CFA Notes

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Contents

1 Tips and Tricks

1.1 Calculator Recommended Settings

Method 1.1.1.

i. *Reset calculator*: $\boxed{2ND}$ $\boxed{+|-}$

ii. *Increase to 9 decimal*: $\boxed{2ND}$ $\boxed{.}$ (FORMAT) $\boxed{9}$ $\boxed{\text{ENTER}}$

iii. *Set period to 1 year*: $\boxed{2ND}$ $\boxed{\text{I/Y}}$ (P/Y) $\boxed{1}$ $\boxed{\text{ENTER}}$

iv. *Set as AOS mode*: $\boxed{2ND}$ $\boxed{.}$ (FORMAT) $\boxed{\uparrow}$ $\boxed{2ND}$ $\boxed{\text{ENTER}}$

Method 1.1.2.

i. *Backspace button*: $\boxed{\rightarrow}$, i.e., pressing $\boxed{2}$ $\boxed{\times}$ $\boxed{3}$ $\boxed{\rightarrow}$ $\boxed{2}$ $\boxed{=}$ will give 4.

ii. *Clear previous entry*: $\boxed{CE|C}$

iii. *Clear everything*: $\boxed{CE|C}$ $\boxed{CE|C}$

iv. *Clear TVM worksheet*: $\boxed{2ND}$ $\boxed{FV}$ (CLR TVR)

Method 1.1.3.

i. *Store in memory*: $\boxed{STO}$ ($\boxed{0}$ to $\boxed{9}$)

ii. *Recall from memory*: $\boxed{RCL}$ ($\boxed{0}$ to $\boxed{9}$)

iii. *Recall last answer*: $\boxed{2ND}$ $\boxed{=}$

iv. *Clear all memory and store values*: $\boxed{2ND}$ $\boxed{0}$ $\boxed{2ND}$ $\boxed{CE|C}$

Method 1.1.4.

i. *Set up calculator for single variable statistics*: $\boxed{2ND}$ $\boxed{8}$, then $\boxed{2ND}$ $\boxed{\text{ENTER}}$ until we see 1-V on screen. Then clear contents $\boxed{CE|C}$.
Enter data setting and clear the data: $\boxed{2ND}$ $\boxed{7}$ $\boxed{2ND}$ $\boxed{CE|C}$.
Enter single-var data: [VALUE] $\boxed{\text{ENTER}}$ $\boxed{\downarrow}$ $\boxed{\downarrow}$, enter value in X (data), and leave Y as 1 (frequency).
Enter stats function and toggle $\boxed{\downarrow}$ to see mean, sample s.d., population s.d.
For weighted returns, use X as the return, and Y as the weights.

ii. *Covariance and correlation*: $\boxed{2ND}$ $\boxed{8}$, then $\boxed{2ND}$ $\boxed{\text{ENTER}}$ until we see [LIN] on screen. Then clear contents $\boxed{CE|C}$.
Enter data setting and clear the data: $\boxed{2ND}$ $\boxed{7}$ $\boxed{2ND}$ $\boxed{CE|C}$.
Enter data: [VALUE] $\boxed{\text{ENTER}}$ $\boxed{\downarrow}$ $\boxed{\downarrow}$, enter value in X and Y.
Enter stats function and toggle $\boxed{\downarrow}$ to see r, Sx and Sy, then compute covariance as $Sx \times S_y$.
Correlation is simply the value r computed earlier.

iii. *Time value of money*: Input values into all except one of these: $\boxed{\text{N}}$ $\boxed{I/Y}$ (%), $\boxed{\text{PV}}$, $\boxed{\text{PMT}}$, $\boxed{\text{FV}}$. Then use $\boxed{\text{CPT}}$ on the target variable to solve for the results.

iv. *Interest rate conversion*, i.e., convert nominal 10%, $m = 12$ payments per year into effective rate.
$\boxed{2ND}$ $\boxed{2}$ (ICONV) $\boxed{\uparrow}$ $\boxed{12}$ $\boxed{\text{ENTER}}$, $\boxed{\downarrow}$ $\boxed{10}$ $\boxed{\text{ENTER}}$, $\boxed{\downarrow}$ $\boxed{\text{CPT}}$ to get effective rate.

v. *Cash flow computation*: clear memory with [CF] [$2ND$] [$CE|C$], then input [VALUE] [ENTER] [$\downarrow$].
Enter interest rate with [NPV] [VALUE] [ENTER] [$\downarrow$], then [CPT] to get present value, PV.

vi. *Amortisation schedule*: i.e., \$1000 on 3-year loan, interest rate of 10%.
Check payment per year, make sure it is 1 (with [$2ND$] [I/Y]).
Input information with [3] [N] [10] [I/Y] [1000] [PV] [CPT] [PMT].
Before using amortisation worksheet, clear memory with [$2ND$] [PV] (AMORT) [$2ND$] [$CE|C$].
To see interest and principal repayment at each time period, set $P1$ as [t] for year t, then use [CPT] [$\downarrow$] to see the values at each time period.

