Level II of the CFA® 2025 Exam

Item-Set Questions - Quantitative Methods

Offered by AnalystPrep

Last Updated: Feb 28, 2025

Table of Contents

Case 1: Brittany Ruiz

Brittany Ruiz is the chief investment officer (CIO) at Black-Mount Capital Advisory Firm (BMCA), a leading U.S. based money management firm. Last year, BMCA launched the BMCA Equity Fund that invested in domestic and international markets stocks, including those of Russia, Brazil, Canada, and the U.K. During its annual performance review, Ruiz discovered that the fund earned a considerably less return than that of its benchmark. Concerned with the outcome, Ruiz called a meeting with the fund's portfolio management team to discuss key issues related to the quantitative analysis of the fund's investments. A leading quantitative expert, Anthony Webb, was invited to chair the meeting. While analyzing the regression models used by the PM team to predict stock returns, Webb requested the information provided in Exhibit 1. The information relates to a time-series model for annualized monthly returns to a Brazilian stock index.

Exhibit 1: Annualized Monthly Returns to a Brazilian Stock Index

Lag	Autocorrelation
1	0.1320
2	0.1856
3	-0.0098
4	0.0056
5	-0.0062

Critical t-value	1.96
Number of observations	398

After his analysis, Webb presented the following conclusions to the portfolio management team:

Conclusion 1: "This time series can be best modeled using a moving average (2) model rather than an autoregressive model."

Conclusion 2: "A moving average (2) model would be different from a simple moving average because the former would place different weights on the terms in the moving average. And unlike the MA(2), a simple moving average is based on observed time series values."

Since 10% of the BMCA Equity Fund was invested in large-cap Russian stocks, Webb considered it crucial to study the characteristics of the Russian capital markets. While reviewing BMCA's autoregressive (1) model used to predict the Russian inflation rate, Webb suspected that the model might have a unit root. To accurately test for the presence of a unit root in the time series,

Webb decided to regress the first difference of the time series on the first lag of the time series. After obtaining the regression results, Webb calculated the t-statistic conventionally for the coefficient. He then used the critical t-values computed by Dickey and Fuller to determine significance. Since he could not reject the null hypothesis at the 5% significance level, Webb concluded that the series did not have a unit root and was stationary.

When talking to Ruiz about 'random walks' Webb stated that a time-series that was a random walk could not be analyzed using standard regression analysis. He made the following statements:

Statement 1: "There is no finite mean-reverting level for a random walk. In addition, the variance of the time-series increases or decreases as we go further into the future without any lower or upper bound. This violates the assumption of a finite variance for the time-series."

Statement 2: "To model a random walk, we should first-difference it. This results in a mean-reverting level of 0. In addition, the variance of a first-differenced time-series is not only finite, but is also constant. The time-series then becomes covariance stationary."

Webb continued by stating that if a time-series is a random walk, it is best to model the first-differenced series with an autoregressive model to predict future movements in the time-series. He also stated that the key to choosing the correct model was to analyze each model's R^2: the first-differenced AR model would generally have an R^2 greater than the R^2 of the original AR model for a random walk, since the first-differenced model better fits the data.

Q.1 Webb is *most accurate* with respect to:

A. Conclusion 1 and conclusion 2.

B. Conclusion 2 only.

C. Neither conclusion 1 nor conclusion 2.

Q.2 Is Webb's conclusion regarding the presence of a unit root in the inflation rate time-series *most likely* correct:

A. Yes.

B. No, because the regression variables that he used and his computed t-statistic were incorrect.

C. No, because his application of the regression-based unit root test was incorrect.

Q.3 Webb is *most accurate* with respect to:

A. Statement 1 only.

B. Statement 2 only.

C. Neither statement 1 nor statement 2.

Q.4 With regards to his comments about random walks, Webb is *most likely*:

A. Correct.

B. Incorrect about the criterion of choosing the correct model.

C. Incorrect about the use of first-differenced AR models and about the criterion of choosing the correct model.

Case 2: Quality Investment Advisory

Quality Investment Advisory (QIA) is a U.S. based asset management firm providing financial advice and portfolio management services to private and institutional clients. Rob Wallace works as the chief portfolio manager at QIA's headquarters in Chicago, USA. Wallace is currently managing a $5 million portfolio of John Mackintosh - one of the firm's oldest high net worth clients. The portfolio invests a significant portion in the stocks of emerging markets, like those of Russia and Brazil.To estimate the returns to Brazilian stock investments, Wallace used a regression model with the dependent variable measuring the Brazilian stock return and the independent variables measuring (I) the growth in the Brazilian GDP and (II) the return on a Brazilian market index. Exhibit 1 displays the results to estimating this regression.

