FINM 36700 Midterm 1 Solutions

Portfolio and Risk Management

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Name: _____

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- This exam is **closed book** and **closed notes**.
- You are **not** allowed any electronics or calculator.

Section	Questions	Points per Question	Points Awarded	Points Possible
1	20	2		40
2	20	2		40
3	15	2		30
Total	55	-		**110**

Section 1

Select True or False

1. The mean-variance tangency weights depend on the investor's risk aversion.

   x True

   ✓ False

2. Asset Managers Ken Booth and David Griffin can only invest in stocks in the S&P 500. Ken's firm only allows him to invest in the long direction (or, equivalently, he is restricted from holding short positions), while David has no such restrictions. Does David's efficient frontier dominate Ken's efficient frontier?

   ✓ True

   x False

3. Mean-variance optimization requires the assumption that returns are normally distributed.

   x True

   ✓ False

4. The maximum mean return available to a mean-variance investor can be achieved by allocating 100% weight to the tangency portfolio.

   x True

   ✓ False

Multiple Select: Indicate all the true statements, whether that is 0, 1, or multiple.

5. Which of the following statements apply to portfolio returns stats as a function of portfolio weights?

   x Mean return is sub-additive

   ✓ Mean return is linear

   x Mean return is super-additive

   ✓ Volatility is sub-additive

   x Volatility is linear

   x Volatility is super-additive

6. Why does Harvard Management Company (HMC) optimize portfolios by asset class instead of optimizing thousands of individual securities directly?

   x HMC aggregates to asset classes for numerical feasibility.

   ✓ HMC aggregates to asset classes for statistical feasibility.

- x HMC aggregates out of practical convenience, as the two-stage optimization gives the same result.
- x HMC prefers to be overly conservative in understating the degree of diversification.

7. A portfolio's mean-variance frontier would benefit from the addition of which of the following assets?

   - ✓ asset with $0 <$ correlations < 1
   - ✓ asset with correlations < 0
   - ✓ asset with Sharpe ratio > 0
   - ✓ asset with Sharpe ratio < 0
   - ✓ asset with Sharpe ratio $>$ tangency Sharpe

8. The portfolios which form the the mean-variance frontier (no risk-free asset) are...

   - ✓ linear combinations of the tangency and GMV portfolio weights
   - x nonlinear combinations of the tangency and GMV portfolio weights

9. At the margin, for a large diversified portfolio, which of the following statistics notably impact the MV optimization weights.

   - ✓ mean
   - x volatility
   - x skewness
   - ✓ covariance

10. Mean-variance efficient portfolios offer the following:

    - ✓ Minimize risk for a given level of return
    - x Maximize risk for a given level of return
    - x Minimize return for a given level of risk
    - ✓ Maximize return for a given level of risk

11. In a class discussion, we optimized the largest stocks in the S&P 500. When including SPY as an asset, we found that the largest weight went to BRK. What was true of BRK?

    - ✓ low Sharpe ratio
    - x high Sharpe ratio
    - ✓ low correlations to the other stocks
    - x high correlations to the other stocks
    - x low correlations to SPY
    - ✓ high correlations SPY

12. What are possible effects of imposing weight restrictions on MV optimization? An example of such restriction: a maximum of 80% portfolio weight assigned to US equities.

- ✓ Reduces maximum Sharpe ratio achievable within sample
- ✓ May be more feasible for institutional controls
- x Always leads to equal weighting among all assets
- ✓ Prevents large and offsetting allocations to highly correlated assets
- x Linearizes the optimization problem, making it easier to solve

13. The constrained MV optimization was notable for which of the following?

    - x Has a closed-form solution
    - ✓ Easy to solve numerically
    - ✓ The objective function is convex.
    - ✓ The constraints are convex.

14. In discussing the Harvard case, we found the **constrained** MV frontier was...

    - x substantially shifted right (worse performance)
    - ✓ substantially limited in range (narrower performance)

15. Suppose

    - Asset A has an expected return of 6% and a volatility of 30%,
    - Asset B has an expected return of 3% and a volatility of 60%.
    - A and B are perfectly negatively correlated

    If there are no arbitrage opportunities in the economy, the risk-free rate must be which of the following? Select one.

    - x -4%
    - x -3%
    - x -2%
    - x -1%
    - x 0%
    - x 1%
    - x 2%
    - x 3%
    - x 4%
    - ✓ none of the above
    - x undetermined

16. In the Harvard Case on TIPS, which of the following statistics are particularly hard to measure with precision?

    - ✓ mean
    - x vol

x pairwise correlation

17. Suppose we have an MV frontier based on a set of n stocks, all with cross correlation ρ. Suppose we add a new stock, j, to the set. Under which of the following scenarios will it expand the MV frontier for which correlations of j to the other stocks?

