FINM 36700 Final Exam

Portfolio and Risk Management

December 9, 2024

Name: ______________________________

UChicago ID: ______________________________

- This exam is **closed book** and **closed notes**.
- You are **not** allowed any eletronics or calculator.
- Every numbered question is worth **3 points**.

Section	Points Awarded	Possible
1		27
2		18
3		15
4		15
5		12
6		15
Total		**102**

1 Multiple Choice

1. The ___________ factor is widely use in factor pricing models, but the statistical evidence for it mattering is weak.

   (a) market
   (b) profitability
   (d) momentum
   (e) size
   (f) value

2. A momentum strategy going long on the upper decile (top 10%) and short on the lower decile (bottom 10%) of past winners/losers will probably have ___________ and ___________ than the same strategy using quintiles (20%).

   (a) higher volatility, higher mean return
   (b) higher volatility, lower mean return
   (c) lower volatility, higher mean return
   (d) lower volatility, lower mean return

3. The performance of the momentum strategy may be an indication of...

   Select all that apply

   - ☐ **market inefficiency**
   - ☐ **risk premium**
   - ☐ arbitrage

4. The APT says that...

   Select all that apply

   - ☐ **perfect linear factor decomposition implies complete linear factor pricing**
   - ☐ complete linear factor pricing implies perfect linear factor decomposition

5. More specifically, what type of linear factor decomposition is required by the APT?

   Select all that apply

   - ☐ $R^2 = 1$ for all assets.
   - ☐ Zero cross-correlation of returns.
   - ☐ **Uncorrelated residuals of decomposed asset returns**

6. The 10-year Sharpe ratio of an investment series with **zero** serial correlation will be ________ the 1-year Sharpe ratio.

   (a) smaller than
   (b) equal to
   (c) larger than

The 10-year Sharpe ratio of an investment series with **negative** serial correlation will be _________ the 1-year Sharpe ratio.

(a) smaller than

(b) equal to

(c) larger than

7. Suppose we have a portfolio of 100 stocks, and we want to consider if we should add a new stock to our portfolio. Our primary consideration should be:

   (a) P/E ratio.

   (b) dividend yield.

   (c) correlation to our portfolio.

   (d) skewness.

   (e) kurtosis.

   (f) maximum drawdown.

   (g) Sharpe ratio.

8. Some possible issue(s) with using maximum drawdown as a risk-metric is/are that: _________

   Select all that apply.

   - ☐ It assumes log-normal returns.
   - ☐ It assumes returns are i.i.d.
   - ☐ **It is path dependent.**
   - ☐ It is biased towards higher volatility assets.

9. Which of the following is notable about LTCM's performance?

   Select all that apply.

   - ☐ **High alpha**
   - ☐ Low alpha
   - ☐ High beta
   - ☐ **Low beta**
   - ☐ Long realized volatility
   - ☐ **Short realized volatility**
   - ☐ **High information ratio**
   - ☐ Low information ratio

2 Fill-In-The-Blank

Fill in each blanks with a single word. Use the following words: low(er), high(er), positive, negative.

1. Typically, stock returns have **negative** skewness and **positive/high** *excess* kurtosis.

2. A problem with MV-optimization is **high** correlations among assets and **low** out-of-sample R^2.

3. Fama-French use different "cuts" of SMB when constructing HML and RMW to achieve **low/lower** correlations among their factors.

4. All else being equal, an asset with a smaller tracking error will have a **higher** *absolute* information ratio.

   The above statement is true unless $\alpha = 0$

5. Assuming an asset has positive excess returns, our forecasted probability of negative cummulative returns is **lower** for longer time horizons. The volatility of our forecasted cumulative return is **higher** for longer time horizons.

6. Consider the following calculation of VaR 5% based on a 60-day window.

$$\mathrm{VaR}_{t+1} = \hat{\mu}_{i,t} + z_{0.05}\hat{\sigma}_{i,t}$$
$$\hat{\sigma}^2_{i,t} = \frac{1}{T-1}\sum_{k=t-60}^{t}(r_{i,k} - \hat{\mu}_i)^2$$

   Many practitioners modify this formula. Rewrite the formula with this modification.

$$\mathrm{VaR}_{t+1} = z_{0.05}\hat{\sigma}_{i,t}$$
$$\hat{\sigma}^2_{i,t} = \frac{1}{T}\sum_{k=t-60}^{t}(r_{i,k})^2$$

   The mean estimate is often unrealible.

