

Investigation of Demand and Stability of Ukrainian Educational Market

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ABSTRACT— *In the current work we analyze the demand and stability of the development of Ukrainian educational market. In the article we propose the methodology of the investigation of higher educational market which includes three main units. We determine the structure of demand for specialists with higher education for certain types of economic activity. Also, investigation of the disproportions between supply and demand of specialists with higher education by the economic activity areas. In the article, we analyzed the stable and unstable periods of the educational market development and cointegration educational market with the labor market. The stability theory and non-linear analysis are the mathematical tools of the investigation.*

Keywords— higher education, stability, demand, educational market, forecasting.

1. INTRODUCTION

The investigation of the reforms onto the educational market is one of the actually problem in the last two decades (Neave, 1988; OECD, 2003; Eurydice, 2000; 2008). A lot of country made a series of reforms since 1990s and many current educational reform initiatives have their origin in this period. The changing role of the state vis-a-vis higher education institutions was a main reform in this period [5].

Also, we can look marketisation of higher education - the application of the economic theory of the market to the provision of higher education (Williams, 1995, Brown, 2010).

As noted by Ben Jong Bloed (2010), higher education funding has multiple aspects: who pays for higher education (including the topics of cost-sharing in higher education and external funding to universities), how public funding is allocated to universities, what incentives the allocation mechanism creates, and how much autonomy universities have in decision-making over financial and human resources [8]

P.Maasen (2000) [10] considers that in Europe the massification of higher education over the last two to three decades has resulted in substantial increases in the level of public funds directed to higher education institutions. In particular during the 1980s and early 1990s, governments have looked for ways to make higher education more efficient in order to put an end to the continuous growth of the higher education budget. In many countries this has led to a growing interest of higher education institutions in non-public sources of income. In other countries the foundation of the funding mechanism changed from input based to output oriented [9, 11, 12]. As a consequence of these developments, and also encouraged by the growing Europeanisation and globalisation of higher education, much interest has emerged in looking abroad for new perspectives on the organisation and funding of higher education and for understanding how other (European) countries have dealt with their budgetary problems concerning higher education

The system of higher education in Ukraine is indicated by two aspects [5, 7]. From one hand, it is sufficiently developed in the component fundamental-natural, technical, medical, educational, training. From the other hand, it is extremely insensitive to changes in the market environment. The main aim of the government is reforming activity of higher education in the new socio-political environment, to balance it with the needs of the economy and people. For this,

need solve following important tasks: expansion of university autonomy; development of higher education in Ukraine on the basis of a pan-European system of academic work of students; strengthening the interaction of higher education and the labor market; establishing the principle of equality of all forms of Universities and their faculty; improving social security of teachers and students, the construction of a new system of relations between legislative bodies and educational institutions. An effective instrument for this adjustment is justified change of government order on certain areas of training and qualifications within selected state order for a university. Therefore, the development and improvement of methodological approaches to the investigation of stability and demand on the educational market, construction of adaptive mechanisms determining labor market needs for competency and quantitative component specialists with higher education are the actually problem.

Therefore, the investigation of the demand, supply and stability of educational market are the global aim in the regulation of this market. We propose to solve following task for this aim:

- i) Determination of the structure of demand for specialists with higher education for the different types of economic activity;
- ii) Investigation of the educational market stability;
- iii) Forecasting demand and supply onto the educational market;

We constructed methodology to solve these tasks.

2. METHODOLOGY

The methodology of investigation includes three main units (fig. 1).

2.1. Expert analysis of structures of supply of higher educational market and demand of labor market.

We used expert analysis for the investigation of the structure of demand with higher education specialist. The choice of experts is the first step of this analysis. For our tasks we choose ten main specialists in the management of economic activity area. Each expert constructed structure of the demand by following rule: total sum of all sciences (18) by each economic activity area is 100 (appendix).

