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## QUALITY AS THE BASIS OF EFFECTIVE MANAGEMENT OF THE EDUCATIONAL MARKET AND A GOAL OF DEVELOPMENT OF UNIVERSITIES IN THE CONDITIONS OF INDUSTRY 4.0

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**Abstract:** *The purpose of the article is to evaluate the effectiveness of managing the educational markets in the countries of the world that have the highest global competitiveness in the sphere of education, to determine and compare the factors of development of universities in the conditions of Industry 4.0 in these countries, and to develop recommendations for increasing the effectiveness of managing the educational market. For evaluating the effectiveness of managing the educational market, the authors' method is used, which is based on the classical formula of measuring effectiveness as a ratio of results and costs. For evaluating the susceptibility of the indicators of development of universities in the conditions of Industry 4.0 to the influence of various factors, the authors use the method of correlation analysis and the method of calculation of direct average. The information and analytical basis of the research includes the analytical and rating materials of CWUR, Legatum Institute, Online learning consortium, QS, Times Higher Education (THE) and World Bank for 2019. It is substantiated that quality is the basis of effective management of the educational market and is a goal of development of universities in the conditions of Industry 4.0. Growth of the volume of state financing of education and improvement of the macro-economic environment will allow achieving internationalization of education, but they have small influence on its results. Quality of education determines the effectiveness of the national market of education, but is hardly managed at the level of macro-economy.*

**Key words:** *Effective management; Market of education; Development of entrepreneurial structures; Universities; Industry 4.0; Quality management; Quality of education.*

### 1. Introduction

In the conditions of Industry 4.0, universities perform two important functions. The first function – production – consists in preparation of digital personnel for Industry 4.0, which allows conducting full-scale

digital modernization of certain spheres of the economy and of the economy on the whole. Execution of this function envisages development of digital competences with undergraduates and employees in the process of receipt of vocational or university education (including higher education) or taking the advanced training.

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The second function – social – is connected to overcoming and prevention of unemployment rate, which appears due to transition to Industry 4.0, adaptation of consumers to purchase of goods and services (including state services) with the usage of breakthrough digital technologies of Industry 4.0. Execution of this function envisages development of digital competences with the population in the process of the courses of digital literacy. Though both functions are assigned to modern universities in the national strategies of countries for transition to Industry 4.0, the deficit of the educational infrastructure, which shows the insufficient execution of these functions, is noted as one of the key barriers on the path of implementation of the above strategies.

An example is the Program “Digital economy of the RF”, adopted by the Decree dated July 28, 2017, No. 1632-r (Government of the RF, 2019), in which training of personnel and development of education are given as the top-priority direction of digital modernization of the Russian economy until 2024. Due to this, development of universities in the conditions of Industry 4.0, aimed at successful execution of the set functions, is a “market gap”, which could be overcome only with state interferences with the natural market processes without which the transition to Industry 4.0 cannot be implemented.

That’s why the scientific problem of evaluating the current level and determining the perspectives of increase of effectiveness of the educational market management in the interests of development of universities in the conditions of Industry 4.0 is very important. The main attention in this paper is paid to opposition of the indicators of efficiency (of which the main one is quality of education) and internationalization of education and to research of their influence on effectiveness of the educational market and on development of universities in the conditions of Industry 4.0.

The working hypothesis is that institutional factors (e.g., conditions for entrepreneurship, level of development of “knowledge economy”, etc.) stimulate the development of universities to a larger extent than the traditional financial factors (the key of which is state financing of education) and, thus, increase of effectiveness of managing the educational market requires more attention to the institutional factors.

The purpose of the research is to evaluate the effectiveness of managing the educational markets in the countries with the highest global competitiveness in the sphere of education, to determine and compare the factors of development of universities in the conditions of Industry 4.0 in these countries, and to develop recommendations for increasing the effectiveness of managing the educational market.

## 2. Literature review

The issue of managing the educational market in the conditions of Industry 4.0 is studied in the works of the modern authors in detail. Addamo et al. (2017) dwell on the experience of material stimulation of the higher school’s workers (by the example of Italy), depending on efficiency. Capano and Pritoni (2019) and Daraio et al. (2019) note that state management of the national educational market should have systemic and versatile character. Popkova (2019) and Popkova & Sergi (2019) note the significance of the educational market for establishment and development of the digital economy and Industry 4.0. Sozinova (2019) notes the complexity of formation of Industry 4.0 depending on the position of the economic system in the global economic system. Based on this, she substantiates the presence of new challenges for the national educational markets. Waheed et al. (2018) write of digital modernization of the national educational markets in the conditions of Industry 4.0 and the necessity to adapt the practice of management of these markets to the new economic conditions.

