The Stanford University Honor Code
The Honor Code is an undertaking of the students, individually and collectively, that they will not give or receive unpermitted aid in examinations… that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.

I acknowledge and accept the Honor Code.

Name _____________________________  (Signed) _____________________________

Student ID _________________________       Major _____________________________

Undergraduate / Graduate          Summer 2008 Visiting Student?  Yes No

Please answer 8 questions (out of eleven) professionally within the allocated time.
If you have additional time, you may attempt the ninth question as a bonus one.
Write your answers directly on the question paper in the spaces provided.

Any More Fun Books to Read this summer?
A review of a New York Times Bestseller

“Four hundred years ago, Francis Bacon warned that our minds are wired to deceive us. "Beware the fallacies into which undisciplined thinkers most easily fall--they are the real distorting prisms of human nature." Chief among them: "Assuming more order than exists in chaotic nature." Now consider the typical stock market report: "Today investors bid shares down out of concern over ...." Sigh. We're still doing it.

Our brains are wired for narrative, not statistical uncertainty. And so we tell ourselves simple stories to explain complex thing we don't--and, most importantly, can't--know. The truth is that we have no idea why stock markets go up or down on any given day, and whatever reason we give is sure to be grossly simplified, if not flat out wrong.

Nassim Nicholas Taleb first made this argument in Fooled by Randomness, an engaging look at the history and reasons for our predilection for self-deception when it comes to statistics. Now, in The Black Swan: the Impact of the Highly Improbable, he focuses on that most dismal of sciences, predicting the future. Forecasting is not just at the heart of Wall Street, but it's something each of us does every time we make an insurance payment or strap on a seat belt. ....

Chris Anderson
Editor-in-chief, Wired Magazine
Question I (25 points - Swaps)

Ashton Bishop is the debt manager for Globe Telephone, which needs €3.33 billion Euro financing for its operations. Bishop is considering the choice between issuance of debt denominated in:

- Euros (€), or
- U.S. dollars, accompanied by a combined interest rate and currency swap.

a. Explain one risk Globe would assume by entering into the combined interest rate and currency swap.

Bishop believes that issuing the U.S.-dollar debt and entering into the swap can lower Globe’s cost of debt by 45 basis points. Immediately after selling the debt issue, Globe would swap the U.S. dollar payments for Euro payments throughout the maturity of the debt. She assumes a constant currency exchange rate throughout the tenor of the swap.

Exhibit 1 gives details for the two alternative debt issues. Exhibit 2 provides current information about spot currency exchange rates and the 3-year tenor Euro/U.S. Dollar currency and interest rate swap.

Exhibit 1
Globe Telephone Debt Details

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Euro Currency Debt</th>
<th>U.S. Dollar Currency Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Par value</td>
<td>€3.33 billion</td>
<td>$3 billion</td>
</tr>
<tr>
<td>Term to maturity</td>
<td>3 years</td>
<td>3 years</td>
</tr>
<tr>
<td>Fixed interest rate</td>
<td>6.25%</td>
<td>7.75%</td>
</tr>
<tr>
<td>Interest payment</td>
<td>Annual</td>
<td>Annual</td>
</tr>
</tbody>
</table>

Exhibit 2
Currency Exchange Rate and Swap Information

<table>
<thead>
<tr>
<th>Spot currency exchange rate</th>
<th>$0.90 per Euro ($0.90/€1.00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-year tenor Euro/U.S. Dollar fixed interest rates</td>
<td>5.80% Euro/7.30% U.S. Dollar</td>
</tr>
</tbody>
</table>

b. Show the notional principal and interest payment cash flows of the combined interest rate and currency swap.

Note: Your response should show both the correct currency ($) or €) and amount for each cash flow.

Answer problem b in the template provided.
### Template for problem b

#### Cash Flows of the Swap

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Globe pays</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notional principal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Globe receives</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notional principal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest payment</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cash Flows of the Swap**

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Globe pays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notional principal</td>
<td>$3 billion</td>
<td></td>
<td>€3.33 billion</td>
</tr>
<tr>
<td>Interest payment</td>
<td>€193.14 million$</td>
<td>€193.14 million</td>
<td>€193.14 million</td>
</tr>
<tr>
<td>Globe receives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notional principal</td>
<td>€3.33 billion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest payment</td>
<td>$219 million$</td>
<td>$219 million</td>
<td>$219 million</td>
</tr>
</tbody>
</table>

### CFA Guideline Answer

**a.** Globe would assume both counterparty risk and currency risk. Counterparty risk is the risk that Bishop’s counterparty will default on payment of principal or interest cash flows in the swap.

Currency risk is the currency exposure risk associated with all cash flows. If the US$ appreciates (Euro depreciates), there would be a loss on funding of the coupon payments; however, if the US$ depreciates, then the dollars will be worth less at the swap’s maturity.

**b.** Globe borrows US$3 billion; pays it out to receive €3.33 billion in exchange at Year 0. This cash flow reverses at Year 3. Interest payments for Globe are €3.33 billion x 5.8%, or €193.14 million at Year 0, 1, 2 and 3. Interests received by Globe are $3 billion x 7.3%, or $219 million at Year 0, 1, 2 and 3.