✓ Average correlations with j are less than ρ.
✓ Some correlation with j is less than ρ.
✓ Average correlation with j is less than 0.
✓ Some correlation with j is less than 0.

18. In calculating the tangency of S&P 500 stocks, we found that as number of stocks increase...

x the net market value increased
✓ the gross market value increased
✓ the mean increased
✓ the Sharpe ratio increased

19. We estimated portfolios using alternative algorithms including risk parity and a diagonalized covariance matrix. Based on those in-sample findings, select the accurate statements below.

x The risk parity portfolio had higher Sharpe ratio than the diagnalized portfolio.
✓ The classic MV portfolio had the highest Sharpe ratio.
x The equal weighted portfolio had an in-sample Sharpe ratio nearly as high as the MV optimized?

20. Suppose you have a large, well-diversified portfolio of S&P 500 stocks. Which of the following stats for each asset would most closely align with the MV optimized weights of each asset?

Choose exactly one.

x mean
x Sharpe ratio
x alpha
✓ Information ratio
x average cross-correlation

Section 2

Multiple Select: Indicate all the true statements, whether that is 0, 1, or multiple.

1. If a portfolio has a beta of 0 with respect to the market factor, it means the portfolio is risk-free.

   x True
   ✓ False

2. Which statements are correct?

   ✓ Treynor uses systematic market risk via β, but it is silent on idiosyncratic risk.
   ✓ The Information Ratio evaluates factor performance per unit of non-factor volatility
   x If a fund perfectly market-hedges itself, Treynor and Information Ratio are undefined / not informative.
   x A manager can game Treynor by levering into the benchmark if the benchmark captures the true factor exposures.
   ✓ Information Ratio is harder to game if the benchmark captures the true factor exposures.

3. A manager writes in the quarterly letter:

   `"Our 3-factor regression explains 95% of our monthly return variation. Therefore..."`

   ✓ "... our tracking error is low."
   x "... our alpha is high."
   x "our Info Ratio is high."

4. Which statements are correct about using an intercept in a Linear Factor Decomposition?

   ✓ In performance attribution, the intercept is an estimate of excess performance.
   ✓ For tracking (replication), the intercept gives the amount invested in the risk-free rate.
   ✓ The suggested hedging ratios will differ based on whether an intercept was included.

5. You want to build a replication for a hedge fund's monthly returns using Linear Factor Decomposition and monthly rebalancing of the hedge. Which of the following would you suggest could be used for building the hedge?

   ✓ Returns on an ETF holding Treasury bonds
   ✓ Returns of Treasury futures contracts.
   x Implied returns of a diversified index of Treasury bonds.

6. You hedge assets against the market. Which single performance number gives the cleanest skill-per-basis-risk assessment?

   ✓ Information ratio

- x Treynor ratio on the hedged sleeve.
- x Sharpe of the market index.
- x R^2 of the hedging regression.

7. What are the primary consequences of high multicollinearity in a Linear Factor Decomposition?
   - x The model's R-squared will be artificially low.
   - x The alpha estimate (α) will be biased and unreliable.
   - ✓ The individual beta estimates (β) will be unstable and have large standard errors.
   - x The model's overall explanatory power for the set of factors will be compromised.
   - ✓ It becomes difficult to interpret a single factor's beta as its marginal contribution to the fund's risk.
8. Which investors would likely find a high R-squared in a linear factor decomposition of their returns relative to a set of broad market factors?
   - ✓ A benchmarked mutual fund
   - x A long-short hedge fund
   - x A prop trader seeking market dislocations.
9. I run a linear factor decomposition: $Y = \alpha + \beta X + e$. Select all correct mappings:
   - ✓ Hedge: own Left Hand Side, sell Right Hand Side. Objective = small basis.
   - ✓ Track: don't own the Left Hand Side, buy the Right Hand Side. objective = $\alpha \approx 0$ with small Tracking Error
   - ✓ Replicate (tradeable tracking): Don't own Left Hand Side, buy Right Hand Side. often omit intercept, enforce span. Accept drift/TE trade-off.
   - x In all three, including a positive intercept guarantees investable outperformance.
10. A high R^2 in the replication regression ensures out-of-sample (OOS) weight stability
    - x True
    - ✓ False
11. The HDG ETF aims to
    - ✓ capture hedge-fund beta
    - x achieve lower fees than individual hedge funds
    - x replicate the "bottom-up" holdings of typical hedge funds
12. A commodity trading advisor has a proprietary model that predicts the price of corn. They want to trade this signal while neutralizing their exposure to broad swings in the commodity market, which they proxy with a commodity factor we'll call X.

