ΑΣΚΗΣΕΙΣ – Κεφάλαιο 5

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- **15.4, 15.6, 15.7, 15.9, 15.10, 15.11, 15.12, 15.13, 15.18, 15.20, 15.25, 15.26**

15.4. *Follow Bank has a \$1 million position in a five-year, zero-coupon bond with a face value of \$1,402,552. The bond is trading at a yield to maturity of 7.00 percent. The historical mean change in daily yields is 0.0 percent and the standard deviation is 12 basis points.*

a. What is the modified duration of the bond?

ANSWER: MD = D/(1 + R) = 5/(1.07) = 4.6729 years

b. What is the maximum adverse daily yield move given that we desire no more than a 1 percent chance that yield changes will be greater than this maximum?

ANSWER: Potential adverse move in yield at 1 percent = 2.33σ = 2.33 x 0.0012 = 0.002796

c. *What is the price volatility of this bond?*

ANSWER: Price volatility = MD x potential adverse move in yield
= 4.6729 x 0.002796 = 0.013065 or 1.3065 percent

d. *What is the daily earnings at risk for this bond?*

ANSWER: DEAR = (\$ value of position) x (price volatility)
= \$1,000,000 x 0.013065 = \$13,065

15.6. *The DEAR for a bank is \$8,500. What is the VAR for a 10-day period? A 20-day period? Why is the VAR for a 20-day period not twice as much as that for a 10-day period?*

ANSWER: For the 10-day period: VAR = 8,500 x $[10]^{½}$ = 8,500 x 3.1623 = \$26,879
For the 20-day period: VAR = 8,500 x $[20]^{½}$ = 8,500 x 4.4721 = \$38,013
The reason that 20-day VAR $\neq$ (2 x 10-day VAR) is because $[20]^{½} \neq (2 \times [10]^{½})$. The interpretation is that the daily effects of an adverse event become less as time moves farther away from the event.

15.7. *The mean change in the daily yields of a 15-year, zero-coupon bond has been five basis points (bp) over the past year with a standard deviation of 15 bp. Use these data and assume that the yield changes are normally distributed.*

a. *What is the highest yield change expected if a 99 percent confidence limit is required; that is, adverse moves will not occur more than 1 day in 100?*

ANSWER: If yield changes are normally distributed, 98 percent of the area of a normal distribution will be 2.33 standard deviations (2.33σ) from the mean – that is, 2.33σ – and 2 percent of the area under the normal distribution is found beyond ± 2.33 (1 percent under each tail, -2.33σ and $+2.33\sigma$, respectively). Thus, for a one-tailed distribution, the 99 percent confidence level will represent adverse moves that not occur more than 1 day in 100. In this example, it means 2.33 x 15 = 34.95 bp. Thus, the maximum adverse yield change expected for this zero-coupon bond is an increase of 34.95 basis points, or 0.3495 percent, in interest rates.

b. *What is the highest yield change expected if a 95 percent confidence limit is required?*

ANSWER: If yield changes are normally distributed, 90 percent of the area of a normal distribution will be 1.65 standard deviations (1.65σ) from the mean – that is, 1.65σ – and 10 percent of the area under the normal distribution is found beyond ± 1.65 (5 percent under each tail, -1.65σ and $+1.65\sigma$, respectively). Thus, for a one-tailed distribution, the 95 percent confidence level will represent adverse moves that not occur more than 1 day in 20.Thus, the maximum adverse yield change expected for this zero-coupon bond is an increase of (1.65 x 15 =) 24.75 basis points, or 0.2475 percent, in interest rates.

15.9. *Bank Alpha has an inventory of AAA-rated, 15-year zero-coupon bonds with a face value of $400 million. The bonds currently are yielding 9.5 percent in the over-the-counter market*.

a. *What is the modified duration of these bonds?*

ANSWER: MD = D/(1 + R) = 15/(1.095) = 13.6986

b. *What is the price volatility if the potential adverse move in yields is 25 basis points?*

ANSWER: Price volatility = (MD) x (potential adverse move in yield)
= (13.6986) x (0.0025) = 0.03425 or 3.425 percent.

c. *What is the DEAR?*

ANSWER: Daily earnings at risk (DEAR) = ($ value of position) x (Price volatility)

Dollar value of position = \$400m/(1 + 0.095)^{15} = \$102,529,350. Therefore,
DEAR = \$102,529,350 x 0.03425 = \$3,511,279.

d. *If the price volatility is based on a 99 percent confidence limit and a mean historical change in daily yields of 0.0 percent, what is the implied standard deviation of daily yield changes?*

ANSWER: The potential adverse move in yields = confidence limit value x standard deviation value. Therefore, 25 basis points = 2.33 x σ, and σ = 0.0025/2.33 = 0.001073 or 10.73 basis points.

