# FinQuiz Formula Sheet CFA Program Level II

## QUANTITATIVE METHODS

### Learning Module 1: Basics of Multiple Regression and Underlying Assumptions

1. **Multiple Regression**

$Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + \ldots + b_kX_{ki} + \varepsilon_i, i = 1, 2, \ldots n.$

2. **Prediction Equation**

Prediction equation = $\widehat{Y}_i = \widehat{b}_0 + \widehat{b}_1 X_{1i} + \widehat{b}_2 X_{2i} + \ldots + \widehat{b}_k X_{ki} + \varepsilon_i, i$

### Learning Module 2: Evaluating Regression Model Fit and Interpreting Model Results

1. **Coefficient of Determination: $R^2$**

$$= \frac{\text{Sum of square regression}}{\text{Sum of square total}} = \frac{\sum_{i=1}^{n}(\widehat{Y} - \overline{Y})^2}{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}$$

2. **Adjusted $R^2$**

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

3. **F-Statistic or F-Test**

$$= \frac{MSR}{MSE} = \frac{\left(\frac{\text{Sum of square regression}}{k}\right)}{\left(\frac{\text{Sum of squares error}}{n-k-1}\right)}$$

*where,*

*df numerator = k = 1*

*df denominator = n – k – 1 = n – 2*

4. **ANOVA**

| ANOVA | SS | MSS | F |
|---|---|---|---|
| Regression df = 1 | SSR $= \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$ | $\frac{SSR}{k}$ | $\frac{SSR/k}{SSE/(n-k-1)}$ |
| Error df = n-2 | SSE $= \sum_{i=1}^{n}(y_i - \hat{y})^2$ | $\frac{SSE}{n-k-1}$ | |
| Total df = n-1 | SST $= \sum_{i=1}^{n}(y_i - \bar{y})^2$ | | |

5. **Akaike's information criterion (AIC)**

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

6. **Schwarz's Bayesian information criterion (BIC or SBC)**

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

### Learning Module 3: Model Misspecification

1. **Breusch–Pagan (BP) test**

Test statistic = n × $R^2_{residuals}$

*where,*

*$R^2_{residuals}$ = $R^2$ from a second regression of the squared residuals from the first regression on the independent variables*

*n = number of observations*

2. **Variance Inflation Factor $VIF_j$**

$$VIF_j = \frac{1}{1 - R_j^2}$$

 

## Learning Module 4: Extensions of Multiple Regression

1. **Studentized residual $t_{i^*}$**

$$t_{i^*} = \frac{e_i^*}{S_{e^*}} = \frac{n}{}\sqrt{\frac{n-k-1}{SSE(1-h_{ii})-e_i^2}}$$

2. **Cook's distance $D_i$**

$$D_i = \frac{e_i^2}{k \times MSE}\left[\frac{h_{ii}}{(1-h_{ii})^2}\right]$$

3. **Linear regression** *with 3 independent Variables*

$$Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + e_i$$

4. **Logistic regression (logit)**

$= \ln\left(\frac{P}{1-P}\right)$

$= b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \varepsilon$

$P = \frac{1}{1+exp[-(b1X1 + b2X2 + b3X3 + \varepsilon)]}$

## Learning Module 5: Time Series Analysis

1. **Linear Trend Models**

$y_t = b_0 + b_1t + \varepsilon_t$

Predicted/fitted value of $y_t$ in period (T + 1)

$= \hat{y}_{t+1} = \hat{b}_0 + \hat{b}_1(T+1)$

2. **Log-Linear Trend Models**

$$y_t = e^{b_0+b_1t}$$

3. **Autoregressive Time-Series Models**

First order autoregressive AR (1):

$x_t = b_0 + b_1 x_{t-1} + \varepsilon_t$

pth-order autoregressive AR (p):

$x_t = b_0 + b_1 x_{t-1} + b_2 x_{t-2} + \ldots + b_p x_{t-p} + \varepsilon_t$

4. **Mean reverting level**

$$x_t = \frac{b_0}{1-b_1}$$

5. **Chain Rule of Forecasting:**

One-period ahead forecast

$$\hat{x}_{t+1} = \hat{b}_0 + \hat{b}_1 x_t$$

Two-period ahead forecast=

$$\hat{x}_{t+2} = \hat{b}_0 + \hat{b}_1 x_{t+1}$$

6. **Random Walks and Unit Roots:**

*Random Walk without drift:*

$x_t = x_{t-1} + \varepsilon_t$ where, $b_0 = 0$ and $b_1 = 1$.