Exhibit 1
Regression Analysis Results

	Coefficient	Standard Error
Intercept	0.0095	0.013
Annual % increase in GDP	0.667	0.337
Annual return to Brazilian market index	2.245	0.245
ANOVA		
Regression Sum of Squares	0.9436	
Residual Sum of Squares	0.3426	
Observations	60	

While talking to Mackintosh about the results of the regression, Wallace made the following comment:

"The interpretation of the slope coefficient of the annual percentage increase in GDP is that for every 1 unit increase in GDP, we would expect your return to increase by 0.667 units. The coefficient value of 0.667 will remain constant even if we remove the second independent variable."

Mackintosh requested to know exactly how changes in market return would impact the return on his Brazilian investment. Wallace gave the following response:

"Let's assume the change in market return over a year is 1%. If we compared the return on your investment at the beginning of the year with the return at the end of the year, we would expect an increase of 2.245%. However, to ensure that this holds, we would have to calculate the F-statistic using data from the regression, particularly the sum of squared residuals and the regression sum of squares."

After he met with Mackintosh, Wallace met with Colin Edwards - a statistician at QIA's headquarters - with whom he had been managing a multimillion dollar institutional fund. Edwards suggested using a multiple regression model to determine whether (I) an increase in the U.S. literacy rate and (II) an improvement in technology would affect the stocks' P/E.

Q.1 Which of the following statements about the regression on Brazilian stocks return is *most accurate* :

A. The Brazilian stocks return is very closely related to the annual return on the Brazilian market index.

B. The Brazilian stocks return is closely related to the annual percentage increase in GDP.

C. The Brazilian stocks return is unrelated to both the annual return on the Brazilian market index and the annual percentage increase in GDP.

Q.2 Using the information provided in Exhibits 1, the F-statistic is *closest* to:

A. 2.754.

B. 78.49.

C. 79.87.

Q.3 With respect to his comment, Wallace will *most likely* be correct only if the:

A. Second independent variable is uncorrelated with the annual % increase in GDP.

B. Intercept and the second independent variable are uncorrelated with the annual % increase in GDP.

C. Residuals of the regression represent the expected net effect on Brazilian stock returns of a 1 unit increase in annual GDP after removing that part of GDP that is correlated with the market index return.

Q.4 With respect to the effect of change in market return on the Brazilian investment return, Wallace is *least* accurate with respect to:

A. The comparison of returns only.

B. Neither the comparison of returns nor the F-statistic.

C. Both the comparison of returns and the F-statistic.

Case 3: Jack Blessing

Jack Blessing, a portfolio manager, follows stocks in the telecommunication industry. Currently, Blessing is researching TeleBrand Enterprises (TBE), a leading competitor in the industry. Initially, Blessing estimated a linear trend model, with a trend coefficient of 1154.78, to fit the data on annual sales of TBE, but found out that the regression errors were correlated across observations. He, therefore, rejected the model and estimated a linear trend in lognormal TeleBrand sales. Exhibit 1 displays some information related to the current regression. Blessing used the most recent 20-year data to estimate the regression coefficients.

Exhibit 1

Regression Statistics	
R-squared	0.9588
Standard error	0.1563
Observations	20

	Coefficient	**Standard error**
Intercept	6.789	0.02745
Trend	0.0965	0.01301

Blessing invited Shane Sweet, his colleague, to discuss the output of his analysis. Sweet made the following comments:

Statement 1: "Based on your current model, the sales of TeleBrand Enterprises are expected to grow at a constant rate of 10.13% per year. In contrast, the previous model predicted that sales would increase by $1154.78 from one year to the next."

Statement 2: "Using the current model, the predicted sales for next year are approximately $977.99 million."

Blessing has short-listed another company -- CareLink Ltd -- for inclusion in his portfolio. Blessing plans to use a time-series model to predict CareLink's profit margin for future periods. He believes that the current period's profit margin is significantly related to the most recent profit margin. To test this, Blessing uses figures for the quarterly profit margin from the second quarter of 2005 through the fourth quarter of 2019. He estimated the intercept and coefficient to be 0.0934 and 0.7986, respectively and concluded that the two were statistically significant. However, Sweet told Blessing to test the residual autocorrelations to determine whether the model is correctly specified. She made the following comment:

Statement 3: “In a regression such as this one, serial correlation in the error term is much more

critical in its consequences than for cross-sectional models since it causes estimates of the intercept and slope coefficient to be inconsistent. Also, if CareLink's profit margin has always been more volatile in certain periods than in others, likely, the profit margin is not covariance stationary."

Following Sweet's advice, Blessing calculated the following autocorrelations:

Exhibit 2

Lag	Autocorrelations
1	0.0986
2	0.0438
3	-0.1743
4	-0.2319

Blessing uses his estimated regression equation to predict CareLink's profit margin in six months. The current profit margin is 35%.