1.2 Memorise for Exams

Definition 1.2.1. *Critical Z-values*

One-Tailed Test	Two-Tailed Test
–	68% (1.0)
–	90% (1.645)
95% (1.645)	95% (1.96)
97.5% (1.96)	–
99% (2.33)	99% (2.58)
99.5% (2.57)	–

2 Quantitative

2.1 Time Value of Money

Definition 2.1.1. *Expected Annual Rate*

$$\text{EAR} = (1 + \text{periodic rate})^m - 1$$
$$\text{EAR} = e^r - 1$$

Definition 2.1.2. *Continuous Compounding*

$$FV_N = PVe^{r_s N}$$

Definition 2.1.3. *Ordinary Annuity*: first cash flow one period from now.

$$FV_N = A\left[\frac{(1+r)^N - 1}{r}\right]$$

Definition 2.1.4. *Annuity Due*: first cash flow occurs from today.

$$FV_N = A\left[\frac{(1+r)^N - 1}{r}\right](1+r)$$

Definition 2.1.5. *Perpetuity*: never ending cash flows.

$$PV = \frac{A}{r}$$

2.2 Statistics

Definition 2.2.1. *Harmonic Mean*

$$\overline{X}_H = \frac{n}{\sum_{i=1}^{n} \frac{1}{X_i}}$$

Definition 2.2.2. *Mean Absolute Deviation*

$$\text{MAD} = \frac{\sum_{i=1}^{n} |X_i - \overline{X}|}{n}$$

Definition 2.2.3. *Semi-variance*: average squared deviation below mean

$$s^2 = \frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1} \quad \forall X_i \leq \overline{X}$$

Definition 2.2.4. *Chebyshev Inequality*: proportion of observations within k standard deviation of arithmetic mean is at least $1 - \frac{1}{k^2}$

$$P(|X - \mu| \geq k\sigma) \leq \frac{1}{k^2}$$

Definition 2.2.5. *Coefficient of Variance* (CV): the lower the CV value the better; less risk per unit return.

$$CV = \frac{s}{\overline{X}}$$

Definition 2.2.6. *Skewness*:

i. Symmetric: mean = median = mode
ii. Positive skew: mode < median < mean
iii. Negative skew: mean < median < mode

Positive skewness is preferred.

Definition 2.2.7. *Excess Kurtosis*: characterises kurtosis relative to the normal distribution.

i. Normal, mesokurtic distribution: excess kurtosis = 0
ii. Leptokurtic distribution: excess kurtosis > 0
iii. Platykurtic distribution: excess kurtosis < 0

Definition 2.2.8. *Odds*:

i. Odds for event $E = \frac{P(E)}{1-P(E)}$
ii. Odds against event $E = \frac{1-P(E)}{P(E)}$

Definition 2.2.9.

i. Expected value: $E(X) = \sum_{i=1}^{n} P(X_i)X_i$
ii. Variance: $\sigma^2(X) = E[(X - E[X])^2] = \sum_{i=1}^{n} P(X_i)[X_i - E[X_i]]^2$
iii. Covariance: $\text{Cov}(R_i, R_j) = E[(R_i - E[R_i])(R_j - E[R_j])]$
iv. Correlation: $\rho(R_i, R_j) = \frac{\text{Cov}(R_i, R_j)}{\sigma(R_i)\sigma(R_j)}$

Definition 2.2.10.

i. Portfolio variance: $\sigma^2(X) = E[(R_p - E[R_p])^2] = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \text{Cov}(R_i, R_j)$
ii. Joint distribution function: $\text{Cov}(R_A, R_B) = \sum_i \sum_j P(R_{A,i}, R_{B,j})(R_{A,i} - E[R_A])(R_{B_i} - E[R_B])$.
Sum all possible standard deviation cross-products, weighted by the appropriate joint probability.

