

# CRAQ IT

---

## SESSION 1

---

CFA LEVEL III

## Anderson Case Study

Anderson has a client with a fixed income portfolio valued at USD 700,000,000 with a modified duration of 5.1. The ongoing Russia-Ukraine conflict has led to a significant surge in oil prices, consequently resulting in an inflationary environment. To address this issue, the US Federal Reserve is expected to aggressively hike interest rate. Hence, the client wants to decrease the modified duration to 3.5 and has three plain vanilla interest rate swaps available to accomplish the same.. Exhibit 1 provides the details on the available swaps.

**Exhibit 1: Selected Swap Contracts**

Counter-party	Maturity	Payment Frequency
Lux	3 years	Quarterly
Ash	3 years	Semi-Annually
Trim	5 years	Annually

The duration of the fixed leg is approximately 0.8 times the maturity of the swap, and the duration of the floating leg is approximately one-half the time between payments. Anderson wants to minimize the counter-party risk.

- A. Determine which counter-party's swap contract will best achieve Anderson's objective. Justify your response
- B. Calculate the notional principal of the swap into which Anderson's client should enter and determine whether the client should pay the fixed-rate or pay the floating-rate

**SOLUTION**

- A.** Anderson's objective is minimize counter-party risk. To determine the optimal swap contract, Anderson must select the counterparty whose swap has the lowest notional value. This, in turn, translates to opting for the swap with the highest net duration, calculated as the difference between the fixed and floating legs.

The duration of the fixed leg of the swaps is approximately 0.8 times the maturity of the swap, and the duration of the floating leg is approximately one-half the time between payments.

**For the Lux Contract:**

$$\begin{aligned}\text{Net Duration} &= (\text{MD of the Fixed Leg} - \text{MD of the Floating Leg}) \\ &= (3 \times 0.8 - 0.25 \times 0.5) \\ &= 2.275\end{aligned}$$

**For the Ash Contract:**

$$\begin{aligned}\text{Net Duration} &= (\text{MD of the Fixed Leg} - \text{MD of the Floating Leg}) \\ &= (3 \times 0.8 - 0.5 \times 0.5) \\ &= 2.15\end{aligned}$$

**For the Trim Contract:**

$$\begin{aligned}\text{Net Duration} &= (\text{MD of the Fixed Leg} - \text{MD of the Floating Leg}) \\ &= (5 \times 0.8 - 1 \times 0.5) \\ &= 3.5\end{aligned}$$

After calculating the net duration of each swap contract, Anderson has determined that the Trim's swap contract has the longest net duration of 3.5. Therefore, Anderson recommends the Trim swap contract as the best option to achieve the desired decrease in modified duration while minimizing counter-party risk.

**B. Notional Principal**

$$\begin{aligned} &= (\text{Target ModDur} - \text{Current ModDur}) \times \text{Portfolio Value} / (\text{Swap ModDur}) \\ &= (3.5 - 5.1) \times 700,000,000 / 3.5 \\ &= (-)\text{USD } 320,000,000. \end{aligned}$$

Since Anderson aims to decrease the duration of his portfolio, it would be logical for him to receive the floating and pay the fixed leg of the swap.

## Peter Pond Case Study

---

Peter Pond, CFA, manages a \$150 million portfolio. His current asset allocation strategy is 80% stocks, 20% bonds. The equities have a combined beta of 1.03. The fixed-income segment has an overall modified duration of 6.1. Because of his rather pessimistic short-term economic outlook, Pond would like to temporarily adjust the portfolio's asset allocation to 65% stocks, 35% bonds. At the same time, Pond would like to adjust the beta of the stock portion from 1.03 to 0.99 and the duration of the bond portion from 6.1 to 5.7. Instead of selling stocks and buying bonds, Pond will use stock index futures and bond futures to synthetically re-allocate the portfolio. The stock index futures contract has a price of \$231,000 and a beta of 1.01. The bond futures contract is priced at \$125,000 with an implied duration of 6.4. The bond to futures yield beta equals 1.0. Pond assumes cash equivalents have a duration of 0.25.

