable bond will fall when rate volatility rises.

Statement 2 is false. The Z-spread on a callable bond will be affected by credit risk and liquidity risk, relative to benchmark bonds used to calculate the spot rates. Z-spreads are also affected by embedded options. Embedded call (put) option increases (decreases) the Z-spread. The option adjusted spread (AOS) removes the uncertainty of the embedded option feature by modelling the impact on the bonds cash flows. Instead of the Z-spread, a constant OAS should be added to each spot and expected future 1-period rates in a binomial tree such that the backwardly induced price converges with market price. The OAS reflects credit and liquidity risk relative to the benchmark securities only.

Statement 3 is true.

Callable bonds exhibit negative convexity when yields fall to low levels. This is due to the price compression the bond experiences relative to a straight bond as the option moves towards the money.

(Module 27.6, LOS 27.l)

Related Material

SchweserNotes - Book 4

59. (A) $104.89.

Explanation

First compute the missing rate using the relationship:

upper rate = lower rate $e^{2 \times \text{volatility}}$ = 2.85%$e^{2x0.2}$ = 4.25%

Then use backward induction

T_0	T_1	T_2	T_3
			$106.00
		$99.68	
		$6.00	
		$105.68	
	$100.84		$106.00
	$6.00	~~$101.68~~	
	$106.84	$101.00	
		$6.00	
$104.89		$107.00	
	$103.23		$106.00
	$6.00	~~$103.06~~	
	$109.23	$101.00	
		$6.00	
		$107.00	
			$106.00

Value at T2 Upper:

106 / 1.0634 = 99.68.

Value at T2 Middle:

106 / 1.0425 = 101.67. Replace with the call price of $101.

Value at T2 Lower:

106 / 1.0285 = 103.06. Replace with the call price of $101.

Value at T1 Upper:

((99.68 + 101) / 2 + 6) / 1.0545 = 100.84. Bond is not callable at T1.

Value at T1 Lower:

((101 + 101) / 2 + 6) / 1.0365 = 103.23. Bond is not callable at T1.

Value at T0

((100.84 + 103.23) / 2 + 6) / 1.03 = $104.89.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

60. (C) Three.

Explanation

Comment 1 is true. A correctly calibrated (to treasury securities) binomial tree will reflect the credit and liquidity risk of treasury securities. Corporate bonds typically will have greater credit and liquidity risk than government securities and as a result, the rates in the tree are too low. Backward induction using the tree would value the corporate bond too high relative to its market price.

Comment 2 is true. The option adjusted spread (OAS) is the constant spread when added to the treasury spot and expected future 1-period rates in the tree, will value the callable corporate bonds equal to its market price.

Comment 3 is true. If the analyst increases the volatility assumption used to build the tree the spread between lower and upper forward rates will widen. Backwardly inducing the corporate callable bond will now result in a lower value. It is important to note that this is the analyst changing their assumption used to build the tree which will not impact the bond's actual market price. As the backwardly induced value is now lower but the market price remains unchanged, a smaller OAS needs to be added to force the backwardly induced value to be equal to the market price.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

61. (B) One.

Explanation

Comment 1 is true. Effective duration calculates sensitivity to a 100 basis point change in yield to maturity by taking the arithmetic mean impact of parallel upwards and downwards shift in a bonds yield on price. Even for option free bonds, this linear estimation approach causes estimation error due to convex nature of bonds. An embedded option causes greater estimation error. A callable bond will react very differently to upwards and downwards shifts yield due to the option moving towards or away from the money. A solution to this is to analyse sensitivity to upwards and downwards shifts in yield separately by using one-sided durations.

Comment 2 is false. Effective duration of a callable bond will be less than (or equal to) an otherwise identical straight bond.

Comment 3 is false. Key rate duration measures the sensitivity of a bond's price to a change in a single par rate, holding all other par rates constant. For an option free bond, the highest key rate duration is the maturity-matched key rate. For callable bonds with low coupons, the greatest key rate duration will be the maturity-matched key rate (due to the low probability of the bond being called). As the coupon rate is increased, the probability of the bond being called increases and as a result the key rate relating to the call date will increase while the maturity-matched key rate will decrease.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

62. (C) Bond B

Explanation

Bond B has an embedded call option which limits its upside resulting in negative convexity. Bonds A and C do not have such limits.

(Module 27.3, LOS 27.e)

Related Material

SchweserNotes - Book 4

63. (A) Bond B.