The priorities, problems, and perspectives of development of universities in the conditions of Industry 4.0 are studied in detail in various works. Akşit (2018) points out the important role of computer sciences and program technologies in organization of universities for Industry 4.0. Kazimirov (2018) thinks that universities - in the conditions of Industry 4.0 – occupy a new position in the national system of value creation: they turn from suppliers of production factors in the economy to suppliers of top-priority products (educational services) and into sources of competitive advantages of Industry 4.0. Saud et al. (2018) note the necessity for professional advanced training of academic staff in the conditions of industrial revolution 4.0 (shown by the example of state-funded universities of Malaysia).

The issue of measuring and management of quality of education is also solved in the works of the modern scholars and experts. Zhang et al. (2019) provide the results of an experiment of increasing the accessibility (equality and social justice of applicants and undergraduates) and quality of higher education in China, based on which the scholars substantiate the expedience of increasing the quality for stimulating the development of the digital society and Industry 4.0. Dicker et al. (2019) write that the very notion “quality” in higher education could be critically reconsidered in the modern society and economy, as it could be treated differently, depending on the context. For example, in the conditions of Industry 4.0, quality of higher education is based on mastering of digital competencies by students.

Dubey et al. (2019) provide the results of reformation of technical higher education within the program of raising the quality of technical education with support from the World Bank in India. The researchers come to the conclusion that quality should be the basis of the modern reforms in the sphere of higher education. Guo et al. (2019) point out that development of the national system of

education should be based on increase of quality and provision of social justice (increase of education’s accessibility), as only high quality could ensure the return of investments into education from the state (financing of education) and from consumers (tuition fee) (substantiated by the example of China).

Latif et al. (2019) write of high complexity of measuring the quality of services in the sphere of higher education. Naim et al. (2019) deem it necessary to ensure interoperability of online education in the interests of increasing the quality of higher education and developing the educational market. Felce (2019) notes that it is necessary to manage quality in higher education, as quality is a so called “market gap” of education, which is overcome by targeted corporate management and state regulation. Stensaker et al. (2019) describe cooperation between the state and universities and control from the state as perspective tools of implementing the national educational programs. As an example of successful experience, the authors describe the practice of quality management in higher education of Norway.

Hu et al. (2019) analyze the factors that influence the quality of transnational higher education in China, conducting a content analysis of the reports of self-assessment of Chinese universities from the positions of quality of education. Ming (2019) performs evaluation of effectiveness of higher education of undergraduates in colleges and universities based on the integration of the regime of double flip class through the prism of quality of education. Susanto and Suyatno (2019) think that quality of higher education is a variable of implementation of organizational perspectives – improvement of organizational structure of universities and usage of the possibilities of their organizational culture.

Abubakar et al. (2019) perform a modeling of the general structure of quality management for higher educational

establishments in Ghana. Soenarto et al. (2019) provide the results of analysis of the influence of quality of education on innovations in campuses of private universities. Vučijak et al. (2018) consider the practice of teaching entrepreneurship in Eastern Europe and Russia and come to the conclusion and quality plays the key role in this process. Osman et al. (2018) substantiate that during provision of quality of higher education an important mediation role belongs to the institutional image (brand) of university – though it does not guarantee certain quality of university's educational services.

Sharok (2018) provides the proofs that during evaluation of the quality of university's services an important role belongs to the social and psychological factors of students' satisfaction with education, which complicates the objective evaluation of the quality of higher education of. Pedro et al. (2018) show that teaching methods have vivid influence on the perceived quality and satisfaction of consumers with higher education. Petrenko et al. (2018) write that the educational market is the core of the service sphere in the post-industrial economy and thus the quality of education determines sustainability of economy on the whole. Sibirskaya et al. (2019) compare remote and traditional education according to the criterion of effectiveness at the micro-level and in connection with development of macro-economic systems. The scholars come to the conclusion that quality of education is of top-priority, regardless of the form of education (remote or traditional).

Popkova et al. (2017a) put quality of education on the first position among the modern tools and criteria of effectiveness of the modern media-education. Popkova et al. (2017b) write that quality of education is a new criterion and priority of development of media-education in the globalizing world. Popkova et al. (2017c) point out the strategic role of media-education in the conditions of development of the information economy

and note that increase of the quality of education is the driving force of development of the modern media-education. Popkova & Sergi (2019) note that in the complex and variable digital economy quality of education is a universal criterion of assessment of development of socio-economic systems.