Definition 2.2.11.

i. Labelling: of N objects with k different labels. Total combinations $= \frac{n!}{n_1!n_2!...n_k!}$

ii. Combination: $nCr = \frac{n!}{(n-r)!r!}$

iii. Permutations: $nPr = \frac{n!}{(n-r)!}$

Definition 2.2.12. *Measurement scales*

i. Nominal: categorises data, but do not have rank

ii. Ordinal: data is sorted $(<, >)$

iii. Interval: differences are meaningful $(<, >, +, -)$

iv. Ratio: true zero is origin $(<, >, +, -, 0)$

Definition 2.2.13.

i. Monte Carlo Simulation: provides distribution of possible solutions to complex functions

ii. Scenario analysis: shows changes in key financial quantities that result from given economic events

iii. Historical simulation: approach in back-testing data

Definition 2.2.14.

i. Empirical probability: estimated from data as relative frequency of occurrence

ii. Subjective probability: drawn on personal or subjective judgment

iii. Priori probability: Obtained based on logical analysis

Definition 2.2.15. *Probability Distributions*

Distribution	Notation	PMF or PDF	Mean	Variance
Binomial	$X \sim B(n,p)$	$P(X=x) = \binom{n}{x}p^x(1-p)^{n-x}$	np	$np(1-p)$
Normal	$X \sim N(\mu,\sigma^2)$	$f(x) = \frac{1}{\sigma\sqrt{2\pi}}\exp(-\frac{1}{2}(\frac{x-\mu}{\sigma})^2)$	μ	σ^2
Standard Normal	$X \sim N(0,1)$	Standardised with $Z = \frac{X-\mu}{\sigma}$	0	1
Log-Normal	$X \sim \text{Lgn}(\mu,\sigma^2)$	$\frac{1}{x\sigma\sqrt{2\pi}}\exp\left(-\frac{(\ln x-\mu)^2}{2\sigma^2}\right)$	$\exp(\mu+\frac{\sigma^2}{2})$	$[\exp(\sigma^2)-1]\exp(2\mu+\sigma^2)$
Student's t	$X \sim t_v$	–	0	$\frac{v}{v-2}$ for $v>2$, $v=n-1$

Definition 2.2.16. *Central Limit Theorem*
For any distribution, mean $\overline{X}$ approaches a normal distribution with mean μ and variance $\frac{\sigma^2}{N}$ as $N \to \infty$.

Definition 2.2.17. *Confidence Interval*

$$\text{Point Estimate} \pm \text{Reliability Factor} \times \text{Standard Error}$$

Definition 2.2.18. *Biases*:

i. Data Mining: Continually mixing and matching factors until two or more data series that are highly correlated are discovered.

ii. Sample Selection: Data availability leads to certain assets being excluded from analysis, i.e. non-response

iii. Survivorship: Studies on databases that have eliminated all companies that have ceased to exist.

iv. Look-ahead: Studies assume that fundamental info is available when it is not. Bias results up.

v. Time Period: Test design is based on a time period that may make results time-period specific.

vi. Data Snooping: Bias in inference drawn due to prying into empirical results of others to guide own analysis

2.3 Hypothesis Testing

Definition 2.3.1. *One-tailed and Two-tailed Tests of Single Mean*

i. Two-tailed test $H_0 : \theta = \theta_0$ against $H_\alpha : \theta \neq \theta_0$.
Reject H_0 if test statistic $z < -z_{\alpha/2}$ or $z > z_{\alpha/2}$.

ii. Right-tailed test $H_0 : \theta \leq \theta_0$ against $H_\alpha : \theta > \theta_0$.
Reject H_0 if test statistic $z > z_\alpha$.

iii. Left-tailed test $H_0 : \theta \geq \theta_0$ against $H_\alpha : \theta < \theta_0$.
Reject H_0 if test statistic $z < -z_\alpha$.

Definition 2.3.2. The *test statistic* is as follows:

$$\text{Test statistic} = \frac{\text{Sample statistic} - \text{Value of population parameter under } H_0}{\text{Standard error of sample statistic}}$$

Definition 2.3.3. *Type I and Type II Errors*

Decision	H_0 True	H_0 False
Do not reject H_0	Correct Decision	Type II Error
Reject H_0	Type I Error	Correct Decision

Definition 2.3.4.

i. *Significance Level*: probability of incorrectly rejecting the null hypothesis.

ii. *Power of Test*: Probability of correctly rejecting the null hypothesis (not committing a Type II error).

iii. *P-Value*: Smallest level of significance at which the null hypothesis can be rejected.

Definition 2.3.5. *One-tailed and Two-tailed Tests of Two Mean*

i. Two-tailed test $H_0 : \mu_1 - \mu_2 = 0$ against $H_\alpha : \mu_1 - \mu_2 \neq 0$.
Reject H_0 if test statistic $t > t_{\alpha/2}$ or if $t < t_{1-\alpha/2}$, with $df = v$.

ii. Right-tailed test $H_0 : \mu_1 - \mu_2 \leq 0$ against $H_\alpha : \mu_1 - \mu_2 > 0$.
Reject H_0 if test statistic $t > t_{1-\alpha}$, with $df = v$.

iii. Left-tailed test $H_0 : \mu_1 - \mu_2 \geq 0$ against $H_\alpha : \mu_1 - \mu_2 < 0$.
Reject H_0 if test statistic $t < t_\alpha$, with $df = v$.