---

1. €193.14 million = €3.33 billion x 5.8%
2. $219 million = $3 billion x 7.3%
c. Globe would not reduce its borrowing cost, because what Bishop saves in the Euro market, she loses in the dollar market. The interest rate on the Euro pay side of her swap is 5.80 percent, lower than the 6.25 percent she would pay on her Euro debt issue, an interest savings of 45 bps. But Bishop is only receiving 7.30 percent in U.S. dollars to pay on her 7.75 percent U.S. debt interest payment, an interest shortfall of 45 bps. Given a constant currency exchange rate, this 45 bps shortfall exactly offsets the savings from paying 5.80 percent versus the 6.25 percent. Thus there is no interest cost savings by selling the U.S. dollar debt issue and entering into the swap arrangement.
Question II (25 points - Offshore banking)

The diagram below was introduced in class. Use it to answer the questions that follow.

![Diagram of Offshore Interest Rates and Market Shares]

a. (5 points) Which financial center is the leader in the offshore markets? What leader's advantage does the center enjoy?

b. (10 points) How is the followers' deposit rate ($R_D$) decided? What is that rate?

c. (10 points) How is the followers' lending rate ($R_L$) decided? What is that rate?

Note: When you answer parts b and c, you may make the simplifying assumption that all the centers have the same cost of banking ($X^*$).

[Answer to Question II, 25 points]
**Question III (25 points – Synthetic interest rate futures)**

a. (10 pts) Derive the following equation with the given diagram:

\[
1 + i_{FC,t_1,t_2} = \frac{F_{t_1}}{F_{t_2}} \cdot (1 + i_{S,t_1,t_2})
\]

![Figure 11A.1 Synthetic Eurocurrency Interest Rate Pricing](image)

b. (15 points) Consider the case of a treasurer who plans to invest £1 million in the Eurocurrency market for three months beginning March 15, 2008. Assume that today (December 15, 2007) the treasurer could hedge the return of investing with a forward rate agreement arranged with a bank. Alternatively, the treasurer could create synthetic interest rate futures. Draw the schematic diagram. Show the steps and numerical calculations.

**[Answer to Question III, 25 points]**

From the interest rate parity condition, we know that the rate for a forward transaction on \( t_1 \) is given by:

\[
1 \cdot (1 + i_{S,t_0,t_1}) = 1 \cdot \frac{1}{S_{t_0}} \cdot (1 + i_{FC,t_0,t_1}) \cdot F_{t_1}
\]

\[
\frac{F_{t_1}}{S_{t_0}} = \frac{1 + i_{S,t_0,t_1}}{1 + i_{FC,t_0,t_1}} \quad (11A.1)
\]
The rate for a forward transaction on $t_2$ is given by:

$$1 \cdot (1 + i_{$,t_0,t_2}^{\$}) = 1 \cdot \frac{1}{S_{t_0}} \cdot (1 + i_{FC,t_0,t_2}^{FC}) \cdot F_{t_2}$$

$$F_{t_2} = \frac{1 + i_{$,t_0,t_2}^{\$}}{1 + i_{FC,t_0,t_2}^{FC}}$$

where $i_{$,t_0,t_2}^{\$}$ and $i_{FC,t_0,t_2}^{FC}$ are implied forward interest rates at time $t_0$ for the period $t_1$ to $t_2$.

$(11A.1)$ and $(11A.3) \Rightarrow$

$$1 + i_{FC,t_1,t_2}^{FC} = \frac{F_{t_1}}{F_{t_2}} \cdot (1 + i_{$,t_1,t_2}^{\$})$$

Equation $(11A.4)$ predicts that the implied forward interest rate on FC is uniquely related to the implied forward interest rate on US$ and the term structure of forward exchange rates.
Investment Example of Synthetic Euro-£ Hedge

1. Buy March 2008 Euro-$ Futures at 94.00 (6.00% yield)

2. Sell March 2008 Sterling Futures at 1.567 $/£

3. Buy June 2008 Sterling Futures at 1.555 $/£
Question IV (25 points - Dual-currency bonds and Currency option bond)

A company is deciding whether to issue a one-year dual-currency bond or a one-year currency option bond.

• The dual-currency bond would be issued in SFr (Swiss francs) with a principal of 100 SFr per bond, with interest payable in SFr and principal repaid in U.S. dollars ($50). Denote \( x \) the interest at which this bond is issued.

• The currency option bond is issued in SFr (100 SFr), and the interest and principal are repaid in SFr or $ at the option of the bondholder. The principal repaid is either 100 SFr or $50 and the interest rate is either \( y \) SFr or 1/2 \( y \) dollars.

As you guessed, the current spot exchange rate is 2 SFr/$. The current one-year market interest rates are 6% in SFr and 10% in $. One-year currency options are quoted in Chicago. A put SFr is quoted at 1.2 U.S. cents per SFr; this option premium is for one SFr, with a strike price of 50 US cents.

(a) (15 points) What is the fair interest rate \( x \) on the dual-currency bond?

(b) (10 points) What is the fair interest rate \( y \) on the currency option bond?

[Answer to Question IV, 25 points]

Coupon may be assumed to be paid once per year, or twice per year.

(a) One-year dual-currency bond:

The cash flow is CHF 100\( x \) + U.S.$ 50 at the end of year one. We have to translate into CHF, hence:

\[
100 = \frac{100x}{1.06} + 2 \frac{50}{1.10}
\]

The interest rate \( x \) at which this bond should be issued is:

\[ x = 9.64\% \]
[Answer to Question IV, 25 points]

Coupon may be assumed to be paid once per year, or twice per year.

