

# Model of Distribution of Budget Vacancies in University

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**ABSTRACT**— *In the current work we constructed the Model of Distribution of Budget Vacancies in University in conditions of Universities autonomy. In the article we determine the brand attractiveness of one budget vacancy and use this category into the model of distribution. The model of distribution based onto the linear optimization methods. We made distribution of vacancies in Simon Kuznets Kharkiv National University of Economics and receive real and optimize distributions. Its show uneven distribution structure and low level of orientation real distribution onto the demand of the national economy. This distribution gives tools to University in management of the budget vacancies distribution for the increase profitability of University.*

**Keywords**— budget vacancies, distribution, educational market, autonomy, profitability

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## 1. INTRODUCTION

The processes of higher education autonomization, which started in the 20th century in Europe, greatly influenced the development of the institutional autonomy of higher educational establishments worldwide. Universities autonomy allows the use of both existing and new features to enhance the university position.

Broadly speaking, the provision of university autonomy means granting it independence and responsibility in decision making. [1] In Magna Charta Universitatum universities autonomy is defined the next way: “The university is an autonomous institution at the heart of societies differently organized because of geography and historical heritage; it produces, examines, appraises and hands down culture by research and teaching”. [2]

The evolution of university autonomy can be seen as follows [1, 3]:

1) 1158 – the first adopted decree "On university autonomy» (Authentica habita, University of Bologna) by Emperor Frederick Barbarossa who sacked the students and teachers of duties and taxes;

2) 1231 – a formal appeal of the Pope - the Papal Bull (Parens Scientiarum, Paris), which recognized the right of universities as a legal entity to assign degrees;

3) the beginning of the XIX century – the idea of Wilhelm von Humboldt (Humboldt education reform) on the structure of the university, which was expressed in the form of freedom in teaching, learning, unity in education and research and formed the basis for a modern research university and the modern concept of academic freedom;

4) XIX century - Regulatory policy regarding universities of Western Europe (reducing the role of the autonomy of universities - increasing state control);

5) 1965 - International Association of Universities (IAU) defined university autonomy as an authority in decisions on: who will teach, what will be taught, who will learn, who gets a degree, and what should be researched;

6) 1970 - Organization for Economic Co-operation and Development (OECD) conducted the first study on the "index of autonomy" in decision-making structure among 52 higher education institutions in Europe.

Key stages in the lately development of the institutional autonomy of universities and their main provisions are summarized in Table 1.

The possibility of implementing the institutional autonomy main principles laid down in the Law of Ukraine "On Higher Education" [12].

In The Law university autonomy is defined as autonomy, independence and accountability of higher education in making decisions regarding the development of academic freedom, organization of educational process, research, internal governance, economic and other activities, independent selection and placement of personnel within the limits established by this Law.

Table 1. Key stages in the development of the modern university institutional autonomy