- A.** How many stock and bond index futures contracts should Pond buy or sell?
- B.** Three months later, Pond closes out the futures positions. The stocks in his portfolio have fallen in value by 1.7%, while the bonds have risen by 1.5%. The stock index futures price is \$227,069; the bond futures price is \$126,884. Determine the market value of the overall portfolio (including the futures payoffs).
- C.** Estimate the market value of the portfolio if Pond had actually sold stocks and purchased bonds. Assume that Pond was able to achieve the desired asset allocation, beta, and modified duration targets. Assume also that the revised equity segment fell by 1.7% and the revised fixed-income segment rose by 1.5%. Ignore transaction costs.
- D.** Pond chose futures to modify the portfolio rather than to buy/sell bonds and fixed-income securities. What factors might cause a difference in the portfolio's three-month horizon market value using the futures strategy, versus directly buying and selling the underlying securities (the values calculated in parts 2 and 3 above)? Ignore transaction costs.

**SOLUTION****A. This problem must be solved in three parts:**

1. Modify the overall asset allocation strategy by adjusting the portfolio's asset allocation from 80% stock, 20% bonds to 65% stock, 35% bonds.

The amount of stock to convert to bonds is:

\$150,000,000 (0.80)	\$120,000,000
\$150,000,000 (0.65)	\$ 97,500,000
	\$ 22,500,000

\$22,500,000 is the amount of the stock portfolio that must be reduced. The number of contracts to accomplish this strategy is:

$$\begin{aligned}
 N_{sf} &= \left( \frac{\beta_T - \beta_S}{\beta_f} \right) \left( \frac{S}{f} \right) \\
 &= \left( \frac{0 - 1.03}{1.01} \right) \left( \frac{\$22,500,000}{\$231,000} \right) \\
 &= -99.33
 \end{aligned}$$

Pond should sell 99 stock index futures, effectively creating just under \$22,500,000 of synthetic cash by setting the beta of \$22,500,000 equal to zero.

Next, Pond should purchase \$22,500,000 of bond futures contracts:

$$\begin{aligned}
 N_{Bf} &= \left( \frac{MDUR_T - MDUR_B}{MDUR_f} \right) \left( \frac{B}{f} \right) \beta_y \\
 &= \left( \frac{6.1 - 0.25}{6.4} \right) \left( \frac{\$22,500,000}{\$125,000} \right) 1.0 \\
 &= 164.53
 \end{aligned}$$

Pond should buy 165 bond futures contracts.

2. Adjust the beta and duration by changing the beta of the stocks from 1.03 to 0.99 and the modified duration of the bonds from 6.1 to 5.7.

To change the beta of the remaining equities

(\$120,000,000 - \$22,500,000 = \$97,500,000)

$$N_{sf} = \left( \frac{0.99 - 1.03}{1.01} \right) \left( \frac{\$97,500,000}{\$231,000} \right) \\ = -16.7$$

Pond should sell 17 stock index futures contracts to lower the portfolio's beta to 0.99.

To achieve the target modified duration on the fixed-income segment, including the new allocation (total fixed-income allocation is \$30,000,000 + \$22,500,000 = \$52,500,000):

$$N_{bf} = \left( \frac{5.7 - 6.1}{6.4} \right) \left( \frac{\$52,500,000}{\$125,000} \right) 1.0 \\ = -26.25$$

Pond should sell 26 bond futures contracts to lower the portfolio's modified duration to 5.7.

3. Net out the contract numbers calculated in parts A and B to find the total number of contracts to buy/sell. To accomplish Pond's overall risk management strategy, the total number of futures contracts needed is:

Stock Index Futures		Bond Futures	
Part A:	-99 contracts	Part A:	165 contracts
Part B:	-17 contracts	Part B:	-26 contracts
Total:	116 contracts	Total:	139 contracts

Pond should sell 116 stock index futures contracts and buy 139 bond futures contracts to synthetically accomplish the desired asset allocation, beta and duration objectives.