Definition 2.3.6. *One-tailed and Two-tailed Tests of Single Variance*

i. Two-tailed test $H_0 : \sigma^2 = \sigma_0^2$ against $H_\alpha : \sigma^2 \neq \sigma_0^2$.
Reject H_0 if test statistic $> \chi^2_{\alpha/2}$ or if test statistic $< \chi^2_{1-\alpha/2}$, with $df = n - 1$.

ii. Right-tailed test $H_0 : \sigma^2 \leq \sigma_0^2$ against $H_\alpha : \sigma^2 > \sigma_0^2$.
Reject H_0 if test statistic $> \chi^2_\alpha$, with $df = n - 1$.

iii. Left-tailed test $H_0 : \sigma^2 \geq \sigma_0^2$ against $H_\alpha : \sigma^2 < \sigma_0^2$.
Reject H_0 if test statistic $< \chi^2_{1-\alpha}$, with $df = n - 1$.

Definition 2.3.7. *One-tailed and Two-tailed Tests of Two Variances*

i. Two-tailed test $H_0 : \sigma_1^2 = \sigma_2^2$ against $H_\alpha : \sigma_1^2 \neq \sigma_2^2$.
Reject H_0 if test statistic $> F_{\alpha/2}$.

ii. Right-tailed test $H_0 : \sigma_1^2 \leq \sigma_2^2$ against $H_\alpha : \sigma_1^2 > \sigma_2^2$.
Reject H_0 if test statistic $> F_\alpha$.

iii. Left-tailed test $H_0 : \sigma_1^2 \geq \sigma_2^2$ against $H_\alpha : \sigma_1^2 < \sigma_2^2$.
Reject H_0 if test statistic $< F_{1-\alpha}$.

Method 2.3.8. *Statistical Test Summaries*

i. *Test of Single Mean*

Sample	Variance	Small Sample	Large Sample
Normal	Known	$z = \frac{\overline{X}-\mu_0}{\sigma/\sqrt{n}}$	$z = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$
Normal	Unknown	$t_{n-1} = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$	$t_{n-1} = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$ or $z = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$
Non-normal	Known	Not Available	$z = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$
Non-normal	Unknown	Not Available	$t_{n-1} = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$ or $z = \frac{\overline{X}-\mu_0}{s/\sqrt{n}}$

ii. *Test of Two Mean*

Sample	Variance	Test Statistics	Degrees of Freedom
Normal	Equal, Unknown	$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$, where $s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$ is pooled estimator of common variance	$df = n_1 + n_2 - 2$
Normal	Unequal, Unknown	$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$df = \frac{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}{\frac{(s_1^2/n_1)^2}{n_1} + \frac{(s_2^2/n_2)^2}{n_2}}$
Normal	Paired, Unknown	$t = \frac{\overline{d} - \mu_{d0}}{s_{\overline{d}}}$, where $\overline{d} = \frac{1}{n}\sum_{i=1}^{n} d_i$, $s_{\overline{d}} = \frac{1}{\sqrt{n}}\frac{\sum_{i=1}^{n}(d_i - \overline{d})^2}{n-1}$	$df = n - 1$

iii. *Correlation Test*: Assess correlation strength of two variables, $H_0 : \rho = 0$ against $H_1 : \rho \neq 0$.
Test statistic is $t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$, where r is the sample correlation.
Degrees of freedom is $df = n - 2$.

iv. *Test of Single Variance Equality*: compare variance of population σ^2 against hypothesised value σ_0^2.
Test statistic is $\chi^2 = \frac{(n-1)s^2}{\sigma_0^2}$, where sample variance is $s^2 = \frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}$.
Degrees of freedom is $df = n - 1$.

v. *Test of Two Variance Equality*: for two populations with normal distribution.
Test statistic is $F = \frac{s_1^2}{s_2^2}$.
Degrees of freedom for numerator is $df_1 = n_1 - 1$, for denominator is $df_2 = n_2 - 1$.

vi. *Spearman Rank Test*: If the assumption that two variables are uncorrelated is not valid, use the test.

1. Rank observations on X from large to small. For ties, assign average of ranks. Do same for Y.
2. Calculate difference d_p, between the ranks of each pair of observations on X and Y.
3. With sample size n, test statistic is $r_s = 1 - \frac{\sum_{i=1}^{n} d_i^2}{n(n^2-1)}$.
   If $n > 30$, use t-test instead, where $t = \frac{(n-2)^{1/2} r_s}{(1-r_s^2)^{1/2}}$ with degrees of freedom $df = n - 2$.

vii. *Parametric vs Non-Parametric Tests*

	Parametric	Non-Parametric
Tests on single mean	t-test, z-test	Wilcoxon signed-rank test
Tests on differences between means	t-test, approx t-test	Mann-Whitney U test
Tests on mean differences (paired)	t-test	Wilcoxon signed-rank test, sign test