Event	Achievements
Magna Charta Universitatum (1988) [2]	Magna Charta states that the university should be an autonomous institution. It should be autonomous in research and teaching. Its research and teaching must be independent of all political and economic power to perform its role in society. Teaching and research in universities should be connected to meet the up to date needs of society. The fundamental principle of freedom in research and training is the main basis for university life.
The Lima Declaration on Academic Freedom and Autonomy of Institutions of Higher Education (1988) [4]	In Lima Declaration 'Autonomy' is defined as "the independence of institutions of higher education from the State and all other forces of society, to make decisions regarding its internal government, finance, administration, and to establish its policies of education, research, extension work and other related activities [4]". Governments should respect and maintain universities rights for academic freedom in education, research, administrative and service functions. No one can influence on the right to carry out research work. Lime Declaration also states an academic freedom in teaching, contacts with academic counterparts, freedom of study for students, freedom for association. The autonomy should also contain independent university's administration and determination of policies of education, research, extension work, allocation of resources and other related activities.
Sorbonne Joint Declaration (1988) [5]	Basic requirements for education qualifications in the academic field within Europe were structured in constructive scheme. The basis for recognition of higher education degrees among the countries of European Union was adopted. Further inter-university agreements and harmonization of the overall framework of degrees and cycles were stated.
The Bologna Declaration of 19 June 1999 [6]	The further development of the Bologna Magna Charta Universitatum principles was accepted by European higher education institutions. Universities' independence and autonomy should develop according to changing needs in society and scientific knowledge.
Salamanca Declaration (2001) [7]	Principles: Institutional autonomy with accountability. Education clearly viewed as a public responsibility. Enhancement of research-based higher education. Respect for diversity. Key Issues: Quality as a fundamental building block. Trust building. Relevance of the curriculum to real-world needs. Mobility of students, graduates, and professionals as a central value. Compatibility and flexibility in the framework for qualifications at undergraduate and graduate levels. Enhanced attractiveness of the European Higher Education Area for the rest of the world.
"Realising the European Higher Education Area" Communiqué of the Conference of Ministers responsible for Higher Education in Berlin on 19 September 2003 [8]	The main role of higher education quality in European Higher Education Area was proven. Ministers took commitment to support further development of education quality. They stated the need to develop universal criteria and methodologies on quality assurance. They also stated that the basic principles of education quality should develop within the institutional autonomy.
London Communiqué 18 May 2007 [9]	Development of the European Higher Education Area should be based on institutional autonomy, academic freedom, equal opportunities and democratic principles. Strong institutions, which are diverse, adequately funded, autonomous and accountable should play the main role in this process. The further implementation of principles of nondiscrimination and equitable access was stated.
Communiqué of the Conference of European Ministers Responsible for Higher Education, Leuven and Louvain-la-Neuve, 28-29 April 2009 [10]	The European values of institutional autonomy, academic freedom and social equity should be adopted in ongoing reform of higher education systems. The development of higher education institutions autonomy should be strongly connected with universities responsibility to society needs. Public funding will remain the main way to guarantee equitable access to higher education and further development of autonomous higher education institutions. But it is also needed to seek new funding sources and methods.
Budapest-Vienna Declaration on the European Higher Education Area March 12, 2010 [11]	The major role of an academic freedom, autonomy and accountability of higher education institutions in the European Higher Education Area was confirmed. According to these principles the higher education institutions will develop peaceful democratic societies and strengthen social cohesion.

Successful implementing of main principles of institutional autonomy will allow Ukraine's universities to maintain development in conditions of economic, social and demographic crisis.

The main challenges for the Ukrainian universities in this context are:

The difficult economic situation;

Negative changes in the demographic situation;

Increased competition in the market of educational services.

The deepening of economic crisis leads to a significant reduction in the population's solvency. In fact, most of the students are not able to pay for studying on a contract basis to university. Data illustrating stated problems are shown in Table. 2.

Table 2. Data illustrating negative tendencies in Ukraine\*

Indicator	2010	2011	2012	2013	2014	2015
Average income for one family, UAH	3481	3853,9	4144,5	4470,5	4563,3	5231,7
Inflation index	109,1	104,6	99,8	100,5	124,9	143,3
Exchange rate UAH/USD	7,93	7,96	7,99	7,99	11,88	21,84
Average monthly income for one family, USD	438,97	484,16	518,71	559,51	384,12	239,55
Amount of school graduates, thousands	391	364	215	329	304	247
Students accepted for training, thousands	392	314,5	341,3	348	291,6	259,9
Students who pay tuition fees, thousands	447	492	527	568	396	261

\*sources: State Statistic Service of Ukraine official site <http://www.ukrstat.gov.ua/> [13], National Bank of Ukraine official site <https://bank.gov.ua/> [14]

Fig. 1 shows the dynamics of changes in household incomes in Ukraine.

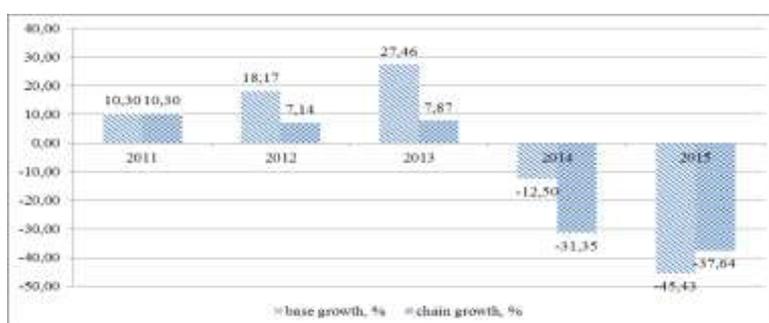


Figure 1. Dynamics of average monthly income for one family, USD (%)

The diagram illustrates the positive trend of income up to 2013 inclusive. Subsequent trend shows a substantial decrease in household incomes in both the chain and in basic terms.

