MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

Syllabus
of the academic discipline
"MATHEMATICAL MODELLING IN ECONOMICS AND MANAGEMENT: ECONOMETRICS"
for students of training direction
6.030601 "Management"
of all forms of study

Kharkiv
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S 98 **Syllabus** of the academic discipline "Mathematical Modelling in Economics and Management: Econometrics" for students of training direction 6.030601 "Management" of all forms of study / compiled by T. Klebanova, L. Guryanova, O. Sergienko et al. – Kharkiv : S. Kuznets KhNUE, 2016. – 36 p. (English)

The thematic plan of the academic discipline and its contents are given according to the modules and themes. Plans for lectures and laboratory sessions, material to consolidate knowledge (tasks for self-study, test questions), criteria for assessment of students' knowledge are provided.

Recommended for students of economic specialities.

Introduction

Modern economists should know and be able to use in practice the latest economic and mathematical methods and models. The rapid development and wide application of computer technology determine requirements for the training of modern economists who should be able to analyze complex social and economic phenomena using modern software packages.

Mathematical Modelling in Economics and Management: Econometrics (hereinafter Econometrics) is one of the basic academic disciplines of the economic and mathematical cycle being of theoretical, methodological and practical importance.

This discipline provides theoretical knowledge of qualitative properties of economic systems, evaluation of relationships between quantitative indicators of economic development and econometric models of economic systems and processes.

1. Description of the academic discipline

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Subject area, training direction, academic qualification</td><td colspan="2">Characteristics of the academic discipline</td></tr>
<tr><td>Full-time students</td><td>Part-time students</td></tr>
<tr><td rowspan="5">2.5 credits.
2 modules.
2 content modules</td><td rowspan="5">Subject area: 0306 "Management and administration"</td><td colspan="2">Optional</td></tr>
<tr><td colspan="2">Year of training</td></tr>
<tr><td>2nd</td><td>2nd</td></tr>
<tr><td colspan="2">Semester</td></tr>
<tr><td>4th</td><td>2nd</td></tr>
<tr><td rowspan="6">90 hours
(total number)</td><td rowspan="6">Training direction: 6.030601 "Management"</td><td colspan="2">Lectures</td></tr>
<tr><td>18 hours</td><td>8 hours</td></tr>
<tr><td colspan="2">Laboratory work</td></tr>
<tr><td>18 hours</td><td>8 hours</td></tr>
<tr><td colspan="2">Independent work</td></tr>
<tr><td>54 hours</td><td>74 hours</td></tr>
<tr><td rowspan="2">Hours per week (full-time study): classroom: 2; self-study: 3</td><td rowspan="2">Academic qualification: Bachelor</td><td colspan="2">Type of control</td></tr>
<tr><td>modular control</td><td>modular control</td></tr>
</table>

Note. The ratio of class hours to self-study and individual work is 67 % for full-time students, 22 % for part-time (distance) students.

2. The purpose and objectives of the academic discipline

The purpose of the academic discipline is to build econometric models that quantitatively describe the relationship between economic variables.

The objective of the academic discipline is mastering the basic principles, methods and tools regarding the objectives of econometric modelling, methods of solution and analysis for wide use in the economy and business.

The object of the academic discipline is a set of socioeconomic processes taking place in the economic system.

The subject of the academic discipline is econometric methods and models used to define and study the quantitative relationship between socio-economic phenomena.

The academic discipline "Econometrics" is the base for bachelors of training direction "Management".

The required training base for studying the academic discipline. In order to best learn the academic discipline students need to acquire knowledge and skills in the field of general economics, macro- and microeconomics, the theory of probability and mathematical statistics, stochastic processes.

The academic discipline provides the study of the following disciplines: "Forecasting Social and Economic Processes", "The Theory of Economic Risk", "Methods of Economic and Statistical Studies", "Nonlinear Models of Economic Dynamics".

As a result of studying the academic discipline a student must

know:

the conceptual foundations, principles and approaches to the construction and analysis of econometric models;

the main types of econometric models used for studying economic processes;

the basic methods of building econometric models.

be able to:

independently set goals for applied economic tasks;

determine the extent of the necessary information for precise formulation and solution of applied economic problems;

adequately use econometric models applied to solving economic problems;

use information technology-based PC application for solving economic problems;

analyze the results, and make respective effective decisions based on them.

Learning the academic discipline "Econometrics" provides the formation of students' **competences** listed in Table 2.1.

Table 2.1

Professional competences that students receive after studying the academic discipline

Competence code	Competence name	The components of the competence
1	2	3
		The ability to analyze causal relationships in economic processes

Table 2.1 (the end)

1	2	3
E1	The ability to evaluate, analyze and forecast the social, economic and financial processes through the use of regression and econometric methods	The ability to identify endogenous and exogenous variables for the model. The ability to estimate the parameters of the regression equations. The ability to carry out statistical verification of econometric models. The ability to apply specific methods of estimating the parameters under multicollinearity. The ability to apply the methods for indicating autocorrelation and specific methods of estimating the parameters under autocorrelation. The ability to apply the methods for indicating heteroscedasticity and specific methods of estimating the parameters under heteroscedasticity. The ability to analyze the processes of reproduction using production functions. The ability to assess the parameters of an econometric model of the dynamics

The structure of the components of professional competences and their formation according to the National Qualifications Framework of Ukraine is given in Appendix A.

3. The syllabus of the academic discipline

Module 1. Econometric modelling basics

Topic 1. Econometrics and econometric modelling

1.1. Econometric modelling as a method of scientific research.

The subject, methods and objectives of the academic discipline. The role of econometric studies in economics. Classification of econometric models.

1.2. The features of the econometric model.

The econometric model, its types. Formation of a set of observations. The accuracy of the source data. The concept of homogeneity of observations. The stages of econometric modelling.

1.3. Examples of econometric models.

Phillips Curve. Okun's law. The neoclassical microeconomic model –

demand. The neoclassical microeconomic model – supply. The Cobb – Douglas production function.

Topic 2. Simple linear regression

2.1. The concept of paired regression.

The regression equation. A simple linear econometric model, the basic assumption.

2.2. Methods of estimating the parameters of a regression model.

The method of the least squares normal equations system. Properties of the model parameter estimates.