15.10. *Bank Beta has an inventory of AAA-rated, 10-year zero-coupon bonds with a face value of \$100 million. The modified duration of these bonds is 12.5 years, the DEAR is \$2,150,000, and the potential adverse move in yields is 35 basis points. What is the market value of the bonds, the yield on the bonds, and the duration of the bonds?*

ANSWER: Price volatility = (MD) x (potential adverse move in yield)
= (12.5) x (0.0035) = 0.04375 or 4.375 percent

DEAR = ($ value of position) x (Price volatility)
DEAR = \$2,150,000 = ($ value of position) x 0.04375
= > ($ value of position) = \$2,150,000/0.04375 = \$49,142,857 = market value

Dollar value of position = \$100m/(1 + yield)^{10} = \$49,142,857.
= > yield = (\$100m/\$49,142,857)$^{1/10}$ – 1 = 7.36%
Therefore, the bonds currently are yielding 7.36 percent in the over-the-counter market.

MD = D/(1 + R) = 12.5 = D/(1.0736) = > D = 12.5 x 1.0736 = 13.42 years

15.11. *Bank Two has a portfolio of bonds with a market value of \$200 million. The bonds have an estimated price volatility of 0.95 percent. What are the DEAR and the 10-day VAR for these bonds?*

ANSWER:

DEAR	= ($ value of position) x (Price volatility)
	= \$200 million x 0.0095
	= \$1,900,000
10-day VAR	= DEAR x $\sqrt{N}$ = \$1,900,000 x $\sqrt{10}$
	= \$1,900,000 x 3.1623 = \$6,008,328

15.12. *Suppose that an FI has a €1.6 million long trading position in spot euros at the close of business on a particular day. Looking back at the daily percentage changes in the exchange rate of the €/$ for the past year, the volatility or standard deviation (σ) of daily percentage changes in the €/$ spot exchange rate was 62.5 basis points (bp). Calculate the FI's daily earnings at risk from this position (i.e., adverse moves in the FX markets with respect to the value of the euro against the dollar will not occur more than 1 percent of the time, or 1 day in every 100 days) if the spot exchange rate is €0.80/$1, or $1.25/€, at the daily close.*

ANSWER: The first step is to calculate the dollar-equivalent amount of the position.

Dollar equivalent value of position = FX position x ($ per unit of foreign currency)
= €1.6 million x $1.25/€
= $2 million

If changes in exchange rates are historically normally distributed, the exchange rate must change in the adverse direction by 2.33σ, or

FX volatility = 2.33 x 62.5 bp = 145.625 bp or 1.45625%

As a result,

DEAR = Dollar value of position x FX volatility
= $2 million x 0.0145625
= $29,125

This is the potential daily earnings at risk exposure to adverse euro to dollar exchange rate changes for the bank from the €1.6 million spot currency holding.

15.13. *Bank of Southern Vermont has determined that its inventory of 20 million euros (€) and 25 million British pounds (£) is subject to market risk. The spot exchange rates are $1.25/€ and $1.60/£, respectively. The σ's of the spot exchange rates of the € and £, based on the daily changes of spot rates over the past six months, are 65 bp and 45 bp, respectively. Determine the bank's 10-day VAR for both currencies. Use adverse rate changes in the 99th percentile*.

ANSWER:

FX position of €	= €20m x 1.25 = $24 million
FX position of £	= £25m x 1.60 = $40 million
FX volatility €	= 2.33 x 65bp = 151.45bp, or 1.5145%
FX volatility £	= 2.33 x 45bp = 104.85bp, or 1.0485%
DEAR	= ($ value of position) x (Price volatility)
DEAR of €	= $24m x .015145 = $348,941
DEAR of £	= $40m x .010485 = $419,400
10-day VAR of €	= $348,941 x √10 = $348,841 x 3.1623 = $1,103,448
10-day VAR of £	= $419,400 x √10 = $419,400 x 3.1623 = $1,326,259

15.18.

