National Research University Higher School of Economics

The International College of Economics and Finance

Syllabus for *Elements of Econometrics*, 2019-2020.

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Course Pre-requisites.

Statistics, Mathematics for Economists, Introduction to Economics**.**

Course description:

The Elements of Econometrics is an introductory full year course for the 3-rd year ICEF students. The course is taught in English and finally examined by the University of London international programme, or by ICEF final exam.

The stress in the course is done on the essence of statements, methods and approaches of econometric analysis. The conclusions and proofs of basic formulas and models are given which allows the students to understand the principles of econometric theory development. The main attention is paid to the economic interpretations and applications of the econometric models. The first part of the course is devoted to the cross-section econometrics; the second part – to the time series and panel data econometrics.

Learning Objectives and Learning Outcomes

The students get in the course basic knowledge and skills of econometric analysis and its application in Economics. They should be able to:
- apply econometric methods to the investigation of economic relationships and processes;
- verify economic facts, theories and models with real data;
- evaluate the quality of statistical and econometric analysis;
- do and evaluate forecasting for time series and cross section data;
- understand econometric methods, approaches, ideas, results and conclusions met in economic books and articles.

The students should understand essential differences between the time series and cross section data and those specific econometric problems met in the work with these types of data (measurement errors, endogeneity, autocorrelation, non-stationarity and others), as well as with panel data, and apply the appropriate econometric methods (instrumental variables, maximum likelihood estimation, models of dynamic processes, etc.).

The students should get the skills of construction and development of linear regression models, get acquainted with some non-linear models and special methods of econometric analysis and estimation (binary choice models, , understanding the area of their application in economics.

The methods and models should be mastered practically on real economic data sets with modern econometric software.

The course contributes in the development of the following general competencies:

-ability to work with information: to find, evaluate and use information from various sources, necessary to solve scientific and professional problems;
- ability to do research, including problem analysis, setting goals and objectives, identifying the object and subject of research, choosing the means and methods of research, assessing its quality;
- ability to collect and analyze the data and calculate economic and socio-economic indicators characterizing the activities of economic entities;
- ability to choose tools for processing economic data, analyze the results of calculations and substantiate the findings;
- ability to analyze and interpret the data of domestic and foreign statistics on socio-economic processes and phenomena, to identify trends in changing of socio-economic indicators;
- ability to solve analytical and research problems with modern technical means and information technologies;
- ability to organize their activities in the framework of professional tasks.

Methods of Instruction

The following methods and forms of study are used in the course:
- lectures (2 hours a week)
- classes (2 hours a week, conducted in the computer room, there are combined theoretical and applied analysis and practical applications of the econometric methods studied in the course)
- home assignments for each topic consisting of theoretical and applied parts
- the applied essay (Semester 2)
- teachers' consultations
- self study, which can be conducted with the course materials and in a computer room, making home assignments using econometric software, work with economic data bases, with ICEF, UoL, and other course materials
- Online studies using the ICEF (I-3) and UoL Virtual Learning Environment (I-2) information systems, as well as other online resources (I1-I7): lectures videos, webinars, online tasks and contests.

In total the course includes: 56 hours of lectures, 56 hours of classes.

Essential Reading and Course Materials:

The Fifth or Fourth edition of textbook "Introduction to Econometrics" by Christopher Dougherty is the main textbook for the course (the main difference between the two editions is some notation). The University of London Study Guide (2), Examination papers and Examiners' Reports are widely used in the course. Another (supplementary) recommended textbook is "Basic Econometrics" by D.N.Gujarati (3) containing some extra course information, derivations, tests, proofs and applications. Useful information for the course can be found in the "Introductory Econometrics" by J.M.Wooldridge (4). The books by Greene (6), Verbeek (8) and Kennedy (7) are recommended as supplementary reading: the first contains deeper presentation of course materials, the others – useful explanations and comments. The ICEF lecture notes (9) may be helpful for reference and topics revision.
The Virtual Learning Environment (VLE, The University of London, I-2), and the ICEF Information System (I-3) are the main information sources for course studies providing various materials (slides, videolectures, webinar recordings, lecture notes, former exam papers, home assignments, etc). ICEF Video lectures are available at I-7.

Main Reading:

1. Dougherty, Christopher. Introduction to Econometrics. Oxford University Press, 2011, 2016 (4th or 5thd edition) (CD).
2. Dougherty, Christopher. Elements of econometrics. Study Guide. University of London. 2016.

