CHAPTER 26: HEDGE FUNDS

PROBLEM SETS

1. No, a market-neutral hedge fund would not be a good candidate for an investor's entire retirement portfolio because such a fund is not a diversified portfolio. The term *market-neutral* refers to a portfolio position with respect to a specified market inefficiency. However, there could be a role for a market-neutral hedge fund in the investor's overall portfolio; the market-neutral hedge fund can be thought of as an approach for the investor to add alpha to a more passive investment position such as an index mutual fund.

2. The incentive fee of a hedge fund is part of the hedge fund compensation structure; the incentive fee is typically equal to 20% of the hedge fund's profits beyond a particular benchmark rate of return. Therefore, the incentive fee resembles the payoff to a call option, which is more valuable when volatility is higher. Consequently, the hedge fund portfolio manager is motivated to take on high-risk assets in the portfolio, thereby increasing volatility and the value of the incentive fee.

3. There are a number of factors that make it harder to assess the performance of a hedge fund portfolio manager than a typical mutual fund manager. Some of these factors are
   - Hedge funds tend to invest in more illiquid assets so that an apparent alpha may be in fact simply compensation for illiquidity.
   - Hedge funds' valuation of less liquid assets is questionable.
   - Survivorship bias and backfill bias result in hedge fund databases that report performance only for more successful hedge funds.
   - Hedge funds typically have unstable risk characteristics making performance evaluation that depends on a consistent risk profile problematic.
   - Tail events skew the distribution of hedge fund outcomes, making it difficult to obtain a representative sample of returns over relatively short periods of time.

4. The problem of survivorship bias is that only the returns for survivors will be reported and the index return will be biased upwards. Backfill bias results when a new hedge fund is added to an index and the fund's historical performance is added to the index's historical performance. The problem is that only funds that survived will have their performance added to the index, resulting in upward bias in index returns.

5. The Merrill Lynch High Yield index may be the best individual market index for fixed income hedge funds and the Russell 3000 may be the individual market index for equity hedge funds. However, a combination of indexes may be the best market index, as it has been found that multifactor model do the best in explaining hedge fund returns. Of equity hedge funds, market neutral strategies should have a return that is closest to risk-free, but they are not risk free.

6. Funds of funds are usually considered good choices for individual investors because they offer diversification and usually more liquidity. One problem with funds of funds is that they usually have lower returns. This is a result from both the additional layer of fees and cash drag (resulting from the desire for liquidity).

7. Of the equity hedge funds, market neutral strategies should have a return that is closest to risk-free; however, they are not completely risk-free and typically have exposure to both systematic and unsystematic risks.

8. No, statistical arbitrage is not true arbitrage because it does not involve establishing risk-free positions based on security mispricing. Statistical arbitrage is essentially a portfolio of risky bets. The hedge fund takes a large number of small positions based on apparent small, temporary market inefficiencies, relying on the probability that the expected return for the totality of these bets is positive.

9. Management fee = 0.02 × $1 billion = $20 million

	Portfolio Rate of Return (%)	Incentive Fee (%)	Incentive Fee ($ million)	Total Fee ($ million)	Total Fee (%)
a.	-5	0	0	20	2
b.	0	0	0	20	2
c.	5	0	0	20	2
d.	10	20	10	30	3

10. The incentive fee is typically equal to 20 percent of the hedge fund's profits beyond a particular benchmark rate of return. However, if a fund has experienced losses in the past, then the fund may not be able to charge the incentive fee unless the fund exceeds its previous high-water mark. The incentive fee is less valuable if the high-water mark is $67, rather than $66. With a high-water mark of $67, the net asset value of the fund must reach $67 before the hedge fund can assess the incentive fee. The high-water mark for a hedge fund is equivalent to the exercise price for a call option on an asset with a current market value equal to the net asset value of the fund.

