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Teaching Methodology of Econometric Modeling with the Help of Interactive Teaching Methods

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ABSTRACT

The focus of the paper is the theoretical and practical issues of teaching methodology, based on econometric modeling. The article reveals the features of econometric construction models, based on formulas and functions, embedded in Microsoft Excel spreadsheet. With the help of this table processor the students were asked to further analyze economic objects and build their own forecasts. We introduce different variants of the approach to the construction of models, namely the possibility to choose between ready-made models, obtained with the help of built-in functions, and models, designed and implemented by students on their own with the help of formulas. Special attention is paid to the formation of professional and applied competencies, contributing to the development of economic thinking and the implementation of interdisciplinary intersections of econometrics, economic theory and computer science. The article shows the use of interactivity in the study of econometrics. The novelty of the research is the use of interactive teaching methods for the study of econometric modeling, parallel to the formation of economic thinking.

Keywords: Interactive teaching methods, pair work, model, econometric modeling, economic analysis of objects, forecasting.

1. INTRODUCTION

Present-day Russian system of higher education is a three-level structure which comes as a result of significant changes of the whole system of higher education. There is a consistent requirement for Russian universities to train highly qualified experts, relevant for domestic and international labor markets. It is important to note that the criteria for evaluating the effectiveness of Russian higher education institutions focus on the "job placement of graduates" indicator.

According to the Russian Federal State Education Standards (FSES) of higher education, the training program "38.03.01 Economy" is based on a number of competences and a system of credits. On completion the program graduates are expected to acquire common cultural competences; general professional competences; professional competences; applied professional competences and a number of professional skills, which make them qualified for the degree of "Academic Bachelor". These skills include economic cost accounting; analytical research and development; organization and management; teaching. However, there is one more degree – "Applied Bachelor" – which is focused around the following skills: cost accounting; financial accounting; banking clearing and management; insurance management (Russian Federal State Education Standards of Higher Education; Formation of the business model of a specialist with higher education, 1984; Harlamov 2001).

To introduce Russian FSES of higher education to basic professional educational programs of the third generation it is important to observe the significant requirement to use active and interactive methods and forms of learning activities in the process of education (Zelenina 2014).

Nowadays much attention is paid to active and interactive methods and forms of education which form the basis of many learning innovations: interactive lectures, group projects, presentations, scientific seminars, case studies' analysis, simulation of manufacturing processes or activities. In addition to the above, recent studies indicate that interactivity also include computer work and methods of using computer equipment (Zelenina 2014; Stupina 2009.).

It is important to note that the choice of interactive forms and methods depends on many factors: the unique aspects of the course, the subject matter of the educational material, the individual qualities of students, their abilities, etc. (Babanskij 1989; Formation of the business model of a specialist with higher education, 1984).

In modern conditions students devote a significant amount of time to working on their own, combining classroom and extracurricular work, studying the recommended literature and performing different types of tasks. To meet the imperative of the time and form the competencies it is critical to understand that highly qualified teachers are not enough. We need new teaching methods that enhance learning and cognitive activities, mental activities, and increase future graduates level of education.

2. DATA AND METHODS

Now we proceed to the description of methodological approaches to teaching econometric modeling which improve students' economic strategic thinking.

Econometric modeling tasks form a large number of skills, ranging from the analysis of the econometric model which describes economic processes and phenomena, to interpretation of findings and strategic decision-making. The above allows the formation of the following competencies: the ability to collect, analyze and process data necessary for professional applications (General Professional Competence-2); the ability to choose the tools for processing of economic data in accordance with the task, alongside with the ability to analyze the results of the calculations and justify the findings (General Professional Competence -3); the ability to build standard theoretical and econometric models, to analyze and interpret meaningful results, based on the description of economic processes and phenomena (Professional Competence-4) (Russian Federal State Education Standards of Higher Education).

The research of the economic process or activity with the help of the model is reduced to the addition of missing elements and links in relation to the original object. Models help describe the order of elements and build their common structure. They indicate the functioning of all elements in particular and the system as a whole. It is necessary to find out what economic process is reflected by the proposed model. Much attention should be paid to the specific features of the original object, reflected by the model. Finally, it is possible to decide on the further study of the phenomenon with the help of the model.

If models contain unknown elements (their conceptual content), they can be a source of educational information. For example, an equation serves as a means of representation, as well as, the reproduction in the external form of internal communications and relations among objects. Equations and their systems are typical econometric models, used to solve econometric problems. The amount of information about the object, received by a student while studying the model, is an important criterion for the methodological value of this model in the process of new material acquisition.

