Course: **Econometrics I**  
Instructor: Dr. Javad Abedini (Home page: [http://gsme.sharif.edu/~abedini/](http://gsme.sharif.edu/~abedini/))

**Textbooks**  

**Course outline**  
1. **Introduction**
2. **Statistical and Mathematical Reviews** *(D.M., Ch. 1)*
3. **The Simple Regression Model: basic concepts** *(W., Ch. 2 + class)*
   3.1. What does mean “regression”?  
   3.2. Avoiding some confusions  
   3.3. Different types of data  
   3.4. Relationship with the probability theory  
   3.5. Population regression function (PRF)  
   3.6. Why is there an error term in the model?  
   3.7. Sample regression function (SRF)  
   3.8. The simple regression model  
   3.9. Deriving the OLS estimator for two-variable regression model  
   3.10. Estimates, fitted measures and residuals (with an example)  
   3.11. The randomness of estimated coefficients (a Monte Carlo experiment)  
   3.12. Algebraic properties of OLS statistics  
   3.13. Goodness of fit (R-squared)  
   3.14. Linearity versus non-linearity in the OLS regression  
   3.15. Regression through the origin  
   3.16. **Empirical Investigation Using STATA**
4. **Multiple Regression Analysis** (W., Ch. 3)

4.1. Motivation for multiple regression
   4.1.1. The model with two independent variables
   4.1.2. The model with k independent variables

4.2. Mechanics and interpretation of Ordinary Least Squares
   4.2.1. Obtaining the OLS estimates
   4.2.2. Interpreting the OLS regression equation
   4.2.3. On the meaning of “holding other factors fixed” in multiple regression
   4.2.4. Changing more than one independent variable simultaneously
   4.2.5. OLS fitted values and residuals
   4.2.6. A “partialling out” interpretation of multiple regression
   4.2.7. Comparison of simple and multiple regression estimates
   4.2.8. Goodness-of-Fit
   4.2.9. Regression through the origin

4.3. **Empirical Investigation Using STATA**

5. **The Geometry of OLS Estimation** (D.M., Ch. 2)

5.1. Geometry of vector spaces
   5.1.1. Scalar product and the norm of a vector
   5.1.2. The concept of orthogonality
   5.1.3. Linear dependency
   5.1.4. The rank of a matrix

5.2. A geometric concept of the OLS estimator
   5.2.1. Orthogonality condition with the OLS
   5.2.2. Geometrically writing a regression relation
   5.2.3. Orthogonal projections

5.3. Linear transformation of regressors

5.4. The Frisch-Waugh-Lovell theorem

5.5. **Empirical Investigation Using STATA**

6. **Statistical Properties of the OLS estimator** (D.M., Ch. 3)

6.1. The concept of Data Generating Process

6.2. Unbiasedness of the estimator
   6.2.1. Definition of Bias
   6.2.2. Conditions of the unbiasedness
   6.2.3. Is the OLS estimator unbiased?

6.3. Consistency of the estimator
   6.3.1. Definition of consistency
   6.3.2. Law of large numbers
   6.3.3. Is the OLS estimator consistent?

6.4. Efficiency of the estimator
   6.4.1. Covariance matrix of the OLS parameter estimates
   6.4.2. Precision of the least squares estimates
   6.4.3. Linear functions of parameter estimates
   6.4.4. The variance of forecast errors
   6.4.5. Is the OLS estimator efficient?

6.5. Gauss-Markov Theorem (a BLUE estimator)

6.6. Estimating the variance of the error terms

6.7. Misspecification of linear regression models
6.7.1. Statistical properties with Overspecification
6.7.2. Statistical properties with Underspecification
6.8. Alternative measures of goodness of fit

7. **Inference using the OLS estimator: issues on testing hypothesis** *(W., Ch. 4 + class)*

7.1. A review on main distributions
7.2. Steps in hypothesis testing
7.3. Testing hypothesis about a single population parameter: the t-test
   7.3.1. Testing against one-sided alternative
   7.3.2. Two-sided alternatives
   7.3.3. Testing other hypothesis about the parameter
   7.3.4. Computing P-value for t-tests
   7.3.5. Economic, or practical versus statistical significance
7.4. Confidence intervals
7.5. Computing a type II error
7.6. Significance tests
7.7. Testing single linear combination of parameters
7.8. Testing multiple linear restrictions: the F-test
   7.8.1. Testing exclusion restrictions
   7.8.2. Relationship between F and t statistics
   7.8.3. The R-squared form of the F statistic
   7.8.4. Computing P-values for F-tests
   7.8.5. The F statistic for overall significance of a regression
   7.8.6. Testing general linear restrictions
   7.8.7. Reporting regression results

7.9. **Empirical Investigation Using STATA**

8. **Bootstrapping** *(class)*

9. **Extreme-Bounds-Analysis** *(class)*

10. **Practical issues when using the OLS estimator** *(W., Ch. 6 + class)*

10.1. Functional forms
10.2. Selection of regressors
10.3. Residual analysis
10.4. Interpreting the results
10.5. The role of dummy variables

11. **Regression diagnostics and solutions to model violations** *(W., Ch. 8, 9, 12 + class)*

11.1. Non-zero mean for the residuals
11.2. Non-normally distributed errors
11.3. Multicollinearity among the regressors
   11.3.1. What is multicollinearity?
   11.3.2. What is perfect multicollinearity?
   11.3.3. Causes for multicollinearity
   11.3.4. Implications of multicollinearity
   11.3.5. How to detect multicollinearity: tests and indicators
   11.3.6. Solutions to multicollinearity
11.4. Heteroskedasticity
   11.4.1. What is heteroskedasticity?
   11.4.2. Types of heteroskedasticity
11.4.3. Causes for heteroskedasticity
11.4.4. Implications of heteroskedasticity
11.4.5. Testing for heteroskedasticity
   11.4.5.1. Breusch-Pagan test
   11.4.5.2. White’s test
   11.4.5.3. Park test
   11.4.5.4. Glejser test
   11.4.5.5. Goldfeld-Quandt test
   11.4.5.6. Other tests
11.4.6. Solutions to heteroskedasticity
11.5. Autocorrelation
   11.5.1. What is autocorrelation?
   11.5.2. Positive and negative autocorrelation
   11.5.3. Causes for autocorrelation
   11.5.4. Implications of autocorrelation
   11.5.5. First order autocorrelation: a time-series approach, AR(1)
   11.5.6. Stationarity of residuals
   11.5.7. Variance and covariance of the residuals under AR(1)
   11.5.8. Cochrane-Orcutt estimator
   11.5.9. Prais-Winsten estimator
   11.5.10. Testing for autocorrelation
     11.5.10.1. Durbin–Watson test
     11.5.10.2. Breusch-Godfrey-Lagrange multiplier test
11.6. Empirical Investigation Using STATA

12. Generalized Least Squares (class)
   12.1. Motivation for a GLS estimator
   12.2. Variance-covariance matrix with GLS
   12.3. Feasible GSL, FGLS

Student evaluation criteria
The learning of each student will be evaluated based on the following items: Midterm exam (6 points), Final exam (6 points), Empirical project using STATA (5 points), Class participation (1 point), Exercises (TA class, 2 points). The content of the midterm exam will be excluded from the final exam. Student will learn to work with STATA for doing their empirical projects. Several empirical examples will be also conducted in the TA class.

Lectures
The principal class holds on Saturdays and Mondays between 9:30 and 11:00. The timing for the TA class will be arranged later.

Office Hours
Saturday and Monday 11:00-12:30 or by appointment using abedini@sharif.edu