(b) Let’s call C the CHF coupon on the currency-option bond. We have $C = 100y$. The cash flows of the currency-option bond are as follows:

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF 100</td>
<td>CHF $(C+100)$ or</td>
</tr>
<tr>
<td>U.S.$ \frac{1}{2}(C+100)$</td>
<td></td>
</tr>
</tbody>
</table>

To replicate the cash flows, we first buy a 1-year straight CHF bond repaid CHF $(100+C)$, then we buy the quantity $(100+C)$ of the one year CHF put.

This combination exactly replicates the cash flows of the currency-option bond. Hence, its total value at time 0 should be equal to CHF 100. We write below the CHF value of this replication portfolio. One CHF option costs 1.2 U.S. cents or 0.024 CHF at the spot exchange rate of 2 CHF/$.

<table>
<thead>
<tr>
<th>Market Value</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond</td>
<td>$1/1.06$ CHF</td>
<td>$100+C$</td>
</tr>
<tr>
<td>Option</td>
<td>$(0.012\times2)$ CHF</td>
<td>$100+C$</td>
</tr>
</tbody>
</table>

$$100 = \frac{100+C}{1.06} + 0.024(100+C)$$

$$C = 3.37$$

The interest rate $y$ on the currency option bond is:

$$y = \frac{C}{100} = 3.37\%$$
Question V (25 points – Real Options—Copano project revisited in the inflation era)
Suppose that a commodity chemical company titled Copano is considering investing in a new plant. The project will cost $50 million immediately for permits and preparation, which will take a year. At the end of that year, the firm could invest $500 million to complete the design phase. Managers believe that once the design phase is over, the firm has a two-year window during which it can invest the $1 billion needed to build the plant. Since the project involves a phased investment, it can be treated as a compound option: A $50 million investment creates the right to invest $500 million in one year, and exercise of the option creates the right to invest $1 billion to purchase a new asset, namely the plant. The possible plant values may be constructed by a multiplicative factor of 1.25 when market flourishes and a multiplicative factor of (1/1.25) when market turns sour.

a. Draw Copano’s event tree.
b. With risk-free interest rate being 13%, replicate each call option with borrowing (B) and asset / plant purchase (M), and draw the Copano decision tree in the inflation era. Clearly indicate your decisions on the decision tree.

[Answer to Question V, 25 points]

1,000 x 1.25 = 1,250; 1,000 x (1/1.25) = 800
1,250 x 1.25 = 1,562.5; 800 x (1/1.25) = 640
1,562.5 x 1.25 = 1,953.125; 640 x (1/1.25) = 512
### Answer to Question V, 25 points

<table>
<thead>
<tr>
<th></th>
<th>1,953.13</th>
<th>1,562.50</th>
<th>1,250</th>
<th>1,250</th>
<th>800</th>
<th>800</th>
<th>640</th>
<th>512</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,250</td>
<td>1,000</td>
<td>1,000</td>
<td>800</td>
<td>800</td>
<td>640</td>
<td>512</td>
<td></td>
</tr>
<tr>
<td>54.46-50</td>
<td>1,250</td>
<td>162.69</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>583.99-500</td>
<td>562.50</td>
<td>953.13</td>
<td>677.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The bold face red number is from synthetic portfolio calculation and has incorporated the flexibility value. The crossed out numbers are underestimated value without flexibility thinking.
Real Option Calculation

M (1,953.13) – (1 + .13) (B) = 953.13
M (1,250) – (1 + .13) (B) = 250
  • M=1, B=884.96
  • 1 * 1,562.5 – 884.96 = 677.54
M (1,250) – (1 + .13) (B) = 250
M (800) – (1 + .13) (B) = 0
  • M = 0.556, B=393.31
  • 0.556 * 1,000 – 393.31 = 162.69
M (800) – (1 + .13) (B) = 0
M (512) – (1 + .13) (B) = 0
  • M = 0, B = 0
  • 0 * 640 – 0 = 0

M (1,562.5) – (1 + .13) (B) = 677.54
M (1,000) – (1 + .13) (B) = 162.69
  • M = 0.915, B = 666.01
  • 1 * 1,250 – 666.01 = 583.99
M (1,000) – (1 + .13) (B) = 162.69
M (640) – (1 + .13) (B) = 0
  • M = .452, B = 255.95
  • .452 * 800 – 255.95 = 105.65
M (1,250) – (1 + .13) (B) = 83.99
M (800) – (1 + .13) (B) = 0
  • M = .1866, B = 132.14
  • .1866 * 1,000 – 132.14 = 54.46 > 50

The project is worth doing at t=0, t=1 (upper branch), kept open at t=2 (upper two), worth doing at t=3 (upper two)!!!

From Event Tree Strategic Decision with flexibility

The decision diagram needs to be modified later.
**Question VI (25 points – Put-Call-Forward Parity)**

a. Derive the Put-Call-Forward Parity with diagrams and equations.

b. How do you take advantage of the arbitrage opportunity if you find that the actual price of the put option is **above** the theoretical price determined using the parity condition?

c. What are the three exact steps to arbitrage if you find that the actual price of the put option is **below** the theoretical price determined using the parity condition?