11. a. First, compute the Black Scholes value of a call option with the following parameters:

$S_0 = 62$
$X = 66$
$R = 0.04$
$\sigma = 0.50$
$T = 1$ year

Therefore: $C = \$11.685$

The value of the annual incentive fee is:

$0.20 \times C = 0.20 \times \$11.685 = \$2.337$

b. Here we use the same parameters used in the Black-Scholes model in part (a) with the exception that $X = 62$

Now: $C = \$13.253$

The value of the annual incentive fee is

$0.20 \times C = 0.20 \times \$13.253 = \$2.651$

c. Here we use the same parameters used in the Black-Scholes model in part (a) with the exception that:

$X = S_0 \times e^{0.04} = 62 \times e^{0.04} = 64.5303$

Now: $C = \$12.240$

The value of the annual incentive fee is

$0.20 \times C = 0.20 \times \$12.240 = \$2.448$

d. Here we use the same parameters used in the Black-Scholes model in part (a) with the exception that $X = 62$ and $\sigma = 0.60$

Now: $C = \$15.581$

The value of the annual incentive fee is

$0.20 \times C = 0.20 \times \$15.581 = \$3.116$

12. a. The spreadsheet indicates that the end-of-month value for the S&P 500 in September 1977 was 96.53, so the exercise price of the put written at the beginning of October 1977 would have been

$0.95 \times 96.53 = 91.7035$

At the end of October, the value of the index was 92.34, so the put would have expired out of the money and the put writer's payout was zero. Since it is unusual for the S&P 500 to fall by more than 5 percent in one month, all but 10 of the 120 months between October 1977 and September 1987 would have a payout of zero. The first month with a positive payout would have been January 1978. The exercise price of the put written at the beginning of January 1978 would have been

$$0.95 \times 95.10 = 90.3450$$

At the end of January, the value of the index was 89.25 (more than a 6% decline), so the option writer's payout would have been:

$$90.3450 - 89.25 = 1.0950$$

The average gross monthly payout for the period would have been 0.2437 and the standard deviation would have been 1.0951.

b. In October 1987, the S&P 500 decreased by more than 21 percent, from 321.83 to 251.79. The exercise price of the put written at the beginning of October 1987 would have been

$$0.95 \times 321.83 = 305.7385$$

At the end of October, the option writer's payout would have been:

$$305.7385 - 251.79 = 53.9485$$

The average gross monthly payout for the period October 1977 through October 1987 would have been 0.6875 and the standard deviation would have been 5.0026. Apparently, tail risk in naked put writing is substantial.

13. a. In order to calculate the Sharpe ratio, we first calculate the rate of return for each month in the period October 1982—September 1987. The end of month value for the S&P 500 in September 1982 was 120.42, so the exercise price for the October put is

$$0.95 \times 120.42 = 114.3990$$

Since the October end of month value for the index was 133.72, the put expired out of the money so that there is no payout for the writer of the option. The rate of return the hedge fund earns on the index is therefore equal to

$$(133.72/120.42) - 1 = 0.11045 = 11.045\%$$

Assuming that the hedge fund invests the $0.25 million premium along with the $100 million beginning of month value, then the end of month value of the fund is

$$\$100.25 \text{ million} \times 1.11045 = \$111.322 \text{ million}$$

The rate of return for the month is

$$(\$111.322/\$100.00) - 1 = 0.11322 = 11.322\%$$

The first month that the put expires in the money is May 1984. The end of month value for the S&P 500 in April 1984 was 160.05, so the exercise price for the May put is

$0.95 \times 160.05 = 152.0475$

The May end of month value for the index was 150.55, and therefore the payout for the writer of a put option on one unit of the index is

$152.0475 - 150.55 = 1.4975$

The rate of return the hedge fund earns on the index is equal to

$(150.55/160.05) - 1 = -0.05936 = -5.936\%$

The payout of 1.4975 per unit of the index reduces the hedge fund's rate of return by