    Which of the following should be goals of the trader?
    - x Construct a portfolio with a beta of 1.0 relative to X.
    - x Maximize the R-squared of the regression of their predicted corn returns against X.

- ✓ Achieve a high alpha relative to the residual (to X) volatility.
- x Create a tracking portfolio that minimizes tracking error relative to X.

13. A key criticism of the Merrill Lynch Factor Model (MLFM) used by HDG was that it was "backward-looking." What does this criticism primarily refer to?

- x The model used historical data, which is never predictive of the future.
- ✓ The model used a rolling 24-month regression, so its factor weights would adapt to changes in hedge fund strategies with a significant lag.
- x The model did not include forward-looking economic indicators like inflation forecasts.
- x The factors themselves, like the S&P 500, only reflect past performance.

14. What is the correct hierarchy of replication/tracking in the ProShares case?

- x HDG tracks the HFRI, which is replicated by the MLFM.
- x HDG tracks the MLFM, which is a version of the MLFM-ES that tracks the HFRI.
- x HDG directly tracks a basket of individual hedge funds that make up the HFRI.
- ✓ HDG tracks the MLFM-ES, which is a tradable version of the MLFM, which in turn is a statistical model of the HFRI.

15. Another criticism of the MLFM was "missing alternative betas." Which of the following is the best example of a missing beta that a real hedge fund might have exposure to, but the six-factor MLFM model would not capture?

- x Exposure to small-cap stocks (Russell 2000).
- x Exposure to the US dollar/Euro exchange rate.
- ✓ Exposure to the returns from merger arbitrage spreads.
- x Exposure to developed international equity markets (MSCI EAFE).

Questions on Table 1.

Statistic	Fund A: Alpha Seeker	Fund B: Market Tracker
Alpha	2%	0.25%
Beta	0.2	0.98
R-squared	0.10	0.95
Residual Vol.	4.00%	0.50%

Table 1: Use for questions 16 to 20

16. See Table 1. Based on the table, select any/all statements that accurately reflect Fund A's strategy and performance.

- x The fund is a closet indexer.

- x The fund's low R-squared suggests the manager is unskilled because the model fails to explain returns.
- x The fund has very low basis risk, making it an excellent tool for hedging the market.

17. See Table 1. A portfolio manager already holds a large, passive S&P 500 portfolio. They want to add one of these funds to achieve the best improvement in their overall portfolio's risk-adjusted return. Which fund should they choose and why?

- x Fund B, because its high R-squared ensures it will not deviate much from the existing portfolio.
- ✓ Fund A, because its alpha is high and its market beta is low, meaning most of its risk-return profile is a diversifying addition.
- x Fund B, because its Treynor Ratio will be higher than Fund A's due to its large beta.
- x Fund A, because its Sharpe Ratio is guaranteed to be higher than Fund B's.

18. See Table 1. The Information Ratio for Fund A is...

- x .1
- x .2
- x .3
- x .4
- ✓ .5
- x cannot be calculated with the given information.

19. See Table 1. The Treynor Ratio for Fund A is...

- x .1
- x .2
- x .3
- x .4
- x .5
- ✓ cannot be calculated with the given information.

20. See Table 1. If an analyst argued that Fund A's alpha is not skill but simply exposure to a "value" factor missing from the model, which of the following metrics would support that critique?

- x high multi-factor R-squared
- ✓ lower multi-factor alpha

Section 3

Multiple Select: Indicate all the true statements, whether that is 0, 1, or multiple.

1. How does VaR compare to CVaR for a return series?

   x VaR is always greater in absolute value than CVaR.

   ✓ CVaR is always greater in absolute value than VaR.

2. Suppose we have 4 assets, all of which are positively correlated with each other. We calculate the

   (a) the VaR of an equally weighted portfolio (weights of 25% each),

   (b) the VaR of a portfolio with the most volatile asset dropped (weights of 25% each, except a weight of 0 for the most volatile).

   What can we say about (a) versus (b)?

   x VaR of (a) is greater (in absolute value) than VaR of (b)

   x VaR of (a) is less (in absolute value) than VaR of (b)

3. Suppose we have 4 assets which are positively correlated with each other. We calculate the

   (a) the volatility of an equally weighted portfolio (weights of 25% each),

   (b) the volatility of a portfolio with the most volatile asset dropped (weights of 25% each, except a weight of 0 for the most volatile).

   What can we say about (a) versus (b)?

   ✓ Volatility of (a) is greater than volatility of (b)

   x Volatility of (a) is less than volatility of (b)

   x We cannot say which is greater.