---

**Figure 12.12** Buying a Call and Selling a Put Replicates Buying a Forward Profit and Loss Positions at Maturity

*Buy Call and sell Put, you obtain a € Forward.*
In terms of net cash inflow, buying a call and selling a put nets “– C + P”

In Table 12.8, we see that buying a call and selling a put (labeled the option portfolio) entails an initial cash flow of $– C + P$. At maturity, either the call is in the money (and worth $S_T - K$) or the put is in the money (and also worth $S_T - K$). The option portfolio always returns $S_T - K$. As we have seen in Chapters 3 and 11, a long forward foreign exchange position can be replicated by borrowing the domestic currency and lending the foreign currency. Thus, in the initial period, we borrow the present value of the option strike price $[K \exp(-r_d T)]$. At maturity, we must repay an amount equal to the strike price ($-K$). To complete the forward position, we invest an amount of foreign currency equal to the present value of the currency spot rate $[S_1 \exp(-r_f T)]$. At maturity, this investment returns an amount of foreign currency now valued at $S_T$. Thus, the forward contract (in Table 12.8) always returns an amount $S_T - K$. By the law of financial arbitrage, it must be the case that for European options:

$$-C + P = +K \exp(-r_d T) - S_1 \exp(-r_f T) \quad (12.4)$$

A synthetic foreign currency forward is borrowing local currency, exchange for foreign currency, and lend foreign currency till maturity. Or, in terms of net cash inflow, “$K(1+r_d)^T - S(1+r_f)^T$”, or in continuous term “$K \cdot \exp(-r_d T) - S_1 \cdot \exp(-r_f T)$”.
b. If you find that the actual price of the put option is above the theoretical price determined using the parity condition, you should construct the theoretical/synthetic put options and sell them to the market. Theoretical/Synthetic put options can be constructed in three steps:

(i) Buy call option.
(ii) Sell “PV=(F_{1,T}) / Exp(r_d \cdot T)” amount of forward with maturity T.
(iii) Buy Bond for “(K) / Exp(r_f \cdot T)” [the bond has a maturity value K].

c. If you find that the actual price of the put option is below the theoretical price determined using the parity condition, you should keep equation (12.5) in mind:

\[ P = C - (F_{1,T} - K) / Exp(r_d \cdot T) \]

You should buy the inexpensive actual/outright put option from the market and

(i) Sell call option.
(ii) Buy “PV=(F_{1,T}) / Exp(r_d \cdot T)” amount of forward with maturity T.
(iii) Sell Bond for “(K) / Exp(r_d \cdot T)” [the bond has a maturity value K].
Question VII (25 points -- Bond Portfolio)

Below are two portfolios with a market value of $500 million. The bonds in both portfolios are trading at par value. The dollar duration of the two portfolios is the same.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Years to Maturity</th>
<th>Par Value (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds Included in Portfolio I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2.0</td>
<td>$120</td>
</tr>
<tr>
<td>B</td>
<td>2.5</td>
<td>$130</td>
</tr>
<tr>
<td>C</td>
<td>20.0</td>
<td>$150</td>
</tr>
<tr>
<td>D</td>
<td>20.5</td>
<td>$100</td>
</tr>
<tr>
<td>Bonds Included in Portfolio II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>9.7</td>
<td>$200</td>
</tr>
<tr>
<td>F</td>
<td>10.0</td>
<td>$230</td>
</tr>
<tr>
<td>G</td>
<td>10.2</td>
<td>$ 70</td>
</tr>
</tbody>
</table>

Answer the following questions.

(a) Which portfolio can be characterized as a bullet portfolio?

(b) Which portfolio can be characterized as a barbell portfolio?

(c) The two portfolios have the same dollar duration; verify. Explain whether their performance will be the same if interest rates change.

(d) If they will not perform the same, how would you go about determining which would perform best assuming that you have a six-month investment horizon? Briefly explain.

[Answer to Question VII, 25 points]

(a) Which portfolio can be characterized as a bullet portfolio?

In a bullet strategy, the portfolio is constructed so that the maturities of the securities in the portfolio are highly concentrated at one point on the yield curve. Thus, Portfolio II can be characterized as a bullet portfolio because the maturities of its securities are concentrated around one maturity (ten years).

(b) Which portfolio can be characterized as a barbell portfolio?

In a barbell strategy, the maturities of the securities included in the portfolio are concentrated at two extreme maturities. Thus, Portfolio I can be characterized as a barbell portfolio because the maturities of its securities are concentrated at two extreme maturities (two years and twenty years).

(c) The two portfolios have the same dollar duration; explain whether their performance will be the same if interest rates change.

\[ dP = -(\text{dollar duration})(dy). \]

Even if the yield curve shifts in a parallel fashion due to changes in interest rates, two portfolios with the same dollar duration will not give the same performance if they have differences in dollar convexity. Although with all other things equal, it is better to have more convexity than less; the market charges for convexity in the form of a higher price or a lower yield. But the benefit of the greater convexity depends on how much yields change. As can be seen from the illustration in the
second column of Exhibit 22-8 of Fabozzi, if market yields change by less than 100 basis points (up or down), the bullet portfolio--which has less convexity--will provide a better total return that the barbell portfolio.