2.4 Regression

Definition 2.4.1. *Linear Regression Assumptions*

i. Linearity: $Y \sim a_i X_i$, where a_i is a constant, Y is dependent variable, X_i is independent variable.
ii. Homoscedasticity: Variance of residual $Var(Y - \hat{Y})$ is constant $\forall$ observations (Y is actual, $\hat{Y}$ is predicted).
iii. Independence: Residuals are uncorrelated across observations, $E[\epsilon_i \epsilon_j] = 0 \ \forall i \neq j$.
iv. Normality: Residual term is normally distributed.
v. Expected value of residual term is zero, $E[\epsilon] = 0$.
vi. Independent variable is uncorrelated with the residuals.

Definition 2.4.2. *Regression Performance Plots*:

i. Scatterplot (variable vs variable): for possible correlation between independent variables, identify outliers.
ii. Scatterplot (residual vs predicted): for possible correlation between residual and predict value.
iii. Normal Q-Q plot (theory vs empirical distribution): residual vs normal distribution. If residuals are along the diagonal, then it is good.

Definition 2.4.3. The estimated *slope coefficient* $\hat{b}_1$ is computed as $\hat{b}_1 = \frac{Cov(X,Y)}{\sigma_X^2}$.

Definition 2.4.4. The *standard error (SE)* is defined as $SE = \frac{\sigma}{\sqrt{n}}$.

Definition 2.4.5. The *regression coefficient confidence interval* is defined as $\hat{b}_1 \pm (t_\alpha + SE_{\hat{b}_1})$, where t_α is the critical two-tailed t-value for the confidence level α, with degrees of freedom $df = n - 2$.

Definition 2.4.6. *Test of Slope Coefficient Significance*
Two-tailed test $H_0 : b_1 = 0$ against $H_\alpha : b_1 \neq 0$.
Test statistic is $t = \frac{\hat{b}_1 - b_1}{SE_{\hat{b}_1}}$, with degrees of freedom $df = n - 2$.
Reject H_0 if $t > t_{\alpha/2}$ or $t < -t_{\alpha/2}$.

		Test of the Slope	Test of the Correlation
Step 1	State the hypotheses.	H_0: $b_1 \leq 0$ versus H_a: $b_1 > 0$	H_0: $\rho \leq 0$ versus H_a: $\rho > 0$
Step 2	Identify the appropriate test statistic.	$t = \frac{\hat{b}_1 - B_1}{s_{\hat{b}_1}}$ with 6 – 2 = 4 degrees of freedom.	$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$. with 6 – 2 = 4 degrees of freedom.
Step 3	Specify the level of significance.	α = 5%.	α = 5%.
Step 4	State the decision rule.	Critical t-value = 2.132. Reject the null if the calculated t-statistic is greater than 2.132.	Critical t-value = 2.132. Reject the null if the calculated t-statistic is greater than 2.132.
Step 5	Calculate the test statistic.	$t = \frac{1.25 - 0}{0.312398} = 4.00131$	$t = \frac{0.8945\sqrt{4}}{\sqrt{1-0.8001}} = 4.00131$
Step 6	Make a decision.	Reject the null hypothesis. There is sufficient evidence to indicate that the slope is greater than zero.	Reject the null hypothesis. There is sufficient evidence to indicate that the correlation is greater than zero.

Figure 1: One-sided tests for slop and correlation, single regression

Definition 2.4.7. The *predicted values confidence interval* is defined as $\hat{Y} \pm (t_{\alpha/2} \times SE_f)$, where $t_{\alpha/2}$ is the critical two-tailed t-value for the confidence level α, with degrees of freedom $df = n-2$, and SE_f is the standard error of the forecast. Note that $SE_f^2 = SEE^2 \left[1 + \frac{1}{n} + \frac{(X-\overline{X})^2}{(n-1)\sigma_X^2}\right]$, where σ_X^2 is the variance of the independent variable, X is the value of the independent variable for which the forecast was made.

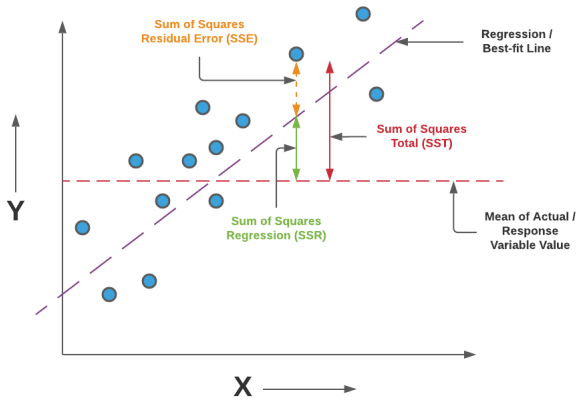

Figure 2: Regression Error Terms

Definition 2.4.8. *Analysis of Variance (ANOVA)* analyses the total variability of the dependent variable:

i. Sum of total squares (SST): measures total variation in dependent variable. Sum of squared differences between actual and mean value, $SST = \sum_{i=1}^{n}(Y_i - \overline{Y})^2$.