Supplementary reading

3. Gujarati D.N. Basic Econometrics. McGraw-Hill, 4th edition, 2003 (Gu); 5th edition (2009, Gujarati D.N., and D.C.Porter).
4. J.M.Wooldridge. Introductory Econometrics. A modern approach., 2013, 2016, 2019 (5th, 6th, and 7th editions) (W).
5. Econometric Views User's Guide. Quantitative Micro Software, LLC.
6. Greene W.H. Econometric Analysis. Prentice Hall int. 7th ed., 2012, and earlier editions (Gr).
7. Kennedy P. A Guide to Econometrics. Blackwell Publishers, 6th edition, 2008, and earlier editions (K).
8. Verbeek, M. A Guide to Modern Econometrics. Wiley, 4rd edition, 2012, and earlier editions.
9. Zamkov O.O. Elements of Econometrics. Lecture motes. I-3, 2014-2019 (ICEF Information System).

Online resources

1. http://global.oup.com/uk/orc/busecon/economics/dougherty5e/ (I-1)
2. http://my.london.ac.uk/ (I-2)
3. http://icef-info.hse.ru (I-3).
4. https://www.eviews.com/home.html (I-4)
5. http://www.gks.ru (I-5).
6. http://www.cbr.ru (I-6).
7. https://yadi.sk/d/ORQVlB5ahk5KXQ (I-7)

Special Equipment, Software and Data Bases:

The main **software** used in the course is Econometric Views (version 11 and earlier ones). The 10 Student Lite version is available at I-4 for free. Network version of EViews 8 or 10 are available in the computer classes.
The students may use other Econometric software for doing the assignments; the Data Sets in the UoL VLE (I-2) are available in EViews, Stata, and Gretl formats. Stata 14 or 15 is available in the computer classes, Gretl is a free software (available at I-2).
MS Excel, MS Word, and MS Powerpoint are used are used for the course and student work.

Equipment: computer, projector, Internet connection.

Data: For making class and home assignments the following data bases are used: data prepared by Christopher Dougherty at the University of London (data for estimation of earnings functions based on NLSY survey at the USA; annual data on demand, disposable income and relative prices for aggregated goods and services in the USA - the data is available at I-1, I-2);
Data for main macroeconomic indicators for Russia, 1992-2019 (I-5, I-6);
Annual data for estimated GNP, labour and capital in USSR economy for 1928-1987;
Data on ICEF students' academic performance.

Grading System and Examination Type:

The students sit two mid-term written exams in October and in March, first semester written exam in December, and University of London International programme exam (or ICEF final exam) in May. October and December exams include multiple choice and free response parts. March and May exams are free response (open questions) exams.

The first semester grade is determined as follows: December exam grade gives 50% of the grade, October exam - 25%, and 25% is given for home assignments. In the final course grade the University of London (or ICEF final) exam grade gives 40%, the first semester grade gives 30%, and 30% is given for the second semester (20% - for March exam and 10% for home assignments). In the second semester the applied essay is set with the bonus points given equal to 2 regular home assignments. Additional bonus points can be given by the lecturer for class participation during the year (not more than 5 out of 100), and for the Universiade and other contests.

In 2019-2020, December exam and the University of London (or ICEF final) exam have a status of exam in the Curriculum with possible retakes, while October and March mid-term exams have a status of Control Paper (with no retakes).

The formula for the grade for the course is:

$$G=0.3*(0.25*G_{oct}+0.5*G_{dec}+0.25*G_{ha1})+0.2*G_{march}+0.1*(G_{ha2}+G_{essay})+0.4G_{fin}+G_{bonus}$$

ha1 and ha2 – home assignments in semester 1 and 2, G_{fin} – the grade for final exam of the University of London or ICEF. G_{oct}, G_{dec} and G_{march} - the grades for October, December and March ICEF exam and mid-terms out of 100. G_{essay} – bonus points for essay corresponding to 2 regular home assignments, G_{bonus} – bonus points for class participation and contests, as described above.

The passing grade for the University of London exam is 40 out of 100, the passing grade for the course is 25 out of 100.

All grades are given initially out of 100. The final grades are also transferred to 10- and 5-points grades in accordance with the ICEF Grading Regulations (par. 3).

Retakes are organized in accordance with the HSE Interim and Ongoing Assessment Regulations (incl. Annex 8 for ICEF). Grade determination after retakes is done in accordance with ICEF Grading Regulations (par. 5).

Sample materials for knowledge assessment are available in ICEF Information system (I-3, for all ICEF exams) and in the UoL VLE (I-2, for the University of London exams).

Course Outline.

1. Introduction to Econometrics.

Statistical Investigation of Economic Variables' Relationships. Relationships in the economy: examples, problems of estimation and analysis (demand functions, earnings functions, economic growth models). Economic data: cross section data, time series data, panel data.

Main statistical concepts and facts used in the course.