Sweet manages the fixed income allocation of an institutional fund. Since bond returns largely depend on current and future inflation rates, Sweet is building a time-series model for U.S. inflation, using monthly observations. She has estimated two models, an AR (1) and an AR (2) model. Exhibit 3 presents a contrast between the regression statistics of the two models.

Exhibit 3

Regression statistics	AR(1)	AR(2)
R-squared	0.586	0.657
Standard error	3.129	3.325
Observations	249	248
Average squared error	15.963	15.158

Sweet is assessing the predictive capabilities of the models to determine their real-world contribution.

Q.1 Sweet is *most* accurate with respect to:

A. statement 1 only.

B. statement 2 only.

C. both statements 1 and 2.

Q.2 Is Sweet *most likely* correct with respect to statement 3, and is the time-series model for estimating CareLink's profit margin correctly specified?

A. Yes.

B. Statement 3 is correct, but the model is misspecified.

C. Statement 3 is incorrect, but the model is correctly specified.

Q.3 Which of the following about the regression estimating CareLink's profit margin is *most* accurate?

A. If the current profit margin is 44.62%, the regression estimates that the profit margin will fall in the next period.

B. If the current profit margin is 48.33%, the regression estimates that the profit margin will rise in the next period.

C. If the current profit margin is 43.09%, the regression estimates that the profit margin will rise in the next period.

Q.4 The estimated profit margin of CareLink Ltd in two quarters (six months) is *closest* to:

A. 37.29%.

B. 39.12%.

C. 40.58%.

Case 4: Lily Richards

Lily Richards, CFA, is a quantitative analyst at Gateway Constructors (GC). GC specializes in the construction of national highways.

In recent times, Richards has been involved in two specific projects. As part of her first project, she has been looking at ways to increase efficiency in the construction process, especially regarding fuel consumption. She ran a regression explaining the variation in fuel consumption as a function of distance. The total variation of the dependent variable was 160.85, the explained variation was 80.15, and the unexplained variation was 100.70. She had 60 monthly observations.

In the other project, she has been asked to look into a contract agreement CG has with a third party valuation firm. The contract is near expiration and GC is contemplating the development of its project price-forecasting model. It has tasked Richards with building the model.

To develop the model, Richards intends to use linear regression. Each project is expected to be priced by multiplying a margin percentage by net construction costs and adding a base price; the base price is the minimum project price. The regression model will be based on several projects' prices from 2005 to 2010. She justifies her data selection technique with the following statement:

Statement 1: “Industry conditions were significantly different during the pre-2005 era.”

Her regression model is as follows:
Forecasted project price = Base Price + Margin(Construction costs)

Two years after her model's implementation, Richards conducts various tests. She gathers the following data for analysis (Exhibits 1 and 2).

Exhibit 1
Regression Data and Analysis of Variance (ANOVA)

Multiple R	0.8821
R-squared	0.7651
Standard Error of Estimate	0.6346
Observations	60

	Coefficients	**Standard Error**
Base Price	950	8.535
Margin	0.10	0.429

ANOVA

	df	**Sum of Squares (SS)**
Regression	1	0.1856
Residual	60	0.0268
Total	61	0.2124

Exhibit 2
Significance Levels

df	$p = 0.10$	$p = 0.05$	$p = 0.025$
2	1.886	2.920	4.303
60	1.296	1.671	2.000
70	1.294	1.667	1.994

To uncover potential assumption violations and to better understand the data outliers, Richards intends to plot her results in a scatter plot. She discusses the scatter plot results with fellow manager Earl Matthews upon completing them.

The two employees arrive at the following conclusions concerning the regression analysis.
Conclusion 1: Upon visual inspection, it appears that there is no directional relationship between the residuals and the predicted values from the regression model since the line is centered near 0.00. It is a good outcome since residuals are expected to behave independently of the model, suggesting that regression errors are uncorrelated and have a constant variance. Hence,

multiple linear regression meets several of its underlying assumptions.

Conclusion 2: Three residuals appear to be outliers in the scatter plot. Thus, these data cannot be used to determine whether shocks from factors not included in the model occurred at these points.

Q.1 In Richard's first project on fuel efficiency, the standard error of the estimate in the regression is *closest* to:

A. 1.3177

B. 1.5247

C. 1.736

Q.2 Based on Exhibit 1. The F-test statistic is *closest* to:

A. 114.44.

B. 401.73.

C. 885.00.

Q.3 Which of the two conclusions arrived at by both employees is *most accurate* :

A. Conclusion 1

B. Conclusion 2

C. Both Conclusions 1 and 2.

Q.4 From data available in Exhibit 1, the value of adjusted R^2 is *closest* to:

A. 0.111

B. 0.8694

C. 0.7611

Case 5: Tabitha Meng

Tabitha Meng, CFA, is a quantitative analyst with Hafei Securities Ltd, a company based in Bangkok, Thailand. Haifei has built a reputation providing stock brokering and investment advisory services to large institutional investors. In the recent past, the company expanded its portfolio and brought in a team of equity and fixed income analysts. Meng is a member of this team.