ii. Sum of squares regression (SSR): measures variation in dependent variable as explained by independent variable. Sum of square distances between predicted and mean value, $SSR = \sum_{i=1}^{n}(\hat{Y}_i - \overline{Y})^2$.

iii. Sum of squares residual error (SSE): measures unexplained variation in dependent variable. Sum of squared vertical distance between actual and predicted values. $SSE = \sum_{i=1}^{n}(Y_i - \hat{Y})^2$.

iv. Mean squares regression (MSR): $MSR = \frac{SSR}{k}$, where k is number of independent variables.

v. Mean squares error (MSE): $MSE = \frac{SSE}{n-k-1}$, where k is number of independent variables.

vi. Standard error of estimate (SEE): $SEE = \sqrt{\frac{\sum_{i=1}^{n}(Y_i - \hat{Y})}{n-2}} = \sqrt{MSE}$.

vii. Standard error of intercept: $SE_{\hat{b}_0} = \sqrt{\frac{1}{n} + \frac{\overline{X}^2}{\sum_{i=1}^{n}(X_i - \overline{X})^2}}$

Definition 2.4.9. *Test of Slope Intercept Significance*
Two-tailed test $H_0 : b_0 \leq B_0$ against $H_\alpha : b_0 > B_0$.
Test statistic is $t = \frac{\hat{b}_0 - B_0}{SE_{\hat{b}_0}}$, with degrees of freedom $df = n - 2$.
Reject H_0 if $t > t_\alpha$.

Step 1	State the hypotheses.	H_0: $b_0 \leq 3\%$ versus H_a: $b_0 > 3\%$
Step 2	Identify the appropriate test statistic.	$t_{intercept} = \frac{\hat{b}_0 - B_0}{s_{\hat{b}_0}}$ with 6 – 2 = 4 degrees of freedom.
Step 3	Specify the level of significance.	$\alpha = 5\%$.
Step 4	State the decision rule.	Critical t-value = 2.132. Reject the null if the calculated t-statistic is greater than 2.132.
Step 5	Calculate the test statistic.	$t_{intercept} = \frac{4.875 - 3.0}{\sqrt{\frac{1}{6} + \frac{6.1^2}{122.64}}} = \frac{1.875}{0.68562} = 2.73475$
Step 6	Make a decision.	Reject the null hypothesis. There is sufficient evidence to indicate that the intercept is greater than 3%.

Figure 3: Slope intercept test of regression

Definition 2.4.10. *Coefficient of determination, R^2*, measure goodness of fit of regression to data.

$$R^2 = \frac{SST - SSE}{SST} = \frac{SSR}{SST}$$

Note that R^2 do not allow us to know if coefficients are statistically significant. There is no info on bias in estimated coefficients and predicted values. There is no info if model fit is good as well.

Definition 2.4.11. *Adjusted R^2*, adjusts for degrees of freedom.

$$\overline{R}^2 = 1 - \left[\left(\frac{n-1}{n-k-1}(1-R^2)\right)\right]$$

where k is number of independent variables.

If we are adding new independent variable to the regression, if the coefficient t-statistics $> |1.0|$, then $\overline{R}^2$ will increase. If coefficient t-statistics $< |1.0|$, then $\overline{R}^2$ will decrease.

Definition 2.4.12. *Information Criterions*

i. *Akaike Information Criterion (AIC)*: evaluate model parsimony. Lower AIC means better fitting.

$$AIC = n\ln(\frac{SSE}{n}) + 2(k+1)$$

where n is the sample size, k is number of independent variables.

ii. *Bayesian Information Criterion (BIC)*: gives greater penalty than AIC if model has more parameters. Lower BIC means better fitting.

$$BIC = n\ln(\frac{SSE}{n}) + \ln(n)(k+1)$$

AIC is preferred if model is used for prediction. BIC is preferred if best goodness of fit is desired.

