**Syllabus**

**1. Name of a subject – Econometrics**

The main learning outcome of this discipline is acquiring by a student the basic mathematical statistic knowledge and skills (forming competences) for solving standard economical tasks.

**2. Mapping of learning outcomes (list of competences), with the relevant indicators described and subject learning outcomes indicated**

 The discipline provides necessary tools to form competences listed below.

The section lists the graduates’ coded competencies that are to be developed during the learning process, indicators that show their development (generalized descriptions of specific actions performed by the graduate that clarify and reveal the competence content), learning outcomes (knowledge, skills) with indicators of competence development (in the form of a table):

 Table 1

|  |  |  |  |
| --- | --- | --- | --- |
| Competence code | Competence  | Competence development indicators[[1]](#footnote-1) | Learning outcomes (skills and knowledge) and indicators that show competence development[[2]](#footnote-2)  |
| PKN-1 | Possession of basic scientific concepts and categorical apparatus of modern economics and their application in solving applied problems |  | Know the modern economic concepts, models; categorical and scientific apparatus in the analysis of economic phenomena and processes; Be able to demonstrate knowledge of modern economic concepts, models; use categorical and scientific apparatus in the analysis of economic phenomena and processes; |
| PKN-3 | Ability to apply mathematical methods to solve standard professional financial and economic problems, to interpret the obtained mathematical results. |  | Know the basic mathematical concepts and methods required to solve standard financial and economic problems.Be able to solve typical mathematical and financial and economic problems, interpret the results obtained.Possess the skills of mathematical modeling of economic phenomena and processes. |
| UK-4 | Ability to use applied software in solving professional problems |  | Know the main methods and means of obtaining, presenting, storing and processing data;Be able to use the basic methods and means of obtaining, resenting, storing and processing data; |
| UK-10 | Ability to search, critically analyze, generalize and systematize information, use a systematic approach to solve assigned tasks |  | Know of the methods for describing the composition and structure of the required dataand information; collection methods, data processing and interpretation;Be able to describe the composition and structure of the required data and information; competently implement the processes of collecting, processing and interpreting data; |

**3. Place of the discipline subject in the curriculum**

The discipline *"Econometrics"* is a discipline of the Module of Econometrics and Computer Science of the direction of training 38.03.01 *"Economics"*.

The study of the discipline *"Econometrics"* is based on the knowledge gained in the framework of the corresponding disciplines of secondary vocational education. The discipline "Econometrics" is the theoretical basis for all disciplines of the module of Mathematics and Computer Science, and mathematical concepts and methods are used in the future in the study of general professional disciplines and disciplines of the profile.

The section describes what place is occupied by the subject in the program curriculum.

**4. Workload in credits and academic hours, with class work (lectures and seminars) and self-study indicated**

The data are presented in the form of a table.

Table 2

|  |  |  |
| --- | --- | --- |
| **Type of work**  | **Total** **(in credits and hours)**  | **Semester 5 (in hours)** |
| **Overall workload**  | ***5/180*** | ***180*** |
| ***Class work***  | ***50*** | ***50*** |
| *Lectures*  | ***16*** | ***16*** |
| *Seminars*  | ***34*** | ***34*** |
| ***Self-study***  | ***130*** | ***130*** |
| Formative assessment  | ***Creative Research*** | ***Creative Research*** |
| Summative assessment  | ***Exam*** | ***Exam*** |

**5. Subject content (with the thematic components indicated).**

1. **Introduction to Econometrics**

Relationships in the economy on the example of supply and demand functions. Economic data. Main statistical concepts and facts used in the course.

1. **Simple Linear Regression Model (SLR). Ordinary Least Squares (OLS) estimation**

Proposals and notation in SLR. SLR Model Estimation using Ordinary Least Squares (OLS). Expressions for the OLS estimators of slope coefficient and intercept: derivation and interpretation. Gauss-Markov conditions 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 R2. F-statistics and F-test. Relationship between R2 and correlation coefficients. Formulas for estimates b1 and b2. SLR model without intercept. OLS-estimation, properties and applications.

1. **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 R2. Adjasted R2. Testing hypotheses using t- statistics and F-statistics. OLS-estimation of the model with k explanatory variables. Properties of coefficients. F-test. Multicollinearity. Estimation multiple regression models. Arbitrage pricing model (APT model).