From many economic problems that can be solved with the help of econometric modeling, one can select a subset of tasks by the general method of solving them. It is possible to select series of tasks from each of these subsets. The solution of these series of tasks may be available in specific circumstances which lead to the decision of relevant educational objectives.

We start our analysis from the first type of tasks (preparatory level), which we call "tasks-components". Such tasks are complementary: they contain ready-made econometric models. It is important to pay attention to such tasks, as they help find a solution to problems of the second level - econometric problems. Part of the first type task result (or the entire result) may be a part of solving the problem of the second type, providing some outcome for it. Preparatory level task can bring methodological assistance. It can suggest the solution method, outline the general form of the solution, and the direction in which to begin to work.

The solution of such problems must be built in accordance with the structure of the modeling process, the intermediate result of which is the construction of an econometric model.

The tasks of the second type include:

1. Problems with the construction of regression models.
2. Problems with the use of simultaneous equations.
3. The practical application of econometric modeling tasks in microeconomics and macroeconomics.
4. Objectives of the economic analysis and forecasting based on time series.

To create a complex of econometric problems we must distinguish the following criteria for the selection of the content:

1. The plot of the economic tasks. Successful plots contribute to the motivation of studying the content.
2. The presence of basic and accessible problems, specific to economy and finance.
3. The technology of the solution process, *i.e.* the rules and regulations that require compliance of the results with the research purpose.
4. Multi-level tasking, *i.e.* the construction of tasks' system, based on the principle of increasing difficulty.

The main requirement for econometric problems is the presence of didactic functions. They should contribute to the creation of necessary conditions for the assimilation of theoretical material. Didactic functions develop the skills in accordance with the requirements of the syllabus and the required competences. In this context a problem acts as an independent didactic unit. Various authors (Burmistrova 2001; Kiyko 2010; Lukankin 1989; Meshcheryakova 1974; Stupina 2009; Uemov 1962) referred to problems in different ways. They differentiated between training problems, key problems and informative problems. We differentiate between a fact-problem and a problem-task. Preparatory level tasks should be seen as a fact-problem. The solutions to fact-problems result in a new fact, a new formula. Econometric problems should be seen as a problem of method. In the course of problem-method decision-making it is possible to find a new method or a new way of thinking.

Econometric modeling in training is a means of implementing a set of econometric problems, the essential features of which are as follows:

1. Applicability to the college course of econometrics.
2. The opportunity to use econometric approaches as the most appropriate ones in problem-solving while teaching econometrics as a subject.

To illustrate the application of the preparatory level tasks we will consider the theme "Binary regression" (Borodic 2004; Katyshev, Magnus and Pereseckij, 2002; Kiyko and Schukina 2016; Kremer and Putko 2002; Fedoseev, 2005). The students were asked to use Microsoft Excel spreadsheet to solve this problem-task (Yanovskij and Buhovec 2007; Kiyko 2005).

3. THE TASK OF THE FIRST TYPE "BINARY REGRESSION"

There are data about 17 Russian regions, which show the number of petrochemicals production (Y) and GDP per motorist (X) in 2015. The data are presented in Table 6.1.

Table 6.1
Data on the production number of petrochemicals and gross domestic product

Y	19	27	19	45	55	68	51	82	85	100	63	130	136	60	72	80	180
X	6	5	7	9	12	15	18	21	22	24	25	26	27	28	35	37	41

It is required for:

1. To calculate descriptive statistics with the built-in functions of Microsoft Excel spreadsheet. These statistics are focused on the processing of data obtained during the experiment. The results are of much practical value. Students have to calculate:
   - The sample mean average.
   - Sample variance.
   - Sample standard deviation.
   - Standard error.
   - Excess.
   - Asymmetry.
   - Calculate the sample coefficient of correlation.

2. To choose mean correlation coefficient.
3. To construct the correlation field of defined variables and to formulate a hypothesis about the type of relations.
4. To calculate the parameters of binary model regression Y where X : $y = a\_0 + a\_1 x$.
5. To assess the quality of the constructed regression equation using determination coefficient R2.
6. To evaluate the significance of the built regression equation with the help of Fisher F-test.
7. to perform petrochemical output forecast Y, if the value of gross domestic product X will be 108% of the average level.
8. To construct a 95% confidence interval for the forecast value.

An example of solving the problem.