*Correcting Random Walk:*

$y_t = x_t - x_{t-1}$

*Random walk with a drift:*

$x_t = b_0 + x_{t-1} + \varepsilon_t$ where, $b_0 \neq 0$ and $b_1 = 1$

*By taking first difference*

$y_t = x_t - x_{t-1} = b_0 + \varepsilon_t$

7. **Using Dickey-Fuller Test**

$x_t - x_{t-1} = b_0 + (b_1 - 1)\, x_{t-1} + \varepsilon_t$

8. **Smoothing Past Values with n-Period Moving Average**

$$\frac{x_t + x_{t-1} + x_{t-2} + \ldots + x_{t-(n-1)}}{n}$$

9. **Correcting Seasonality in Time Series Models:**

*For quarterly data*

$x_t = b_0 + b_1x_{t-1} + b_2x_{t-4} + \varepsilon_t$

*For monthly data*

$x_t = b_0 + b_1x_{t-1} + b_2x_{t-12} + \varepsilon_t$

10. **ARCH model** =

$$\hat{\varepsilon}^2_t = \alpha_0 + \alpha_1\hat{\varepsilon}^2_{t-1} + \mu_t$$

where

$\mu_t$ is an error term

Predicting variance of errors in period t+1 = $\hat{\sigma}^2_{t+1} = \hat{\alpha}_0 + \alpha_1\hat{\varepsilon}^2_t$

## Learning Module 6: Machine Learning

1. **LASSO:**

Penalty term (when $\lambda > 0$) = $\lambda \sum_{k=1}^{K} |\bar{b}_k|$

 

$$\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 + \lambda \sum_{k=1}^{K}|\hat{b}_K|$$

When $\lambda$ = 0,

LASSO penalized regression = OLS regression

**Learning Module 7:**
**Big Data Projects**

1. **Normalization**

$$X_{i(normalized)} = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

where $X_i$ = value of observation

*Performance Metrics:*

2. **Accuracy**

$$= \frac{TP+TN}{TP + FP + TN + FN}$$

F1 score = (2*P*R)/(P + R)

*where*
*T = true, F = false, P = positive,*
*N = negative*

3. **Receiver Operating Characteristic (ROC):**

False positive rate: FPR

$$FPR = \frac{FP}{TN+FP}$$

True positive rate TPR:

$$TPR = \frac{TP}{TN+FP}$$

4. **Root Mean Square Error: RMSE:**

$$RMSE = \sum_{i=1}^{n}\frac{(Predicted_i - Actual_i)^2}{n}$$

# ECONOMICS

**Learning Module 1**
**Currency Exchange Rates**

1. **Bid-offer Spread**
Offer price – Bid price

2. **Forward Rate:**

$$\text{Fwd rate} = \text{Spot Exchange rate} + \frac{\text{Forward points}}{10{,}000}$$

3. **Forward Premium or Discount:**

$$= \frac{\text{spot exchange rate} - \left(\frac{\text{forward points}}{10{,}000}\right)}{\text{spot exchange rate}} - 1$$

4. **To convert spot rate into forward quote:**
Spot exchange rate × (1 + % premium)
Spot exchange rate × (1 - % discount)

5. **Covered interest rate parity:**

$$(1 + i_d) = S_{f/d}(1 + i_f)\left(\frac{1}{F_{f/d}}\right)$$

$$F_{f/d} = S_{f/d}\left(\frac{1 + i_f}{(1 + i_d)}\right)$$

Using day count convention:

$$\left(1 + i_d\left[\frac{Actual}{360}\right]\right) =$$

$$S_{f/d}\left(1 + i_f\left[\frac{Actual}{360}\right]\right)\left(\frac{1}{F_{f/d}}\right)$$

$$F_{f/d} = S_{f/d}\left(\frac{1 + i_f\left[\frac{Actual}{360}\right]}{1 + i_d\left[\frac{Actual}{360}\right]}\right)$$

6. **Uncovered Interest Rate Parity :**

- $i_f - \%\Delta S^e_{f/d} = i_d$
- $\%\Delta S^e_{f/d} = i_f - i_d$

Forward premium or discount:

- For one year horizon =

$$F_{f/d} - S_{f/d} =$$

$$S_{f/d}\left(\frac{i_f - i_d}{1 + i_d}\right) \cong S_{f/d}(i_f - i_d)$$

- Using day count convention:

$$F_{f/d} - S_{f/d} = S_{f/d}\left(\frac{\left[\frac{Actual}{360}\right]}{1 + i_d\left[\frac{Actual}{360}\right]}\right)(i_f - i_d)$$