The performed literature overview on the selected topic showed that despite the high level of elaboration of the problems of the research at the fundamental level, the methodological issues of evaluation of effectiveness of educational market management are not studied sufficiently. They do not provide enough factual and analytical data for scientific substantiation of the dominating influence of the institutional factors over the financial factors on the development of universities and effectiveness of educational market management in the conditions of Industry 4.0.

The role and value of quality for provision of effectiveness of the national educational market and development of universities in the conditions of Industry 4.0 are not defined by the modern economic science. Studies of quality of education and management of quality of education are conducted separately from the studies of effectiveness of the educational market and development of universities in the conditions of Industry 4.0. There are no logical ties between these topics. This paper is to fill the determined gaps in the system of the modern economic knowledge.

### 3. Materials and method

For evaluating the effectiveness of managing the educational market, the authors use the method based on the classical formula of measuring the effectiveness as a cost/result ratio. The results of development of universities in the conditions of Industry 4.0 are as follows:

- Efficiency of education (EE): instead of the leading university of the country in the rating CWUR, which focuses on the indicators of the value of educational services for consumers (quality of education and successfulness of graduates employment);
- Internationalization of education (IE): the place of the leading (in the international ratings) university of the country in the rating QS in which the main attention is paid to the indicators of international activities of universities (the share of foreign lecturers and teachers).

The expenditures for development of universities in the conditions of Industry 4.0 are as follows:

- Financing of education (FE): the position of the country in the

ranking of the World Bank as to the volume of state expenditures for education;

- Institutional environment (IE): the position of the country in the rating Legatum Institute as to the index of economy's well-being.

The following formula is used for calculations:

$$EFme = (1/EE + 1/IE) / (FE + IE), \quad (1)$$

EFme – indicator of effectiveness of education management in the conditions of Industry 4.0 – the higher the better.

For evaluating the susceptibility of the indicators of development of universities in the conditions of Industry 4.0 to the influence of various factors, the methods of correlation analysis and calculation of direct average are used. The initial statistical data are shown in Tables 1 and 2.

**Table 1.** Indicators of development of universities and their correspondence to the conditions of Industry 4.0 as a result of 2018

Country	Leading university	Quality of education, position	Successfulness of employment, position	Share of foreign lecturers, %	Share of foreign students, %	Share of remote education, %
		y <sub>1</sub>	y <sub>2</sub>	y <sub>3</sub>	y <sub>4</sub>	y <sub>5</sub>
USA	Harvard University	2	1	96.5	75.2	8.3
UK	University of Cambridge	5	19	97.4	97.7	4.6
Japan	University of Tokyo	17	8	0.0	0.0	2.8
Canada	University of Toronto	86	157	97.0	92.1	6.1
Switzerland	ETH Zurich	29	98	100.0	98.8	3.4
France	Sorbonne University/ Ecole normale superieure, Paris	46	344	94.4	60.4	2.1
Germany	Heidelberg University/ Technical University of Munich	71	807	53.0	44.8	2.0

**Table 1.** Indicators of development of universities and their correspondence to the conditions of Industry 4.0 as a result of 2018 (continued)

Country	Leading university	Quality of education, position	Successfulness of employment, position	Share of foreign lecturers, %	Share of foreign students, %	Share of remote education, %
Australia	University of Melbourne/ The University of Western Australia	232	408	100.0	72.9	1.5
Brazil	University of São Paulo	583	256	0.0	0.0	1.3
China	Peking University/ Beijing Normal University	340	67	33.3	0.00	1.2
Russia	Moscow State University/ Moscow Institute of Physics and Technology (MIPT – Moscow Phystech)	23	384	23.7	35.5	1.1

Source: compiled by the authors based on (CWUR, 2019), (Online learning consortium, 2019), (QS, 2019)

**Table 2.** Factors of development of universities that determine the effectiveness of the educational market management in 2018

Country	Government expenditure on education, total (% of GDP)	Legatum prosperity index, position			
		Economic quality pillar	Business environment pillar	Governance pillar	Education pillar
		x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>	x <sub>4</sub>
USA	4.99	13	1	19	9
UK	5.54	16	4	11	12
Japan	3.47	19	19	17	21
Canada	5.27	21	3	8	15
Switzerland	5.10	4	10	4	2
France	5.46	30	17	21	29
Germany	2.66	11	12	10	20
Australia	5.45	28	9	12	8
Brazil	6.24	77	114	75	91
China	1.88	27	43	118	44
Russia	3.82	63	60	124	22

Source: compiled by the authors based on (Legatum Institute, 2019), (World Bank, 2019)

## 4. Results

### 4.1 Evaluation of effectiveness of management of the educational market and development of universities in the conditions of Industry 4.0 and determination of their dependence on quality

Formula (1) is used for evaluating the effectiveness of education management in 2018 in the countries with the highest global competitiveness in the sphere of education – the results are presented in Table 3.