1. With the help of the built-in Microsoft Excel spreadsheet "Descriptive statistics" function from "Data analysis" package let us build descriptive statistics (Table 6.2):

Table 6.2
Descriptive statistics

Y		*X*	
Mean average	74,82353	Mean average	21,05882
Standard error	10,40512	Standard error	2,667162
Standard deviation	42,90139	Standard deviation	10,99699
Sample variance	1840,529	Sample variance	120,9338
Excess	0,968328	Excess	–0,84705
Asymmetry	0,957655	Asymmetry	0,125673

On filling in the table, we can conclude the following:

- It is possible to define a clear and unambiguous description of the concepts that we are going to use in the construction of the model (descriptive interpretation).
- We are able to identify an order among the discussed concepts, their interrelations, their patterns, and so on (structural interpretation).
- It is possible to find out correlations (sometimes expressed in quantitative terms) between the initial concepts and variables (factorial interpretation).

2. With the help of the "Correlation" function we find the correlation coefficient (Table 6.3):

Table 6.3
Correlation Coefficient

	X	*Y*
X	1	
Y	0,764055	1

It is evident that the correlation coefficient is quite high. In other words, the petrochemical production and gross domestic product are in an average statistical relationship. Obviously, it is important to explore this relationship in more detail by means of regression analysis.

With the function "Diagram" we construct the correlation field (Figure 6.1).

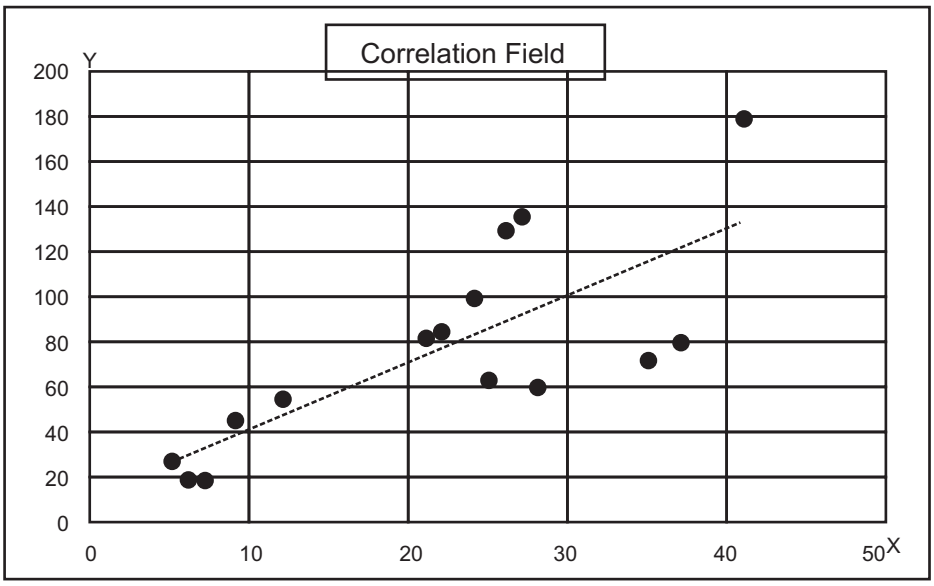

Figure 6.1: Correlation Field

The dots on the figure mark the original data. The straight line corresponds to the regression model.

With the function "Regression" let us find the parameters of the linear model, the coefficient of determination. Then we will check the model for statistical significance, and assess the quality of the constructed model (Table 6.4).

The resulting regression equation $y = 12{,}16 + 2.99 \cdot x + \varepsilon$ is statistically significant (F-statistics equals to 18,23 at *p*-value equals to 0.00091). This means that the identified relationship is meaningful and the model can be used for economic analysis and forecasting.

The coefficient of determination of the equation R^2 is 0.58. This suggests that the resulting model reproduces 58% of the overall variation in the endogenous variable – production of petrochemical products. A1 coefficient regression equation is statistically significant (*p*-value equals to 0.000912), and therefore can be interpreted economically. Its value indicates that, on average with an increase in gross domestic product to $ 10, the production of petrochemicals increase by 29.9 USD, *i.e.* approximately 30% of the additional gross domestic product, which is spent on petrochemicals.

The confidence interval for the parameter a_1 will be (1.48; 4.50). This interval does not contain zero, which is equivalent to a conclusion about the importance of a_1 parameter. a_0 parameter is not significant because of its *p*-value of 0.4885, which is higher than the standard value of 0.05. The confidence interval for the parameter a_0 is (–24.69; 49.01). It includes a zero value that is equivalent to the insignificance of this factor and, therefore, we argue that parametre a_0 has no real economic significance.