Explanation

When the underlying option is at (or near) money, callable bonds will have lower one-sided down-duration than one-sided up-duration; the price change of a callable when rates fall is smaller than the price change for an equal increase in rates. In this problem, the coupon rate is given to be equal to the current level of rates and hence the bond should be at par and the underlying option is at-the-money.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

64. (A) Bond C.

Explanation

Increase in rates would increase the likelihood of the put option being exercised and reduce the expected life (and duration) of the putable bond the most.

(Module 27.5, LOS 27.j)

Related Material

SchweserNotes - Book 4

65. (C) 98.246.

Explanation

The tree will have three nodal periods: 0, 1, and 2. The goal is to find the value at node 0. We know the value at all nodes in nodal period 2: V_2 =100. In nodal period 1, there will be two possible prices:

$V_{i,U}$ = [(100 + 6.4) / 1.076 + (100+6.4) / 1.076] /2 = 98.885

$V_{i,L}$ = [(100 + 6.4) / 1.068 + (100 + 6.4) / 1.068] / 2 = 99.625.

Since 98.885 is less than the put price, $V_{i,U}$ = 99

V_0 = [(99 + 6.4) / 1.076) + (99.625 + 6.4) / 1.076)] / 2 = 98.246.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

66. (C) **lower than 50bps.**

Explanation

The OAS of the three bonds should be same as they are given to be identical bonds except for the embedded options (OAS is after removing the option feature and hence would not be affected by embedded options). Hence the OAS of bond C would be 50 bps absent any changes in assumed level of volatility.

When the assumed level of volatility in the tree is decreased, the value of the embedded put option would decrease and the computed value of the putable bond would also decrease. The constant spread that is now needed to force the computed value to be equal to the market price is therefore lower than before. Hence a decrease in the volatility estimate reduces the computed OAS for a putable bond.

(Module 27.4, LOS 27.h)

Related Material

SchweserNotes - Book 4

67. (A) **decline.**

Explanation

As volatility increases, so will the option value, which means the value of a callable bond will decline. Remember that with a callable bond, the investor is short the call option.

(Module 27.3, LOS 27.d)

Related Material

SchweserNotes - Book 4

68. (B) **minus the price of a callable bond of the same maturity, coupon and rating.**

Explanation

The value of the option embedded in a bond is the difference between that bond and an option-free bond of the same maturity, coupon and rating. The callable bond will have a price that is less than the price of a non-callable bond. Thus, the value of the embedded option is the option-free bond's price minus the callable bond's price.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

69. (A) **on both interest rate changes and changes in the market price of the stock.**

Explanation

The value of convertible bond includes the value of a straight bond plus an option giving the bondholder the right to buy the common stock of the issuer. Hence, interest rates affect the bond value and the underlying stock price affects the option value.

(Module 27.8, LOS 27.n)

Related Material

SchweserNotes - Book 4

70. (B) **the difference between the value of the option-free bond and the callable bond.**

Explanation

The callable bond is equivalent to the option-free bond except that the issuer has the option to call the bond at the call price before maturity. Therefore, for the holder of the bond, the bond is worth the same as the option-free bond reduced by the value of the option.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

71. (C) **Bond B.**

Explanation

Decrease in rates would increase the likelihood of the call option being exercised and reduce the expected life (and duration) of the callable bond the most.

(Module 27.5, LOS 27.j)

Related Material

SchweserNotes - Book 4

72. (A) **Credit and liquidity risk.**

Explanation

OAS is "Option-adjusted" and hence includes no compensation for option risk: OAS is compensation for taking credit and liquidity risk. (Nominal spread, by comparison, includes compensation for liquidity risk, credit risk, and option risk.) Analysts prefer higher OAS, after controlling for credit and liquidity risk.

(Module 27.4, LOS 27.g)

Related Material

SchweserNotes - Book 4

73. (A) **Callable bond, option-free bond, putable bond.**

Explanation

The put features increase the value of a bond and the call feature lowers the value of a bond, when all other things are equal. Thus, the putable bond generally traders higher than a corresponding option-free bond, and the callable bond trades at a lower price.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

74. (C) **lower risk and lower return potential.**

Explanation

Buying convertible bonds in lieu of direct stock investing limits downside risk due to the price floor set by the straight bond value. The cost of the risk protection is the reduced upside potential due to the conversion premium.