3 Factor Pricing Tests

Consider that you run time-series and a cross-sectional tests for the Fama-French 3 Factor model. First, you run the time-series test for 25 test-assets:

$$\tilde{r}^i_t = \alpha + \beta^i_{\text{MKT}}\tilde{r}_{\text{MKT},t} + \beta^i_{\text{SMB}}\tilde{r}_{\text{SMB},t} + \beta^i_{\text{HML}}\tilde{r}_{\text{HML},t} + \varepsilon^i_t$$

After, you run a cross-sectional test:

$$\mathbb{E}[\tilde{r}^i] = \eta + \lambda_{\text{MKT}}\beta^i_{\text{MKT}} + \lambda_{\text{SMB}}\beta^i_{\text{SMB}} + \lambda_{\text{HML}}\beta^i_{\text{HML}} + \nu^i$$

Answer the following questions only mentioning the relevant parameter or equation.

1. What is the market premium implied by the cross-sectional estimation?

$$\lambda_{\text{MKT}}$$

2. What is the market premium implied by the time-series estimation?

$$\tilde{\mu}_{\text{MKT}} = \frac{1}{n}\sum_{i=1}^{n}\tilde{r}_{\text{MKT},i}$$

3. What 4 parameters are you estimating in the cross-sectional test?

$$\lambda_{\text{MKT}}, \lambda_{\text{SMB}}, \lambda_{\text{HML}}, \eta$$

4. If you have estimates of the equations above, which estimate would be most important to assess the **cross-sectional** test?

$$R^2, \quad \textbf{OR} \quad \text{MAE} = \frac{1}{25}\sum_i \mid \nu_i \mid$$

5. If you have estimates of the equations above, which estimate would be most important to assess the **time-series** test?

$$\text{MAE} = \frac{1}{25}\sum_i \mid \alpha_i \mid$$

4 Regressions

Write a regressions that you would estimate to solve the following:

- Use $\tilde{r}$ to represent excess returns.
- Use r to represent returns.

1. Check if a hedge fund that invested in stocks listed in the Small Cap Index (SC) and in the SPY (SPY) generates value by doing active investing.

$$\tilde{r}^{\text{HF}} = \alpha + \beta_{\text{SC}}\tilde{r}_{\text{SC},t} + \beta_{\text{SPY}}\tilde{r}_{\text{SPY},t} + \varepsilon_t \quad \textbf{OR} \quad \tilde{r}^{\text{HF}} = \hat{\alpha} + \hat{\beta}_{\text{SC}}\tilde{r}_{\text{SC}} + \hat{\beta}_{\text{SPY}}\tilde{r}_{\text{SPY}}$$

2. Calculate the optimal hedge ratio between AAPL's excess returns ($\tilde{r}_{\text{A}}$) and SPY excess returns ($\tilde{r}_{\text{SPY}}$) considering that the past mean excess return of AAPL is a good proxy for the future mean return AAPL.

$$\tilde{r}_{\text{A}} = \beta\tilde{r}_{\text{SPY}} + \varepsilon \quad \textbf{OR} \quad \tilde{r}_{\text{A}} = \hat{\beta}\tilde{r}_{\text{SPY}}$$

It should not include an α because the mean excess return of AAPL is a good proxy for the future mean return AAPL.

3. Test a factor model that uses the market excess returns ($\tilde{r}_{\text{MKT}}$) and the unemployment rate (u) - only write the final regression.

$$\mathbb{E}[\tilde{r}^i] = \eta + \lambda_{\text{MKT}}\beta^i_{\text{MKT}} + \lambda_u\beta_u + \nu^i$$

OR

$$\tilde{\mu}^i = \alpha + \lambda_{\text{MKT}}\beta^i_{\text{MKT}} + \lambda_u\beta_u + \nu^i$$

OR

$$\tilde{\mu}^i = \hat{\alpha} + \hat{\lambda}_{\text{MKT}}\beta^i_{\text{MKT}} + \hat{\lambda}_u\beta_u$$

4. Check if a particular stock has momentum in its excess returns ($\tilde{r}_i$).

$$\tilde{r}_{i,t+1} - \tilde{\mu}_i = \beta(\tilde{r}_{i,t} - \tilde{\mu}_i) + \varepsilon_{i,t+1}$$