- B. The market value of the portfolio including the futures transactions (effectively 65% stock, 35% bonds):

Stocks: \$150,000,000 (0.80)(1 – 0.017)	\$ 117,960,000
Bonds: \$150,000,000 (0.20)(1 + 0.015)	\$ 30,450,000
<b>Futures contracts payoffs:</b>	
Stock gain/loss = # contracts ( $f_{\text{END}} - f_{\text{BEG}}$ ) = – 116(227,069 – 231,000)	\$ 455,996
Bond gain/loss = # contracts ( $f_{\text{END}} - f_{\text{BEG}}$ ) = 139(126,884 – 125,000)	\$ 261,876
Overall portfolio value	\$ 149,127,872

- C. The market value of the portfolio if stocks and bonds had been bought/sold (65% stock, 35% bonds):

Stocks: \$150,000,000 (0.65)(1 – 0.017)	\$ 95,842,500
Bonds: \$150,000,000 (0.35)(1 + 0.015)	\$ 53,287,500
Overall portfolio value	\$149.130.000

- D. The \$2,128 difference between using the futures strategy to synthetically adjust the portfolio versus buying/selling the underlying securities (\$149,127,872 – \$149,130,000 = \$2,128) is quite small given the original portfolio value. Discrepancies may occur because the number of contracts was rounded. In addition, actual stocks and bonds will not necessarily react in the precise manner implied by their betas/durations.



# Johnson and Nguyen Case Study

Johnson and Nguyen discuss the financial objectives of their client, Rachel Kim. In a recent meeting, Kim, a retiree with a \$3,500,000 investment portfolio, expressed her desire to update her investment goals as follows:

**Goal 1:** Over the next 15 years, she wants to maintain her current standard of living, which requires \$80,000 per year (95% probability of success). Inflation is expected to average 3% annually over the time horizon, and withdrawals take place at the beginning of the year.

**Goal 2:** In 5 years, she plans to purchase a vacation home for \$500,000 in nominal terms (80% probability of success).

**Goal 3:** Kim wants to leave a bequest of \$1,000,000 to her grandchildren in 20 years (70% probability of success).

**Goal 4:** Kim wants to start a philanthropic foundation in 10 years with a corpus of \$2,000,000 (60% probability of success).

Exhibit 1 provides the details of the three sub-portfolios, including Kim's allocation to the sub-portfolios and the probabilities that they will exceed the expected minimum return.

## Exhibit 1: Investment Sub-Portfolios & Minimum Expected Return for Success Rate

Assume 0% correlation between the time horizon portfolios.

Sub-Portfolio	Orient	Norway	Zenith	Cash
Expected Return	6.21%	7.20%	8.12%	0.05%
Expected SD	5.01%	6.10%	7%	0.00%
Current Allocation	47.63%	37.62%	10.00%	4.75%

Probability (%)	Minimum Expected Return (%)			
<b>Time Horizon: 5 years</b>				
<b>88%</b>	5.63%	5.88%	5.21%	0.05%
<b>85%</b>	4.08%	4.29%	4.85%	0.05%
<b>80%</b>	3.01%	2.10%	2.93%	0.05%
<b>Time Horizon: 10 years</b>				
<b>79%</b>	6.10%	6.88%	6.32%	0.05%
<b>65%</b>	5.21%	5.30%	5.60%	0.05%
<b>60%</b>	4.08%	4.10%	4.02%	0.05%
<b>Time Horizon: 15 years</b>				
<b>99%</b>	3.83%	3.92%	3.63%	0.05%
<b>95%</b>	4.12%	4.20%	4.15%	0.05%
<b>90%</b>	2.35%	2.55%	2.35%	0.05%
<b>Time Horizon: 20 years</b>				
<b>70%</b>	3.93%	3.34%	4.00%	0.05%
<b>65%</b>	4.29%	4.59%	4.98%	0.05%
<b>60%</b>	5.01%	5.92%	5.99%	0.05%

1. Assuming she wants to maintain her allocation to cash for her daily liquidity needs, determine the amount she would need to allocate in Sub-Portfolio: Orient, Norway and Zenith, in order to meet her goals.
2. In case, Kim's current Investment portfolio was valued at \$30,00,000 (instead of 35,00,000), identify and demonstrate the issue Kim would most likely run into. Suggest one suitable solution for the same, assume the current allocation to cash (4.75%) is not to be compromised.
3. Mention the behavioural bias engrained in the Goal Based Investing Approach (GBI) and categorise the same into cognitive or emotional.
4. Mention one drawback of GBI.