2.3. Verification of a pair regression model.

Checking the model adequacy by Student's t-test and the Fisher criterion. The correlation and determination coefficients. Forecast based on a simple linear model.

Topic 3. Multiple linear regression

3.1. Methods of constructing a multiple linear econometric model.

A multiple linear model, the basic assumption. Preconditions for applying ordinary least squares. The economic interpretation of the model parameters. Evaluation of multiple parameters of the model and test of its adequacy. The multiple correlation coefficient. Prediction based on a multiple linear model.

3.2. Various aspects of multiple regression: dummy variables.

Qualitative factors. Dummy (artificial) variables. The rules for construction of regression with dummy variables. Three main types of dummies in regression models with time series.

Topic 4. The problem of multicollinearity in regression

4.1. Multicollinearity and its causes.

Complete (perfect) multicollinearity. Partial (imperfect) multicollinearity. Multicollinearity, the reasons for its occurrence. The negative consequences of multicollinearity. The impact of multicollinearity on the characteristics of a multiple linear model.

4.2. Methods for assessing the degree of multicollinearity.

Methods for assessing the degree of multicollinearity. Maximum conjugacy. The Farrar – Glauber Test.

4.3. Methods for eliminating multicollinearity.

The method for elimination of model variables. Elimination of one of the two strongly associated factors. Unacceptable (inadmissible) multicollinearity.

Permissible multicollinearity. Methods of inclusion/exclusion factors. Methods that use external information. Ridge regression. Methods of data transformation. The method of principal components.

Module 2. Applied econometrics

Topic 5. Autocorrelation

5.1. Definition, causes and consequences of autocorrelation.

Autocorrelation of residuals. The effects of autocorrelation in the construction of econometric models.

5.2. The test for autocorrelation.

Methods for checking autocorrelation of residuals. Durbin – Watson statistic. The von Neumann criterion. The cyclic and uncyclic autocorrelation coefficient.

5.3. Estimation of the model with autocorrelation residuals.

Methods for estimating the parameters of the known and unknown autocorrelation coefficient. The Aitken method. The Cochrane – Orcutt procedure, the Hildreth – Lu procedure, the Durbin procedure.

Topic 6. Heteroscedasticity

6.1. Definition, causes and consequences of heteroscedasticity.

The concept of homoscedasticity and heteroscedasticity. The causes of heteroscedasticity.

6.2. The test for heteroscedasticity.

Criteria for checking heteroscedasticity. The μ-test. The Goldfeld – Quandt test. The Glejser test. The Park test. Properties of the model parameter estimates in the case of heteroscedasticity.

6.3. Estimation of the model with heteroscedasticity of residuals.

The Aitken theorem. The generalized least squares method (GLS). The properties of the model parameter estimates obtained from the GLS.

Topic 7. Nonlinear regressions. Productive functions

7.1. Non-linear univariate econometric models and their properties. Methods of estimating the parameters of nonlinear models.

Nonlinear univariate econometric models and their properties. Methods of estimation of the parameters of nonlinear models. Examples of linearization.

7.2. Production functions, their classification and basic properties.

The production function. Classification of production functions. The main properties of the production function. Characteristics of the main single-factor production functions.

7.3. The Cobb – Douglas production function, features of construction and main characteristics.

The production function of Cobb – Douglas, its properties and parameter estimation. Characteristics of the production function (average and marginal productivity of resource, output elasticities of capital and labor, the isoquant curve, the isocost curve).

Topic 8. Dynamic econometric models

8.1. Basic concepts and types of time series.

Types of econometric models of dynamics.

8.2. Trend models.

Trends, types of trends. Checking the availability of a time series trend.

8.3. Smoothing models of time series.

Methods for smoothing time series. Decomposition of the time series models. Autoregressive models and moving average models, Box – Jenkins models. Identification and estimation of parameters.

8.4. The method of characteristics.

The algorithm of the method of characteristics. The system of characteristic performance changes for different types of curves.

4. The structure of the academic discipline

Before studying the academic discipline "Econometrics", students have to get acquainted with the discipline syllabus, its structure, methods of teaching, types and methods of knowledge control.

The thematic plan of the academic discipline "Econometrics" consists of two modules, each of which is a relatively independent unit of the academic discipline that logically connects several elements of the academic discipline.

Training is carried out in the following forms: lectures and laboratory classes, self-study. The structure of the discipline is presented in Table 4.1.

Table 4.1

The structure of the academic discipline

Names of content modules and topics	The number of hours for full-time students				The number of hours for part-time students			
	total	including			total	including		
		lectures	laboratory	self-study		lectures	laboratory	self-study
Module 1. Econometric modelling basics								
Topic 1. Econometrics and econometric modelling	5	2	–	3	10	1	1	8
Topic 2. Simple linear regression	15	2	4	9	10	1	1	8
Topic 3. Multiple linear regression	15	4	2	9	10	1	1	8
Topic 4. The problem of multicollinearity in regression	11	2	2	7	15	1	1	13
Total hours per module	**46**	**10**	**8**	**28**	**45**	**4**	**4**	**37**
Module 2. Applied econometrics								
Topic 5. Autocorrelation	10	2	2	6	10	1	1	8
Topic 6. Heteroscedasticity	10	2	2	6	10	1	1	8
Topic 7. Nonlinear regressions. Productive functions	14	2	4	8	10	1	1	8
Topic 8. Dynamic econometric models	10	2	2	6	15	1	1	13
Total hours per module	**44**	**8**	**10**	**26**	**45**	**4**	**4**	**37**
Total	**90**	**18**	**18**	**54**	**90**	**8**	**8**	**74**

5. The plans of laboratory classes

Laboratory work is a form of study that is aimed at developing the abilities and skills of construction and analysis of different classes of econometric models with packages of applied programs. Laboratory classes are based on the preprepared methodical material – a set of tasks of varying complexity to be solved by students in class.

Before doing laboratory work (Table 5.1), students have to answer test questions that show their preparedness to do the laboratory work, including the mastery of the necessary theoretical knowledge and understanding of the goal. After the laboratory work the teacher assesses the mastery of skills and the achievement of the goal of this work.