A significant decline in real incomes and the increase in the negative effects of inflation reduces the ability of prospective students to pay tuition contract whose value is an average of 300 to 800 USD per year. These trends have led to increased tendency of sharp drop in number of students enrolled in the contract form of studying. This trend is approximated by a polynomial function of 2-nd degree ( $R^2 = 0,92$ ). Several smoother results obtained by predicting on average growth rates. The expected value of the amount of contract students will be: in 2016 – 234 thousand, and in 2017 – 210 thousand (Fig. 2).

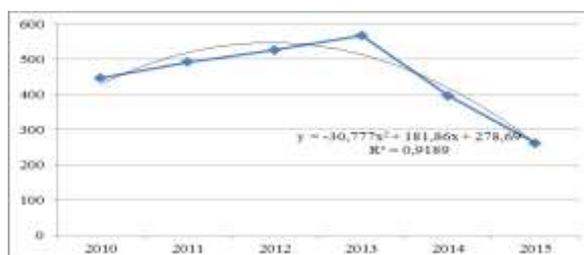
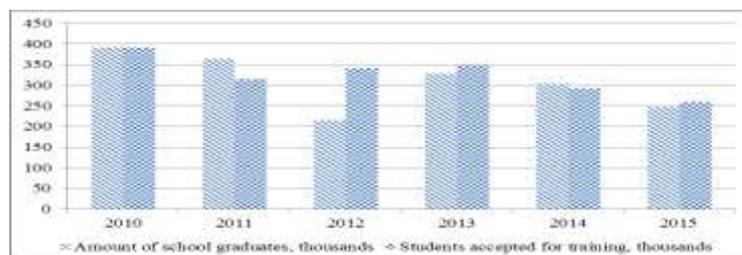


Figure 2. Trend in decreasing amount of "commercial" students in Ukraine (thousands)

Simultaneously with the reduction of solvent demand for university services, increased competition between institutions of higher education caused by demographic processes. There is a wave-like change in the number of school leavers with a clear downward trend. Accordingly, it reduces the number of potential applicants and students accepted for training (Fig. 3).

This situation significantly affects the development of higher education in Ukraine. Thus, the universities need to

make maximum use of all opportunities to preserve autonomy and strengthen their positions. One of the ways is to strengthen the financial autonomy of universities independence. Implementation of this direction allows to intensify the process of resources attraction. Among the higher education funding sources share of the tuition fees takes a considerable position. Implementation of higher educational establishments autonomy in the area of internal control is possible by redistribution of “budget” vacancies between the university specialties. The solving of this optimization problem will both increase the economic efficiency and financial autonomy of the university, and will help to strengthen the brand attractiveness of the higher educational establishments.



**Figure 3.** Decreasing trend of students, accepted for learning in higher education institutions

Total funding of higher educational establishments in Ukraine consists of two main components: funding from the state budget - according to the number of a budget vacancies assigned to a specific higher educational establishment, and funding from individuals and legal entities - the so-called "contractual" places. In the conditions of adopted in 2016 budget vacancies allocation system, higher educational establishments has no control over their redistribution between specialties within the university. This greatly reduces the possibility of effective management of higher educational establishments activities and violate the principles of autonomy. In addition, the adopted rules imply that the amount of budget vacancies allocated in the next academic year cannot be more than in the previous. Thus, with the natural fluctuations of the number of students between the regions and universities there is a risk of a stable change of the regional distribution of public funding of higher educational establishments. To minimize these negative effects it seems to be appropriate to provide autonomy of higher educational establishments in the field of redistribution of budget vacancies between specialties (or specializations). This will also increase the overall attractiveness of the university for students and its economic efficiency through the implementation of the principles of autonomy. To solve this problem optimization economic and mathematical model was developed. It optimizes the distribution of "budget" vacancies between specialties (or specializations) within the university. We propose to solve following task for this aim:

- i) Determination of the demand for specialists with higher education in specializations;
- ii) Construction the model of the distribution of budget vacancies;
- iii) Analysis the optimize and real value of the of the distribution of budget vacancies in University;

We constructed methodology to solve these tasks.

## 2. METHODOLOGY

### 2.1. Objective function

The main purpose of distribution of budget vacancies in universities could be described from two sides. From the external side, effective distribution of budget vacancies increases the brand level of university in the competitive environment. From the internal side, we can increase the profitability of university through distribution of budget vacancies. In this case, we need determine the brand attractiveness of one budget vacancy for the university.