Let us find 108% of the average gross domestic product, according to the following formula: $21{,}05 \cdot 0{,}108 = 22{,}74$. We obtain the predicted value of $y = 12{,}16 + 2.99 \cdot 22{,}74 = 80{,}072$. We can assert that the gross domestic product, equals to 22.74 USD, where petrochemicals production will amount to 80.072 USD.

Table 6.4
Regression statistics of binary regression

Results					
Regression statistics					
Multivariate R	0,764054683				
R-square	0,583779559				
Norm R-square	0,551762602				
Standard error	30,35100244				
Observations	15				
Dispersion analysis					
	df	*SS*	*MS*	*F*	*Magnitude F*
Regression	1	16796,34979	16796,34979	18,23344919	0,000912552
Excess	13	11975,38354	921,1833492		
Total	14	28771,73333			
	Coefficients	*Standard Error*	*t-statistics*	*P-Meaning*	*Lower 95%*
Y-crossing	12,1619469	17,05956394	0,712910772	0,488501013	–24,69300033
X	2,986371681	0,699373936	4,270064308	0,000912552	1,475466151
					Upper 95%
					49,01689413

The first three tasks teach students to build regression models for the ready-made equation, to check the estimates obtained for statistical significance, as well as to evaluate the adequacy of the entire model. The last two tasks are a step in the preparation of students to work with the problem of the second type. In the constructed model students make economic forecasts, as well as set the correspondence between the correct choice of the linear model and empirical data.

After acquiring basic skills to address the first type of econometric problems (namely, forming the ability to collect, analyze and process data, students learn to select the tools to handle economic data, analyze the results of calculations and justify the findings), then we offer students to work in pairs. This working mode gives everyone the opportunity to participate in the work, to practice cooperation skills, interpersonal communication (*e.g.*, active listening, to express personal opinions on the issue, to develop a common view to resolve disagreements). To develop such skills is not always possible in a big team.

Working in small groups, the students have a great opportunity to be heard by the interlocutors, to solve disagreements and to reach consensus. The use of small group work also gives a positive effect, because it allows students to participate actively in the teaching and learning activities, practice the skills of mutually beneficial cooperation, multiply the skills to work in a team, to enrich the baggage of interpersonal communication and the principles of communicativeness and autonomy (Nyam 2014).

The group work can be applied to a variety of learning situations: learning new material, setting new goals, consolidating the material, the control of knowledge acquisition. Depending on the topic, the goal, the desired result, splitting students into groups can be carried out with a differentiating approach (Schukina and Schukina 2015).

Working with problems of the second type in pair work mode helps ensure a better knowledge of theoretical material and self-esteem. All these skills are necessary for the implementation of economic and statistical calculations, which allow the formation of knowledge about the mechanisms of construction of standard econometric models. These skills provide for the analysis of the interpretation of the results and contribute to the development of students' competencies (Schukina 2005; Schukina and Schukina 2015).

To illustrate the method, we consider the topic "Multiple Regression" (Borodich 2004; Magnus and Pereseckij, 2002; Kiyko and Schukina 2016; Kremer and Putko, 2002; Fedoseev 2005).

4. THE PROBLEM OF THE SECOND TYPE: "MULTIPLE REGRESSION"

The Keynesian theory established a linear relationship between demand, money supply and interest rates. Consider the model of the following form. Let m be the money supply (bln. rub.), y – the gross national product (GNP) (bln. rub.), i – the interest rates on 6-month federal bonds (%). Table 6.5 presents data on these variables for the period 2000-2015 in the economy of Siberian Federal District.

It is required:

1. To determine which of these variables will act as some endogenous variables, and which as exogenous, that is to build a model specification.
2. To rate OLS coefficients of the resulting model.
3. To justify economically the signs of coefficients in the constructed model.
4. To rate prognostic capabilities of the resulting model, taking into account the coefficient of determination.
5. To find the average coefficients of elasticity and provide their economic interpretation.
6. To rate the importance of the equation as a whole and the importance of individual factors.
7. To give an economic interpretation of the coefficients of the resulting model.
8. To forecast the dependent variable, provided that.

m = (mean value of money, increased by k%)

y = (GNP average value, reduced by k%)

i = (average value of the rate increased by k%)

k equals to the number of the test-variant).