The data from Table 3 show that in all countries with the highest global competitiveness in the sphere of education

(Top-10), the effectiveness of education management is very high (exceeds the minimum value of 1). The lower the global competitiveness of the country in the sphere of education, the higher the effectiveness of education management in it. This shows the increase of marginal costs with development of education.

Let us perform a regression analysis of the dependence of the indicators of effectiveness of managing the educational market in 2018 in the factors of development of universities in the conditions of Industry 4.0. Let us build a matrix of paired correlation coefficients for determining the doubling (collinear) variables (correlation coefficient  $r \geq 0.95$ ) (Table 4).

**Table 3.** Evaluation of effectiveness of education management in 2018

Country	Efficiency of education	Internationalization of education	Financing of education	Institutional environment	Effectiveness of the educational market management, shares of 1
	position				
USA	1	1	24	12	$(1+1)/(1/24+1/12)=16.00$
UK	4	5	12	10	$(4+5)/(1/12+1/10)=49.09$
Japan	12	28	44	19	$(12+28)/(1/44+1/19)=530.77$
Canada	17	31	15	9	$(17+31)/(1/15+1/9)=270.00$
Switzerland	28	73	21	2	$(28+73)/(1/21+1/2)=184.43$
France	29	43	13	22	$(29+43)/(1/13+1/22)=588.34$
Germany	46	64	55	11	$(46+64)/(1/55+1/11)=1008.33$
Australia	57	93	14	14	$(57+93)/(1/14+1/14)=1050.00$
Brazil	77	121	7	90	$(77+121)/(1/7+1/90)=1285.98$
China	92	256	60	48	$(92+256)/(1/60+1/48)=9280.00$
Russia	126	355	41	59	$(126+355)/(1/41+1/59)=11635.39$

Source: compiled and calculated by the authors based on (CWUR, 2019), (QS, 2019), (Legatum Institute, 2019), (World Bank, 2019)

**Table 4.** Matrix of paired correlation coefficients of variables

	y1	y2	y3	y4	y5	x1	x2	x3	x4	x5
y1	1.00									
y2	0.07	1.00								
y3	-0.46	-0.07	1.00							
y4	-0.56	-0.08	0.93	1.00						
y5	-0.47	-0.49	0.54	0.58	1.00					
x1	0.43	-0.56	0.37	0.05	0.20	1.00				
x2	0.64	0.16	-0.60	-0.54	-0.50	0.22	1.00			
x3	0.31	-0.10	-0.29	-0.46	-0.38	0.07	0.91	1.00		
x4	-0.28	0.01	-0.25	-0.06	-0.29	-0.41	0.69	0.71	1.00	
x5	0.59	-0.14	-0.56	-0.65	-0.27	0.07	0.77	0.91	0.54	1.00

Source: calculated and compiled by the authors

As is seen from Table 4, the doubling variables are absent, neither of the obtained coefficients of correlation equals or exceeds 0.95. Therefore, all variables should be considered during the regression analysis. The results of the regression analysis of dependence of the indicators and factors of development of universities, which determine the effectiveness of management of the educational market in 2018, are given in Tables 5-6. As the regression models are multifactorial, multiple  $R$  is a linear coefficient of correlation between variable  $y$  and factors  $x_1, x_2, x_3, x_4$  and  $x_5$ .

Based on Table 5, we compiled the following model of multiple linear regression:  $y = -103.7947 + 22.6368 * x_1 - 2.7821 * x_2 + 0.9784 * x_3 + 0.6675 * x_4 + 6.3769 * x_5$ . Multiple  $R$  strived to 1, constituting 0.8710. This shows that the variable is closely connected to and depends on the

factors that influence it. The coefficient of determination ( $R^2$ ) acquired the value 0.7586 (high). Therefore, the influence of the selected factors is the cause of the change of the dependent variable by 75.86%.

However, at the significance level  $\alpha = 0.05$ , neither of the obtained estimate coefficients is significant (p-values of all coefficients exceed 0.05). The table F-distribution at the significance level  $\alpha = 0.05$ ,  $k_1 = m = 5$  and  $k_2 = n - m - 1 = 11 - 5 - 1 = 5$  equals 5.05 ( $F_{table}$ ). Estimate F-distribution constitutes 3.1420.  $F_{obs} < F_{table}$  ( $3.1420 < 5.05$ ). Therefore, the compiled regression equation is not statistically significant according to F-criterion. This allows concluding that quality of education is not determined by the factors of financing of education and institutional environment and depends on internal characteristics of universities in the conditions of Industry 4.0.