Meng is forecasting quarterly sales of Smart Inc., a smart TV manufacturer based in Thailand. The regression model is:

$$\text{Sales}_t = b_0 + b_1 \text{Sales}_{t-1} + \epsilon_t$$

The regression results for the smart TV sales model are presented in the exhibits below:

Exhibit 1: Regression statistics for smart TV sales model

R-squared	0.7436
Observations	120

	Coefficient	**Standard Error**
Intercept	313.24	99.43
Lag 1	0.67	0.16

Exhibit 2: Autocorrelation of Residuals for smart TV sales model

Lag	**Autocorrelation**
1	-0.083
2	0.092
3	0.075
4	0.117
5	0.068
6	-0.125

**The critical values, assuming 5% significance level and 118 degrees of freedom, are 1.980 for a two-tail t-test and 1.658 for a one-tail t-test.*

Thai National Oil Limited (TNOL) is a state-owned, giant oil exploration, refining and marketing

company with a presence across East Asia. TNOL is planning to issue bonds with an 15-year maturity. Several of Haifei's investment clients are intent on subscribing to the issue. Meng starts working on a quantitative model to forecast changes in quarterly profit of TNOL based on several macroeconomic variables. The regression model formulated is as follows:

$$\Delta \text{Profit}_t = b_0 + b_1 \Delta \text{GDP} + b_2 \Delta \text{FX} + b_3 \Delta \text{Int}_t + \epsilon$$

Where,

ΔProfit_t=change in quarterly profit of TNOL

ΔGDP=change in quarterly GDP for Thailand

ΔFX=change in foreign exchange rate THB/USD

ΔInt_t=change in policy interest rate of Thai Central Bank

For the model to forecast change in profit of TNOL, regression results are as follows:

Exhibit 3: Regression statistics for quarterly profit model

R-squared	0.8921
Observations	48
SEE	0.7978

ANOVA	**Degree of Freedom**	**SS**
Regression	3	231.54
Residual	44	?
Total	47	?

	Coefficient	**Standard Error**
Intercept	2.75	0.83
ΔGDP	2.38	0.62
ΔFX	0.51	0.15
ΔInt	1.07	0.31

Note: The critical values, assuming 5% significance level and 46 degrees of freedom, are 2.013

for a two-tail t-test and 1.679 for a one-tail t-test. The critical value for an F-test is 2.816.

Q.1 If TV sales in Q1 were 1,137, the number of sales forecasted for Q2 is *closest* to:

A. 762

B. 1075

C. 1137

Q.2 The mean reverting level of the autoregressive time series to predict sales of Smart Inc. is *closest* to:

A. 313

B. 467

C. 949

Q.3 The value of the F-statistic for the model to forecast TNOL profit change is *closest* to:

A. 86

B. 121

C. 136

Q.4 Is Meng's concern that the model exhibits multicollinearity substantiated by statistical results:

A. Yes, multicollinearity is a problem because of a very high R-squared

B. Yes, multicollinearity is a problem because of a high F-test value

C. No, multicollinearity is not a problem because the t-tests for regression parameters are significant

Case 6: Quincy Zane

Quincy Zane, an experienced financial analyst, is studying the durability of MotorGo's new product in the shape of hybrid cars. In particular, she would like to understand exactly how the maintenance costs of this car related to the distance driving.

Zane asks her junior assistant, Ray Smith, to collect data for her and conduct statistical tests to facilitate the analysis. Smith collects data from the use of these new cars. Zane tells him to be cautious about interpreting the results, as she tells him, "I am concerned that the annual maintenance costs might increase more for cars with higher odometer readings."

Nevertheless, after asking for help from his company's engineers, Smith collects 25 data points and conducts a linear regression, summarizing them in a few tables. He notices that the final car reported by the engineers had an odometer reading of 85.650 (in thousands of kilometers) as of the end of the last calendar year.

Smith defines the dependent variable as Costs, or maintenance costs (in thousands of EUR) for the last calendar year for a given car. He defines the independent variable as the Odometer, or the distance that has been driven (in thousands of kilometers) at the end of the last completed calendar year.

Exhibit 1: Descriptive Statistics

Statistic	Costs	Odometer
Mean	10.575	123.4
Sum of squared deviations	1,850.4	116,487
Sample covariance	593.75	

Exhibit 2: Regression Statistics

Regression statistics	
R^2	0.9421
Standard error of estimate	2.1581
Observations	25

	Coefficients	Standard Error	t-statistic	p-value
Intercept	-4.5243	0.8919	-5.0729	0
Odometer	0.1223	0.006323	19.3464	0