Calculate the 95% confidence interval for values of explanatory variables.

Table 6.5
Data on the volume of money supply, the gross national product and the interest rate on 6-month government bonds

m	265,1	283,4	301,7	320	338,3	356,6	374,9	393,2
y	1106,50	1130,08	1253,38	1276,96	1400,26	1423,84	1547,14	1570,72
i	4,247	5,306	4,365	4,424	4,483	4,542	5,601	4,66
m	411,5	469,8	448,1	466,4	484,7	503	521,3	499,6
y	1694,02	1445,30	1568,60	1592,18	1715,48	1739,06	1893,20	1916,78
i	4,719	5,778	4,837	4,896	4,955	5,014	5,073	4,132

Students were asked to identify the economic object and the study purpose. Presenting the mental solution of the problem, students had to describe the economic entity (or form the econometric model). We, in turn, tried to warn them from the absolutism of the result, because even high-quality model is a model which tries to adjust specifications to the available empirical evidence.

With the help of the problem information about the properties of the structural and functional elements of the object, the students identified structural relationships and properties of the economic model: the "demand" of the money supply depends on the gross national product and on rates on 6-month government bonds, which in turn are regulated by time. Next, the students ahd to substitute the original object for its economic econometric "copy", "hold a dialogue" with it, that is, to highlight the most significant relations. Researchers (and such students are) need to remember that there are no ideal models. Due to the constantly changing conditions of the flow of economic processes there cannot be quality models. Even very resistant models need to be revised under new conditions.

After analyzing the conditions of the problem, the students found that the main object of the study is the amount of money in the Siberian Federal District. The aim of the research is to study the dynamics of broad money supply, which depends on the gross national product (GNP) and the interest rate on 6-month government bonds, as well as, to determine the amount of money at a specified value, based on the forecast of the gross national product and the interest rate.

The money supply demand dynamics was understood as the process of market accession (the money supply).

To determine the relationship between the elements of an econometric model, students began to form patterns. The changes in gross national product and rates on 6-month government bonds resulted in the conclusion that the econometric model of money demand is a multiple regression model with two exogenous variables that affect the endogenous variable. In this case we considered each of the three variables as dependent variables. We asked the students to find examples of factors that affect the amount of money from the theory of economics. The students identified the size of the official discount rate, as well as some open market operations, which affect the activities of commercial banks by the volume of resources available to them. The students also described the policy of quantitative loan restrictions. In our case the possibility of intensive monetary growth based on the implicit weak assumption of the inflow of foreign capital, simultaneously keeping inflation at a low level. So we directed our research at the main criterion of selecting the correct specification, i.e. the use of the model to predict values of the explained variable.

The result of the discussion was the model of multiple linear regression of the form : $m = b_0 + b_1 \cdot y + b_2 \cdot i$. Basic and affordable issues, specific to the sphere of economic theory, contributed to the motivation of studying the appropriate econometric material.

The models were constructed by means of "Data Analysis" MICROSOFT Excel spreadsheet (Table 6.6).

Resulting equation : $m = -255{,}65 + 0{,}308 \cdot y + 39{,}54i + \varepsilon$

The coefficient of determination $R^2 = 0{,}88$. This equation is meaningful (F-statistic = 0.0000122 <0.05) and by 88% explains the variation of endogenous variable m. The sign "+" in front of the variable i is not in line with expectations: it was natural to assume that the decrease in the interest rate *i* will lead to an increase in the money supply, *i.e.* the sign in front of the variable i must be negative. Similarly, if the money supply grows, the gross national product does not increase, but only prices are rising. It would be logical to assume that the coefficient of the variable *y* is negative.

Table 6.6
Regression statistics of multiple regression

Results						
Regression statistics						
Multiple R	0,936422					
R-square	0,876885					
Norm R-square	0,857945					
Standard error	32,02244					
Observations	16					
Dispersion analysis						
	df	*SS*	*MS*	*F*	*Magnitude F*	
Regression	2	94947,93	47473,9	46,296	1,22E-06	
Excess	13	13330,67	1025,43			
Total	15	108278,6				
Coefficients		*Standard error*	*t-statistics*	*P-meaning*	*Lower 95%*	*Upper 95%*
Y-crossing	–255,647	95,99678	–2,6630	0,0195	–463,036	-48,25
y	0,308229	0,03377	9,12743	5,13E-07	0,235275	0,3811
i	39,54393	17,74671	2,22824	0,04414	1,204489	77,883

The coefficient of elasticity of GDP $э_y = 0,308.\frac{1517,09}{402,35} = 1,16\%$ shows that the money supply will increase by 1.16%, if the gross domestic product grows by 1%. The coefficient of elasticity of interest rates on 6-month bonds $э_i = 39,54.\frac{4,81}{402,35} = 0,47\%$ shows that the money supply will increase if the rate on 6-month bonds increases by 1%.