**Table 5.** Regression analysis of dependence of quality of education on the factors of development of universities that determine the effectiveness of the educational market management in 2018

<i>Regression statistics</i>						
Multiple R	0.8710					
R-square	0.7586					
Adjusted R-square	0.5171					
Standard error	127.8674					
Observations	11					
<i>Dispersion analysis</i>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	256862.1975	51372.4395	3.1420	0.1173	
Residual	5	81750.3479	16350.0696			
Total	10	338612.5455				
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	-103.7947	225.7576	-0.4598	0.6650	-684.1230	476.5336
$x_1$	22.6368	50.5941	0.4474	0.6733	-107.4195	152.6932
$x_2$	-2.7821	5.8154	-0.4784	0.6525	-17.7310	12.1668
$x_3$	0.9784	4.9139	0.1991	0.8500	-11.6532	13.6100
$x_4$	0.6675	2.1126	0.3160	0.7648	-4.7631	6.0982
$x_5$	6.3769	4.2918	1.4858	0.1975	-4.6557	17.4094

Source: calculated and compiled by the authors

**Table 6.** Regression analysis of dependence of successfulness of graduates’ employment on the factors of development of universities that determine the effectiveness of the educational market management in 2018

<i>Regression statistics</i>						
Multiple R	0.6755					
R-square	0.4562					
Adjusted R-square	-0.0875					
Standard error	254.9186					
Observations	11					
<i>Dispersion analysis</i>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	272618.7948	54523.7590	0.8390	0.5740	
Residual	5	324917.3870	64983.4774			
Total	10	597536.1818				
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	967.7977	450.0740	2.1503	0.0842	-189.1544	2124.7498
x1	-192.3175	100.8653	-1.9067	0.1149	-451.6000	66.9650
x2	18.3185	11.5937	1.5800	0.1749	-11.4839	48.1209
x3	-0.5489	9.7964	-0.0560	0.9575	-25.7314	24.6336
x4	-7.3468	4.2117	-1.7444	0.1415	-18.1734	3.4798
x5	-3.3912	8.5563	-0.3963	0.7082	-25.3859	18.6034

Source: calculated and compiled by the authors

Based on Table 6, we compiled the following model of multiple linear regression:

$$y = -967.7977 - 192.3175 \cdot x_1 + 18.3185 \cdot x_2 - 0.5489 \cdot x_3 - 7.3468 \cdot x_4 - 3.3912 \cdot x_5.$$

Multiple R strives to 1, constituting 0.6755. This shows that the variable is closely connected to and depends on the factors that influence it. The coefficient of determination ( $R^2$ ) acquires the value 0.4562 (moderate). Therefore, the influence of the selected factors is the cause of the change of the dependent variable by 45.62%.

However, at the significance level  $\alpha=0.05$  neither of the obtained estimate coefficients is significant (p-values of all coefficients exceed 0.05). Table F-distribution at the significance level  $\alpha=0.05$ ,  $k_1=m=5$  and  $k_2=n-m-1=11-5-1=5$  equals 5.05 ( $F_{table}$ ). Estimate F-distribution constitutes 0.8390.

$F_{obs} < F_{table}$  ( $0.8390 < 5.05$ ). Therefore, the compiled regression equation is not statistically significant according to F-criterion. This allows concluding that successfulness of graduates’ employment is not determined by the factors of financing of education and institutional environment.

Based on Table 7, we compiled the following model of multiple linear regression:

$$y = -28.3635 + 26.1569 \cdot x_1 - 0.9298 \cdot x_2 - 1.2175 \cdot x_3 + 0.6251 \cdot x_4 + 0.3059 \cdot x_5.$$

Multiple R strives to 1, constituting 0.9262. This shows that the variable is closely connected to and depends on the factors that influence it. The coefficient of determination ( $R^2$ ) acquired the value 0.8579 (high). Therefore, the influence of the selected factors is the cause of the change of the dependent variable by 85.79%.

However, at the significance level  $\alpha=0.05$  neither of the obtained estimate coefficients is significant (p-values of all coefficients exceed 0.05). Table F-distribution at the significance level  $\alpha=0.05$ ,  $k_1=m=5$  and  $k_2=n-m-1=11-5-1=5$  equals 5.05 ( $F_{table}$ ). Estimate F-distribution constitutes 6.0387.

$F_{obs}>F_{table}$  (6.0387>5.05). Therefore, the compiled regression equation is statistically significant according to F-criterion. This allows concluding that the share of foreign lecturers is determined by the factors of financing of education and institutional environment.