$1.4975/160.05 = 0.00936 = 0.936\%$

The rate of return the hedge fund earns is therefore equal to

$-5.936\% - 0.936\% = -6.872\%$

The end of month value of the fund is

\$100.25 million × 0.93128 = \$93.361 million

The rate of return for the month is

$(\$93.361/\$100.00) - 1 = -0.06639 = -6.639\%$

For the period October 1982—September 1987

Mean monthly return = 1.898%

Standard deviation = 4.353%

Sharpe ratio = (1.898% – 0.7%)/4.353% = 0.275

b. For the period October 1982—October 1987

Mean monthly return = 1.238%

Standard deviation = 6.724%

Sharpe ratio = (1.238% – 0.7%)/6.724% = 0.080

14. a. Since the hedge fund manager has a long position in the Waterworks stock, he should sell 15 contracts, computed as follows:

$$\frac{\$2{,}000{,}000 \times .75}{\$50 \times 2{,}000} = 15 \text{ contracts}$$

b. With all market risk hedged away, the standard deviation of the monthly return of the hedged portfolio is equal to the standard deviation of the residuals, which is 6%. The standard deviation of the residuals for the stock is the volatility that cannot be hedged away. For a market-neutral (zero-beta) position, this is also the total standard deviation.

c. The expected rate of return of the market-neutral position is equal to the risk-free rate plus the alpha:

$0.5\% + 2.0\% = 2.5\%$

A return of zero (or worse) would therefore be at least 2.5% less than the expected return. Translating this to a *z*-score, this return would be

$-2.5\%/6.0\% = -0.4167$, or .4167 standard deviations below the mean.

We assume that monthly returns are approximately normally distributed. Therefore, the probability of a negative return is $N(-0.4167) = 0.3385$

15. a. The residual standard deviation of the portfolio is smaller than each stock's standard deviation by a factor of $\sqrt{100} = 10$ or, equivalently, the residual variance of the portfolio is smaller by a factor of 100. So, instead of a residual standard deviation of 6 percent, residual standard deviation is now 0.6 percent.

b. The expected return of the market-neutral position is still equal to the risk-free rate plus the alpha:

$0.5\% + 2.0\% = 2.5\%$

Now the *z*-value for a rate of return of zero is

$-2.5\%/0.6\% = -4.1667$

Therefore, the probability of a negative return is $N(-4.1667) = 0.0000155$
A negative return is very unlikely. This is because both sources of risk have been eliminated: market risk has been hedged using the futures, and idiosyncratic risk has been dramatically reduced through diversification.

16. a. The manager does not sell enough contracts to fully hedge market exposure. Beta is reduced from .75 to .25 (rather than all the way to zero). For the improperly-hedged portfolio:

$\text{Variance} = \beta^2\,\text{Var}(r_M) + \text{Var}(e) = (0.25^2 \times 5^2) + 6^2 = 37.5625$

Standard deviation = 6.129%

b. Since the manager has underestimated the beta of Waterworks, the manager will sell only 10 S&P 500 contracts (rather than the 15 contracts in Problem 14):

$$\frac{\$2{,}000{,}000 \times .50}{\$50 \times 2{,}000} = 10 \text{ contracts}$$

The portfolio is not completely hedged so the expected rate of return is no longer 2.5%. We can determine the expected rate of return by adding the total dollar value of the stock position to the value of the futures position.

The dollar value of the stock portfolio will be:

$$\$2,000,000 \times (1 + r_{portfolio}) = \$2,000,000 \times [1 + 0.005 + 0.75 \times (r_M - 0.005) + 0.02 + e]$$
$$= \$2,042,500 + \$1,500,000 \times r_M + \$2,000,000 \times e$$

The dollar proceeds from the 10 futures contracts sold will be:

$$10 \times \$50 \times (F_0 - F_1) = \$500 \times [(S_0 \times 1.005) - S_1]$$
$$= \$500 \times S_0 \times [1.005 - (1 + r_M)]$$
$$= \$500 \times 2{,}000 \times [.005 - r_M]$$
$$= \$5{,}000 - \$1{,}000{,}000 \times r_M$$

The total dollar value of the hedged position is the sum of the stock portfolio value plus futures proceeds:

$\$2{,}047{,}500 + \$500{,}000 \times r_M + \$2{,}000{,}000 \times e$

Notice that the position still has positive exposure to the market because too few contracts have been sold.