The economic interpretation of the regression coefficients equation is associated with the analysis of the present situation. The value of the coefficient of the variable *y* (GNP), which equals to 0.308, indicates that in case of increase of GDP by one point, all other things being equal, the amount of money on average will increase by 0.308 billion. rub. Simultaneously, the coefficient value of the variable *i* (rate of 6-month bonds) value of 39.54 indicates that if there is an increase in rates by one point, other things being equal, the money supply will increase by an average 39.54 billion. rub.

The forecasted value is calculated up to the 10th version, where *y* = 1365,38 (the average value of GDP, reduced by 10%). The average value of the rate is equal to 5.30, (average rate increased by 10%). The result: *m* = –255,65 + 0,308 · 1365,38 + 39,54 · 5,30 = 374,29 m (bn. rub.). The analysis of these results shows that, on condition of the above-mentioned values of the explanatory variables, the money supply will average 374 billion. rub. with a probability of 0.95, i.e. it is almost certain to expect that the average value of m (the money supply) will cover the range from 305.12 to 443.46 billion. rub.

The assumptions made, the selected parameters of the problem, as well as, a simple econometric model of money demand, made it possible:

1. To follow the dynamics of the money supply, and its correlation with the gross national product and the rate of the bonds.
2. To determine the maximum amount of money.
3. To determine the time of stabilization of the monetary demand.
4. To interpret the elasticity coefficients and the coefficient of determination.
5. To forecast dynamics with the given predicted values of the model.

By means of solving the problem and doing research, the students understood that all correlations between fixed and variable values are expressed by the drawn up equations. Computer calculations covered all stages of solving the problems. Computers allowed the students to conduct research, to perform analysis of the results, to pay attention to the accuracy of algorithms, to evaluate the accuracy of the model, to face with an error of approximate calculations, and to see the interconnection of various sciences and disciplines, and, finally, to get the satisfaction from the work done.

Meeting the challenge of using a computer has allowed to "play" a variety of options for the development of the test of the economic process (the stabilization of the money supply, money supply growth resulting in inflation, potential revenue dependence on interest rates, the alternative cost of holding money).

During interpretation the model reflects reality, whose patterns are investigated in theory and therefore require interpretation by the formalization. In solving the problems, discussed above, the students had to improve their mental operations: analysis, synthesis, comparison, abstraction, generalization, concretization. Only after the students have mastered the basic techniques, processes, and methods of thinking, they acquire the ability to combine the knowledge, manifested in the performance of the proposed tasks.

To build a culture of problem-solving techniques we find it necessary to distinguish the following methodological solutions of econometric problems:

1. We tried to prevent our students from searching for solutions to econometric problems without analyzing the problems carefully. The process of analysis involves the consideration of logical conditions of the problem;
2. We were teaching our students to properly use economic terms. For this purpose, they had to use economic dictionaries and reference books;
3. We controlled the process of solving the problem.

After a detailed analysis of the work, which was carried out in pairs, we discussed the results. The students were asked to review and then perform their own case-assignment on "fictitious variables".

Case study: "Fictitious variables" (Borodich 2004; Magnus and Pereseckij, 2002; Kiyko and Schukina 2016; Kremer and Putko, 2002; Fedoseev 2005).

There is evidence of 31 observations on the cost of one-bedroom apartment sold in the primary housing market in the Kirov district of the city of Omsk. Apartment price is measured in units. The fictitious variable "Ground floor or not" equals to 1 unit, in case the apartment is located on the ground floor. 0 unit, if the apartment is on any other floor. The total area is measured in square meters. The time, left before the house is fully operational, is measured in months. The variable "We need transportation to and from work or not" equals to 0, if the house is a 15-minute walk from work, and 1 otherwise.

With the tool "regression" analysis in Microsoft Excel spreadsheet we designed and listed (Table 6.7) indicators of apartment prices dependences' from the factors.

In constructing the model of exclusion it is required to remove the first factor:

1. Ground floor or not.
2. The need/no need for transport to work.
3. The time left before the house is fully operational.
4. The total area.