For presentation of laboratory work students have to make individual reports which should contain: problem statement, printed basic model results,

analysis and calculations and conclusions for clear economic interpretation of the results. The total score for the performance of each laboratory work is entered in the appropriate log. The resulting score for students' labs is taken into account in the calculation of the final assessment of this discipline.

Table 5.1

The list of lab topics

Topic	The syllabus issues	The number of hours	Recom-mended literature
Module 1. Econometric modelling basics			
Topic 2. Simple linear regression	Construction and analysis of a simple linear regression	4	Basic: [1; 4; 5]. Additional: [6 – 8]
Topic 3. Multiple linear regression	Part 1. Construction and analysis of a multiple linear regression. Part 2. Assessment of multicollinearity and its exclusion from the model	4	Basic: [1 – 4]. Additional: [6 – 8]
Topic 4. The problem of multicollinearity in regression			
Module 2. Applied econometrics			
Topic 5. Autocorrelation	Construction of a multilinear model in terms of autocorrelation and hetero-scedasticity	4	Basic: [1 – 4]. Additional: [6 – 8]
Topic 6. Heterosce-dasticity			
Topic 7. Nonlinear regressions. Productive functions	Construction of the Cobb – Douglas production function	4	Basic: [1; 3; 5]. Additional: [6 – 8]
Topic 8. Dynamic econometric models	Construction of the trend	2	Basic: [1; 3; 5]. Additional: [6; 10]

A sample laboratory task

Laboratory work 2. Building and Analysis of Multiple Linear Econometric Models

The aim is to consolidate the theoretical and practical material on the topic "Multiple regression", to acquire the skills in modelling and analysis of multifactorial econometric models in Microsoft Excel.

The objective is to verify the existence of a linear multiple connection between coincident indicators in "Data Analysis" add-in of Microsoft Excel.

1. Build a linear multifactorial econometric model (include all coincident factors) and determine all its characteristics (parameters of the model, mean square deviation of the model parameters, dispersion and mean square deviation of the model errors, coefficients of multiple correlation and determination) with the help of "Data Analysis" add-in in Microsoft Excel.

2. Check the statistical significance of the model parameters. Check the model's adequacy with the help of the Fisher's criterion.

3. Adduce tables with the theoretical values of the dependent indicator and the values of the model's errors. Build a graph of the linear function. Build a histogram and a graph of the distribution of errors. Adduce grouping of data by values of errors, give an economic interpretation.

4. Find the forecasted value of the dependent variable *Ypr* and confidential intervals if there is available data about future values of independent indicators (*X1pr, X2pr, X3pr*).

5. Adduce a matrix of pair correlations for factorial features. Check the model for the presence of multicollinearity (tight linear connection) between factorial variables with the help of the Farrar – Glauber algorithm.

6. Exclude from the model the factors, which have the least influence on the dependent variable or are interconnected with each other (use the results of the Student's criterion, the Farrar – Glauber algorithm and the coefficients of pair correlations). Determine all characteristics of the new regression, draw conclusions about its adequacy.

6. Independent work

Independent work of students (IWS) is a form of the educational process in which a student performs the scheduled tasks independently under the guidance of the supervisor.

The purpose of the IWS is mastering the full curriculum and formation of students' general and professional competences that play a significant role in the becoming of future top-level professionals.

The teaching time allotted for individual work of full-time students is defined by the curriculum. During individual work students become active participants in the educational process, learn to develop a conscious attitude

to mastering the theoretical and practical knowledge, freely navigate in the cyberspace, bear individual responsibility for the quality of their training. IWS includes work on the lecture material; studying the recommended literature, basic terms and concepts for the discipline topics; laboratory classes; preparing to speak at seminars; in-depth learning of lectures on particular topics or issues; individual assignments (carrying out individual and complex computational tasks) on the studied topic; essays on given issues; search and review of the literature on the given discipline problems; analytical review of scientific publications; testing the students' personal knowledge through questions for self-assessment; preparation for current control; preparation for the module control; systematization of the learned material to prepare for testing.

An essential element of successful learning of the academic discipline is the independent work of students with special domestic and foreign economic literature, the normative acts on state regulation of the economy, statistical data. The main types of independent work offered to students for mastering the theoretical knowledge of the discipline are presented in Table 6.1.

6.1. Questions for self-study

Questions for self-study are presented in Table 6.1.

Table 6.1

Tasks for independent work of students and forms of control

Topic name	Content of independent work of students	The numbers of hours	Forms of IWS control	Recom-mended literature
1	2	3	4	5
Module 1. Econometric modelling basics				
Topic 1. Econometrics and econometric modelling	1. The role of econometric studies in economics. 2. The features of econometric modelling. 3. Classification of econometric models. 4. The algorithm for constructing econometric models	3	Presentation of results. Tests on the theoretic material	Basic: [3; 5; 7 – 9]

Table 6.1 (continuation)

1	2	3	4	5
Topic 2. Simple linear regression	1. The method of least squares normal equations system. Properties of the model parameter estimates. 2. Checking the model adequacy by the Student's t-test and the Fisher criteria. 3. Forecasts based on linear models	9	Presentation of results. Tests on the theoretic material	Basic: [2; 3; 7; 8]
Topic 3. Multiple linear regression	1. The multiple linear econometric model, the basic assumption. 2. The method of the least squares normal equations system. Properties estimates of the model parameters. 3. Checking the model adequacy by Student's t-test and Fisher criteria. 4. Forecasts based on multiple linear models	9	Presentation of results. Tests on the theoretic material	Basic: [2; 3; 7; 8]
Topic 4. The problem of multicollinearity in regression	1. The concept of multicollinearity. The impact of multicollinearity on the characteristics of a multiple linear model. 2. Methods of assessing the degree of multicollinearity.The Farrar – Glauber method. 3. Methods for exclusion of multicollinearity	7	Presentation of results. Tests on the theoretic material	Basic: [3 – 5; 7; 8]
Module 2. Applied econometrics				
Topic 5. Autocorrelation	1. Autocorrelation of residuals. The effects of autocorrelation in the construction of econometric models. 2. Methods of checking autocorrelation of residuals. The Durbin – Watson statistics. The Neumann criterion. 3. Methods for estimating the parameters of autocorrelation residues. The Cochrane – Orcutt procedure, the Hildreth – Lu procedure, the Durbin procedure	6	Presentation of results. Tests on the theoretic material	Basic: [3; 4; 7; 8]