**SOLUTION****1.**

Goal 1	
POS	95%
Amount	80000(per year in real terms bgn)
Inflation	3%
Portfolio Chosen	Norway
Inflation adjusted rate	1.17%
Tenure	15
Amount required today	₹ 11,07,927.88

Goal 2	
POS	80%
Tenure	5
Amount	500000
Portfolio Chosen	Orient
Amount required today	₹ 4,31,095.08

Goal 3	
POS	70%
Tenure	20
Amount	1000000
Portfolio Chosen	Zenith
Amount required today	₹ 4,56,386.95

Goal 4	
POS	60%
Tenure	10
Amount	2000000
Portfolio Chosen	Norway
Amount required today	₹ 13,38,205.16

Total Amount required

$$= (11,07,927.88 + 4,31,095.08 + 4,56,386.95 + 13,38,205.16) = 33,33,615.07$$

Amount available today	35,00,000.00
Cash allocation @ 4.75%	1,66,250.00
Remaining Funds	33,33,750.00
Orient	4,31,112.53
Norway	24,46,232.05
Zenith	4,56,405.42

## 2. Issue- Capital insufficient

### Demonstration

Current portfolio value = \$ 30,00,000

Cash allocation (4.75%) = 1,42,500

Hence, remaining amount left for the goals = 28,57,500

However amount required is shown in the table below

Portfolio	Amount to be invested in	To meet Goal	Weights
Orient	₹ 4,31,095.08	2	12.93%
Norway	₹ 24,46,133.04	1&4	73.38%
Zenith	₹ 4,56,386.95	3	13.69%
Total Amount required	₹ 33,33,615.07		100.00%

Hence there is deficit of = 33,615-28,57,500 = 4,76,115

When there is capital insufficiency, potential solutions include the following:

- Increasing the amount of contributions toward a goal
- Reducing the goal amount
- Delaying the timing of a goal (e.g., retiring a few years later than originally planned)
- Adopting an investment strategy with higher expected returns, albeit within the client's acceptable risk tolerance and risk capacity

However, in this case it seems that reducing the goal amount for the low priority goals (Goal 4, 3 and 2) would be a suitable solution.

## 3. Mental Accounting – Cognitive: Information processing

#### 4. Drawbacks of GBI

- Sub-portfolios add complexity.
- Goals may be ambiguous or may change over time.
- Does not consider co-relation amongst Sub-Portfolios.

## John Case Study

John an active fixed-income manager anticipates an economic recovery in the next year from the current contraction phase, with a greater favorable impact on lower rated issuers. The manager chooses a tactical CDX (credit default swap index) strategy combining positions in investment-grade and high-yield CDX contracts to capitalize on this view. The current market information for investment-grade and high-yield CDX contracts is as follows:

CDX Contract	Tenor	CDS Spread	EffSpreadDur <sub>CDS</sub>
CDX IG Index	5 years	240 bps	4.67
CDX HY Index	5 years	600 bps	4.60

Assume that both CDX contracts have a \$100,000,000 notional with premiums paid annually, and that the EffSpreadDur<sub>CDS</sub> for the CDX IG and CDX HY contracts in one year are 3.80 and 3.74, respectively. Ignore TVM

1. Suggest the appropriate tactical CDX strategy.
2. Calculate the one-year return on the tactical CDX strategy suggested in the previous question under the following scenarios:
  - A. Spreads remain constant
  - B. An economic recovery scenario in which investment-grade credit spreads fall by 25% and high-yield credit spreads halve.
  - C. An economic depression scenario in which investment-grade credit spreads rises by 50% and high-yield credit spreads double.

## SOLUTION

1. The investor should initially sell protection on the CDX HY Index and buy protection on the CDX IG Index.
2. The price of a CDS contract may be approximated as follows:

$$\text{CDS Price} \approx 1 + ((\text{Fixed Coupon} - \text{CDS Spread}) \times \text{EffSpreadDur}_{\text{CDS}})$$

Current CDS prices are estimated by multiplying  $\text{EffSpreadDur}_{\text{CDS}}$  by the spread difference from the standard rates of 1% and 5%, respectively:

$$\text{CDX HY: } 95.4 \text{ per } \$100 \text{ face value, or } 0.954 (= 1 + (5.00\% - 6.00\%) \times 4.60)$$

$$\text{CDX IG: } 93.462 \text{ per } \$100 \text{ face value, or } 0.93462 (= 1 + (1.00\% - 2.40\%) \times 4.67)$$

