The Princeton Review®

CFA LEARNING OUTCOMES DECODED

In our series *Learning Outcomes Decoded* we break down a single Learning Outcome Statement (LOS) from the CFA level 1 curriculum. Dave Kaczorowski, CFA, author of this article, is the Content Manager of the CFA team at the Princeton Review and a teacher of the live online review sessions. He is a professor of finance at the University of San Francisco.

QUANTITATIVE METHODS: HYPOTHESIS TESTING

LOS: Explain and interpret p-value as it relates to hypothesis testing

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Prior learning modules in this subject profile the Z-score and the T-score as measures of statistical significance. Module 6 introduces the p-value, which may be interpreted as an alternative view of the concept of significance. The p-value is a key component of the ANOVA table and a highly testable measure in hypothesis testing.

Hypothesis testing

An analyst who wants to run a statistical test of whether two factors have a relationship must first establish a *null hypothesis*. The null states that there is no relationship or the relationship is too small to be significant. The goal is to disprove the null hypothesis by using statistical data to show a statistically significant relationship. There are two possible outcomes of the test:

- *Fail to reject the null hypothesis*—The result falls within the confidence interval. The difference between the two is small enough that it may be mistaken for statistical noise at that level of significance.
- *Reject the null hypothesis*—The result falls outside the confidence interval. The difference between the two is too large to be mistaken for noise, prompting the conclusion that there is a significant difference.

The p-value

The p-value is the portion of the probability distribution outside the calculated test statistic. In a two-sided test, it is the area to the left and the right of the confidence interval. For a one-sided test, it is the area outside the distribution on the relevant side. In the context of the hypothesis test, the p-value is the smallest level of significance at which the null can be rejected. If the test results in a p-value less than the desired significance level, then the analyst should reject the null hypothesis in favor of the alternative.

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Example

An analyst conducts a hypothesis test to determine if a given sample is greater than a population average (one-tailed test). The test reveals a p-value of 0.033. This value suggests that the null hypothesis should be rejected (there is a significant relationship) at any significance level less than that value.

- At the 95% level (1.65 standard deviations above the mean), a one-tailed test leaves 5% of the distribution outside the confidence interval or a 5% significance level. The p-value is 0.033 or 3.3%, outside the interval. In this case, the difference between the sample and the population is too large to ignore. The null hypothesis should be rejected in favor of the alternative hypothesis that the sample is larger.
- At the 99% level (2.33 standard deviations above the mean), the significance level is 0.01, greater than the p-value. The p-value is inside the confidence interval of the distribution. Therefore, the result may be interpreted as statistical noise. The analyst should fail to reject the null hypothesis and not conclude that the sample is greater than the population average.
- The null hypothesis should be rejected at any significance level greater than 3.3%. If the analyst conducted a test at the 96.69% level, then the null would be rejected, but just barely.

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PRACTICE QUESTION

An analyst wants to determine if the Chinese bond market is currently underpriced. He conducts a hypothesis test on a diversified sample of bonds, using the null hypothesis that any underpricing is within an average of 0.01 Yuan. The p-value resulting from the test is 0.081. At a 95% significance level, it can be *most likely* concluded that:

A. There is significant underpricing in the fixed-income market

B. There is no significant underpricing in the fixed-income market

C. The data is insufficient for a conclusion

B is correct. Since the analyst wants to determine only if the market is underpriced, this is a one-tailed test. At a 95% confidence interval, the significance level is 5%. The p-value of the test is 8.1%, greater than the threshold of 5%. The analyst cannot conclude that the underpricing is statistically significant.