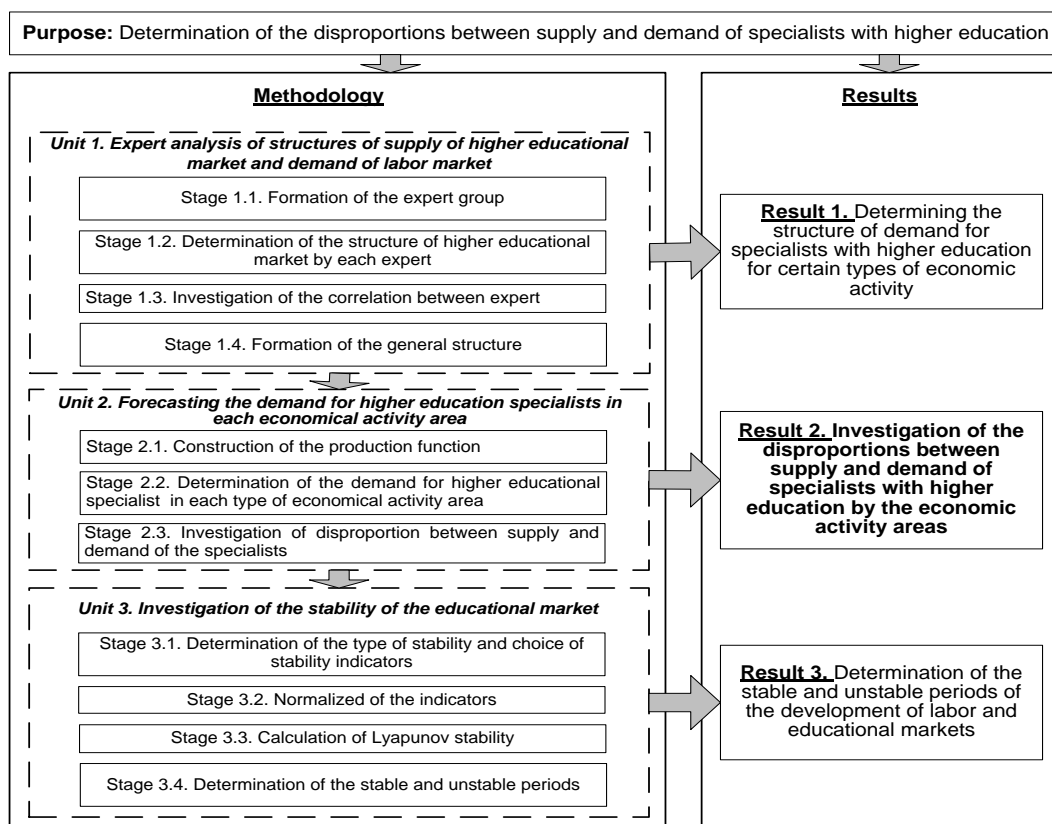


Figure 1. Methodology of the investigation of higher educational market

The high correlation between experts is a one of the main condition of the using of expert analysis. We propose to use rang pair correlation coefficient for this aim. If the expert's opinions are correlate each other, and then we construct general structure by following rule. Each cell of the general structure is average of the estimates of each expert.

2.2. Forecasting the demand for higher education specialists in each economical activity area

The traditional economical mathematical instrument for the investigation relation between labor market and national economy is production function. The production function has some types, but in our paper we will use Cobb-Douglas function with time parameter. This parameter demonstrates the influence of the science progress onto economy. This function is

$$Y = a_0 L^{a_1} K^{a_2} e^{a_3 t}$$

Where a_0, a_1, a_2, a_3 are parameters of the function, L – labor market's factor, K - capital factor, t – time.

We used following factors in the model: the demand of high educational specialist by economical activity area as labor factor and investment into the facilities as capital factor. We will receive formula of the demand for the specialist after the some transformation.

$$L = \sqrt[a_1]{\frac{Y}{a_0 K^{a_2} e^{a_3 t}}}$$

The forecasting demand for the specialist allows calculating the quantitative structure of demand by economic areas and educational sciences. Quantitative structure of demand is a base of the investigation of disproportion between demand of labor market and supply of educational market. Structure rows show the demand for specialists by each economical activity area and structure columns show the demand of specialists by educational sciences (required supply). The disproportion onto the educational market is inequality between required and real supply of specialists. The formula is

$$D^j = \sum_i q_i^j - S^j$$

Where D^j is estimate of disproportion for j science; q_i^j - required supply j science specialist in i area S^j - real supply.