The students' project should re-build a regression model using fictitious variables. The economic rationale of the entire model and the individual factors should be presented in the form of a presentation in Microsoft Office Power Point package (4-5 slides minimum).

Table 6.7
The regression statistics model with fictitious variables

Results						
Regression statistics						
Multiple R	0,82					
R-square	0,68					
Norm R-square	0,63					
Standard error	2207,94					
Observations	31					
Dispersion analysis						
Regression	4	274807688	68701922	14092712	3,06E-06	
Excess	26	126749909,5	4874996,521			
Total	30	401557597,5				
Coefficients		*Standard error*	*Statistics*	*Meaning*	*Upper 95%*	*Lower 95%*
Y-crossing	20875,65	2766,7	7,54	5,2108608	15188,25	2653,05
Ground floor or not	1231,55	903,3	1,36	0,1844520	–625,225	3088,338
Total area, sq.metres	484,00	67,8	7,14	1,393E07	344,6623	623,3443
The time left before the house is fully operational	–80,24	134,7	-0,60	0,5565513	–337,15	196,6629
The need/no need for transport to work	220,74	847,8	0,26	0,7966486	–1521,88	1963,56

The data in Table 6.7 allow us to achieve several objectives:

1. Firstly, students understand it that besides quantitative variables, there exist qualitative variables, whose value is expressed by a text description, a picture or any other way. To measure the quality parameters is not possible with the help of a numerical scale. Examples of qualitative variables are: the number of floors in the house, construction materials, location area (need/no need transport to work), etc.;

2. Secondly, students come to realize that the construction of the model is individual in each situation. Models should be based on serious knowledge of economic theory and statistical analysis.

5. RESULTS

The experimental verification of the data obtained in our study was conducted with the students who studied in the field of economics. The experiment took place in 2012 and 2015 during the academic years.

The hypothesis: A method of using interactive teaching methods in the study of econometric modeling contributes to the quality of economic thinking of students of economic universities thereby increasing the competitiveness of the future graduates.

In our experiment, the control group (CG) and experimental group (EG) were formed from two sub-groups of second-year students of economic department of Omsk State Agricultural University, whose specialization training program was "38.04.01 - Economy". The size of the subgroup was 24 persons. The distribution of students in the study groups was performed by the dean's office, regardless of their academic performance, capacity, etc. This ensures uniformity of EG and CG and the representativeness of the sample in the statistical analysis. Econometrics Education in the EG was carried out on the experimental procedure, the main provisions of which are reflected in the study, and CG - on the traditional.

Statistical evaluation of the experimental procedure was carried out using the Wilcoxon-Mann-Whitney test (Grabar' and Krasnyanskaya 1977). The test was used to identify differences in the distributions of the studied properties of objects in two sets. These sets were compared and described from the point of their properties. The results of the study of the properties of the members of the independent samples are of much value. There were enough requirements, which allowed the use of the Wilcoxon-Mann-Whitney test for testing the hypothesis. For example, the two samples were random and independent members of each sample were also independent of each other. The possibility of consultation between the members of the sample was excluded.

Due to the fact that we have preliminary data on the state of knowledge of students of the control and experimental groups (results of examinations), one-sided criterion is applicable for processing.

The null hypothesis (H_0): There are no significant differences in training methods, so experimental procedure does not give the best results with respect to the traditional techniques used in the control group, and the difference in the mean values of points emerged by chance.

The alternative hypothesis (H_1): An experimental method is significantly more efficient than traditional methods used in the control group, and the differences in the mean values did not appear by chance.

We united the sample data sets with EG and CG ranking procedure (see table 6.8).

Table 6.8
Data and ranking results of combining of the control and experimental samples

No.	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	23		1,5		27		14		29		25,5			32	38,5
		23	1,5		27		14			29	25,5			32	38,5

No.	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*	*No.*	*EG*	*CG*	*R*
		24	3			27	14			29	25,5		32		38,5
	25		6			27	14		30		28,5			32	38,5
		25	6		28		20			30	28,5			33	41
		25	6			28	20		31		33		33		43,5
	25		6			28	20			31	33		34		43,5
		25	6		28		20		31		33		34		43,5
	26		10			28	20			31	33			34	43,5
	26		10		28		20			31	33		35		46,5
		26	10		28		20			31	33		35		46,5
	27		14		29		25,5			31	33		36		48

