

ECONOMIC STATISTICS SKILLS ASSESSMENT (ESSA)

LEARNING Goals

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Probability

1. Use the basic laws of probability to derive marginal, joint, and conditional probabilities of events.
 - a. Understand what an experiment, outcome, event, sample space are;
 - b. Laws of probability: exclusion, union, complementarity, multiplication;
 - c. Apply Bayes' rule.

Random Variables

2. Choose appropriate distributions for real-world quantities.
 - a. Not all variables will have a normal distribution;
 - b. Discrete vs continuous random variables.
3. Compute various characteristics of univariate and bivariate random variables given their distributions.
 - a. E.g., mean, median, variance, standard deviation, covariance, correlation
4. Derive distributions and characteristics of functions of random variables.
 - a. Understand what *independence* is (i.e., $E[f(X)g(Y)] = E[f(X)]E[g(Y)]$ for all $f(\cdot)$, $g(\cdot)$) and its implications.

Estimation

5. Estimate population characteristics using random (independent and identically distributed) samples
 - a. Remember that an estimator is a random variable.
 - b. Compute bias and variance of simple estimators (e.g., the sample mean).
 - c. Assess whether an estimator is biased.

6. Understand and apply the central limit theorem and the law of large numbers.
 - a. The distribution of a sum of a “large” number of random variables will approach a normal distribution;
 - b. Sample mean converges to population mean with a “large” sample
7. Compute and interpret standard errors and confidence intervals of estimates.
 - a. Interpretation is dependent on the magnitude of the estimate and the standard error
 - b. Standard errors measure precision.
 - c. Confidence intervals combine information from the point estimate and the standard error.

Hypothesis Testing

8. Translate questions in English into appropriate formal hypothesis tests.
 - a. One- vs two-sample tests
 - b. Paired tests
 - c. One-tailed vs two-tailed tests
9. Perform hypothesis tests by computing test statistics and p-values
 - a. Understand the role that the sample size plays in hypothesis testing;
 - b. Choose appropriate distribution of the test statistic under the null hypothesis (sample size matters here too);
10. Interpret hypothesis test results
 - a. Rejection and failure to reject
 - b. Type I and Type II errors
 - c. Interpret p -values as the lowest significance level (α) at which the null hypothesis is rejected.
 - d. Another interpretation of confidence intervals is a collection of all null hypotheses which would not be rejected at the “ $100\% - CI$ confidence level” significance level.