2.3. Investigation of the stability of the educational market

In this unit we used ordinary Lyapunov stability. The trajectory is sustainable by *Lyapunov* if there is another trajectory $y(t)$ that goes from y_0 and close to the trajectory $x(t)$ at any time (point y_0 is close to point x_0) (fig. 2).

The stability has two main kinds; there are classical stability and asymptotical stability.

Classical stability for the trajectory determined following equation:

$$\|x(t) - y(t)\| < \varepsilon, \text{ if } \|x_0 - y_0\| < \delta \tag{1}$$

Asymptotical stability is

$$\lim_{t \rightarrow \infty} \|x(t) - y(t)\| = 0, \text{ при } \|x_0 - y_0\| < \delta \tag{2}$$

The main idea of the Lyapunov stability in the educational market is determine of stability of the interrelation between requirements of labor market and supply from the educational market.

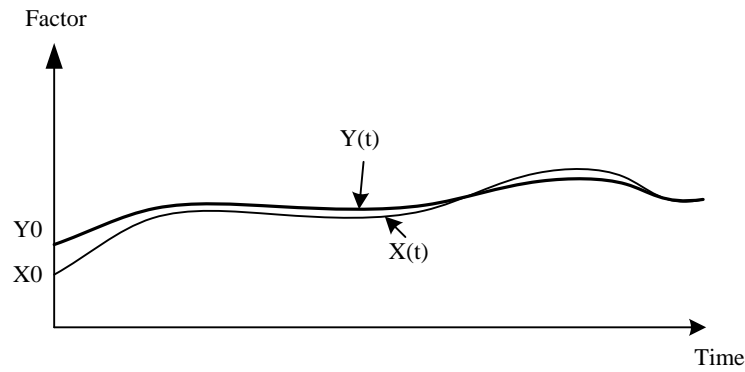


Figure 2. Lyapunov stability

3. RESULTS

3.1. Determining the structure of demand for specialists with higher education for economical activity areas

The calculation of the general structure of higher educational specialists demand is in the table 1. This table shows that exist high interrelation (more then 60% in the structure) between some economic areas and some sciences. Thus, Fishing is correlated with Agriculture, forestry and fisheries (83% in structure). Mining, Manufacturing, Electricity, gas and water are correlated with Engineering. Financial activities, real estate, renting and business activities are interrelation with Social sciences, business and law Transport and communication, Education are correlated with relevant science.

Table 1. The structure of demand for specialist with higher education

Economic activity area	Science																		Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Agriculture, hunting and forestry	0	0	5	4	4	0	2	4	45	27	8	0	0	0	0	0	0	1	100
Fishing	0	0	5	4	4	0	2	0	83	0	0	0	1	0	0	0	0	1	100
Mining	0	0	17	10	61	0	0	8	0	0	0	0	1	0	0	0	3	0	100
Manufacturing	0	1	17	10	60	1	0	0	4	0	0	0	2	0	0	0	2	3	100
Electricity, gas and water	0	0	8	10	60	15	0	0	0	0	0	2	0	0	0	0	3	2	100
Construction	0	1	10	10	18	52	0	8	0	0	0	0	0	0	0	0	1	0	100
Trade; repair of motor vehicles, household goods and personal use	0	0	45	4	40	0	3	0	0	3	1	0	1	2	0	0	1	0	100
Hotels and restaurants	0	0	16	7	20	0	2	0	3	3	0	0	3	43	0	0	1	2	100
Transport and communication	0	2	9	3	16	0	60	0	0	0	0	2	3	3	0	0	1	1	100
Financial activities	0	2	64	10	14	0	2	1	0	0	0	0	1	2	0	0	2	2	100
Real estate, renting and business activities	0	3	60	6	8	0	0	2	0	0	0	0	4	8	0	0	4	5	100
Public administration	0	0	59	6	11	0	0	0	0	0	0	0	1	5	10	3	3	2	100
Education	61	5	14	5	1	1	1	1	1	1	1	1	1	1	1	1	2	1	100
Health and social assistance	0	1	3	5	10	0	0	0	0	0	0	53	20	5	3	0	0	0	100
Provision of communal and personal services; cultural and sport	7	57	4	2	4	0	0	0	0	0	0	0	5	15	3	0	3	0	100
Activities of households	5	0	38	2	4	0	0	0	13	0	10	10	3	12	0	0	3	0	100
Activities of extraterritorial organizations	1	1	40	7	12	0	0	0	0	0	0	10	6	5	10	5	0	3	100