Table 6.1 (the end)

1	2	3	4	5
Topic 6. Heteroscedasticity	1. The concept of homoscedasticity and heteroscedasticty. 2. Testing the presence of heteroscedasticity. The Goldfeld – Quandt test. The Glejser test. 3. The generalized least squares method. The properties of the model parameter estimates obtained from GLS	6	Presentation of results. Tests on the theoretic material	Basic: [2 – 4; 7; 8]
Topic 7. Nonlinear regressions. Productive functions	1. Nonlinear univariate econometric models and their properties. 2. Methods for estimating the parameters of nonlinear models. Examples of linearization. 3. The production function of Cobb – Douglas, its properties and parameter estimation. 4. Characteristics of the production function	8	Presentation of results. Tests on the theoretic material	Basic: [3; 5; 7; 8]
Topic 8. Dynamic econometric models	1. Types of econometric models of dynamics. 2. Methods for smoothing time series. 3. The decomposition of time series models	6	Presentation of results. Tests on the theoretic material	Basic: [3; 5; 7 – 10]

6.2. Control questions for self-assessment

Module 1. Econometric modelling basics

Topic 1. Econometrics and econometric modelling

1. Define the socioeconomic system. Give examples.
2. Provide a definition of a mathematical model.
3. What are the characteristics of econometric modelling?
4. Give a definition of an econometric model.
5. What are the stages of building econometric models?
6. What econometric methods are used in the construction and analysis of econometric models?
7. Give examples of the use of econometric models for the study of economic processes.

Recommended literature: basic [3; 5]; additional [7 – 9].

Topic 2. Simple linear regression

1. Describe the features of linear econometric models.

2. Explain the method of least squares for estimating the parameters of simple econometric models.

3. What is the concept of unbiasedness, consistency and efficiency assessments?

4. What hypotheses must be satisfied by the model deviation in order to make estimation of the model parameters, obtained using OLS, to be unbiased, consistent and efficient?

5. In this connection is it necessary to check the statistical significance of the estimates of the model parameters?

6. What is the Student's t-test?

7. How are confidence intervals defined for the model parameter estimates?

8. What is the adequacy of the model? Methods for determining the adequacy of the model.

Recommended literature: basic [1 – 3]; additional [7; 8].

Topic 3. Multiple linear regression

1. Record the various forms of the system of normal equations for a multiple linear model. What methods can be used to solve the system of normal equations in this case?

2. How is the statistical significance of the model parameter estimates determined?

3. What is the coefficient of multiple correlation?

4. What methods can be used to calculate the coefficient of multiple correlation?

5. How can you calculate predictive values for a multiple econometric model?

Recommended literature: [2; 3; 7; 8].

Topic 4. The problem of multicollinearity in regression

1. Define what multicollinearity is. Why does multicollinearity exist in linear econometric models?

2. How does the existence of multicollinearity affect the characteristics of multiple linear econometric models?

3. What methods are used to assess the degree of multicollinearity?

4. What methods are used to eliminate multicollinearity while building models?

5. What is the method for estimation of the model parameters using the coefficient matrix of pair correlations?

6. What is the algorithm for detecting extra factors?

Recommended literature: basic [3 – 5]; additional [7; 8].

Module 2. Applied econometrics

Topic 5. Autocorrelation

1. What is meant by autocorrelation balances?

2. What are the reasons causing the appearance of residual autocorrelation?

3. What properties will estimation of the model parameters obtained through ordinary least squares have in case of the autocorrelation error?

4. What criteria are used for testing the model for an autocorrelation error?

5. What is the essence of the Aitken method?

6. What other methods can be used to estimate the model parameters in the case of an autocorrelation error?

Recommended literature: basic [3; 4]; additional [7; 8].

Topic 6. Heteroscedasticity

1. How are homoscedasticity and heteroscedasticity of model deviations represented?

2. What are the properties of the model parameter estimates obtained using OLS if errors are heteroscedastic?

3. What is the Aitken theorem?

4. What is the generalized least squares method?

5. What are the properties of the model parameter estimates obtained using GLS?

Recommended literature: basic [2 – 4]; additional [7; 8].

Topic 7. Nonlinear regressions. Productive functions

1. Define the production function.

2. List the types of production functions.

3. What are the properties of the production function?

4. What are the characteristics of the production function?

5. The geometric interpretation of the characteristics of production functions.

6. How are Cobb – Douglas parameter estimates determined?

Recommended literature: basic [3; 5]; additional [7; 8].

Topic 8. Dynamic econometric models

1. What are the features of the models of dynamics?
2. What components can be identified in a time series?
3. Define the term "trend". What are the main types of trends?
4. What is the smoothing method?
5. What are the features of autoregressive models?
6. What is the harmonious and spectral analysis?

Recommended literature: basic [3; 5]; additional [7 – 10].

7. Individual consulting work

Individual consulting work is a kind of individual training of students, which aims to assist students in the process of self-study, as well as mastering the educational materials on the academic discipline.

Individual consultation work is carried out in the following forms:

- consultations during which a student can get answers to difficult questions that arise in the learning process: preparation for seminars and practicals; laboratory work; preparing reports for students' scientific conference etc.
- presenting practical, laboratory work, individual tasks;
- exercising current control of students' knowledge in the case of valid reasons for having missed classes.

Individual consulting sessions are initiated by the lecturer according to the schedule that is placed on the department's notice-board.

8. Methods of learning

The following modern educational technologies are used to enhance the teaching of the academic discipline "Econometrics": problem lectures; work in small groups; seminars and discussions.

The forms and methods of enhancement of the learning process are given according to the topics of the discipline in Table 8.1.