Data bases. Software. Course materials presentation.

Review (CD).

2. **Simple Linear Regression Model (SLR) with Non-stochastic Explanatory Variables. OLS estimation.**

Simple Linear Regression Model: definitions and notation, Model A. SLR Model Estimation using Ordinary Least Squares (OLS). Expressions for the OLS estimators of slope coefficient and intercept: derivation and interpretation.

Assumptions of the SLR models and the properties of OLS estimators. Gauss-Markov theorem (formulation). Standard deviations and standard errors of regression coefficients: derivation and interpretation.

Statistical significance of OLS estimators: hypotheses testing using *t*-tests. Derivation and interpretation of confidence intervals. The general quality of regression: determination coefficient R^2. *F*-statistics and *F*-tests. Relationship of R^2 with correlation coefficients.

SLR model without intercept. OLS-estimation, properties and applications.

Chapter 1, Chapter 2 (CD), Chapter 3, Chapter 6 (6.1, Appendix 6A.1) (Gu)

3. **Multiple Linear Regression Model (MLR): two explanatory variables and *k* explanatory variables.**

Derivation and properties of OLS-estimators of MLR with two explanatory variables.

Determination coefficient R^2. Adjusted R^2. Testing hypotheses using *t*-tests and *F*-tests.

OLS-estimation of the model with *k* explanatory variables in vector-matrix form. Properties of coefficients' estimators. *F*-test for groups of variables.

Multicollinearity. Its consequences, detection and remedial measures.

Estimation of production functions in volumes and growth rates' forms as multiple regression models.

Making predictions using Multiple Linear Regression Model. Properties of predictors.

Chapter 3 (CD), Chapters 7-8, 10 (Gu).

4. **Variables Transformations in Regression Analysis.**

Linear and Nonlinear regressions. Linearisation of non-linear functions and their estimation using Ordinary Least Squares. Disturbance term specification. Interpretation of linear, logarithmic and semi-logarithmic relationships. Estimation of functions with constant elasticity and exponential time trends.
Comparison of the quality of regression relationships: linear and semi-logarithmic functions. Box-Cox transformation.
Models with quadratic and interactive explanatory variables: estimation and interpretation.

Chapter 4 (CD), Chapter 6 (6.5-6.7) (Gu).

5. **Dummy Variables.**

Dummy variables in linear regression models. Reference category and dummy variables' trap. Effects of change of the reference category. Types of dummy variables: intercept and slope dummies. Interaction dummies. Multiple sets of dummies. Chow test for structural break. Dummy group test.
Dummy variables in economic models: earnings functions, production functions. Dummy variables in seasonal adjustment.
Chapter 5 (CD), Chapter 9 (Gu).

6. **Linear Regression Model Specification.**

Consequences of Incorrect Specification. Omitting significant explanatory variable. Including unnecessary explanatory variable in the model. Monte-Carlo method in econometric analysis: general principles, areas of application and examples. Proxy Variables.

Testing of linear restrictions on parameters of MLR: single and multiple restrictions, *F*-tests and *t*-tests. Role and examples of linear restrictions in economic models.

Model reparametrisation: interpretation and examples. Short run and long run effects.

Lagged Variables in economic models.

SLR model assumptions' violation. General principles of consequences' analysis, detection and correction. Generalised Least Squares (GLS).

Chapter 6 (CD), Chapter 13 (13.3-13.4) (Gu).

7. Heteroscedasticity.

Concept, consequences and detection of heteroscedasticity. Goldfeld-Quandt and White tests.
Model correction. Logarithmic regressions. Weighted Least Squares (WLS) method as a special case of GLS. White's heteroscedasticity-consistent standard errors.
Reasons and examples of heteroscedasticity in economic models.
Chapter 7 (CD), Chapter 11 (Gu).

8. Stochastic Explanatory Variables. Measurement Errors. Instrumental Variables.

Stochastic explanatory variables in LR models. Model B assumptions. Properties of OLS-estimators and test statistics of stochastic explanatory variables' coefficients: finite sample and asymptotic. Measurement errors: reasons and consequences. Milton Friedman's critique on consumption function estimation: Permanent income hypothesis.
Instrumental variables. Using instrumental variables in M.Friedman's consumption model and in other economic models. Asymptotic properties of IV estimators.
Durbin-Wu-Hausman (DWH) test.
Chapter 8 (CD), Chapter 13 (13.5-13.6) (Gu) .

9. **Simultaneous Equations Models.**

Concept of simultaneous equations model. Exogenous and endogenous variables. Predetermined variables.
The simultaneous equations bias. Inconsistency of OLS estimators. Structural and reduced forms of the model. Model of demand and supply and simple Keynesian equilibrium model as simultaneous equations models.

