SS17 Risk Management Applications of Derivatives

The following information is related to Question 1-4

Joenia Dantas is a financial risk manager for Alimentos Serra (AS), a Brazilian manufacturer and exporter of soybean-based food products. AS is a privately held corporation, wholly owned by Cesar Serra. Recently, AS took out a R25,000,000, four-year, floating-rate bank loan requiring semi-annual payments of interest based on SELIC (Banco Central do Brasil's overnight lending rate) plus a spread of 4.50 percent and repayment of principal at maturity. Serra believes that interest rates will rise in the near future and worries that AS will be unable to absorb the higher loan costs associated with an increase in rates. Dantas tells him that she will convert the loan to a 10.80 percent fixed rate by entering into the pay-fixed side of a four-year, R25,000,000 notional principal interest rate swap with semi-annual payments that exchanges SELIC for a fixed rate of 10.80 percent. She explains that the swap will act as a hedge for the loan, reducing the company's net cash flow risk and net market value risk.

Discussions with Dantas about using interest rate swaps to reduce risk cause Serra to think about the fixed income portion of his personal investment portfolio, which includes R12.0 million in bonds that have a modified duration of 5.50 years. Serra's beliefs about rising interest rates make him want to reduce the bond portfolio's modified duration to 2.00 years using interest rate swaps. In order to determine the correct swap position, he needs to learn how to calculate the modified duration of a swap. He asks Dantas how to do this. She explains it to him, using the example described in Exhibit 1.

Exhibit 1	
Data for Swap Example	
Maturity of swap	4 years
Payment structure	semiannual
Fixed rate on swap	10.8%
Duration of 4-year, 10.8% coupon bond	2.91 years

Serra decides to use a swap that has a modified duration of -2.40 years for the pay-fixed side to reduce his bond portfolio's duration to the desired level.

Dantas knows that AS currently needs to borrow an additional R30,000,000 for 5 years to fund its growth. Brazilian credit markets have tightened and it would cost 17.70 percent per year to borrow this amount locally, but AS can obtain a yen-denominated loan at a fixed rate of 9.50 percent. This would expose it to substantial currency risk. A 5-year currency swap is available in which AS would pay interest in real to the counterparty at 12.20 percent and receive interest in yen from the counterparty at 7.10 percent. The current exchange rate is ¥40/R.

1. Dantas' explanation of her plan to convert the four-year loan from floating to fixed is most likely:
   A. correct.
   B. incorrect, because the fixed loan rate will be 15.30%.
   C. incorrect, because the swap should be entered to pay SELIC.

Solution: B.

Converting a floating-rate loan to a fixed-rate loan requires entering into a plain-vanilla (fixed-for-floating) interest rate swap on the pay-fixed side. The swap should have the same maturity, the same payment frequency, and the same floating interest rate index as the loan and its notional principal should be equal to principal balance of the loan. The borrower will pay the fixed rate on the swap (here 10.80%) and receive the index (SELIC) from the swap counterparty. The borrower will pay the index (SELIC) plus any spread (4.50%) to the lender. The net, fixed interest rate on the swapped loan is the fixed rate on the swap plus any spread over index on the loan or 10.80% + 4.50% = 15.30% in this situation.

2. The duration of the interest rate swap described in Exhibit 1 is closest to:
   A. -2.41 years.
   B. -2.66 years.
   C. -2.91 years.

Solution: B.

The duration of the pay-fixed position in an interest rate swap is equal to the duration of a floating rate bond with the same payment frequency minus the duration of a fixed rate bond with coupon rate equal to the fixed rate and maturity equal to the swap maturity. The duration of the floating rate bond is, on average, half of the time interval between payments (in this case, half of 0.5 years or 0.25 years.) The duration of the fixed rate bond is given as 2.91 years. 0.25 years-2.91 years = -2.66 years.

3. In order to reduce the duration of his bond portfolio to the desired level, Serra will enter into a pay-fixed swap position with a notional principal closest to:
   A. R17.5 million.
   B. R27.5 million.
   C. R42.0 million.

Solution: A.

When the current duration (DB), the target duration (DT), and the value (B) of the bond portfolio are known and the duration of the swap has been calculated, the notional principal of the appropriate swap (NP) is found as $NP = B\left(\frac{MDUR_T - MDUR_B}{MDUR_S}\right)$; In this case, the notional principal is:

$$12,000,000\left(\frac{2.00-5.50}{-2.40}\right)=17,500,000$$

4. If AS enters into the yen-real currency swap with a notional principal of ¥1.2 billion (R30.0 million), net yen interest expense for each year is closest to:
   A. ¥28.80 million.
   B. ¥85.20 million.
   C. ¥114.00 million.

Solution: A.

If AS borrows in yen, it will borrow ¥1.2 billion (=R30,000,000 × ¥40/R). In order to hedge this, it will enter into a currency swap with a notional principal of ¥1.2 billion/R30,000,000. It will receive 7.10% in yen from the swap and pay 9.50% in yen on the loan, for a net payment of 2.40% (on ¥1.2 billion) or ¥28.80 million.