OR

$$\tilde{r}_{i,t+1} - \tilde{\mu}_i = \hat{\beta}(\tilde{r}_{i,t} - \tilde{\mu}_i)$$

OR

$$\tilde{r}_{i,t+1} - \tilde{\mu}_i = \alpha + \beta(\tilde{r}_{i,t} - \tilde{\mu}_i) + \varepsilon_{i,t+1} \quad \text{(in which } \hat{\alpha} = 0\text{)}$$

OR

$$\tilde{r}_{i,t+1} - \tilde{\mu}_i = \hat{\alpha} + \hat{\beta}(\tilde{r}_{i,t} - \tilde{\mu}_i) \quad \text{(in which } \hat{\alpha} = 0\text{)}$$

5. Check if a hedge fund ($\tilde{r}_{\text{HF}}$) has exposure to SPY puts by performing a regression analysis.

$$\tilde{r}_{\text{HF},t} = \alpha + \beta_1 \tilde{r}_{\text{SPY},t} + \beta_2 \tilde{r}^2_{\text{SPY},t} + \varepsilon_t$$

OR

$$\tilde{r}_{\text{HF},t} = \hat{\alpha} + \hat{\beta}_1 \tilde{r}_{\text{SPY},t} + \hat{\beta}_2 \tilde{r}^2_{\text{SPY},t}$$

OR

$$\tilde{r}_{\text{HF},t} = \alpha + \beta_1 \tilde{r}_{\text{SPY},t} + \beta_2 \text{max}(k - \tilde{r}_{\text{SPY},t}, 0) + \varepsilon_t$$

OR

$$\tilde{r}_{\text{HF},t} = \hat{\alpha} + \hat{\beta}_1 \tilde{r}_{\text{SPY},t} + \hat{\beta}_2 \text{max}(k - \tilde{r}_{\text{SPY},t}, 0)$$

5 Allocation

1. The table below gives the annualized estimates of an excess-return mean-variance investment problem. (Recall that GMV stands for Global Minimum Variance portfolio)

	Estimate
Sharpe of GMV	1.1
Expected Return of the GMV	4.0%
Sharpe of the Tangency	1.5
Expected Return of the Tangency	6.0%
Return of the Risk-Free Rate	3.0%

Table 1: Estimates for the Portfolios and Risk-Free Rate

The investor aims for a **5% annualized return** and has access to all three investments: GMV, tangency portfolio, and risk-free asset.

How much should the investor allocate in each of the assets? Write the optimal weights for each asset in the following table:

When the risk-free rate is available, a mean-variance investor should allocate only in the tangency portfolio and the risk-free asset. By limiting their allocation to those two assets, the investor can keep the same Sharpe ratio as the tangency portfolio regardless of their target return. Allocating in the GMV portfolio would decrease the Sharpe ratio.

More specifically, given a target:

$$\begin{aligned}\mathbb{E}[r_p] &= w^{\text{RF}} \cdot \mathbb{E}[r_{\text{RF}}] + w^{\text{TANG}} \cdot \mathbb{E}[r_{\text{TANG}}], \quad \text{constrained to} \quad w^{\text{RF}} + w^{\text{TANG}} = 1 \\ &= (1 - w^{\text{TANG}}) \cdot \mathbb{E}[r_{\text{RF}}] + w^{\text{TANG}} \cdot \mathbb{E}[r_{\text{TANG}}] = 5\% \\ &= (1 - w^{\text{TANG}}) \times 3.0\% + w^{\text{TANG}} \times 6.0\% = 5\%\end{aligned}$$

$$\begin{aligned}w^{\text{TANG}} &= \frac{5.0\% - 3.0\%}{6.0\% - 3.0\%} = \frac{2}{3} \approx 66.7\% \\ w^{\text{RF}} &= 1 - w^{\text{TANG}} = \frac{1}{3} \approx 33.3\%\end{aligned}$$

Asset	Portfolio Weight
GMV Portfolio	**0%**
Risk-Free Asset	$\frac{1}{3} \approx 33.3\%$
Tangency Portfolio	$\frac{2}{3} \approx 66.7\%$

Consider that you are doing analysis on two different hedge funds: Gamma Investors and Eletron Capital. Both are stock driven hedge-funds having the SPY as benchmark.