Note: 1 – Education; 2 - Humanities and arts; 3 - Social sciences, business and law; 4 - Ordinary science; 5 –; 6 - Construction and architecture; 7 – Transport; 8 - Geodesy and land planning; 9 - Agriculture, forestry and fisheries; 10 - Technique and energy agricultural production; 11 – Veterinary; 12 – Health; 13 - Social security; 14 - Service sector; 15 - State management; 16 - War science; 17 – Security; 18 – Special science.

The estimation of the correlation between expert shows that all correlation coefficients are more than 0.75. We can make conclusions about high correlation between experts and possibility of using of the general structure of the demand for the future investigation.

3.2 Investigation of the disproportions between supply and demand of specialists with higher education by the economic activity areas

The dynamic of demand of the high educational specialists shows on fig 3.

We can see in fig. 3 that demand has three main periods

i) Period of creation and formation of a national economy (1991-1997 years). In this period the national economy was being formed breakup of Soviet Union. There was a transition from state ownership to private. A lot of specialist had a Soviet education and labor flow is the main reason of the demand in this period.

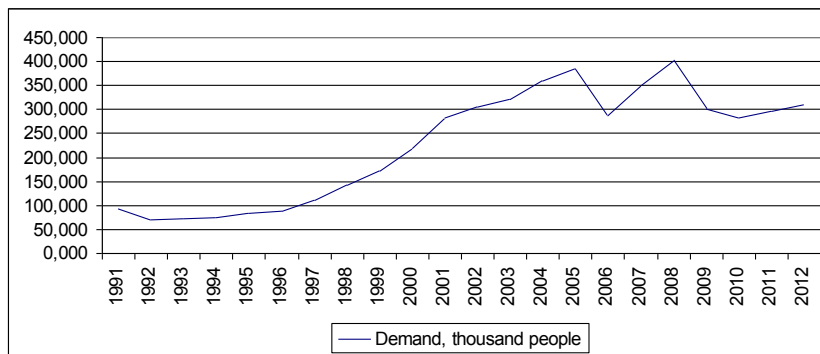


Figure 3. Demand for the high education specialist, 1991-2012 years by Author [13, 14]

ii) Permanently growth (1997-2005 years). During this period, the Ukrainian economy has had high growth rates, which led to the welfare and high standard of living, which has increased the attractiveness of higher education and the requirement on the part of enterprises to skilled high-level skills.

iii) Stability period (2005 – till now). Economy has stable structure. Financial crisis decreases economical growth. Main aim demand is support of personnel flow and outflow.

The supply of specialists shows on a fig.4

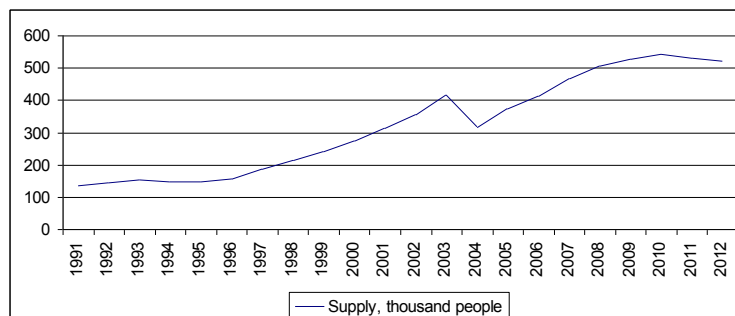


Figure 4. Supply for the high education specialist, 1991-2012 years by Author [13, 14]