The last two columns in Exhibit 22-8 of Fabozzi illustrate the relative performance of a bullet portfolio and a barbell portfolio for a nonparallel shift of the yield curve. Specifically, the first nonparallel shift column assumes that if the yield on the bullet portfolio (consisting of the intermediate-term bond) changes by the amount shown in the first column, the short-term bond in the barbell portfolio will change by the same amount plus 25 basis points, whereas the long-term bond in the barbell portfolio will change by the same amount shown in the first column less 25 basis points. Measuring the steepness of the yield curve as the spread between the long-term yield and the short-term yield, the spread has decreased by 50 basis points. Such a nonparallel shift means a flattening of the yield curve. As can be seen in the exhibit, for this assumed yield curve shift the barbell outperforms the bullet.

In the last column of Exhibit 22-8 of Fabozzi, the nonparallel shift assumes that for a change in the intermediate bond’s yield, the yield on the short-term will change by the same amount less 25 basis points, whereas that on the long-term bond will change by the same amount plus 25 points: thus, the spread between the long-term yield and the short-term yield has increased by 50 basis points, and the yield curve has steepened. In this case the bullet portfolio outperforms the barbell portfolio as long as the yield on the intermediate bond does not rise by more than 250 basis points or fall by more than 325 basis points.

(d) If they will not perform the same, how would you go about determining which would perform best assuming that you have a six-month investment horizon?

To determine which portfolio would have the superior performance, we would want to look at the total return for the six-month investment horizon given expectations about change in yields and how the yield curve will shift.

It is important to note that measures such as yield (yield to maturity or some type of portfolio yield measure), duration, or convexity tell us little about performance over some investment horizon because performance depends on the magnitude of the change in yields and how the yield curve shifts. Therefore, when a manager wants to position a portfolio based on expectations as to how he might expect the yield curve to shift, it is imperative to perform total return analysis. For example, in a steepening yield curve environment, it is often stated that a bullet portfolio with the same duration as a barbell portfolio would perform better that the barbell portfolio. However, as can be seen from Exhibit 22-8 of Fabozzi, it is not the case that a bullet portfolio would outperform a barbell portfolio. Whether the bullet portfolio outperforms the barbell depends on how much the yield curve steepens. An analysis similar to that in Exhibit 22-8 of Fabozzi based on total return for different degrees of steepening of the yield curve clearly demonstrates to a manager whether a particular yield curve strategy will be superior to another. The same analysis can be performed to assess the potential outcome of a ladder strategy.
Question VIII (25 points – Restoring the order and confidence in financial markets)

Read the following Financial Times article about financial markets since subprime mortgage crisis. Then answer the questions that follow.

**Repel the calls to contain competitive markets**

By Alan Greenspan

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The surprise of recent months is not that global economic growth is slowing, but that there is any growth at all. The credit crunch of the past year has not followed the path of recent economically debilitating episodes characterised by a temporary freezing up of liquidity – 1982, 1989, 1997-8 come to mind. This crisis is different – a once or twice a century event deeply rooted in fears of insolvency of major financial institutions.

This crisis was not brought to closure by the world’s central banks’ injection of huge doses of short-term liquidity. Only when sovereign credits were substituted for private bank credit, first in the case of the UK (Northern Rock) and subsequently in the case of the US (Bear Stearns), was a semblance of stability restored to markets. But the London Interbank Offered Rate spreads on overnight index swaps and credit default swaps of financial institutions have not returned to the modest pre-crisis levels. Fears of insolvency have not, as yet, been fully set aside. There may be numbers of banks and other financial institutions that, at the edge of defaulting, will end up being bailed out by governments.

The insolvency crisis will come to an end only as home prices in the US begin to stabilise and clarify the level of equity in homes, the ultimate collateral support for much of the financial world’s mortgage-backed securities. However, US home prices will stabilise only when the absorption of the huge excess of single-family vacant homes that emerged as the US housing boom peaked in 2006 is much further advanced than it is now. New single-family home completions are currently barely under the rate of home demand generated by household formation and replacement needs. Only later this year will the current suppressed level of housing starts be reflected in completion levels consistent with a rapid rate of liquidation of the inventory glut, and this, of course, assumes that current levels of demand for housing hold up.

Pending that outcome, the price of equities worldwide will determine whether the international financial system can maintain a modicum of stability as it eases out of its credit crunch, or falls back into another period of angst and turmoil.

The optimistic case rests on the business world beyond finance. Given this past year’s vast impairment of financial intermediation, nonfinancial corporate business has held up surprisingly well, contributing to a flow of corporate earnings that has helped sustain a stressed global stock market. To be sure, global stock prices are off a fifth from their October 2007 peaks, but still hover at levels last seen in 2006, a demonstrably less fear-ridden period than currently prevails.

A sustained level of global equity prices will be critical if banks are to recapitalise themselves at the higher levels daunted investors now require. The pool of capital is being augmented by a reasonably high level of saving (nearly 24 per cent of world gross domestic product), up significantly from earlier this decade. The flow of new saving will provide some support.
Capital gains, however, are just as important. This can best be observed in the context of the consolidated balance sheet of the world economy. All debt and derivative claims offset in global accounting, leaving real physical and intellectual assets and their market value reflected as net worth. Capital gains cannot finance new physical investment, but do add to global net worth. If, for whatever reason, discounting of prospective future earnings engendered by the world’s physical capital stock declines, the market value of that capital stock rises with no offsetting liability. There is accordingly a larger value of equity shoring up the capital of financial or nonfinancial businesses. Should that discount rate reverse, the value of world equity will fall. Consequently, lower global stock prices could impede the recapitalisation of banks and other financial institutions. Debt issuance would also be suppressed as it leverages off the level of equity.