3 Financial Statement Analysis

3.1 Financial Reporting

Remark 3.1.1. Role of Financial Statement Analysis

i. Role of financial reporting: provide information about company's financial position for use by internal and external parties.

ii. Role of financial analysis: evaluate company past, current, prospective financial position and performance for investment, credit, and similar decisions

Definition 3.1.2. *Financial Statements*

i. Balance sheet (BS): provides information on liquidity, solvency, financial position at a point of time.

$$\text{Assets} = \text{Liabilities} + \text{Owner's Equity}$$

ii. Income statement (IS): provides information on financial performance of activities over period of time on a consolidated basis

iii. Cash Flow Statement (CFS): discloses sources and use of cash. For liquidity, solvency, financial flexibility

iv. Statement of changes in equity: shows changes in owner's investment in the business over time, in order of liquidation and dividends

v. Financial footnotes: includes accounting methods (assumptions and estimates), and disclosure on fixed assets, inventory methods, income taxes, pensions, debt, contingencies etc.

vi. Supplementary schedules: includes additional info on assets and liabilities of company, but is unaudited

vii. Management commentary: includes specific issues on financial statements, current financial condition, liquidity, and planned capital expenditure (Capex). Not audited, for public companies only.

Remark 3.1.3. *Auditor Reports.* In accordance with GAAP, identify inconsistent principles.

i. Unqualified opinion: free of material misstatements (by GAAP). Fairly represented.

ii. Qualified opinion: 1 to 2 situations not compliant with GAAP, rest are fairly presented.

iii. Adverse opinion: materially misstated, generally do not comply with GAAP. Unreliable, inaccurate.

iv. Disclaimer of opinion: auditor could not form and refuses to present an opinion. Issued when auditor cannot complete work.

Remark 3.1.4. *Standard Setting Bodies.* These are private sector, self-regulated bodies.

i. IASB: Standard-setting body of IFRS Foundation. Deliberate, develop, issue international financial reporting standards.

ii. FASB: Issues new and revised standards to develop standards of financial reporting. US GAAP recognised by SEC, but SEC retains authority to establish standards.

Principles: To provide full, accurate, and timely disclosure of financial results, risks, and other information material to investor's decisions. High and internationally acceptable quality.

Remark 3.1.5. *Regulatory Bodies.* These have the legal authority to enforce financial reporting requirements, can overrule private-sector standard setting bodies.

i. IOSCO: Regulate world financial markets. Protect investors, ensure markets are fair, efficient, and transparent, and reduce systematic risk.

ii. SEC: Governs form and content of financial statements through securities act. Oversees PCAOB.

Remark 3.1.6. *Key Regulations*

i. Securities exchange act of 1934: Created SEC, give SEC authority over all aspects of securities industry, empower SEC to require periodic reporting.

ii. Securities act of 1993: Specified financial and other significant information that investors must receive when securities are sold, prohibits misrepresentations, requires initial registration of all public issuances of securities.

iii. Sarbanes-Oxley Act of 2002: Oversee auditors. Ensure auditor independence, corporate responsibility for financial reports, effectiveness of firm's internal control over financial reporting.

Remark 3.1.7. *Financial Statement Analysis Process*

Step	Step Name	Input	Output
1	Articulate the purpose and context of the analysis	• The nature of the analyst's function and context of the analysis such as evaluating an equity or debt investment or issuing a credit rating. • Communication with client or supervisor on needs and concerns. • Institutional guidelines related to developing specific work product.	• Statement of the purpose or objective of the analysis. • A list (written or unwritten) of specific questions to be answered by the analysis. • Nature and content of the report to be provided. • Timetable and budgeted resources for completion.
2	Collect input data	• Financial statements, other financial data, questionnaires, and industry, economic data. • Discussions with management, suppliers, customers, and competitors. • Company site visits (e.g., to production facilities or retail stores).	• Organised financial statements. • Financial data tables. • Completed questionnaires, if applicable.
3	Process data	• Data from previous phase.	• Adjusted financial statements. • Common-size statements. • Ratios and graphs. • Forecasts
4	Analyse and interpret the processed data	• Input data as well as processed data.	• Analytical results.
5	Develop and communicate conclusions and recommendations (e.g., with an analysis report).	• Analytical results and previous reports. • Institutional guidelines for published reports.	• Analytical report answering questions posed in Phase 1. • Recommendation regarding the purpose of the analysis, such as whether to make an investment or grant credit.
6	Follow up	• Information gathered by periodically repeating above steps as necessary to determine whether changes to holdings or recommendations are necessary.	• Updated reports and recommendations.

Remark 3.1.8. *Types of Reports*

i. Registration statement: provides disclosure about securities offered for sale; relationship of new securities to other securities; informational provided in annual filings; recent audited financial statement; risk factors in the business.

ii. Forms 10-K, 20-F, 40-F: Forms 10-K are for US registrants, 40-F are for Canadian, and 20-F for other non-US registrations. This is a legal document with minimal marketing. Provides information on business, financial disclosures, legal proceedings, information related to management.

iii. Annual report: Not SEC requirement. Opportunity for company to present itself to stakeholders and other external parties. Highly polished marketing document. Overlap with 10-K.

iv. Proxy statements, Form DEF-14A: Provides information on litigation, executive compensation, related-party transactions. Proposals that require shareholder vote, security ownership by management and principal owners, director's biographic information.