1. **Variables Transformations in Regression Analysis**

Linearisation of non-linear functions and their estimation using Ordinary Least Squares. Disturbance term specification. Interpretation of linear, logarithmic and semi-logarithmic relationships. Comparison of the quality of regression relationships: linear and logarithmic functions.

1. **Linear Regression Model Specification**

Consequences of Incorrect Specification. Omitting significant explanatory variable. Including unnecessary explanatory variable in the model. Testing of linear constraints on parameters of MLR. F-test and t-tests. Role and examples of linear constraints in economic models. Lagged Variables in economic models. Gauss-Markov conditions' violation. General principles of consequences' analysis, detection and correction. Generalised Least Squares (GLS).

1. **Heteroscedasticity.**

Concept, consequences and detection of heteroscedasticity. Goldfeld-Quandt. Weighted Least Squares (WLS) method as a special case of GLS. Reasons and examples of heteroscedasticity in economic models.

1. **Autocorrelated disturbance term**

Signs and consequences of disturbance term's autocorrelation in LR model. Durbin-Watson d test for first order autocorrelation. Autocorrelated disturbance term and model misspecification. Cochrane-Orcutt (CO) procedure as a special case of GLS. AR, MA, ARMA models.

1. **Modelling with Time Series Data**

Dynamic Processes Models, the initial information.

**6. List of teaching and methodological materials needed for the students self-study**

**6.1. List of questions for student self-study and types of out-of-class activities**

The section lists types of out-of-class activities that correspond to items in the subject content description.

There is a list of questions the students should answer while working independently.

|  |  |  |
| --- | --- | --- |
| **Itemized subject content**  | **Questions the students should answer within the self-study process**  | **Types of out-of-class activities**  |
| **1. Number sets and functions** | Properties of one-variable functions | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **2. Limits and continuity** | Cobweb model of the market for one product | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
| **3. Differential calculus of one-variable function.** | Proofs of main theorems. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
| **4. Integral calculus of one-variable function.** | Average labor productivity, average return on capital. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **5. Multi-variable functions.** | Cost minimization and profit maximization of a multi-product firm. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **6. Differential equations.** | Sustainability of the solution. Stability criterion. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **7. Vectors and matrices.** | Properties of determinant. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **8. Systems of linear algebraic equations.** | Simplex transformations. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **9. Linear space.** | Solution of the tasks. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **10. Linear transformations and quadratic forms.** | Curves of the second order. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| **11. Linear programming.** | The theorems of duality | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |

 Table 3

|  |  |  |
| --- | --- | --- |
| **Itemized subject content**  | **Questions the students should answer within the self-study process**  | **Types of out-of-class activities**  |
|
| Introduction to Econometrics | Relationships in the economy on the example of supply and demand functions. Main statistical concepts and facts used in the course.  | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| Simple Linear Regression Model (SLR). Ordinary Least Squares (OLS) estimation. | Standard deviations and standard errors of regression coefficients: derivation and interpretation. Statistical significance of OLS estimators. OLS-estimation, properties and applications | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
| Multiple Linear Regression Model (MLR): two explanatory variables and k explanatory variables | Derivation and properties of OLS-estimators of MLR with two explanatory variables. Properties of coefficients. F-test. Multicollinearity.  | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
| Variables Transformations in Regression Analysis | Linearisation of non-linear functions and their estimation using Ordinary Least Squares. Disturbance term specification. Interpretation of linear, logarithmic and semi-logarithmic relationships. Comparison of the quality of regression relationships: linear and logarithmic functions. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| Linear Regression Model Specification   | Processes Models, the initial information. Consequences of Incorrect Specification. Omitting significant explanatory variable. Including unnecessary explanatory variable in the model. Testing of linear constraints on parameters of MLR. F-test and t-tests. Role and examples of linear constraints in economic models. Lagged Variables in economic models. Gauss-Markov conditions' violation. General principles of consequences' analysis, detection and correction. Generalised Least Squares (GLS). | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
| Heteroscedasticity | Weighted Least Squares (WLS) method as a special case of GLS. Reasons and examples of heteroscedasticity in economic models. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson.  |
|  Autocorrelated disturbance term  | Autocorrelated disturbance term and model misspecification. Cochrane-Orcutt (CO) procedure as a special case of GLS. AR, MA, ARMA models. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |
| Modelling with Time Series Data. | Dynamic processes of models, initial information. | Work with educational literature and tutorial videos. Analysis of questions on the topic of the lesson. |