Table 8.1

Distribution of forms and methods of the learning process enhancement according to the topics of the discipline

Topic	The practical application of the educational technology
Topic 1. Econometrics and econometric modelling	A problem lecture "The role of econometric modelling in the management of economic systems"
Topic 2. Simple linear regression	A mini-lecture "The definition of the statistical significance and adequacy model". Presentation of the work in small groups
Topic 4. The problem of multicollinearity in regression	A mini-lecture "Building a model based on the Ridge Regression". Presentation of the work in small groups
Topic 5. Autocorrelation	A mini-lecture "Methods for estimating the parameters of the model autocorrelated residues". Presentation of the work in small groups
Topic 6. Heteroscedasticity	A mini-lecture "Criteria for checking heteroscedasticity". Presentation of the work in small groups
Topic 7. Nonlinear regressions. Productive functions	A mini-lecture "Construction and analysis of the Cobb – Douglas function". Presentation of the work in small groups
Topic 8. Dynamic econometric models	A mini-lecture "Construction and analysis of a time series decomposition model". Presentation of the work in small groups

Problem lectures are aimed at developing students' logical thinking. The range of topics is limited to two or three key points; attention of students is focused on the material that is not presented in textbooks; the experience of foreign schools is used; students are provided with printed material, and conclusions are drawn as to the issues under consideration. When teaching students the lecturer offers questions for self-reflection. The lecturer asks questions that encourage students to seek resolution of the problem situation. This system forces students to focus on the problem and begin to think actively searching for the right answer.

At the beginning of the problem lecture the lecturer should articulate the problem to be solved by students. The lecture material should avoid a direct answer to the questions, and cover the material so that the student could use information in solving problems.

Minilectures include presentation of the educational material in a short period of time and are characterized by large capacity, complexity of logical theories, evidence and generalizations. Minilectures are usually held as part of a lesson-study.

At the beginning of a minilecture the lecturer focuses on presenting the lecture outlined in a so-called structural and logical form. The issues concerning the terms of the lectures are submitted for consideration, but they are discussed briefly. The lectures are conducted in a manner that stimulates the students' activity and attention in the perception of the material and directs them to reproducing the information received from the lecturer.

It is expedient to combine problem lectures and minilectures with such a method of the learning process enhancement as work in small groups.

Work in small groups enables the lecturer to structure lectures and practical sessions in the form and content, create opportunities for each student to participate in the class work on the subject, providing the formation of personality features and experience of social intercourse.

After covering the problem (using problem lectures) or short teaching material (using minilectures) students are invited to join a group of 5 – 6 people and present their vision of the material.

Presentations. Presentations to the audience are used to represent certain achievements, perform a group report on individual tasks. One of the positive features of the presentation and its benefits when used in the learning process is the exchange of experience that students have gained while working in a particular small group.

9. Control methods

The system of evaluation of students' knowledge, skills, communication abilities, autonomy and responsibility is based on the Provisional Regulations "On the Assessment of Students' Academic Performance according to the Cumulative Score-Rating System" of Simon Kuznets Kharkiv National University of Economics which define common approaches to the use of the Cumulative Score-Rating System (CSRS) for all structural units (departments, faculties), disciplines and specializations, all educational levels of training full-time students.

The provisions of the CSRS aim to improve the system of assessment of the academic performance and learning, skills, communication abilities, autonomy and responsibility of students, fostering a systemic and systematic knowledge and rhythmic independent work of students throughout the semester and the entire period of training, objectivity of evaluation and adaptation to requirements of the European system of ECTS credits under the credit module educational system.

For evaluation, the extended scale of final control is used: positive evaluation is "excellent" (90 points and above), "good" (74 – 89 points), "satisfactory" (60 – 73 points); negative evaluation is "unsatisfactory" (1 – 59 points); the score 1 – 34 points involves restudy of the discipline; the score 35 – 59 points implies retaking of the exam on the academic discipline.

The system of evaluation of mastering the knowledge, communication abilities, autonomy and responsibility of students according to the National Qualifications Framework of Ukraine for each discipline includes current, modular (determined in accordance with the content module), and final evaluation of knowledge.

Current control is carried out during the semester at the lectures and laboratory sessions and is estimated in the number of points (maximum 100 points; the minimum number that allows the student's result to be credited is 60 points).

Modular control is carried out on the basis of current control of the relevant module contents and aims to provide an integrated assessment of students' knowledge after studying the logically completed part of the discipline – the content module.

The final score for the content module can be set as a total score for all current forms of control under the syllabus of the academic discipline, plus assessment of complex tests.

The order of the current assessment of students' academic performance.

At the beginning of the study of the discipline the student should be informed about the syllabus of the discipline (including its electronic version), the Technological Charts of the Cumulative Rating System of the Discipline (Appendix A) and the Rating Plan of the Discipline (the limit value points of the formed competences, the number of content modules, content, forms of current controls and their evaluation) (Appendix B).

The results of this evaluation of knowledge, skills, communication abilities, autonomy and responsibility of students, according to the National Qualifications Framework of Ukraine for the semester contents for each module are entered by the lecturer, in the electronic log and the Register of the Academic Performance of Students. At the end of the semester, the data from the electronic log is printed.

The current assessment is carried out during lectures and laboratory work and aims to test the readiness of the student to perform a specific job.

The objects of this control are:

1) systematicity, activity and effectiveness of learning the material of the discipline during the semester;

2) attendance;

3) individual tasks;

4) performance of the intermediate test control;

5) performance of modular control tasks.

Independent individual tasks of students are evaluated according to the Technological Chart of the academic discipline (Appendix A).

The intermediate test control is conducted at the end of each topic of the discipline. Conducting this test involves identifying students' mastery of the lecture material of the module and ability to apply it to resolving practical situations. This may include a test containing questions on the theoretical material and a small practical problem.

The test tasks are divided into questions of:

a closed form with proposed answers to be selected, one of which is correct;

an open form with free answers.

The test consists of 15 to 30 questions to assess the knowledge of the discipline main categories depending on the theme.

Evaluation of the students' answers to the tests is made by the formula:

$$\text{The point} = \text{round}\left(\frac{\text{the number of correct answers}}{\text{the total number of answers}} \times 100\right), \quad (1)$$

where "round" is the rounding function according to the general rules.

The results of this assessment of individual tasks and intermediate test control are accumulated to determine the success of the final score. The scores that are entered in the performance data, are calculated by the following formula based on the results of the current control:

$$\text{The point} = \text{round}\left(\frac{\text{current control evaluation}}{100} \times \text{maximum number of points}\right), \quad (2)$$

where "round" is the function under the general rules of rounding to the nearest tenth.