(Module 27.8, LOS 27.q)

Related Material

SchweserNotes - Book 4

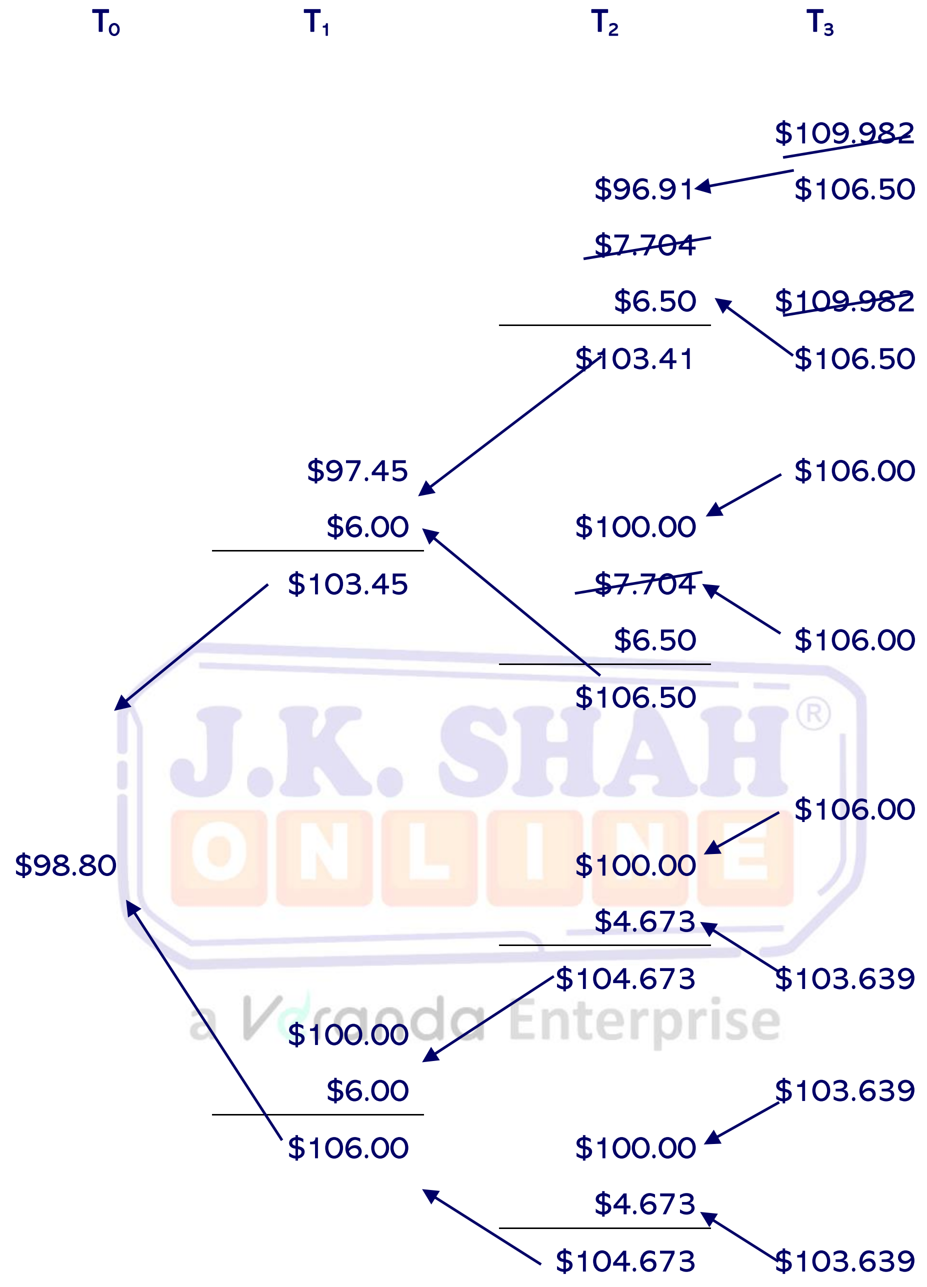
George Nagy is a fixed income manager with Luna Securities. Nagy is analyzing several securities issued by Redna, Inc. First, he is looking at a three-year, annual-pay floating rate note with an embedded cap of 6.5% paying coupons in arrears.

Nagy's assistant has provided him with the binomial interest rate tree below (computed with assumed volatility of 25%) to aid in her analysis.

T_0	T_1	T_2
		9.892%
	7.704%	
6%		6%
	4.673%	
		3.639%

A three-year, Redna, Inc., callable bond is currently trading at a price of $102. An otherwise identical straight bond is also trading. Nagy obtains the report of the firm's chief economist indicating that rates are trending lower.