4. Suppose we have 2 assets with identical mean returns (μ), but different Sharpe Ratios ($SR_1 > SR_2$). Which asset will have a higher empirical VaR?

   x Asset 1.

   x Asset 2.

   x Both assets will have the same VaR.

   ✓ Can't say.

5. Suppose we have 2 assets with identical mean returns (μ), but different Sharpe Ratios ($SR_1 > SR_2$). Which asset will have a higher parametric VaR, assuming normally distributed returns?

   x Asset 1

   ✓ Asset 2

   x Both assets will have the same VaR.

x Can't say.

6. Which of the following are advantages of empirical (historic) VaR over normal (modeled) VaR?

   x Better at reflecting recent changes in market conditions.
   ✓ Can reflect specific skewness.
   x Works well with limited data.
   x Over-sensitivity to outliers

7. Suppose a stable i.i.d return distribution with negative skewness as well as a very large sample size.

   ✓ Empirical VaR will be greater (in absolute value) than normal VaR.
   x Normal VaR will be greater (in absolute value) than empirical VaR.
   ✓ Empirical VaR will have a better hit rate than normal VaR.
   x Normal VaR will have a better hit rate than empirical VaR.

8. Which of the following are advantages of dynamic volatility (EWMA, rolling, GARCH) models over full-sample volatility estimates?

$$\sigma^2_{t,\text{EWMA}} = (1-\lambda)\sum_{i=0}^{\infty}\lambda^i r^2_{t-i}$$
$$\sigma^2_{t,\text{Rolling}} = \frac{1}{N}\sum_{i=0}^{N-1} r^2_{t-i}$$
$$\sigma^2_{t,\text{GARCH}} = \omega + \alpha r^2_{t-1} + \beta\sigma^2_{t-1}$$
$$\sigma^2_{t,\text{Expanding}} = \frac{1}{t}\sum_{i=1}^{t} r^2_i$$

   ✓ Can adapt to different market conditions.
   ✓ Incorporate more recent data more heavily.
   x Are less sensitive to outliers.
   x More statistical power.

9. Which of the following statements accurately reflect the EWMA model?

   x The EWMA model requires estimation of multiple parameters for volatility forecasting
   ✓ The decay factor λ determines how quickly past observations lose influence
   x EWMA incorporates a mean-reverting term to ensure long-run volatility stability
   ✓ EWMA is commonly used for real-time risk metrics due to its simplicity

10. Given the following volatility estimates for an asset at time t, what can we say about the relative normal VaR estimates?

Model	Volatility Estimate at Time t
1. Full-Sample	12%
2. EWMA (half-life 20 days)	10%
3. EWMA (half-life 60 days)	15%

- x VaR 1 > VaR 2 > VaR 3
- ✓ VaR 3 > VaR 1 > VaR 2
- x Volatility has been increasing recently.
- ✓ Volatility has been decreasing recently.

Risk for 0-day Options (questions 11 to 14)

Suppose that we are a 0DTE (zero days to expiration) options trader, where our strategy consists purely of **buying** out-of-the-money (OTM) puts. Most days, these options expire worthless, leading to small losses in our portfolio. However, when the market drops sharply, these options generate enormous returns, leading to large gains in our portfolio.

11. The returns of this portfolio would likely have:
    - x Negative skewness, positive excess kurtosis.
    - x Negative skewness, negative excess kurtosis.
    - ✓ Positive skewness, positive excess kurtosis.
    - x Positive skewness, negative excess kurtosis.
    - x About zero skewness and kurtosis.
12. If we were to calculate normal parametric VaR for this portfolio, we would expect it to:
    - ✓ Overestimate the risk of our portfolio.
    - x Underestimate the risk of our portfolio.
    - x Be an accurate estimate of the risk of our portfolio.
13. Suppose we wanted to calculate "upside VaR", defined as the 99th percentile of our returns, in addition to the usual downside VaR at the 1st percentile, using the empirical method. Then:
    - x Upside VaR would be closer to zero than downside VaR.
    - ✓ Upside VaR would be farther from zero than downside VaR.
    - x Upside VaR would be the same distance from zero as downside VaR.
14. Suppose we wanted to calculate "upside VaR", using the normal parametric method, assuming mean 0. Then:
    - x Upside VaR would be closer to zero than downside VaR.
    - x Upside VaR would be farther from zero than downside VaR.
    - ✓ Upside VaR would be the same distance from zero as downside VaR.
15. If we were to calculate empirical VaR and CVaR for this portfolio, we would expect:
    - x CVaR to be significantly higher (in absolute value) than VaR.
    - x CVaR to be slightly lower (in absolute value) than VaR.
    - ✓ CVaR to be slightly higher (in absolute value) than VaR.
    - x CVaR to be significantly lower (in absolute value) than VaR.