Globalisation is at the root of the past decade’s unprecedented surge in world economic activity. The growth in the volume of global trade has far exceeded the pace of world real GDP growth for decades. Between 2001 and 2007 global cross-border investments (at market values) rose almost two-thirds faster than world nominal GDP, according to data from the International Monetary Fund. The economic edifice – market capitalism – that has fostered this expansion is now being pilloried for the pause and partial retrenchment. The cause of our economic despair, however, is human nature’s propensity to sway from fear to euphoria and back, a condition that no economic paradigm has proved capable of suppressing without severe hardship. Regulation, the alleged effective solution to today’s crisis, has never been able to eliminate history’s crises.

A financial crisis is heralded, in fact defined, by sharp discontinuities of asset prices. The crisis must thus be unanticipated. The fact that risk was heavily underpriced for much of this decade was broadly recognised in the financial community, but the timing of the sharp price correction was nonetheless a surprise.

Recent history is replete with such underpricing persisting for years. Those market players who withdraw from “long” commitments at the first sign of an excess of exuberance, risk losing market share. They thus continue “to dance” as Chuck Prince, the former Citigroup chairman put it, but always assume they will have time to exit the markets. The vast majority invariably fail. When the current crisis emerged, it was assumed that the weak links would be unregulated hedge and private funds. The losses, however, have been predominately in the most heavily regulated institutions – banks.

We may not easily confront or accept the price dynamics of home and equity prices, but we can fend off cries of political despair which counsel the containment of competitive markets. It is essential that we do so. The remarkably strong performance of the world economy since the near universal adoption of market capitalism is testament to the benefits of increasing economic flexibility.

It has become hard for democratic societies accustomed to prosperity to see it as anything other than the result of their deft political management. In reality, the past decade has seen mounting global forces (the international version of Adam Smith’s invisible hand) quietly displacing government control of economic affairs. Since early this decade, central banks have had to cede control of long-term interest rates to global market forces. Previously heavily controlled economies – such as China, Russia and India – have embraced competitive markets in lieu of bureaucratic edict. The danger is that some governments, bedevilled by emerging inflationary forces, will endeavour to reassert their grip on economic affairs. If that becomes widespread, globalisation could reverse – at awesome cost.

The writer is the former chairman of the US Federal Reserve

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a. (5 points) What was the pleasant surprise given this past year’s vast impairment of financial intermediation? Did it have anything to do with the monetary policy?

b. (10 points) “The cause of our economic despair, however, is human nature’s propensity to sway from fear to euphoria and back, a condition that no economic paradigm has proved capable of suppressing without severe hardship.” Did I hear the word “greed”? Elaborate.

c. (10 points) “The danger is that some governments, bedevilled by emerging inflationary forces, will endeavour to reassert their grip on economic affairs. If that becomes widespread, globalization could reverse – at awesome cost.” What did the former Chair of U.S. Federal Reserves mean by “awesome cost”? Will it backfire to some emerging economies themselves if such fear realizes?

[Answer to Question VIII, 25 points] (from Kam Ha)

a. The pleasant surprise is that the global economy is still growing, largely boosted by non-financial corporate business’ performance, which contributed to a flow of corporate earnings, helping to sustain a stressed global stock market. Greenspan implies that the monetary policy of non-intervention has contributed to the strength of global economy.

b. The statement expresses the view that the cycles of fear (causing depression) progressing to euphoria (causing exuberance / bubble) is human nature, essentially stating that financial disasters (caused by greed) are inevitable. When greed takes control, exuberance occurs, only to be relegated to a state of conservatism when the bubble burst. Such tendency cannot be corrected by expanding regulation.

c. Greenspan argued that globalization is at the root of past decade’s surge in world economic activity, leading to expansion and growth of economies. The “awesome cost” is such that this growth would be hurt and the universal adoption of market capitalism would be hampered, if more regulation were to take place. Some emerging economies, especially those whose expansion are caused by globalization, will suffer from increased regulation.
Question IX (25 points – Financial Engineering and Security Design)

[Continued from Question VIII] Read the Financial Times article about financial markets since subprime mortgage crisis. Then answer the questions that follow.

d. (5 points) “But the London Interbank Offered Rate spreads on overnight index swaps and credit default swaps of financial institutions have not returned to the modest pre-crisis levels. Fears of insolvency have not, as yet, been fully set aside.” What are credit default swaps? How does a credit default swaps work? Illustrate with a schematic diagram.

e. (5 points) What are CDOs? What is the structure of a CDO? Illustrate with the given diagram showing three tranches: Senior tranche, Mezzanine tranche and Subordinated tranche. How does Senior tranche differ from the Subordinated tranche in terms of credit rating and price?

f. (5 points) What is a “synthetic CDO”? Illustrate with the given schematic diagram. What cause its price to change? What’s its fate in today’s market in terms of transaction volume and price?

g. (5 points) What is a CDS index? What information does it carry?

h. (5 points) What is the structure of tranched CDX. Illustrate with the given schematic diagram.