**Table 7.** Regression analysis of the dependence of the share of foreign lecturers on the factors of development of universities that determine the effectiveness of the educational market management in 2018

Regression statistics						
Multiple R	0.9262					
R-square	0.8579					
Adjusted R-square	0.7159					
Standard error	22.3942					
Observations	11					
Dispersion analysis						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	15142.1580	3028.4316	6.0387	0.0352	
Residual	5	2507.5111	501.5022			
Total	10	17649.6691				
	<i>Coefficient s</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	-28.3635	39.5384	-0.7174	0.5053	-130.0001	73.2732
x1	26.1569	8.8609	2.9519	0.0318	3.3792	48.9345
x2	-0.9298	1.0185	-0.9129	0.4032	-3.5479	1.6883
x3	-1.2175	0.8606	-1.4147	0.2163	-3.4297	0.9948
x4	0.6251	0.3700	1.6894	0.1519	-0.3260	1.5762
x5	0.3059	0.7517	0.4069	0.7009	-1.6263	2.2381

Source: calculated and compiled by the authors

Based on Table 8, we compiled the following model of multiple linear regression:  $y=-17.5343+23.1493*x_1-0.9038*x_2-0.1335*x_3+0.3333*x_4-0.7539*x_5$ . Multiple R strives to 1, constituting 0.9263. This shows close connection and large dependence of the variable on the influencing factors. The coefficient of determination ( $R^2$ ) acquired the value 0.8581 (high). Therefore, the change of the dependent variable is explained by 85.81% by the influence of the selected factors.

However, at the significance level  $\alpha=0.05$

only one of the obtained estimate coefficients is significant – x1 (its P-value constitutes 0.0379), and p-values of other coefficients exceed 0.05. Table F-distribution at the significance level  $\alpha=0.05$ ,  $k_1=m=5$  and  $k_2=n-m-1=11-5-1=5$  equals 5.05 ( $F_{table}$ ). Estimate F-distribution constituted 6.0459.  $F_{obs}>F_{table}$  (6.0459>5.05). Therefore, the compiled regression equation is statistically significant according to F-criterion. This allows concluding that the share of foreign students is determined by the factors of financing of education and institutional environment.

**Table 8.** Regression analysis of dependence of the share of foreign students and graduates on the factors of development of universities that determine the effectiveness of the educational market management in 2018

<i>Regression statistics</i>						
Multiple R	0.9263					
R-square	0.8581					
Adjusted R-square	0.7161					
Standard error	20.8845					
Observations	11					
<i>Dispersion analysis</i>						
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	13184.9696	2636.9939	6.0459	0.0351	
Residual	5	2180.8195	436.1639			
Total	10	15365.7891				
	<i>Coefficient s</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	-17.5343	36.8729	-0.4755	0.6545	-112.3191	77.2505
x1	23.1493	8.2635	2.8014	0.0379	1.9072	44.3913
x2	-0.9038	0.9498	-0.9515	0.3850	-3.3454	1.5378
x3	-0.1335	0.8026	-0.1663	0.8744	-2.1966	1.9296
x4	0.3333	0.3451	0.9659	0.3785	-0.5537	1.2203
x5	-0.7539	0.7010	-1.0755	0.3313	-2.5558	1.0480

Source: calculated and compiled by the authors

**Table 9.** Regression analysis of dependent of the share of remote education on the factors of development of universities that determine the effectiveness of the educational market management in 2018

<i>Regression statistics</i>						
Multiple R	0.7021					
R-square	0.4930					
Adjusted R-square	-0.0141					
Standard error	2.3418					
Observations	11					
<i>Dispersion analysis</i>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	5	26.6608	5.3322	0.9723	0.5119	
Residual	5	27.4211	5.4842			
Total	10	54.0818				
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	-0.6795	4.1347	-0.1643	0.8759	-11.3080	9.9490
x1	1.1234	0.9266	1.2124	0.2795	-1.2585	3.5054
x2	-0.0645	0.1065	-0.6055	0.5713	-0.3383	0.2093
x3	-0.0486	0.0900	-0.5396	0.6126	-0.2799	0.1828
x4	0.0261	0.0387	0.6744	0.5300	-0.0734	0.1256
x5	0.0330	0.0786	0.4199	0.6920	-0.1690	0.2351

Source: calculated and compiled by the authors

Based on Table 9, we compiled the following model of multiple linear regression:

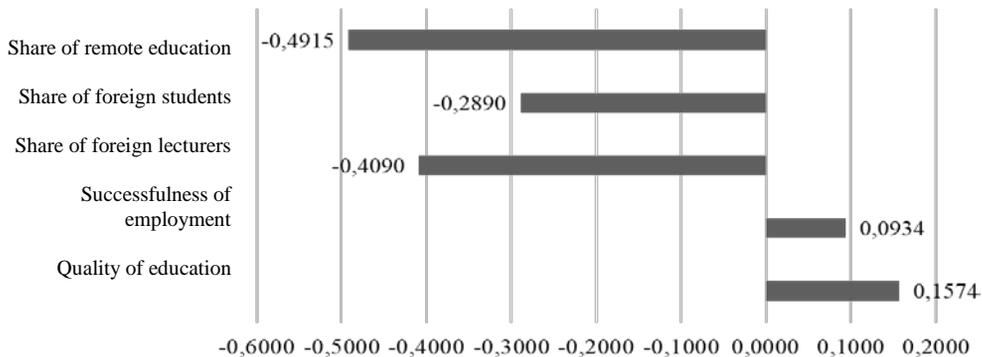
$$y = -0.6795 + 1.1234 * x_1 - 0.0645 * x_2 - 0.0486 * x_3 + 0.0261 * x_4 + 0.0330 * x_5.$$

Multiple R strives to 1, constituting 0.7021. This shows close connection and large dependence of the variable on the influencing factors. The coefficient of determination ( $R^2$ ) acquired the value 0.4930 (moderate). Therefore, the influence of the factors causes the change of the dependent variable by 49.30%.

However, at the significance level  $\alpha=0.05$  neither of the obtained estimate coefficients is significant (p-values of all coefficients

exceed 0.05). Table F-distribution at the significance level  $\alpha=0.05$ ,  $k_1=m=5$  and  $k_2=n-m-1=11-5-1=5$  equals 5.05 ( $F_{table}$ ). Estimate F-distribution constituted 0.9723.  $F_{obs} < F_{table}$  ( $0.9723 < 5.05$ ). Therefore, the compiled regression equation is not statistically significant according to F-criterion. This allows concluding that the share of remote education is not determined by the factors of financing of education and institutional environment.

The calculated paired correlation between the indicators of development of universities in the conditions of Industry 4.0 and effectiveness of the educational market is shown in Figure 1.



**Figure 1.** Paired correlation of the indicators of development of universities in the conditions of Industry 4.0 with effectiveness of the educational market

Source: calculated and compiled by the authors

Figure 1 shows that the indicators of internationalization of education – share of remote education (-0.4915), share of foreign students (-0.2890), and the share of foreign lecturers (-0.4090) – have reverse correlation with effectiveness of the educational market. Correlation between the indicators of efficiency of education and effectiveness of the educational market is direct (correlation with quality of education is the highest – 0.1574); correlation with successfulness of employment – 0.0934.

Thus, as a result of the analysis is it determined that internationalization of

education reduces the effectiveness of the educational market; the key source of its increase is growth of quality of education. Financing of education and the institutional environment determine the conditions for internationalization of education and are closely connected to the share of foreign students and lecturers. However, these factors do not determine the quality of education, which management depends on the internal factors and should be conducted at the micro-economic level (at the level of universities).

#### 4.2 Recommendations for provision of effectiveness of educational market and development of universities in the conditions of Industry 4.0

The results of the performed regression analysis of reverse correlation of the institutional factors and the indicators of development of universities in the conditions of Industry 4.0. The financial factor (state expenditures for education) is the only one that showed positive (and, therefore, the highest) correlation with the indicators of development of universities in the conditions of Industry 4.0. Based on the conclusion, we developed the following authors' recommendations for increasing the effectiveness of managing the educational market in the conditions of Industry 4.0.

Firstly, in case of state management of education it is expedient to pay close attention to the financial factors of development of universities, for which it is recommended to increase the state financing of education. Secondly, there's a necessity for new requirements (criteria of assessment) to the activities of universities in the conditions of Industry 4.0. Prestige of universities (popularity, resource provision, publication activity, and citation rate) should be replaced by the indicators of efficiency (employment of graduates, career growth, level of income, as in the conditions of Industry 4.0 the functional importance of education grows, this moving its self-value and prestige, which are peculiar for "knowledge economy", to the background.

Thirdly, it is necessary to ensure full transparency of the system of evaluation of universities' competitiveness. The representative form and free access are mandatory for the values of the indicators – both in the authoritative global ratings that compiled by Times Higher Education (2019), CWUR (2019) and as the initial values of these indicators – e.g., in the rating QS (2019). This will ensure objectivity of assessment and will expand the possibilities of universities in their own analysis and

setting of precise strategic goals of development – which is impossible with the existing point assessment.