We run the following regression on the excess-returns of the hedge-funds in the past 5 years:

$$\tilde{r}_{p,t} = \alpha + \beta \tilde{r}_{\text{SPY},t} + \varepsilon_t$$

We arrive to the following numbers in which $\hat{\alpha}$, $\tilde{\mu}$ and σ are already annualized.

Estimate	**Gamma Investors**	**Electron Capital**	**SPY**
$\hat{\alpha}$	0.5%	3%	-
$\hat{\beta}$	1.5	0.8	-
$\tilde{\mu}$	15.5%	11%	10%
σ	15%	8%	10%
R^2	87.3%	87.3%	-

Table 2: Estimates for the past 5 years

Based solely on the previous statistics:

2. Consider that your $\mathbb{E}[\tilde{r}_{\text{SPY},t+1}]$ is equal to the average historical excess return (10%). You aim to maximize your expected return for $t+1$ (expected return for the next year). If you could choose only one hedge-fund to allocate **ALL** your money, which one would you choose?

   (a) Gamma

   (b) Electron

$$\mathbb{E}[\tilde{r}_{\text{Gamma},t+1}] = \hat{\alpha}_{\text{Gamma}} + \hat{\beta}_{\text{Gamma}} \mathbb{E}[\tilde{r}_{\text{SPY},t+1}] = 0.5\% + 1.5 \times 10\% = 15.5\%$$
$$\mathbb{E}[\tilde{r}_{\text{Eletron},t+1}] = \hat{\alpha}_{\text{Eletron}} + \hat{\beta}_{\text{Eletron}} \mathbb{E}[\tilde{r}_{\text{SPY},t+1}] = 3\% + 0.8 \times 10\% = 11\%$$

3. Now, consider that even though SPY's premium has been 10% in the past, we now believe it will be lower going forward: $\mathbb{E}[\tilde{r}_{\text{SPY},t+1}] = 4\%$. Given the same objective and restriction as the previous question, which hedge-fund would you choose?

   (a) Gamma

   (b) Electron

$$\mathbb{E}[\tilde{r}_{\text{Gamma},t+1}] = \hat{\alpha}_{\text{Gamma}} + \hat{\beta}_{\text{Gamma}} \mathbb{E}[\tilde{r}_{\text{SPY},t+1}] = 0.5\% + 1.5 \times 4\% = 6.5\%$$
$$\mathbb{E}[\tilde{r}_{\text{Eletron},t+1}] = \hat{\alpha}_{\text{Eletron}} + \hat{\beta}_{\text{Eletron}} \mathbb{E}[\tilde{r}_{\text{SPY},t+1}] = 3\% + 0.8 \times 4\% = 6.2\%$$

4. Finally, consider that you have no view on SPY's future returns and prefer not to be exposed to SPY risk. You will allocate $100 in only one hedge-fund but now you can also allocate any dollar amount in SPY.

   Select the hedge fund in which you would allocate your $100:

   (a) Gamma

   (b) Eletron

   Dollar position in SPY: **-80**

   If we are not willing to take the risk associated with the SPY, the hedge fund with the best α should be chosen.

   The hedge amount should be equal to $-\beta$ of the hedge fund chosen multiplied by 100.

6 FX Carry

1. Being a US FX Carry trader, you run the following regression for different currencies "OTH" against the USD:

$$\mathtt{s}_{t+1} - \mathtt{s}_t = \alpha + \beta\left(\mathtt{r}_{\mathrm{USD},t+1} - \mathtt{r}_{\mathrm{OTC},t+1}\right) + \varepsilon_{t+1}$$

In which:

- OTC represents the other currency.
- $\mathtt{s}$ is the log spot exchange rate of the USD against the OTC currency.
- $\mathtt{r}_{\mathrm{USD},t}$ is the log risk-free rate of the USD at time t.
- $\mathtt{r}_{\mathrm{OTC},t}$ is the log risk-free rate of the OTC currency at time t.