Performing the modular control

Modular control takes the form of a comprehensive test during a colloquium and consists of two parts: a theoretical part and a practical part.

Modular control is carried out in writing upon consideration of the theoretical material and performance of individual tasks within each of the two modules.

So, after studying topics 1 – 4 (module 1) students have to perform **tasks for module 1**; after studying topics 5 – 8 (module 2) they have to carry out the **tasks for module 2**.

The test for modular control contains 2 practical tasks.

A sample task for colloquium 1

Task 1

There are prices of some goods (UAH), and demand for them (UAH, thou) (Table). It is necessary to build a regression of demand for the price of the goods, to check the statistical significance and adequacy of the model; determine the confidence intervals for the predicted values of demand if the price is 9.5 UAH.

Table

Initial data

X	9.8	13	14	15.1	18.2	20.2	23.5	25	27.7	28
У	30	35	40	44	45	42	48	50	55	57

Task 2

There are initial data presented in the Table. It is necessary to determine the correlation coefficients for each pair of independent variables and write the matrix of pair correlations *r*, to determine the presence of multicollinearity in the array of independent variables by the method of Farrar – Glauber.

Table

Initial data

X_1	X_2	X_3
1	2	3
4	10	30
2	13	35
3	14	40
8	15	44
7	18	45

Table (the end)

1	2	3
10	20	42
15	23	48
14	25	50
10	27	55

When evaluating the practical tasks of the modular control the following criteria are used for each of the two tasks:

4 points are given if the student completely solved the logically consistent problem, and explained all the conclusions;

3 points are given if the problem was completely solved, but there is no economic justification, conclusions are not complete;

2 points are given if a logical error was made that affected the solution and final conclusions;

1 point is given if the student could only offer a way to solve the problem;

The total score for the performance of the modular control test is calculated as a sum of the scores obtained for two practical problems of the test.

10. Distribution of points that students can get

The evaluation system of formation of professional competences for full-time students is presented in Table10.1.

Table 10.1

The system of evaluation of the formed professional competences

Professional competences	Training week	Hours		Forms of training		The level of the formed competences	
						Forms of control	Maximum point
1	2	3		4		5	6
Content module 1. Econometric modelling basics							
The ability to define and apply the basic principles of econometric models	1	Class	2	**Lecture**	Topic 1. Econometrics and econometric modelling	Work at the lecture	1
		IWS	3	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework	

Table 10.1 (continuation)

1	2	3		4		5	6
					Solving practical problems in analyzing statistical characteristics series		
The ability to analyze and predict complex economic phenomena based on the construction of the pair of linear regression models to determine their statistical significance and adequacy	2	Class	2	**Lecture**	Topic 2. Simple linear regression	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction and analysis of a one-factor linear model"	Control work K 1	5
						Active participation in the performance of laboratory tasks	1
		IWS	3	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework	
					Solving practical problems to build a one-factor linear model		
	3 – 4	Class	2	**Lecture**	Topic 3. Multiple linear regression	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction and analysis of a one-factor linear model"	Control work K 2	5
						Active participation in the performance of laboratory tasks	1
		IWS	6	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework, presentation of laboratory work	8
					Preparation for reference work		
					Solving practical problems to build a one-factor linear model		
The ability to analyze and predict complex economic phenomena based on the construction of multiple regression linear models, the ability to deprive models of the multicollinearity phenomenon, to determine the significance and adequacy of the model	5 – 6	Class	2	**Lecture**	Topic 3. Multiple linear regression	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction and analysis of a multilinear model"	Active participation in the performance of laboratory tasks	1
		IWS	6	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework	
					Solving practical problems to build a multilinear model		
	7 – 8	Class	2	**Lecture**	Topic 4. The problem of multicollinearity in regression	Colloquium	8
						Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction and analysis of a multilinear model. Assessment of multicollinearity and excluding it from the model"	Control work K 3	5
						Active participation in the performance of laboratory tasks	1

Table 10.1 (continuation)

1	2	3		4		5	6
		IWS	7	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework, laboratory work	9
					Solving practical problems to build a multilinear model, assessing the degree of multicollinearity and excluding it from the model. Preparation for the current reference work		
Content module 2. Applied econometrics							
The ability to analyze and predict complex economic phenomena based on the construction of multiple regression linear models, the ability to deprive models of the heteroscedasticity and autocorrelation phenomena, to determine the model significance and adequacy	9 – 10	Class	2	**Lecture**	Topic 5. Autocorrelation	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction of a multilinear model in terms of autocorrelation, heteroscedasticity"	Active participation in the performance of laboratory tasks	1
		IWS	6	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework	
					Solving practical problems to build a multilinear model in terms of heteroscedasticity, autocorrelation		
	11 – 12	Class	2	**Lecture**	Topic 6. Heteroscedasticity	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction of a multilinear model in terms of autocorrelation, heteroscedasticity"	Control work K 4	5
						Active participation in the performance of laboratory tasks	1
		IWS	6	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework, presentation of laboratory work	7
					Solving practical problems to build a multilinear model in terms of heteroscedasticity, autocorrelation		
	13 – 14	Class	2	**Lecture**	Topic 7. Nonlinear regressions. Production functions	Work at the lecture	1
			2	**Laboratory work**	Laboratory task: "Construction of the production function of Cobb – Douglas"	Active participation in the performance of laboratory tasks	1
		IWS	6	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework	

Table 10.1 (the end)

1	2	3		4		5	6
The ability to analyze and predict complex economic phenomena based on the construction of nonlinear models of multiple regression, analysis of macro- and microeconomic processes of production through the construction of production functions of Cobb – Douglas, determine the significance and adequacy of the model					Solving practical problems to build a production function Cobb – Douglas		
	15 – 16	Class	2	**Lecture**	Topic 8. Econometric models	Work at the lecture	1
						Colloquium	8
			2	**Laboratory work**	Laboratory task: "Analysis of the characteristics of the production function of Cobb – Douglas"	Control work K 5	5
						Active participation in the performance of laboratory tasks	1
		IWS	7	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework, presentation of laboratory work	6
					Solving practical problems to build a production function Cobb – Douglas and analyzing its characteristics		
The ability to analyze and predict complex economic phenomena based on the construction of econometric dynamics models	17	Class	2	**Laboratory work**	Laboratory task: "Building a model of decomposition of the time series"	Active participation in the performance of laboratory tasks	1
						Control work K 6	5
		IWS	4	**Preparation for classes**	Search, selection and review of the literature on the given topic	Checking the homework, presentation of laboratory work	6
					Solving practical problems to build a production function Cobb – Douglas and analyzing its characteristics		
Total hours		**90**		**Maximum number of points on the discipline**			**100**
including				*including*			
class work		36		*current control*			84
self-study		54		*final control*			16

The distribution of points within the topics of the content modules is shown in Table 10.2.