Fourthly, it is necessary to create a new rating of countries as to the level of effectiveness of managing the educational market. Absence of this rating leads to the fact that developed countries spend the resources for development of universities (for achieving the highest competitiveness) ineffectively. Creation of this rating will attract the attention of the global community to expenditures for achievement of competitiveness of the national system of education and will orient governments not only at achievement of high results but also at minimization of expenditures.

Fifthly, the developed, adopted, and implemented national strategies of provision of effectiveness of the educational market and development of universities in the conditions of Industry 4.0 should be based on quality management in the interests of its increase. Due to independence of quality of education on the volume of financing of the educational market in the economy and on the institutional environment at the macro-economic level (from the state), the following measures are offered:

- proclaiming the course at increasing the quality of education as the basis of effectiveness of the national educational market and development of universities in the conditions of Industry 4.0;
- developing the national methodology of objective evaluation of quality of education (through the prism of the level of graduates' competence);
- regular (at least annual) monitoring of quality of education with compilation of universities ratings;
- collecting feedback from concerned parties (lecturers and students) on the current quality of education and current problems and perspectives of its increase and transferring the

results to the universities' management.

The offered measures aimed at forming the favorable conditions and stimulating the increase of quality of education – through the main measures should be implemented at the micro-economic level depending on the specifics of internal organization and position of each university in the market.

According to the offered recommendations, state management of educational market in the interests of provision of its effectiveness and development of universities in the conditions of Industry 4.0 should be conducted in two directions. 1<sup>st</sup> direction: stimulating the internationalization of the national market of higher education through state financing of the measures on modernization (e.g., based on digital technologies) of this market and improving its institutional environment (e.g., modernization of state educational standards).

2<sup>nd</sup> direction: stimulating the growth of efficiency of the national educational market with emphasis on increase of quality of the provided educational services. This direction is to be implemented with flexible measures of influence on the practice of universities management, selected depending on the specifics of an economic system. There might be a need for interactive (changing depending on the context) state management of the national market of higher education.

These directions are not alternative and should be implemented together – for obtaining the synergetic effect. However, in view of the priority of quality of education, it is recommended to focus on the second direction and to redistribute the resources of the state budget and to regulate the national educational market. This will allow supporting the stability of development of the national educational market on the whole and of universities, in particular, in the conditions of Industry 4.0.

## 5. Conclusion

Thus, the working hypothesis was disproved; it was shown that the traditional financial factors (state financing of education) not only have the highest influence but are the only factors that have positive influence (direct connection) on the development of universities in the conditions of Industry 4.0. This allowed specifying the existing concept of state management of the educational market in view of the specifics of Industry 4.0. The offered authors' recommendations will allow increasing the effectiveness of managing the educational market as a goal of development of universities in the conditions of Industry 4.0.

It is substantiated that quality is the basis of effective management of the educational market and is the goal of development of universities in the conditions of Industry 4.0. Though effectiveness of education management in 2018 is high in all countries that have the highest global competitiveness in the sphere of education, there's a need to increase it. Growth of the volume of state financing of education and improvement of the macro-economic environment will allow achieving internationalization of education, but do not influence its results. Quality of education is largely determined by the effectiveness of the national educational market, but it could be hardly managed at the level of macro-economy.

This conclusion changes the existing idea on state management of the educational market in the national economy. Contrary to the existing belief of strong direct influence of the measures of state regulation on the development of universities in the conditions of Industry 4.0, this influence is limited and indirect. Thus, the complexity of state regulation and provision of effectiveness of the national educational market grows.

Instead of clearly formalized and easily measured indicators of the universities' activities – share of graduates that found the job according to their specialty after

graduation, share of foreign lecturers and students, and share of remote education – there’s a need for analysis for a less vivid and complex indicator – quality of education, which largely depends on the context: with similar other indicators and implemented measures of corporate management, the results for quality could differ (due to the specifics of the organizational structure, organizational culture of the university, etc.).

In the conditions of Industry 4.0, state has to refuse from a popular approach to management of the educational market that is based on implementing the model directive measures and instead to master and use a new approach, which envisages flexible regulation. The search for

perspective directions and means of cooperation between the state and universities is also expedient – on these directions is implementation of joint projects in the form of public-private partnership. This will allow the state to influence the practice of corporate management of universities, stimulating the increase of quality of the provided educational services.

The obtained results open a wide field for further scientific research. The scholars should focus on the issue of measuring of quality of education in view of the specifics of the modern economic systems and on management of quality of education at the state and corporate level, as well as systemic research of this process and the functions and interests of its participants.

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