Since the investor is selling HY protection at a discount to par (that is, agreeing to receive the 5% standard coupon while the underlying CDS spread is 6.00%), he will receive an upfront payment =  $[\$100,000,000 \times (1 - 0.954)] = \$4,600,000$ . Investor is buying IG protection at a discount from par (or agreeing to pay the standard 1.00% while the underlying index spread is 2.40%), the investor will pay an upfront payment for entering the position as follows:

$$\$6,538,000 = [\$10,000,000 \times (0.93462 - 1)]$$

$$\text{Hence, initial outflow} = 6,538,000 - 4,600,000 = \$1,938,000$$

In one year, the return is measured by combining the net CDX coupon income or expense with the price appreciation assuming no spread change. As the investor is short CDX HY protection (i.e., receives the 5.00% standard HY coupon) and long CDX IG protection (or pays the standard 1.00% IG coupon), the net annual premium received by the investor at year end is \$4,000,000 ( $= \$100,000,000 \times (5.00\% - 1.00\%)$ ). The respective CDS prices in one year are as follows:

**Scenario 1:** Spreads remains constant

$$\text{CDX HY: } 96.26 \text{ per } \$100 \text{ face value, or } 0.9626 (= 1 + (-1.00\% \times 3.74))$$

$$\text{CDX IG: } 94.68 \text{ per } \$100 \text{ face value, or } 0.9468 (= 1 + (-1.40\% \times 3.80))$$

To offset the existing CDX positions in one year, the investor would buy HY protection and sell IG protection. The investor is able to buy HY protection at a discount of 3.74, resulting in a \$860,000 gain from the short CDX HY position over one year  $(0.9626 - 0.954) \times \$100,000,000$ ). Since the investor must sell IG protection in one year at a lower discount of 5.32, resulting in a loss of \$1,218,000 from the long CDX IG position over 1 year  $(= (0.9468 - 0.93462) \times \$100,000,000)$ . Adding the \$400,000 net coupon payment made by the investor results in a one-year profit from the strategy of \$42,000  $(= \$860,000 - \$1,218,000 + \$400,000)$  with constant spreads.

**Scenario 2:** An economic recovery scenario in which investment-grade credit spreads fall by 25% (i.e. spread becomes 180) and high-yield credit spreads halve (i.e. spread becomes 300)

CDX HY: 107.48 per \$100 face value, or  $1.0748 (= 1 + (5-3)\% \times 3.74)$

CDX IG: 96.96 per \$100 face value, or  $0.9696 (= 1 + (1-1.8)\% \times 3.80)$

To offset the existing CDX positions in one year, the investor would buy HY protection and sell IG protection. The investor is able to buy HY protection at a premium of 7.48, resulting in a \$1,20,80,000 gain from the short CDX HY position over one year  $(1.0748 - 0.954) \times \$100,000,000$ ). Since the investor must sell IG protection in one year at a lower discount of 4.04, resulting in a loss of \$34,98,000 from the long CDX IG position over 1 year  $(= (0.9696 - 0.93462) \times \$100,000,000)$ . Adding the \$400,000 net coupon payment made by the investor results in a one-year profit from the strategy of \$89,82,000  $(= \$1,20,80,000 - \$34,98,000 + \$400,000)$  with contracting spreads.

**Scenario 3:** An economic depression scenario in which investment-grade credit spreads rises by 50% (i.e. spread becomes 360) and high-yield credit spreads double (i.e. spread becomes 1200).

CDX HY: 73.82 per \$100 face value, or  $0.7382 (= 1 + (5 - 12)\% \times 3.74)$

CDX IG: 90.12 per \$100 face value, or  $0.9012 (= 1 + (1 - 3.6)\% \times 3.80)$

To offset the existing CDX positions in one year, the investor would buy HY protection and sell IG protection. The investor is able to buy HY protection at a discount of 26.18, resulting in a \$2,15,80,000 loss from the short CDX HY position



over one year  $(0.7382 - 0.954) \times \$100,000,000$ ). Since the investor must sell IG protection in one year at a higher discount of 9.88, resulting in a gain of \$33,42,000 from the long CDX IG position over 1 year  $(= (0.9012 - 0.93462) \times \$100,000,000)$ . Adding the \$400,000 net coupon payment made by the investor results in a one-year loss from the strategy of \$1,78,38,000  $(= \$33,42,000 - \$2,15,80,000 + \$400,000)$  with widening spreads.