The unbudgeted vacancies have great importance for the profitability of university in the conditions of increase of university's autonomy. Therefore, university can use the distribution of budget vacancies for the management of unbudgeted distribution because big correlation exists between unbudgeted and budget vacancies.

The objective function of model of distribution of budget vacancies is maximize of brand attractiveness of university, which includes local attractiveness of one budget vacancy for each specialization. It is calculate by the formula:

$$Z_i = \sum_{i=1}^m U_i b_i \rightarrow \max \quad (1)$$

where  $m$  is quantity of specialization in university;  $b_i$  is the share of quantity of budget vacancies for  $i$  specialization;

$$U_i = \frac{UB_i}{B_i} \quad (2)$$

where  $U_i$  is brand attractiveness of one budget vacancy for  $i$  specialization in specialty;  $UB_i$  is retrospective quantity of unbudgeted vacancies by  $i$  specialization in specialty;  $B_i$  is retrospective quantity of budget vacancies for  $i$  specialization in specialty.

## 2.2. Linear constraints.

i) The limit of shares of budget vacancies

$$\sum_{i=1}^m b_i \leq 1 \quad (3)$$

ii) Volatility condition for specializations

Volatility shows the changes of budget vacancies and includes two coefficients. There are brand attractiveness coefficient of specialization of the national economy ( $k$ ) and variance coefficient of brand attractiveness of specialization in university ( $v$ ).

The brand attractiveness coefficient of specialization shows the change of the demand for specialist of high education by each specialization for the labor market and calculated by the formula

$$k_i = \sqrt[n-1]{\frac{Y_n^i}{Y_1^i}} \quad (4)$$

Where  $Y_n^i$  is forecast level of demand of the high education specialist for  $i$  specialization;  $Y_1^i$  is retrospective level of demand of the high education specialist for  $i$  specialization.

The variance coefficient of brand attractiveness of specialization shows sensitivity to changing demand onto the high education specialist for each specialization. It is calculated by the formula

$$v_i = \frac{\sigma_i}{\bar{v}} \quad (5)$$

Therefore, the total volatility condition is

$$\begin{cases} b_i \leq b_i^{\max} \cdot k_i + b_i^{t+1} \cdot v_i \\ b_i \geq b_i^{\min} \cdot k_i - b_i^{t+1} \cdot v_i \end{cases} \quad (6)$$

Where  $b_i^{t+1}$  is forecast of the share of budget vacancies by  $i$  specialization in  $t+1$  period;  $b_i^{\max}$  and  $b_i^{\min}$  is minimum and maximum levels of the interval forecast of the share of budget vacancies.

Thus, the model of the distribution of budget vacancies is

$$Z_i = \sum_{i=1}^m U_i b_i \rightarrow \max$$

$$\begin{cases} \sum_{i=1}^m b_i \leq 1 \\ b_i \leq b_i^{\max} \cdot k_i + b_i^{t+1} \cdot v_i \\ b_i \geq b_i^{\min} \cdot k_i - b_i^{t+1} \cdot v_i \end{cases}$$

(7)

### 3. RESULTS

#### 3.1. Determining of the parameters of objective function

According the solving of first task of our investigation, we forecasted the demand of higher educational specialists by the each specializations, which included into the Economics specialty. These data show in the table 3.

Table 3. The demand for specialist with higher education for national economy

Specialization	Interval forecasts		Share of the budget vacancies		Forecast 2017
	minimum	maximum	minimum	maximum	
Labor economics	1524	1684	0,085	0,085	1604
Enterprise economics	1747	1931	0,097	0,097	1839
Accounting and taxation	3267	3611	0,181	0,181	3439
Economic theory	348	384	0,019	0,019	366
Finance, banking and insurance	5946	6572	0,330	0,330	6259
International Economics	671	741	0,037	0,037	706
Marketing	2447	2705	0,136	0,136	2576
Applied Statistics	1052	1162	0,058	0,058	1107
Economical Cybernetics	1027	1135	0,057	0,057	1081

This table shows that exist high level of share for the following specializations: finance, banking and insurance (0,330) and accounting and taxation (0,181). The analyses of the direction of the national economy development give us following data concern brand attractiveness coefficient (table 4). In addition, we calculated the variance coefficient of brand attractiveness in this table.