**6.2. List of questions/assignments/topics for students’ preparation to formative assessment**

**Templates of questions for the exam preparation**

1. What is Econometrics?

2. Nobel Laureates (Examples of Models).

3. Role of Econometrics.

4. Main Application of Econometrics.

5. Cross Section Data.

6. Time Series Data.

7. Pooled Cross Section Data.

8. Panel Data.

9. Principles of specification econometrics models.

10. Matrix of pair correlation. Scatter diagram.

11. What is regression analysis?

12. Difference between Regression and Correlation.

13. The Simple Linear Model.

14. What is the disturbance term?

15. Why does the disturbance term exist?

16. The fitted line.

17. What is a residual for each observation?

18. What is RSS, ESS, TSS?

19. The normal equations for the regression coefficients.

20. Formulas for estimates b1 and b2.

21. OLS technique.

22. Interpretation of a Regression Equation.

23. Goodness of Fit: R2. Three Useful Results.

24. The F-Test of Goodness of Fit.

25. The Random Components of the Regression Coefficients.

26. The Gauss – Markov Theorem.

27. Unbiasedness of the Regression Coefficients.

28. Precision of the Regression Coefficients.

29. Testing Hypotheses Relating to the Regression Coefficients.

30. Confidence Intervals.

31. One-Tailed t –Tests.

32. Heteroscedasticity and Its Implications.

33. Possible Causes of Heteroscedasticity.

34. Detection of Heteroscedasticity: The Goldfeld–Quandt Test.

35. What Can You Do about Heteroscedasticity?

36. Possible Causes of Autocorrelation.

37. Detection of First-Order Autocorrelation: the Durbin–Watson Test.

38. What Can You Do about Autocorrelation?

39. Multiple regression analysis. A Model with Two Explanatory Variables.

40. Derivation of the Multiple Regression Coefficients. A Model with Two Explanatory Variables.

41. Derivation of the Multiple Regression Coefficients. The General Model.

42. Properties of the Multiple Regression Coefficients: Unbiasedness; Efficiency; Precision; Consistency.

43. Multicollinearity.

44. The Market Model.

45. Тhе APT model.

46. The Macroeconometrics Models.

47. The Models of Time Series Data.

**7. Mandatory and optional reading list**

**7.1. Mandatory**

Трегуб И.В. *Математические модели динамики экономических систем*: монография - Москва: РУСАЙНС, 2018. - 164 с.

Трегуб И.В. *Эконометрические исследования. Практические примеры. Econometric studies. Practical examples*. - Москва: Лань, 2017. 164 с.

Tregub I.V. *Econometrics. Model of real system*. М.: 2016, 164 p.

Трегуб И.В. *Эконометрика на английском языке* Учебное пособие. М.: 2017

**7.2. Optional**

Christopher Dougherty. *Introduction to Econometrics*. Fourth Edition. Oxford University Press, 2016

**8. List of IT resources, incl. the list of software, information and reference systems (as appropriate).**

**8. 1. Software:**

1. Windows OS;

2. Microsoft Office software.

**8.2. Databases and information and reference systems**

1. Information and education portal of the Financial University http://portal.ufrf.ru/.

2. Library of digital resources of the Financial University: http://elib.fa.ru/

**8.3. Certified software/hardware used for information protection**

ESET Endpoint Security antivirus software.

Federal State Educational Budgetary institution of higher education

"FINANCIAL UNIVERSITY UNDER THE GOVERNMENT OF THE RUSSIAN FEDERATION "

(Financial University)

Department of Mathematics

**Ilona V. Tregub**

Econometrics

**SYLLABUS**

***Level of Study:*** *Bachelor’s Degree*

***Field of Study:*** *Economics*

***Study Program:*** *International Finance (in English)*

1. To be filled in when the updated Financial University educational standards and federal state educational standards of higher education “3++” are implemented. [↑](#footnote-ref-1)
2. Skills are described when the Financial University educational standards of the 1st generation and federal state educational standards of higher education “3+” are implemented. [↑](#footnote-ref-2)