If we expect the market return to be $r_M = .01$, then the expected total value of the stock plus futures position at the end of the month is:

$\$2{,}052{,}500 + \$2{,}000{,}000 \times e$

The expected rate of return for the (incompletely) hedged portfolio is

$2{,}052{,}500/2{,}000{,}000 - 1 = .02625 = 2.625\%$

Now the z-value for a rate of return of worse than zero is:

$-2.625\%/6.129\% = -0.4283$

The probability of a negative return is $N(-0.4283) = 0.3342$
Here, the probability of a negative return is similar to the probability computed in Problem 14. The underestimation of beta has only a minor impact of the probability of a loss because so a large fraction of total risk is attributable to the idiosyncratic component of return, e.

c. The variance for the diversified (but improperly hedged) portfolio is

$(0.25^2 \times 5^2) + 0.6^2 = 1.9225$

Standard deviation $= \sqrt{1.9225} = 1.3865\%$

The z-value for a rate of return of zero is:

$-2.625\%/1.3865\% = -1.8933$

The probability of a negative return is $N(-1.8933) = 0.0292$

The probability of a negative return is now far greater than the probability we found with proper hedging in Problem 15.

d. The market exposure from improper hedging is far more important in contributing to total volatility (and risk of losses) in the case of the 100-stock portfolio because the idiosyncratic risk of the diversified portfolio is so small in this case. When idiosyncratic risk is minimal, the market risk that results from underestimating beta has a much greater proportional impact on the total risk of the portfolio.

17. a.-f.

	Hedge Fund 1	Hedge Fund 2	Hedge Fund 3	Fund of Funds	Stand-Alone Fund
Start of year value (millions)	\$100.0	\$100.0	\$100.0	\$300.0	\$300.0
Gross portfolio rate of return	20%	10%	30%		
End of year value (before fee)	\$120.0	\$110.0	\$130.0		\$360.0
Incentive fee (Individual funds)	\$4.0	\$2.0	\$6.0		\$12.0
End of year value (after fee)	\$116.0	\$108.0	\$124.0	\$348.0	\$348.0
Incentive fee (Fund of Funds)				\$9.6	
End of year value (Fund of Funds)				\$338.4	
Rate of return (after fee)	16.0%	8.0%	24.0%	12.8%	16.0%

Note that the end-of-year value (after-fee) for the Stand-Alone (SA) Fund is the same as the end-of-year value for the Fund of Funds (FF) before FF charges its extra layer of incentive fees. Therefore, the investor's rate of return in SA (16.0%) is higher than in FF (12.8%) by an amount equal to the extra layer of fees (\$9.6 million, or 3.2%) charged by the Fund of Funds.

d.

	Hedge Fund 1	Hedge Fund 2	Hedge Fund 3	Fund of Funds	Stand-Alone Fund
Start-of-year value (millions)	\$100.0	\$100.0	\$100.0	\$300.0	\$300.0
Gross portfolio rate of return	20%	10%	-30%		
End-of-year value (before fee)	\$120.0	\$110.0	\$70.0		\$300.0
Incentive fee (Individual funds)	\$4.0	\$2.0	\$0.0		\$0.0
End-of-year value (after fee)	\$116.0	\$108.0	\$70.0	\$294.0	\$300.0
Incentive fee (Fund of Funds)				\$0.0	
End-of-year value (Fund of Funds)				\$294.0	
Rate of return (after fee)	16.0%	8.0%	-30.0%	-2.0%	0.0%

Now, the end-of-year value (after fee) for SA is \$300, while the end-of-year value for FF is only \$294, despite the fact that neither SA nor FF charge an incentive fee. The reason for the difference is the fact that the Fund of Funds pays an incentive fee to each of the component portfolios. If even one of these portfolios does well, there will be an incentive fee charged. In contrast, SA charges an incentive fee only if the aggregate portfolio does well (at least better than a 0% return). The fund of funds structure therefore results in total fees at least as great as (and usually greater than) the stand-alone structure.