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The structure of tranched CDX.

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(f) Schematic diagram of a Synthetic CDO

The financial instrument fared poorly nowadays due to the market sentiments of flying to quality after subprime mortgage crisis. The supply has dried out and the value has decreased.

[Answer to Question IX, 25 points]
(d) Schematic Diagram for Credit Default Swaps:

![Schematic Diagram for Credit Default Swaps](image)

**FIGURE 12.3**
Depiction of the cash flows in a credit default swap. The investor owns the reference asset, which was issued by XYZ. The investor buys a credit default swap and pays 40 basis points per year in exchange for the swap writer's payment in the event of a default by XYZ.
Credit default swaps (CDS) are an important recent innovation, permitting holders of corporate bonds to buy insurance against default. (A CDS is really more an option than a swap, but the "swap" terminology is standard.) The CDS buyer pays a premium, usually amortized over a series of payments. If the reference asset experiences a "credit event" (for example, a failure to make a scheduled payment on a particular bond or class of bonds), then the seller makes a payment to the buyer.

A single name CDS makes a payment when a specific company experiences a credit event. The buyer of the swap is the protection buyer. An institutional bondholder, for example, could use a CDS to buy protection against the credit risk of a company. The counterparty providing the credit insurance is the swap writer or protection seller.

(g) CDS index

A CDS index is an average of the premiums on a set of credit default swaps. Thus, a CDS index provides a way to track the overall market for credit. Most trading in the credit market is in CDS indexes.

To a first approximation, it is possible to replicate a CDS index by holding a pool of CDSs. As with a single CDS, one party is a protection seller, receiving premium payments, and the other is a protection buyer, making the payments but receiving a payment from the seller if there is a credit event.

There are numerous ways in which a CDS index product can be structured and traded:

- A CDS index can be funded or unfunded. The unfunded version is like a credit default swap, except that the underlying asset is a basket of firms. The funded index is a note linked to the index with a collateral arrangement in case the note buyer had to make a payment.
- The claims are generally tranched in various ways, for example, simple priority or Nth to default.
- The underlying assets can represent different countries, currencies, maturities, or industries.

A 0–100% tranche on a CDS index can also be described as a synthetic CDO. The returns on a CDS index reflect the performance of the bonds in the index, just as the returns on a CDO reflect the performance of the bonds in the asset pool.
(h) Tranched CDX

Single name credit default swaps first traded in the mid-1990s. In 2001 Morgan Stanley introduced TRACERS, a basket of corporate bonds that investors could trade as a unit, much like an exchange-traded fund. There were both funded and nonfunded TRACERS products. J. P. Morgan created a competing product called HYDI. In 2003 Morgan Stanley and J.P. Morgan merged these products to create TRAC-X. Later in 2003 competing banks introduced CDX as an alternative credit index. In 2004 the TRAC-X and CDX products merged into Dow Jones CDX. These indexes could be traded in both funded and nonfunded products.

Firms can drop out of an index due to bankruptcy or illiquidity, but otherwise the makeup of a given CDX offering is set for the life of the offering. A new CDX is currently offered every 6 months with 5- and 10-year maturities, with the most recent offering being the most heavily traded. For North America, there are versions of the index reflecting investment-grade companies, high-volatility companies, and high-yield companies. The CDX North America index is an equally weighted basket of 125 CDSs representing investment-grade companies. There are also credit indexes for North America, Europe, Asia, Japan, Australia, and emerging markets.

Another notable index is the ABX, an index based on default swaps on bonds backed by risky mortgages. The pricing of ABX tranches was in the news in late 2007 as the subprime mortgage crisis unfolded. (See Box 12.3.)

Tranched CDX has a payoff structure illustrated in Figure 12.4. There are both funded and unfunded products based on this structure. As you would expect from our earlier discussion of CDOs and default correlation, the pricing of the various tranches is sensitive to correlation. In fact, tranche pricing is quoted using implied correlation in much the same way equity option premiums are quoted using implied volatility.

![Figure 12.4](source: Morgan Stanley)
(e) CDO

**Collateralized Debt Obligations**

A *collateralized debt obligation* (CDO) is a financial structure that repackages the cash flows from a set of assets. You create a CDO by pooling the returns from a set of assets and issuing financial claims on this pool. The CDO claims reapportion the returns on the asset pool. Thus, instead of modifying the payoff of a single bond, a CDO creates a new payoff based on a pool of bonds. The bonds in the pool may be ordinary corporate bonds, loans, mortgages, or other assets. Typically, CDO claims are *tranched*, meaning that the different CDO claims have differing priorities with respect to the cash flows generated by the collateral. With a CDO, it is possible to take a group of risky bonds, for example, and create new claims, some of which are less risky than the original bonds and others that are riskier.

Given this general description, there are many different ways a CDO can be structured. First, the asset pool can be a fixed set of assets, in which case the CDO is *static*. If instead a manager buys and sells assets, the CDO is *managed*. Second, the CDO claims can directly receive the cash flows generated by the pool of assets; this is a *cash flow CDO*. Alternatively, the CDO claims can receive payments based on cash flows and the gain or loss from asset sales; this is a *market value CDO*.