We found the statistical significance criterion according to the formula T, based on the data of Table 6.8: T = S– (*n* · (*n* + 1)) / 2 where S - the sum of ranks samples with less volume, *n* – amount of the sample. We calculate the sum of ranks, $S = \sum_{i=1}^{n} R_i$

where R_i – rank assigned to the *i*-th sample of the object, we get: $\sum(R_{эГ}) = 610$, $\sum(R_{кГ}) = 566$. Sum of ranks with a smaller volume, ($\sum(R_{кГ}) = 566$), in this case - is the control group. To obtain the data of Table 6.8 that T = 566– (24 · (24 + 1)) / 2 = 266 (Grabar' and Krasnyanskaya 1977) where *n* – the volume of the sample.

Then we calculated the value of $W_{1-\alpha}$ according to the formula: $W_{1-\alpha} = n_1 . n_2 - W_{\alpha}$, where *n*_1 and *n*_2 – sample sizes, W_{α} – critical values that for sample sizes greater than 20. It is calculated according to the formula: $W_a = \frac{n_1 \cdot n_2}{2} + x_a \cdot \sqrt{\frac{n_1 \cdot n_2 (n_1 + n_2 + 1)}{12} - \sum K}$, where $K = \frac{k^3 - k}{12}$ – correction on the attribution of the same rank, which are the same in meaning, belonging to both samples.

The null hypothesis is rejected when the following inequality is satisfied:

$$T > W_{1-a}.$$

Where

$$a = 0{,}01,$$
$$x_a = 2{,}33,$$
$$n_1 = 24,$$
$$n_2 = 24$$

In this case we get he value

$$W_{0,01} = \frac{24.24}{2} + 2{,}33 \cdot \sqrt{\frac{24 \cdot 24(24 + 24 + 1)}{12} - 100}$$
$$= 398{,}32, \text{ respectively}$$
$$W_{1-0,01} = 24 \cdot 24 - 398{,}32$$
$$= 177{,}68$$

Inequality $T > W_{1-a}$ (266 > 177,68) is satisfied, so we have a reason to reject the null hypothesis and accept the alternative. This means that the method, used in experimental group, is more efficient than the method used in the control group.

6. DISCUSSION

The above led us to the conclusion that the proposed method helps activate economic thinking and stimulates the formation of competencies. Conscious mastery of the system of scientific knowledge led to the need for this knowledge and interest in the subject, consequently, this will allow graduates to compete in the labor market.

The analysis of the results of the experiment led to the conclusion that the proposed method of interactive teaching methods in the study of econometric modeling enhances the effectiveness of the development of economic thinking of students, it contributes to the positive dynamics of the level of competences' formation.

The study found that interactive teaching methods promote greater awareness and accessibility of the material under study; they are an effective means of overcoming formalism in the knowledge of students. Such methods allow to strengthen and develop the economic thinking that contributes to further improvement of the efficiency of econometrics study.

Any knowledge, that students master, can be absorbed by them only in the event that involves the whole system of mental operations. You can not learn how to analyze, if you are not in the context. We see that the mental development and, consequently, professional qualities of future experts depend strongly on how the learning content is built and how much attention is paid to the formation of mental actions.

7. CONCLUSIONS

We have analysed the particular method of econometric modeling teaching with the help of specific examples, using interactive teaching methods. No doubt, teaching econometric modeling contributes to the formation of competences, and therefore the development of economic thinking of students.

Simulating a particular process by creating econometric models, together with the students, we have paid great attention to the aspects of the work with the table processor Microsoft Excel that allows us to simplify the calculations required to solve regression problems, as well as to provide information visually.

Importantly, econometrics, being a relatively young science, is developing rapidly, and offers extensive use of new achievements, related to computer technology. The article discusses the possibility of implementing Microsoft Excel spreadsheet. Of course, there are more effective specialized software packages. Statistica, Econometric Views, STATA, etc., allowing more fully to describe the studied phenomenon and the simulated process. In our view, you firstly need to create a good foundation: form econometric modeling skills, learn how to use ready-made formulas for analysis, forecasting, and then to use more sophisticated software packages for the further improvement of formed skills. Further application of econometric modeling is a promising vista for the research to the authors, who use special software and interactive learning elements.

Econometrics plays an important role in shaping the economic thinking of students. The development of economic thinking, knowledge of econometric modeling will enable graduates of the university to meet the current level of economic development, to be competitive and keep them in demand in the labor market.

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