Also, we can see three periods on a fig. 4

i) Period of creation and formation of a national educational market (1991-1997 years). Educational system in this period adopted for the new economical condition. Big inflation led to low level of welfare and big unemployment which limits opportunity to receive higher education.

ii) Permanently exponential growth (1997-2003 years). In the educational market created a large number of private universities, which could provide more flexible conditions for higher education that caters to the growing needs of the population.

iii) Permanently logarithmic growth (2004 – till now). Some big changes were in education system after 2004. More complicated Licensing requirements were formed. In 2010, educational system reached its limit in the modern economical and demographical situation.

The investigation of the dynamics of demand and supply allowed construction the production function. Models of demand for main three branches are in the table 2 (all models are in the Appendix 1)

Table 2. Models (fragment)

Economical activity area	Models
Agriculture, hunting and forestry	$L = 0,03 \sqrt{\frac{Y}{14422 K^{0,009} e^{0,145t}}}$
Mining	$L = 0,434 \sqrt{\frac{Y}{107,3K^{0,122} e^{0,193t}}}$
Manufacturing	$L = 0,79 \sqrt{\frac{Y}{7,78K^{0,183} e^{0,09t}}}$

We can calculate the demand for specialists in each economic area using the production function (table 3, Appendix 1).

Table 3. Demand for the specialists with higher education level

Economical activity area	Demand, people
Agriculture, hunting and forestry	38380
Mining	1939
Manufacturing	30696

We receive value of required supply based on the results from table 1 and table 3. The results of calculation of disproportion are in the table 4. We have following results of the analysis of disproportions:

i) Throughout the educational market offers specialists with higher education is 10% more than demand that show the strength of the national economy in the labor resource. However, at the same time, this leads to an increase in unemployment of specialists with higher education;

Table 4. Disproportions in the specialists with higher education level

Supply	Sciences								
	1	2	3	4	5	6	7	8	9
Required	19298,43	5443,71	83490,4	17237,58	66958,1	5243,45	10849,56	2863,9	20322,77
Real	23397	32563	148643	20196	54073	10719	11089	2260	5363
Disproportion	4098,57	27119,3	65152,61	2958,42	-12885,1	5475,55	239,44	-603,91	-14959,8
	10	11	12	13	14	15	16	17	18
Required	12875,64	4256,2	22453,1	11728,8	11079	6093,06	1670,87	4418,1	3565,85
Real	3573	1665	11437	1484	3576	1388	182	2575	6306
Disproportion	-9302,64	-2591,2	-11016,1	-10244,8	-7503,38	-4705,06	-1489	-1843,13	2740,15

ii) In the education market, there is a balance only for Transport Sciences. For all other educational sciences, there is a positive or negative disproportion (disproportion more then 10%).

iii) Eleven sciences have negative disproportion (demand more than supply) and six sciences have positive disproportion.

3.3. Determination of the stable and unstable periods of the development of labor and educational markets

We used Lyapunov stability for the investigation of the educational market stability. The stability trajectory is on the fig. 5

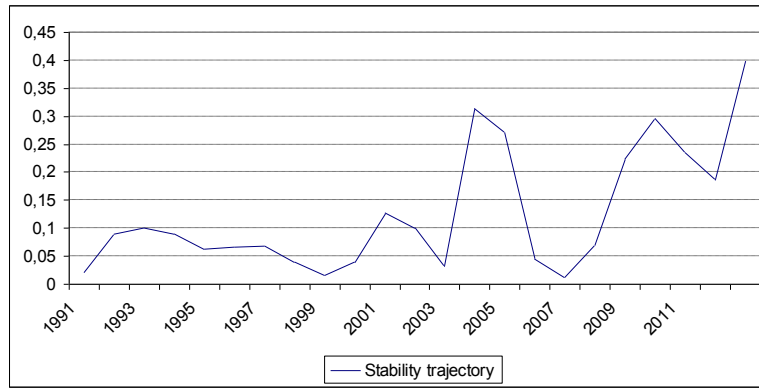


Figure 5. Stability trajectory

We have following results of the analysis of stability trajectory:

- i) The interrelation of the labor and educational market is stable till 2003. After this year national economy continued to grow as the educational market has reached stability.
- ii) Also, we can see stable situation during 2006-2008 years. But financial crisis destroyed growing tendencies of the national economy and educational market.
- iii) In 2013, we forecast increase unstable trajectory. For our opinion we have following reason. Firstly, economical situation is very hard and need global structural changes in economy. In this case, the structure of higher educational specialists should be change. Secondary, attractiveness of higher education for the people gradually falls, because young specialists have a lot of problems for the future possibility for work.

5. CONCLUSION

Thus, we have following main results in this article:

- 1) We offered approach for the investigation and forecasting of the stability educational market, which allows us to calculate disproportion between demand and supply of the higher education specialist and forecast the Lyapunov stability. The general structure of the demand is the base of this approach. Cobb-Douglas function is the mathematical instrument for the forecasting of the disproportion.
- 2) Only one science has balance between real and required supply – transport science. Others sciences have big disproportions between supply and demand, that indicate glut or deficit of higher educational specialist on the labor market. This is indicates the existing problems - the presence of weak links between the needs of the labor market in specialists and their supply of educational system.
- 3) For the forecasting of stability of educational system we used non-linear analysis that recognizes periods of stability and instability. Period of stability is characterized by a unidirectional development of the educational market and the national economy, which reflects the satisfaction of the needs of the labor market for specialists with higher education. Period of instability is characterized by two factors - the structural changes of the national economy and changes in the higher educational market. According to the study proved that in 2009, there is increasing instability of the education market. This is due to the lack of effective forms of interaction between the labor market and the educational market, which leads to significant disproportion between demand and supply of higher educational market.
- 4) The strategy of educational market development is a weak side of educational management in Ukraine. This strategy should be based on the timely monitoring of changing needs for specialists in the labor market in accordance with the strategic imperatives of the national economy and to take into account lags delay the release of such institutions of higher education professionals

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Appendix 1

Table A.4. The parameters of Cobb-Douglas function

Branch	Agriculture, hunting and forestry	Fishing	Mining	Manufacturing	Electricity, gas and water	Constructing	Trade; repair of motor vehicles, household appliances and personal use	Hotels and restaurants
Modification	2	1	2	2	1	1	1	1
Correlation coefficient	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97
a0	4182,36	0,85992	14,59528	184,3002	98,34830	242,6058	5170,732	300,6779
a1	0,512497	28,68597	0,75490	0,7107	0,21220	0,3220	0,694	0,0861
a2	-0,042425	-0,13197	0,55026	0,1988	0,61707	0,5858	0,558	0,3725
a3		-0,53858			0,02808	0,0263	0,022	0,0429
BEД	Transport and communication	Finance	Real estate, renting and business activities	State management	Education	Health	Other community and personal services; culture and sport	Others
Modification	2	1	1	1	1	3	1	4
Correlation coefficient	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97
a0	71821,34	260,4955	42,84439	1252,117	62,85616	5,379790	456,7232	35915,4
a1	0,41	0,1215	0,23206	0,259	0,59204	0,366063	0,2834	0,8
a2	-0,09	0,6185	0,62619	0,345	1,05052	0,946306	0,4093	
a3		0,0814	0,05168	0,024	0,03480		0,0026	0,1

Modifications of Cobb-Douglas function:

- 1) Cobb-Douglas function with exponential science progress $Y = a_0 L^{a1} K^{a2} e^{a3 \cdot t}$
- 2) Cobb-Douglas function with linear science progress $Y = a_0 L^{a1} K^{a2} t$
- 3) Cobb-Douglas function without science progress $Y = a_0 L^{a1} K^{a2}$
- 4) Cobb-Douglas function with exponential science progress and without capital influence $Y = a_0 L^{a1} e^{a3 \cdot t}$