Table 10.2

The distribution of points within the topics

CM1				CM2				Sum
T1	T2	T3	T4	T5	T6	T7	T8	100
10	12	10	9	8	8	14	13	
Colloquium				Colloquium				
8				8				

Note. T1, T2 ... T8 are topics of content modules.

The maximum number of points that a student can accumulate for a week in terms of the forms and methods of training is shown in Table 10.3.

Table 10.3

The distribution of points within the weeks

Topics of content modules			**Lectures**	**Laboratory work**	**Topic tasks**	**Current CW**	**Colloquiums**	**Total**
Content module 1	Topic 1	Week 1	1	–	–	–	–	**1**
	Topic 2	Week 2	1	1	–	5	–	**7**
	Topic 2 – 3	Week 3 – 4	1	1	8	5	–	**15**
	Topic 3	Week 5 – 6	1	1	–	–	–	**2**
	Topic 3 – 4	Week 7 – 8	1	1	9	5	8	**24**
Content module 2	Topic 5	Week 9 – 10	1	1	–	–	–	**2**
	Topic 5 – 6	Week 11 – 12	1	1	7	5	–	**14**
	Topic 7	Week 13 – 14	1	1	–	–	–	**2**
	Topic 7 – 8	Week 15 – 16	1	1	6	5	8	**21**
	Topic 8	Week 17	–	1	6	5	–	**12**
Total			**9**	**9**	**36**	**30**	**16**	**100**

The final score on the academic discipline is determined according to the Provisional Regulations "On the Assessment of Students' Academic Performance according to the Cumulative Score-Rating System" of S. Kuznets KhNUE (Table 10.4).

Table 10.4

The rating scale: national and ECTS

Total points for all the educational activities	ECTS rating	Assessment on the national scale	
		exam, term project (work), practice	test
90 – 100	A	Perfect	passed
82 – 89	B	Good	
74 – 81	C		
64 – 73	D	Fair	
60 – 63	E		
35 – 59	FX	Unsatisfactory	failed
1 – 34	F		

Ratings on this scale are entered in the academic record, student's individual education plan and other academic documents.

11. Recommended literature

11.1. Basic

1. Боровиков В. П. Популярное введение в программу STATISTICA. – Москва : Компьютер Пресс, 1998. – 194 с.

2. Доугерти К. Введение в эконометрику / К. Доугерти ; пер. с англ. – Москва : ИНФРА-М, 1997. – 402 с.

3. Клебанова Т. С. Эконометрия / Т. С. Клебанова, Н. А. Дубровина, Е. В. Раевнева. – Харьков : ИД "ИНЖЭК", 2003. – 128 с.

4. Наконечний С. І. Економетрія / С. І. Наконечний, Т. О. Терещенко, Т. П. Романюк. – Киев : КНЕУ, 1997. – 352 с.

5. Эконометрия на персональном компьютере / Т. С. Клебанова, Н. А. Дубровина, А. В. Милов и др. – Харьков : Изд. ХГЭУ, 2002. – 208 с.

11.2. Additional

6. Боровиков В. П. STATISTICA: искусство анализа данных на компьютере. Для профессионалов / В. П. Боровиков. – Санкт-Петербург : Питер, 2001. – 656 с.

7. Лук'яненко І. Економетрика / І. Лук'яненко, Л. Краснікова. – Київ : Товариство "Знання", КОО, 1998. – 494 с.

8. Магнус Я. Р. Эконометрика. Начальный курс / Я. Р. Магнус, П. К. Катышев, А. А. Пересецкий. – Москва : Дело, 1997. – 248 с.

9. Орлов. А. Н. Эконометрика / А. Н. Орлов. – Москва : Изд. "Экзамен", 2002. – 576 с.

10. Черняк О. І. Динамічна економетрика / О. І. Черняк, А. В. Ставицький. – Київ : КВІЦ, 2000. – 120 с.

11.3. Information resources

11. Економетрика – бібліотека ресурсів [Електронний ресурс]. – Режим доступу : http://efaculty.kiev.ua/ekon.htm.

12. Статистика України : науковий журнал [Електронний ресурс]. – Режим доступу : http://www.ukrstat.gov.ua.

13. Сайт Национального банка Украины. – Режим доступу : http://www.bank.gov.ua.

14. Сайт ПФТС. – Режим доступу : http://pfts.com.

15. Сайт Агентства по развитию инфраструктуры фондового рынка Украины. – Режим доступа : http://www.smida.gov. ua/db.

11.4. Methodical support

16. Мілевський С. В. Тестові завдання з навчальної дисципліни "Математичне моделювання в економіці та менеджменті: Економетрія" [Електронний ресурс] / С. В. Мілевський, О. А. Сергієнко, С. В. Прокопович. – Режим доступу : http://elearn2.ekhneu.org.ua/main/exercice.

17. Прокопович С. В. Математичне моделювання в економіці та менеджменті: Економетрія : опорний конспект [Електронний ресурс] / С. В. Прокопович, О. А. Сергієнко, С. В. Мілевський. – Режим доступу : http://elearn2.ekhneu.org.ua/main/document/document.php?cidReq=MMMECONOMETR&id_session=0&gidReq=0&origin=&id=53.