The result of the regression is the following:

Currency	$\hat{\alpha}$	$\hat{\beta}$	R^2
EUR (Euro)	0.010	0.85	12.1%
BRL (Brazilian Real)	0.049	3.41	9.7%
ARS (Argentine Peso)	0.000	-1.00	8.1%
JPY (Japanese Yen)	-0.005	0.65	15.2%
GBP (British Pound)	0.082	0.84	10.5%
AUD (Australian Dollar)	0.000	1.92	0.3%
CAD (Canadian Dollar)	0.012	0.95	13.1%
CHF (Swiss Franc)	0.000	0.00	0%
INR (Indian Rupee)	0.020	1.25	7.8%
CNY (Chinese Yuan)	0.005	0.80	12.1%
MXN (Mexican Peso)	0.025	-1.10	9.1%
ZAR (South African Rand)	-0.055	-1.50	8.3%
RUB (Russian Ruble)	0.050	1.60	5.1%
KRW (South Korean Won)	0.010	0.00	11.1%
NOK (Norwegian Krone)	0.018	1.07	76.3%
SEK (Swedish Krona)	-0.150	0.22	21.4%
NZD (New Zealand Dollar)	**0.000**	**1.00**	9.4%

Table 3: FX Regression Results with Additional Currencies

(a) Indicate which currency provides no negative or positive premium: **NZD**

(b) Indicate which currency provides the most compeling evidence that the UIP holds: **NZD**

A currency provides no negative or positive premium when the intercept ($\hat{\alpha}$) and slope ($\hat{\beta}$) align with the UIP prediction, implying $\hat{\alpha} = 0$ and $\hat{\beta} = 1$.

The UIP says that, on average, no currency should have positive or negative premium: any difference in risk-free rate should be perfectly offset (on average)

by the depreciation of the currency with the highest risk-free rate. Thus, the answer is the same for both questions.

For the UIP only the average relationship matters, not the R^2.

2. Consider the following data for the USD and the EUR, where each t is one year:

$$R^{f\$}_{t,t+10} = 2$$

Where $R^{f\$}_{t,t+10} := (1 + r^{f\$}_{t,t+1})$ and $r^{f\$}_{t,t+1}$ is the risk free rate for the USD.

$$R^{f€}_{t,t+10} = 3$$

Where $R^{f€}_{t,t+10} := (1 + r^{f€}_{t,t+1})$ and $r^{f€}_{t,t+10}$ is the risk free rate for the EUR.
The spot exchange rate is 1.5 USD/EUR and the forward exchange rate for 10 years is 1.2 USD/EUR.

   (a) **True or False:** The situation is consistent with CIP.

   If the CIP holds, the forward exchange rate should be equal to the spot exchange rate times the ratio of the risk-free rates. In this case, the forward exchange rate is 1.2 USD/EUR, which is not equal to $1.5 \times \frac{2}{3} = 1$. Therefore, the situation is not consistent with CIP.

   (b) **True or False:** The situation is consistent with UIP.
   There is not enough information to determine if the situation is consistent with UIP.

3. Take a look at the following regressions:

$$\text{Equation A:} \quad \mathtt{f}_t - \mathtt{s}_t = \alpha + \beta \left(\mathtt{r}^{f,\$}_{t,t+1} - \mathtt{r}^{f,€}_{t,t+1} \right) + \varepsilon_t$$

$$\text{Equation B:} \quad \mathtt{s}_{t+1} - \mathtt{s}_t = \alpha + \beta \left(\mathtt{r}^{f,\$}_{t,t+1} - \mathtt{r}^{f,€}_{t,t+1} \right) + \varepsilon_t$$

where:

- $\mathtt{f}$ is the log forward exchange rate.
- $\mathtt{s}$ is the log spot exchange rate.
- $\mathtt{r}^{f,\$}$ is the log risk-free rate for the USD.

- $\mathtt{r}^{f,€}$ is the log risk-free rate for the EUR.

Which equation is testing the CIP and which equation is testing the UIP?

Choose the best answer:

(a) Equation A is testing the CIP and Equation B is testing the UIP.

(b) Equation A is testing the UIP and Equation B is testing the CIP.

(c) Both equations are testing the UIP.

(d) Both equations are testing the CIP.

In equation A, you see if the differential between the forward and spot exchange rates is related to the differential between the risk-free rates. Unless this relationship holds true with very high $\hat{\alpha} = 0, \hat{\beta} = 1$ and big R^2, there is opportunity for arbitrage.

In equation B, you see the typical equation to test UIP: the change in the spot exchange rate is related to the differential between the risk-free rates. Here R^2 does not matter. For UIP to hold $\hat{\beta}$ should be equal to 1 and $\hat{\alpha}$ should be equal to 0.