There are at least two reasons for creating CDOs. First, financial institutions will sometimes want to securitize assets, effectively removing them from the institution’s balance sheet by selling them to other investors. A CDO can be used to accomplish this, in which case it is a *balance sheet CDO*. Second, a CDO can be created in response to institutional frictions. For example, some investors are permitted to hold only investment-grade bonds. As we will see, CDOs can potentially be used to create investment-grade bonds from a pool of non-investment-grade bonds. This is called an *arbitrage CDO*. 
a CDO, reapportioning the cash flows from the pool of bonds, in order to accommodate the different kinds of investors. The structure of the CDO is illustrated in Figure 12.2. The total promised payoff on the three bonds is $300; the CDO apportions this payoff among three tranches of unequal size. The senior tranche ($140) receives first claim to the bond payments, the mezzanine tranche ($90) has the next claim, and the subordinated tranche ($70) receives whatever is left. For the bond that is $i$th in line, with a promised

Senior tranche has the best credit rating and can sell for good price. Investors are willing to accept lower returns buying the Senior tranche for its high credit rating and low default rates. Subordinated tranche, on the other hand, sells for lower price and grants higher return to investors due to its low credit rating and high default rates.
**Question X (25 points – hedging with futures and options)**

Palmfue expects to receive royalty payments totaling £2.50 million next month. It is interested in protecting these receipts against a drop in the value of the pound. It can sell 30-day pound futures at a price of $1.6513 per pound or it can buy pound put options with a strike price of $1.6612 at a premium of 2.0 cents per pound. The spot price of the pound is currently $1.6560, and the pound is expected to trade in the range of $1.6250 to $1.7010. Palmfue’s treasurer believes that the most likely price of the pound in 30 days will be $1.6400.

a. (5 points) How many futures contracts will Palmfue need to protect its receipts? How many options contracts? Under what condition (if any, you may be creative) would you recommend Palmfue to hedge 50% of its receipts with futures and the rest with options?

b. (5 points) Diagram Palmfue’s profit and loss associated with the put option position and the futures position within its range of expected exchange rates. Ignore transaction costs and margins.

c. (5 points) Calculate what Palmfue would gain or lose on the option and futures positions within the range of expected future exchange rates and if the pound settled at its most likely value.

d. (5 points) What is Palmfue’s break-even future spot price on the option contract? On the futures contract?

e. (5 points) Calculate and diagram the corresponding profit and loss and break-even positions on the futures and options contracts for those who took the other side of these contracts.

[Answer to Question X, 25 points]

a. Using CME £ options, size of £62,500,
   \# of £ options = 2,500,000 / 62,500 = 40

   Using CME £ futures, size of £62,500
   \# of £ futures = 2,500,000 / 62,500 = 40
   when one wants to diversify the default risk.
b. Options

\[ 2.5M \times (1.6612 - 1.6250) = 90,500 \]

Cost = 0.02 \times 2.5M = 50,000

Gain at $1.6250/£ = 90,500 - 50,000 = 40,500

Loss when rate than $1.6612/£ = -50,000

c. Futures

Gain at $1.6250/£ = 2.5M \times (1.6513 - 1.6250) = 65,750

Loss at $1.7010/£ = 2.5M \times (1.6513 - 1.7010) = -124,250

At most likely value,

Options: 2.5M \times (1.6612 - 1.6400) = 53,000

Cost = 50,000

Gain = 53,000 - 50,000 = 3,000

Futures: Gain = 2.5M \times (1.6513 - 1.6400) = 28,250

d. Options: Gain = 2.5M \times (1.6612 - x) - 50,000 = 0 \Rightarrow x = 1.6412/£

Futures: Gain = 2.5M \times (1.6513 - x) = 0 \Rightarrow x = 1.6513/£
Question XI (25 points – hedging contingent currency fluctuation)
iNOS computer in Britain had a wonderful year selling the world’s lightest cellular phone airweight. When they celebrate for the success, the general manager iNOS received a lawyer’s letter, indicating that iNOS’ heat radiating technology infringed the patent of the current market leader SONi and SONi has filed a lawsuit and asked for a claim of ¥100 billion to resolve the issue.
iNOS’ lawyer said the company may lose the case with a probability of 50%. The CFO was called in to arrange for the financial hedging of the contingent lawsuit loss. You are hired by the CFO to list all possible ways of hedging with financial derivatives; and you are asked to provide detailed discussion of advantages and disadvantages of each alternative. You are also asked to illustrate with all possible scenarios when the hedge is done with options.

[Answer to Question XI, 25 points]

Options
Enter into call options with an amount of ¥100 billion, or 800 call option contracts.
(Scenario 1) If £ weakens against ¥ and iNOS wins the litigation, the call option is in the money and can be sold for a profit.
(Scenario 2) If £ weakens against ¥ and iNOS loses the litigation, the call option will be exercised to acquire enough affordable ¥ to pay for the lawsuit.
(Scenario 3) If £ strengthens against ¥ and iNOS wins the litigation, the call option is out of the money and is left to expire.
(Scenario 4) If £ strengthens against ¥ and iNOS loses the litigation, the call option is out of the money and is left to expire. iNOS will buy more affordable ¥ directly from the spot market.
Disadvantage of hedging with option: lawsuit can be drawn out for years, and options has a strike price, so there might be temporal mismatch between when strike price is reached and lawsuit judgment.

Securities
iNOS can simply invest in securities, giving itself flexibility to pay when it loses, or recoup the investment plus interest if it wins.