Identification problem. Exact identification, underidentification, and overidentification. Rules of identification. Order condition.
Testing exogeneity: Durbin-Wu-Hausman test.
Methods of estimation. Indirect Least Squares (ILS). Instrumental Variables. Two-Stages Least Squares (TSLS). Examples of simultaneous equations models estimation in Economic Analysis.
Chapter 9 (CD), Chapters 18-20 (Gu).

10. Maximum Likelihood Estimation.
The idea of maximum likelihood estimation (ML).
SLR and MLR Models Estimation using ML.
ML Estimators' properties. Test statistics (*z*-statistics, pseudo- R^2, *LR*-statistic) and statistical tests.
Chapter 10 (10.6) (CD), Chapter 4 (4.4, Appendix 4A) (Gu)

11. **Binary Choice Models, Limited Dependent Variable Models.**
Linear probability model: problems of estimation.
Logit-analysis. Probit-analysis. Using Maximum Likelihood for logit and probit models' estimation. Models' interpretation and Marginal effects investigation. Examples of Binary Choice models in Economics.
Censored samples. Direct and truncated estimation. Tobit-model: interpretation and ML estimation.
Chapter 10 (CD), Chapter 15 (Gu).

12. Modelling with Time Series Data. Dynamic Processes Models.
Time series data regressions: Model assumptions. Properties of OLS estimators.

Distributed lag models: geometrically distributed lags, polynomial lags. Koyck transformation and estimation of geometrical lag's parameters.

Autoregressive Distributed Lag (ADL) models. Interpretation and asymptotic properties.

Partial adjustment. Adaptive expectations. Error Correction.

Vector autoregression. VAR model.

Causality in Economics: Granger test.

Chapter 11, Chapter 12 (CD), Chapters 17, 22 (Gu).

13. Autocorrelated disturbance term.
Signs and consequences of disturbance term's autocorrelation in LR model. Durbin-Watson *d*-test for first order autocorrelation. Breusch-Godfrey (BG) test of higher-order autocorrelation. Autocorrelated disturbance term and model misspecification: apparent autocorrelation.
Model correction: Autoregressive transformation. Cochrane-Orcutt (CO) procedure and non-linear estimation. Autoregressive transformation and transformed' model estimation as a special case of GLS. AR, MA, ARMA models.
AR(1) and ADL(1,0) models: Common factor test and model selection.
Autocorrelated disturbance term in a model with lagged dependent variable as one of the explanatory variables. Durbin *h*-statistic and test.
Chapter 12 (CD), Chapter 12 (Gu).

14. Time Series Econometrics: Nonstationary Time Series.
Stationary and nonstationary time series. Definitions and examples of stationary and nonstationary time series. Random walk. Drifts and trends. Consequences of nonstationarity. Spurious regressions. Detection of nonstationarity. Correlograms. Unit root tests. Akaike ans Schwarz Information Criteria.
Cointegration. Fitting models with nonstationary time series. Detrending. Error Correction models.
Chapter 13 (CD), Chapter 21 (Gu).

15. Panel Data Models.
Panel data: economic examples. Unobserved heterogeneity problem. Pooled regressions.
Fixed effect regressions. Within-groups regression models. First differences regression models. Least squares dummy variables (LSDV) regression models.
Random effect regressions.
Fixed effects or random effects: Durbin-Wu-Hausman (DWH) test. Fixed effects or pooled regression: F-test.
Chapter 14 (CD), Chapters 13-14 (W), Chapter 16 (Gu).

Distribution of hours for topics and types of work

No	Topics titles	**Contact hours**	
		Lectures	**Classes**
1.	Introduction to Econometrics.	2	2
2.	Simple Linear Regression Model (SLR) with Non-stochastic Explanatory Variables. OLS estimation.	4	4
3.	Multiple Linear Regression Model (MLR): two explanatory variables and *k* explanatory variables.	6	6
4.	Variables Transformations in Regression Analysis.	2	2
5.	Dummy Variables.	2	2
6.	Linear Regression Model Specification.	2	2
7.	Heteroscedasticity.	2	2
8.	Stochastic Explanatory Variables. Measurement Errors. Instrumental Variables.	4	4
9.	Simultaneous Equations Models.	4	4
10.	Maximum Likelihood Estimation.	2	2
11.	Binary Choice Models, Limited Dependent Variable Models.	2	2
12.	Modelling with Time Series Data. Dynamic Processes Models.	6	6
13.	Autocorrelated Disturbance Term	4	4
14.	Time Series Econometrics: Nonstationary Time Series.	10	10
15.	Panel Data Models.	4	4
	Total:	56	56