18. Сергієнко О. А. Методичні рекомендації до виконання лабораторних завдань з навчальної дисципліни "Математичне моделювання в економіці та менеджменті: Економетрія" [Електронний ресурс] / О. А. Сергієнко, С. В. Прокопович, С. В. Мілевський. – Режим доступу : http://elearn2.ekhneu.org.ua/main/document/document.php?cidReq=MMMECONOMETR&id_session=0&gidReq=0&origin=.

Appendices

Appendix A
Table A.1

The structure of the components of the professional competences of the academic discipline "Mathematical Modelling in Economics and Management: Econometrics" according to the NQF of Ukraine

The components of the competence which is formed under the theme	Minimum experience	Knowledge	Skills	Communications	Autonomy and responsibility
1	2	3	4	5	6
Content module 1. Econometric modelling basics					
Topic 1. Econometrics and econometric modelling					
Determining the purpose of analysis, a set that is modelled, the choice of the methods of analysis, optimizing the composition of information sources needed to build an econometric model	The idea of the nature of the economic structure, especially the various economic sectors, features of the use of macroeconometric models	Knowledge of types of econometric models, their features, the main stages of building an econometric model	Setting goals and objectives of the study, conducting a qualitative analysis of the research object, shaping information base research	Coordination of the formation program of research, information base of research, choice of software environment to implement econometric models	The development of the program of research, construction methods of analysis and forecasting of economic processes, the use of econometric models for the development of the scenario of fore-casts, assessment of risk management decisions
Topic 2. Simple linear regression					
Providing analysis and forecasting socio-economic processes on the basis of one-factor linear models	The criteria of Pearson, Kolmogorov – Smirnov, Romanovsky to test the distribution	Knowledge of estimating the parameters of linear one-factor econometric models, statistical signifi-cance testing criteria for parameters and models in general, the criteria for a model, features of one-factor forecasting based on linear models	The selection of the factor that should be included in the one-factor regression model to estimate the model parameters, to assess the quality of the model form point and interval forecast	Presenting the results of building a one-factor linear regression model to predict its use	Making decisions on the choice of the final version of the model of the socio-economic process of trial options, the use of models for analysis and forecast

Appendix A (continuation)

Table A.1 (continuation)

1	2	3	4	5	6
Topic 3. Multiple linear regression					
Providing analysis and forecasting of socio-economic processes based on multilinear models	Methods of regression model parameter estimation	Knowledge of multi-parameter estimation of linear econometric models, statistical significance of testing criteria parameters and models in general, the criteria for a model, features of forecasting based on a multifactor linear model	Providing selection factor attributes that should be included in a multifactor regression model, estima-ting model parameters, assessing the quality of the model form point and interval forecast	Presenting the results of constructing a multi-linear regression model to predict its use	Making decisions on the choice of the final version of the model of the socio-economic process of trial options, the use of models for analysis and forecast
Topic 4. The problem of multicollinearity in regression					
Carring out the construc-tion of econometric models in terms of multicollinearity	Methods of construction of general linear models	Knowledge of research models for the effect of multicollinearity, methods, evaluation of the models in terms of multicollinearity	Assessing the degree of multicollinearity and building econometric models in terms of multicollinearity using the methods of eliminating one of two highly related factors, the methods of ridge regression, the method of principal components, etc.	Presenting the results of building the econometric model in terms of multi-collinearity	Making decisions on the choice of the method of constructing a model in terms of multicollinearity, improving the forecast quality
Topic 5. Autocorrelation					
Carring out the construc-tion of econometric models in terms of residual autocorrelation	Methods of constructing general linear models	Knowledge of residue testing models for auto-correlation (the Durbin – Watson test, the von Neumann test et al.), methods of parameter estimation of econo-metric models in terms of autocorrelation	Implementing residue testing for the presence of autocorrelation models, parameter estimation using the methods of Aitken, Durbin, Cochrane – Orcutt	Presenting the results of building the econometric model in terms of residual autocorrelation	Making decisions on the choice of the method of constructing a model in terms of autocorrelation residues, improving the forecast quality

1	2	3	4	5	6
Topic 6. Heteroscedasticity					
Carring out the construction of econometric models in terms of residual heteroscedasticity	Methods of constructing general linear models	Knowledge of residue testing for heteroscedasticity models (the tests of Glejser, Park, Goldfeld – Quandt etc.), parameter estimation methods in terms of heteroscedasticity	Implementing the residue testing for the presence of heteroscedasticity models, parameter estimation using the Aitken's method	Presenting the results of building the econometric model in terms of residual heteroscedasticity	Making decisions on the choice of the method of constructing a model in terms of residual heteroscedasticity, improving the forecast quality
Topic 7. Nonlinear regressions. Productive functions					
The construction of nonlinear econometric models, production functions	Methods of general linear model construction	Knowledge of types of nonlinear dependencies that are used to describe the economic processes, their properties, methods, parameter estimation models, methods of the model quality assessment, features of construction of production functions	Providing choice of linear relationship to construct a model of the economic process, evaluating quality parameters and nonlinear models, building a production function to analyze production processes	Presenting the results of research on production-economic systems based on the production function of Cobb – Douglas	Making decisions on the choice of a nonlinear model for analyzing and forecasting socio-economic processes
Topic 8. Dynamic econometric models					
Providing time series prediction based on econometric dynamic models	Methods of linear and nonlinear econometric model construction	Knowledge of the model construction methodology of time series decomposition, evaluation of evolutive, cyclic, seasonal, casual components	Determining the type of time series decomposition models, building a trend model, estimating seasonal and cyclical component, assessing quality prediction	Presenting the research results based on time series decomposition of the time series models	Making decisions on the choice of the model type to study the decomposition of the time series and forecasting

Contents

НАВЧАЛЬНЕ ВИДАННЯ

Робоча програма навчальної дисципліни "МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ В ЕКОНОМІЦІ ТА МЕНЕДЖМЕНТІ: ЕКОНОМЕТРІЯ"

для студентів напряму підготовки 6.030601 "Менеджмент" усіх форм навчання (англ. мовою)

Укладачі: **Клебанова** Тамара Семенівна
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Подано тематичний план навчальної дисципліни та її зміст за модулями й темами. Вміщено плани лекцій і лабораторних занять, матеріал щодо закріплення знань (завдання для самостійної роботи, контрольні запитання), критерії оцінювання знань студентів.

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