v. Interim reports, Forms 10-Q, 6-K: Provided on a quarterly basis, less detailed than annual reports, unaudited statements and footnotes. If no-recurring events take place, included in 10-Q report.

vi. Forms 8-K: Announce major events such as acquisitions, disposal of corporate assets, changes in securities and trading markets, matters related to accountants and financial statements, corporate governance and management changes, regulation FD disclosures.

vii. Forms 3, 4, 5: Report beneficial ownership of securities for any owners greater than 10% per class of securities. Form 3 is initial statement, Form 4 is changes, Form 5 is annual report.

viii. Form 155: Notice of proposed sale of restricted securities or securities held by affiliate of the issuer.

ix. Form 11-K: Annual report of employee stock purchase, savings, etc.

Definition 3.1.9. *Financial Reporting Recognition Principles*

i. *Probable*: economic outcome has high probability of occurrence.

ii. *Measurable*: economic outcome measured exactly with reliability.

Definition 3.1.10. *Financial Reporting Fundamental Qualitative Factors*

i. *Relevance*: potential to affect or make difference in user's decisions. Predictive, confirmatory value.

ii. *Materiality*: omission or misstatement can influence user decisions

iii. *Faithful Representation*: complete, neutral, free from error

Definition 3.1.11. *Financial Reporting Enhancing Qualitative Factors*
Comparable and consistent, verifiable, timeliness, and understandable.

As it takes time to get reliable information, will need to get balance between relevance and reliability.

Definition 3.1.12. *Accounting Assumptions*: on an accrual basis, going concern principle.

Definition 3.1.13. *Types of Costs*

i. *Historical Cost*: recorded at value paid at time of acquisition for assets, and liabilities proceeds in return for obligation.

ii. *Amortised Cost*: historical cost adjusted for amortisation, depreciation, or depletion/impairment.

iii. *Current Cost*: cash or cash equivalents if asset is paid for or liability required to settle obligation currently.

Definition 3.1.14. *Types of Value*

i. *Realisable Value*: cash or cash equivalents if assets sold in an orderly disposal, and liability at settlement.

ii. *Present Value*: assets at present value (PV) discounted of future cash flows. Liabilities at PV discounted of future net cash flows required to settle.

iii. *Fair Value*: amount which an asset could be exchanged, or liability settled between willing parties.

Remark 3.1.15. *IFRS Reporting Requirements*

i. Required financial statements: balance sheet, income statement, statement of changes in equity, cash flow statement, notes.

ii. Required features: fair representation, going concern, accrual basis, consistency, materiality and aggregation, no offsetting. Annual frequency of reporting. Comparative information from previous periods.

iii. Structure and Content:

    1. Balance Sheet: disclose current and non-current assets and liabilities, unless if liquidity-based presentation is more reliable and relevant.
    2. Financial Statements: minimum line-item disclosures.
    3. Notes: disclosures on information.
    4. Comparative information: disclosed for previous period.

iv. Disclosure of accounting policies:

    1. Measurement bases used in preparing financial statements
    2. Significant accounting policies used
    3. Judgments made in applying accounting policies that have the most significant effect on the amounts recognised in the financial statements

v. Sources of estimation uncertainty: Key assumptions about the future and other key sources of estimation uncertainty that have a significant risk of causing material adjustment to the carrying amount of assets and liabilities within the next year

vi. Other Disclosures:

    1. Information about capital and about certain financial instruments classified as equity
    2. Dividends not recognised as a distribution during the period, including dividends declared before the financial statements were issued and any cumulative preference dividends

3. Description of the entity, including its domicile, legal form, country of incorporation, and registered office or business address
4. Nature of operations and principal activities
5. Name of parent and ultimate parent

Effective financial reporting have the following characteristics: transparency, comprehensiveness, consistency

Remark 3.1.16. *Barriers to a single standard*:

i. Valuation approach: judgement is required

ii. Standard-setting approach: principles-based vs rule-based

iii. Measurement approach: what constitutes an asset and a liability. Use of matching principle

If new products are launched by a business, understand the business purposes, then evaluate potential effect on financial statements.

3.2 Basic Financial Statement Analysis

4 Portfolio Management

CFA Level 1 Materials

4.1 Fundamentals

Definition 4.1.1. *Safety-First Ratio*
Optimal portfolio minimises the probability that portfolio return R_p falls below the threshold level R_L.

$$\text{SF Ratio} = \frac{E[R_p] - R_L}{\sigma_p}$$

Note that $P(\text{Return} < R_L) = N(-\text{SF Ratio})$.

i. Calculate each portfolio's safety-first ratio.

ii. Choose the portfolio with maximum safety-first ratio.

5 Formula Sheet

References