Table 4. The volatility coefficients

Specialization	Average value of attractiveness of one budget vacancy ( $U_i$ )	Variance coefficient ( $V_i$ )	Brand attractiveness coefficient ( $K_i$ )
Labor economics	1,38	0,52	0,964
Enterprise economics	1,16	0,51	0,951
Accounting and taxation	1,17	0,36	0,923
Economic theory	0,31	0,07	0,844
Finance, banking and insurance	0,74	0,25	0,939
International Economics	1,03	0,36	0,95
Marketing	1,08	0,36	1,011
Applied Statistics	0,47	0,27	0,965
Economical Cybernetics	0,77	0,22	0,952

Thus, the calculation of the date of linear constraints is in the table 5.

Table 5. Linear constraints of model

Specialization	Limits of the linear constraints	
	$b_i^{\min} \cdot k_i - b_i^{t+1} \cdot v_i$	$b_i^{\max} \cdot k_i + b_i^{t+1} \cdot v_i$
Labor economics	0,0375	0,1254
Enterprise economics	0,0427	0,1416
Accounting and taxation	0,1020	0,2325
Economic theory	0,0149	0,0176
Finance, banking and insurance	0,2272	0,3922
International Economics	0,0219	0,0487
Marketing	0,0884	0,1861
Trade management	0,0405	0,0720
Applied Statistics	0,0417	0,0668
Economical Cybernetics	0,0375	0,1254

### 3.2 Distribution of budget vacancies in Simon Kuznets Kharkiv National University of Economics

We calculated  $b_i$  base the date from table 4 and table 5. The results of the calculations are in the table 6.

Table 6. The results of the optimization of distribution of budget vacancies in University

Specialization	Optimized absolute value of brand attractiveness of one budget vacancy		Real absolute value of brand attractiveness of one budget vacancy in 2013		Budget vacancies 2013	
	objective function	The share of budget vacancy	objective function	The share of budget vacancy	Real	Optimized
Labor economics	0,173	0,125	0,093	0,068	20	37
Enterprise economics	0,164	0,142	0,157	0,135	40	42
Accounting and taxation	0,272	0,233	0,178	0,152	45	69
Economic theory	0,005	0,015	0,008	0,027	8	4
Finance, banking and insurance	0,168	0,227	0,245	0,331	98	67
International Economics	0,023	0,022	0,122	0,118	35	6
Marketing	0,166	0,154	0,080	0,074	22	46
Applied Statistics	0,019	0,041	0,024	0,051	15	12
Economical Cybernetics	0,032	0,042	0,034	0,044	13	12
TOTAL	1,022	1,000	0,941	1,000	296	296
Efficiency			<u>0,92</u>			

Note. The calculation made by 2013 year because we have four level cycle for bachelor and forecast demand for 2017 year (table 3).

We have following results of the analysis of the distribution of the budget vacancies:

i) The negative disproportion looked between optimize and real budget vacancies for the international economics specialization (483%), economic theory specialization (100%) and finance, banking and insurance specialization (46%).

ii) In that time, some specializations need more budget vacancies. There are marketing (52% increase), labor economics (46%) and accounting and taxation (35%).

iii) The efficiency of real distribution of budget vacancies is 0,92 (92%). It shows that negative and positive disproportions are compensate each other. However, the value of objective function is too close to the real distribution, in fact, the structures of model and real distributions are different. In optimize distribution of the budget vacancies we used exogenous factor of national economy that help us to receive 8 percent increase brand attractiveness of Economics specialty in university.

## 5. CONCLUSION

Thus, we have following main results in this article:

1) We constructed the model of distribution of budget vacancies, which maximize the brand attractiveness of University through optimize of budget vacancies for Economics specialty. It help us to receive efficiency distribution of budget vacancies between the specializations of this specialty. In result, on 8 percent increase brand attractiveness of Economics specialty.

2) The objective functions for real and model values of the distribution are too close. But variation of the disproportions between them is 285%. In fact, the structures of model and real distributions are different and it shows low level of orientation real distribution onto the demand of the national economy. In this situation, University needs to find a balance between its interests and the interests of the national economy. This balance can be based onto the profitability of budget and unbudgeted vacancies in University.

Thus, followed by the development of model is modification of model for the determination of profitability University through interrelations of budget and unbudgeted vacancies in Economics specialty.

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