α. *Calculate the DEAR for the following portfolio with the correlation coefficients and then with perfect positive correlation between various asset groups.*

Assets	***Estimated DEAR***	***($\rho_{S,FX}$)***	***($\rho_{S,B}$)***	***($\rho_{FX,B}$)***
Stocks (S)	*$300,000*	*-0.10*	*0.75*	*0.20*
Foreign Exchange (FX)	*200,000*			
Bonds (B)	*250,000*			

ANSWER:

$$\text{DEAR portfolio} = \begin{bmatrix} (\text{DEAR}_S)^2 + (\text{DEAR}_{FX})^2 + (\text{DEAR}_B)^2 \\ + (2\rho_{S,FX} \text{ x DEAR}_S \text{ x DEAR}_{FX}) \\ + (2\rho_{S,B} \text{ x DEAR}_S \text{ x DEAR}_B) \\ + (2\rho_{FX,B} \text{ x DEAR}_{FX} \text{ x DEAR}_B) \end{bmatrix}^{0.5}$$

$$= \begin{bmatrix} \$300{,}000^2 + \$200{,}000^2 + \$250{,}000^2 + 2(-0.1)(\$300{,}000)(\$200{,}000) \\ + 2(0.75)(\$300{,}000)(\$250{,}000) + 2(0.20)(\$200{,}000)(\$250{,}000) \end{bmatrix}^{0.5}$$

$$= [\$313{,}000{,}000{,}000]^{0.5} = \$559{,}464$$

b. *What is the amount of risk reduction resulting from the lack of perfect positive correlation between the various assets groups?*

ANSWER:

$$\text{DEAR portfolio(correlation coefficien ts} = 1) =$$

$$= \begin{bmatrix} \$300{,}000^2 + \$200{,}000^2 + \$250{,}000^2 + 2(1.0)(\$300{,}000)(\$200{,}000) \\ + 2(1.0)(\$300{,}000)(\$250{,}000) + 2(1.0)(\$200{,}000)(\$250{,}000) \end{bmatrix}^{0.5}$$

$$= [\$562{,}500{,}000{,}000]^{0.5} = \$750{,}000$$

The DEAR for a portfolio with perfect correlation would be $750,000. Therefore, the risk reduction is $750,000 - $559,464 = $190,536.

15.20. *Export Bank has a trading position in Japanese yen and Swiss francs. At the close of business on February 4, the bank had ¥300 million and SF10 million. The exchange rates for the most recent six days are given below:*

Exchange Rates per U.S. Dollar at the Close of Business

	2/4	*2/3*	*2/2*	*2/1*	*1/29*	*1/28*
Japanese yen	*80.13*	*80.84*	*80.14*	*83.05*	*84.35*	*84.32*
Swiss francs	*0.9540*	*0.9575*	*0.9533*	*0.9617*	*0.9557*	*0.9523*

a. *What is the foreign exchange (FX) position in dollar equivalents using the FX rates on February 4?*

ANSWER: Japanese yen: ¥300,000,000/¥80.13 = $3,743,916
Swiss francs: SF10,000,000/SF0.9540 = $10,482,180

b. *What is the definition of delta as it relates to the FX position?*

ANSWER: Delta measures the change in the dollar value of each FX position if the foreign currency depreciates by 1 percent against the dollar.

c. *What is the sensitivity of each FX position; that is, what is the value of delta for each currency on February 4?*

ANSWER:

Japanese yen:
1.01 x current exchange rate = 1.01 x ¥80.13 = ¥80.9313/$
Revalued position in $s = ¥300,000,000/80.9313 = $3,706,848
Delta of $ position to Yen = $3,706,848 - $3,743,916
= -$37,068

Swiss francs:
1.01 x current exchange rate = 1.01 x SF0.9540 = SF0.96354
Revalued position in $s = SF10,000,000/0.96354 = $10,378,396
Delta of $ position to SF = $10,378,396 - $10,482,180
= -$103,784

d. *What is the daily percentage change in exchange rates for each currency over the five-day period?*

ANSWER:

Day	Japanese yen:	Swiss franc	
2/4	-0.87828	-0.36554	% Change = (Rate$_t$/Rate$_{t-1}$) - 1 x 100
2/3	0.87347	0.44057	
2/2	-3.50391	-0.87345	
2/1	-1.54120	0.62781	
1/29	0.03558	0.35703	

e. *What is the total risk faced by the bank on each day? What is the worst-case day? What is the best-case day?*

ANSWER:

	Japanese yen			Swiss francs			Total
Day	Delta	% Rate Δ	Risk	Delta	% Rate Δ	Risk	Risk
2/4	-$37,068	-0.87828	$32,556	-$103,784	-0.36554	$37,937	$70,493
2/3	-$37,068	0.87347	-$32,378	-$103,784	0.44057	-$45,724	-$78,102
2/2	-$37,068	-3.50391	$129,883	-$103,784	-0.87345	$90,650	$220,533
2/1	-$37,068	-1.54120	$57,129	-$103,784	0.62781	-$65,157	- $8,028
1/29	-$37,068	0.03558	-$1,319	-$103,784	0.35703	-$37,054	-$38,373

The worst-case day is February 3, and the best-case day is February 2.

f. *Assume that you have data for the 500 trading days preceding February 4. Explain how you would identify the worst-case scenario with a 99 percent degree of confidence?*

ANSWER: The appropriate procedure would be to repeat the process illustrated in part (e) above for all 500 days. The 500 days would be ranked on the basis of total risk from the worst-case to the best-case. The one percent from the absolute worst-case situation would be day 5 in the ranking.

g. *Explain how the 1 percent value at risk (VAR) position would be interpreted for business on February 5.*

ANSWER: Management would expect with a confidence level of 99 percent that the total risk on February 5 would be no worse than the total risk value for the 5th worst day in the previous 500 days. This value represents the VAR for the portfolio.

h. *How would the simulation change at the end of the day on February 5? What variables and/or processes in the analysis may change? What variables and/or processes will not change?*

ANSWER: The analysis can be upgraded at the end of the each day. The values for delta may change for each of the assets in the analysis. As such, the value for VAR may also change. Any historical data used in the analysis will not change.

15.25. *Consider the following discrete probability distribution of payoffs for two securities, A and B, held in the trading portfolio of an FI:*

Probability	*A*	*Probability*	*B*
50.00%	*$80m*	*50.00%*	*$80m*
49.00	*60m*	*49.00*	*68m*
1.00	*-740m*	*0.40*	*-740m*
		0.60	*-1,393m*

Which of the two securities will add more market risk to the FI's trading portfolio according to the VAR and ES measures?

ANSWER:

The expected return on security A = 0.50($80m) + 0.49($60m) + 0.01(-$740m) = $62m
The expected return on security B = 0.50($80m) + 0.49($68m) + 0.0040(-$740m) + 0.0060(-$1,393m) = $62m

For a 99% confidence level, $VAR_A = VAR_B$ = -$740m
For a 99% confidence level, ES_A = -$740m, while ES_B = 0.40(-$740m) + 0.60(-$1,393m) = -$1,131.8m

While the VAR is identical for both securities, the ES finds that security B has the potential to subject the FI to much greater losses than security A. Specifically, if tomorrow is a bad day, VAR finds that there is a 1 percent probability that the FI's losses will exceed $740 million on either security. However, if tomorrow is a bad day, ES finds that there is a 1 percent probability that the FI's losses will exceed $740 million if security A is in its trading portfolio, but losses will exceed $1,131.8 million if security B is in its trading portfolio.

15.26. *Consider the following discrete probability distribution of payoffs for two securities, A and B, held in the trading portfolio of an FI:*

Probability	*A*	*Probability*	*B*
55.00%	*$ 120m*	*55.00%*	*$ 120m*
44.00	*95m*	*44.00*	*100m*
1.00	*-1,100m*	*0.30*	*-1,100m*
		0.70	*-1,414m*

Which of the two securities will add more market risk to the FI's trading portfolio according to the VAR and ES measures?

ANSWER: The expected return on security A = 0.55($120m) + 0.44($95m) + 0.01(-$1,100m) = $96.8m
The expected return on security B = 0.55($120m) + 0.44($100m) + 0.0030(-$1,100m) + 0.0070(-$1,414m) = $96.8m

For a 99% confidence level, $VAR_A = VAR_B$ = -$1,100m
For a 99% confidence level, ES_A = -$1,100m, while ES_B = 0.30(-$1,100m) + 0.70(-$1,414m) = -$1,319.8m

Thus, while the VAR is identical for both securities, the ES finds that security B has the potential to subject the FI to much greater losses than security A. Specifically, if tomorrow is a bad day, VAR finds that there is a 1 percent probability that the FI's losses will exceed $1,100 million on either security. However, if tomorrow is a bad day, ES finds that there is a 1 percent probability that the FI's losses will exceed $1,100 million if security A is in its trading portfolio, but losses will exceed $1,319.8m if security B is in its trading portfolio.