75. (A) $98.80.



Explanation

Value at T_2

Upper = \$106.5 / 1.09892 = \$96.91 (Note coupon capped at \$6.50.)

Middle = \$106 / 1.06 = \$100

Lower = \$103.639 / 1.03639 = \$100

Value at T_1

Upper = $\frac{1}{2}$(\$103.41 + \$106.50) / 1.07704 = \$97.45 (Note coupon capped at \$6.)

Lower = $\frac{1}{2}$($104.63 + $104.63) / 1.04673 = $100

Value at T_0

Price = $\frac{1}{2}$ ($103.45 + $106) / 1.06 = $98.80

(Module 27.7, LOS 27.m)

Related Material

SchweserNotes - Book 4

76. (C) **Statement I is incorrect but Statement II is correct.**

Explanation

The straight bond will be priced higher, as the investor will not have the risk of the bond being called. If interest rate volatility rises then the call option will become more valuable, and the price differential will widen.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4

77. (A) **The put option becomes an effective floor price at each applicable node, instead of the call's effective ceiling price.**

Explanation

A put option is an effective floor at each node. Call feature would no longer be relevant.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

78. (C) **straight, putable, callable.**

Explanation

Since the rates are trending lower, the call option is likely to be exercised while the put will not. Therefore the effective duration of callable < effective duration of putable. Otherwise identical straight bonds will always have a higher (or same) effective durations than either callables or putables.

(Module 27.5, LOS 27.j)

Related Material

SchweserNotes - Book 4

79. (B) 98.00.

Explanation

The putable bond price tree is as follows:

		100.00
A ==> 98.27		
98.00		100.00
	99.35	
		100.00

As an example, the price at node A is obtained as follows:

$Price_A$ = max{(prob x (P_{up} + coupon/2) + prob x (P_{down} + coupon/2))/(1 + rate/2), putl price} = max{(0.5 x (100 + 2) + 0.5 x (100 + 2))/(1 + 0.0759/2),98) = 98.27. The bond values at the other nodes are obtained in the same way.

The price at node 0 = [0.5 x (98.27 + 2) + 0.5 x (99.35 + 2)]/ (1 + 0.0635/2) = $97.71 but since this is less than the put price of $98 the bond price will be $98.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

80. (B) $39.41.

Explanation

The market conversion price is computed as follows:

Market conversion price = market price of convertible security/conversion ratio = $1,050/26.64 = $39.41

(Module 27.8, LOS 27.o)

Related Material

SchweserNotes - Book 4

81. (B) **yield curve has to be shifted upward and downward in a parallel manner and the binomial tree recalculated each time.**

Explanation

Apply parallel shifts to the yield curve and use these curves to compute new forward rates in the interest rate tree. The resulting bond values are then used to compute the effective convexity.

(Module 27.5, LOS 27.i)

Related Material

SchweserNotes - Book 4

82. (C) 98.25.

Explanation

The callable bond price tree is as follows:

		100.00
	98.75	
98.26		100.00
	99.00	
		100.00

The formula for the price at each node is:

Price = min{(prob x (P_{up} + coupon) + prob x (P_{down} + coupon)) / (1 + rate), call price).

Up Node at t = 0.5: min{(0.5 x (100 + 2.5) + 0.5 x (100 + 2.5)) / (1 + 0.038), 99) = 98.75.

Down Node at t = 0.5: min{(0.5 x (100 + 2.5) + 0.5 x (100 + 2.5)) / (1 + 0.026), 99) = 99.00.

Node at t = 0.0: min{(0.5 x (98.75 + 2.5) + 0.5 x (99 + 2.5))/(1 + 0.0318), 99) = 98.25.

(Module 27.2, LOS 27.f)

Related Material

SchweserNotes - Book 4

83. (B) Low coupon callable bonds.

Explanation

Callable bonds with low coupon rate are unlikely to be called; hence, their maturity-matched rate is their most critical rate (i.e., the highest key rate duration corresponds to the bond's maturity). Similarly, putable bonds with high coupon rates are unlikely to be put and are most sensitive to their maturity-matched rates.

(Module 27.6, LOS 27.k)

Related Material

SchweserNotes - Book 4

84. (C) 0.74.

Explanation

The call option value is just the difference the value of the option-free bond and the value of the callable bond. Therefore, we have:

Call option value = 100.16 – 99.42 = 0.74.

(Module 27.1, LOS 27.b)

Related Material

SchweserNotes - Book 4