The following information is related to Question 5-8

Victor Kayent, a portfolio manager for Terracin Investment Partners (TIP), manages the Terracin Fund. Selected information about the Terracin Fund is presented in Exhibit 1.

Exhibit 1. Asset Allocation and Risk Metrics for the Terracin Fund as of 15 January

Asset Class	Market Value	Portfolio Weight	Beta	Modified Duration
US equities*	$350 million	70%	1.10	n/a
US fixed income	$100 million	20%	n/a	5.00
Cash	$50 million	10%	0.00	0.00
Total	$500 million	100%	n/a	n/a

* This portfolio is meant to track the performance of US large-cap stocks, not to exactly replicate the performance of the S&P 500 Index

On 15 January, Kayent receives a forecast from the firm's consultant predicting a US equity market decline over the next three months. Based on this forecast and those generated internally by the firm, Kayent plans to temporarily reduce equity exposure in the fund through the use of S&P 500 and Treasury bond futures contracts. The fund currently has no position in futures. Kayent considers the following three strategies.

Strategy 1: Lower the beta on the US equities portion of the fund to 0.80 for a period of three months.

Strategy 2: Create a synthetic cash position by temporarily converting the US equity exposure in the fund into cash for a period of three months.

Strategy 3: Reduce the US equity allocation in the fund to 50% and increase the US fixed-income allocation to 40% for a period of three months.

Selected data on the relevant S&P 500 futures contracts and Treasury bond futures contracts, as well as other market data, are presented in Exhibit 2.

Exhibit 2. Futures and Market Data as of 15 January

S&P 500 futures		**Treasury bond futures**	
Quoted futures price	2157	Quoted futures price	$105,200
Multiplier	$250	Duration	6.20
Beta	0.90	Yield beta	0.95
Maturity of futures	3 months	Maturity of futures	3 months

Other US market data	
Risk-free rate	0.50%
S&P 500 dividend yield	3.00%

5. Based on Exhibits 1 and 2, how many futures contracts does Kayent need to sell to execute Strategy 1?

A. 175

B. 195

C. 216

Solution: C.

The number of S&P 500 futures contracts needed to be sold to execute Strategy 1 is calculated as follows.

$$N_f = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{S}{f}\right)$$

Given the fund's equity allocation of $350 million,

$$N_f = \left(\frac{0.80 - 1.10}{0.90}\right)\left(\frac{\$350{,}000{,}000}{2157 \times \$250}\right)$$

= –216.35 (–216 rounded)

Because the calculated answer is negative, 216 contracts should be sold.

6. Based on Exhibits 1 and 2, how many futures contracts does Kayent need to sell to execute Strategy 2?

A. 650

B. 654

C. 793

Solution: C.

The number of S&P 500 futures contracts needed to be sold to execute Strategy 2 is calculated as follows.

$$N_f = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{S}{f}\right)$$

Given the fund's equity allocation of $350 million and setting the target beta equal to 0,

$$N_f = \left(\frac{0.00 - 1.10}{0.90}\right)\left(\frac{\$350{,}000{,}000}{2157 \times \$250}\right)$$

= –793.28 (–793 rounded)

Because the calculated answer is negative, 793 contracts should be sold.

7. Based on Exhibits 1 and 2, the number of futures contracts Kayent should sell to adjust the equity allocation in Strategy 3 is:

A. 62.

B. 204.

C. 227.

Solution: C.

The reduction in the stock allocation in the fund from 70% ($350 million) to 50% ($250 million) is done by converting (selling) $100 million in stocks to cash (beta of zero) using stock index futures. The number of S&P 500 futures contracts needed to be sold to reduce the equity exposure to 50% is calculated as follows.

$$N_f = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{S}{f}\right)$$

$$N_f = \left(\frac{0.00 - 1.10}{0.90}\right)\left(\frac{\$100{,}000{,}000}{2157 \times \$250}\right)$$

= –226.65 (–227 rounded)

8. Based on Exhibits 1 and 2, the number of futures contracts Kayent should buy to adjust the fixed-income allocation in Strategy 3 is:

A. 690.

B. 728.

C. 767.

Solution: B.

The increase in the bond allocation in the fund from 20% ($100 million) to 40% ($200 million) is done by converting $100 million in stocks to cash using stock index futures and then converting the $100 million in cash to bonds with a modified duration of 5.00 using bond futures.

Setting the target modified duration to 5.00, the number of bond futures to buy is calculated as:

$$N_f = \left(\frac{MDUR_T - MDUR_B}{MDUR_f}\right)\left(\frac{B}{f}\right)\beta_y$$

$$N_f = \left(\frac{5.00 - 0.00}{6.20}\right)\left(\frac{\$100{,}000{,}000}{\$105{,}200}\right) \times 0.95$$

= 728.26 (728 rounded)