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Did Subsidy Depend on the Performance of Higher Education Institutions in Poland? Comparative study

Sławomir Kalinowski

Chair of Microeconomics, Faculty of Management, University of Economics in Poznań

Since early 1990s the system of financing higher education institutions in Poland is based on the algorithm which binds the value of subsidy also with the performance. It is basically depended on the number and the structure of the students and scientific staff, but within the past years new factors have been introduced: grants acquisition and internationalization. The goal of the article is to verify to what extent the value of the subsidy depended on the performance of the universities. The test produced the positive outcome for the universities of life sciences and universities of economics, which were outstanding for the statistically significant change of the index.

Keywords: higher education institutions, performance based funding, scientific staff potential, algorithm of the subsidy allocation

Introduction

The concept of financing based on the performance criterion (*performance based founding* – PBF) dates back to 1940s and originated in the United States. This system was in force there till the end of 1960s.however, in mid 1990s the system was restored and combined with strategic planning (Liu, 2011, p. 1518). Meanwhile, in 1992 in Poland public financing of universities was launched and a subsidy was calculated basing on the algorithm considering both quantitative and qualitative characteristics of activities of a university (Rocki, 1998). At the very start of this concept of the financing, a subsidy depended in 70% on the Mount of the previous year, the remainder was the result of the calculation depending on the numbers of students as well as the number of faculty members: full-time professors,

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university professors, PhD diploma holders and M.A./M.Sc. diploma holders. In late 2016 the university share in the total amount of a subsidy depended also on the factor of proportional development of educational process, effectiveness in obtaining research grants, legitimacy in awarding honors degree and the scale of international co-operation. The so called "transfer constant" has shrunk from 70% to 65% (Journal of Laws, 1 April 2015, Item 463, p. 10). Initially, the level of the subsidy was determined by the scope of activities while the presently used algorithm includes the impact of a larger number of indices connected with the quality of didactic and scientific activities.

In line with the algorithm applied till late 206, the amount of the subsidy was mostly determined by quantitative factors. The part of the subsidy independent of the transfer constant depends on the number of students and the structure of their community and in 35% on the number and structure of faculty members. Other factors, presumably considering the quality of functioning of the university, determine the independent of the previous year's subsidy amount in 30% (Journal of Laws, 1 April 2015, Item 463, p. 10). The objective of launching the algorithm was to abandon the method of providing subsidies independently of the way of higher education institutions functioning. The aim of the article, therefore, is to find out whether the algorithm of calculating and awarding the subsidies reflected the differences between universities in terms of efficiency of human resources of higher schools in Poland.

Five groups of higher schools, different from one another because of the degree and field of specialization have been selected for the purpose of the research:
- universities of economics,
- universities,
- universities of life sciences,
- universities of technology,
- universities of medicine.

The data gathered for each group allow to determine a number of determinants that constitute the index of strategic potential of human resources. The data concerned the time span of 2002–2015. The empirical part of the research has examined changes to the index of human resources potential within the time span under review. The first objective of the research has been to find out whether individual university groups recorded progression or regression in the area of human potential development. The second objective of the research has been to examine correlations between the share of the subsidy for a group of universities in the subsidy total amount with the value of the index of human resources strategic potential. The answer to the question concerning the occurrence of such a correlation is the answer to the question if the algorithm for providing the subsidies reflected qualitative changes in functioning of universities.

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Results of previous researches

The researches on allocation of spending on higher education were intensified in early 1990s when in the U.S.A. a number of laws on the amount of subsidies to universities related to their performance was enforced (Liu, 2012, p. 1520). The analyses were developed basing on contradicting the methods of public funds allocation depending on the number of students and the number of employees with the methods based on examining *performance indicators*. A comprehensive review of the system of financing university in the OECD states was presented by Jongbloed and Vossenteyn (2001). The detailed study on financing the educational and scientific activities of universities in 11 countries has enabled a classification of countries into those oriented at efficiency of studying and education (Denmark), at the efficiency of studying and outlays for education (Sweden, the Netherlands), outlays for education and efficiency of studying (USA, Japan, Great Britain, Belgium and France) as well as the classification into the countries oriented at outlays for both education and didactics (Australia, Germany and New Zealand) (Jongbloed and Vossenteyn, 2001, p. 141).

Very interesting findings are the result of the study analyzing relationships between effectiveness of universities and public financing in Bulgaria (Tochkov, Nenovsky, Tochkov, 2012). The authors proved that the rankings of effectiveness are negatively correlated with the amount of funds provided by public financing. Moreover, the research indicated that private universities are more effective than public ones. The overall results of this research paved the way to launching *performance based funding* in the sector of public higher school in Bulgaria.

An indispensable element of financing universities basing on their performance is the construction of the optimal tool of measuring their activities. *Data envelopment analysis* (DEA) is a suitable method in this case. This method enabled, i.a., the comparison of performance of 944 universities from 17 European countries (Veiderpass, McKelvey, 2016). The research results indicated Slovakia, Belgium and Latvia as the countries with the most effective universities, and Denmark and Norway as the ones that are underperforming. Another method could be constructing the performance index basing on the base indicators established relatively in relation to the best value (in the set year). The values obtained in such a way are most often weighted in line with the significance of the set measurements. Some studies indicate weaknesses of such an approach that might distort international rankings based on the very approach (Williams, de Rassenfosse, 2016). Regardless of the above, in the presented study the method of the index of human resources quality based on the weighted impact of ten indicators has been applied.

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There are also researches whose results cushion the enthusiasm for financing universities depending on their financing effectiveness. In the test for the German system of higher education it has been proven that the performance of universities impacts only a small proportion of subsidies, and the effectiveness of launching the financing system, based on measured performance depends on the fact whether the financing takes place both on the level of the land and the university (Orr, Jaeger, Schwarzenberger, 2007). In the other article, its authors – having examined huge numbers of bibliometric records – have indicated that *performance based funding* might be detrimental to outstanding scholars working at universities that are ranked low (Abramo, Cicero, D'Angelo, 2011). Still one more study has found out that funding American universities based on the performance index might lead to deterioration in the effectiveness of students at completing their studies (Hillman, Tandberg, Gross, 2014).

The Polish algorithm of a basis subsidy that was applicable and binding till the end of 2016, in 7% made dependent the change to the university share in the overall subsidy amount on the change in qualitative indicators (research indicator, empowerment indicator and exchange indicator)[1]. Thus, it is worth investigating if the formula of the algorithm allows to reflect changes in the human potential of universities.

Description of the research method

The first stage of the research has been calculating the value of ten indicators defining human resources potential of higher education institutions. The calculation was based on the data of the Main Statistical Office in Poland (GUS), denoting the activity of universities in terms of quantitative financing (GUS, the years 2002–2015). The proposed set of indicators is constructed basing on the belief and conviction of the author as for the aspects of activities of university human resources and which of them is the most important. The availability of the data was the impediment to their initial set. Yet, the first index is the ratio of faculty members to the remainder of employees:

$$W_1 = \frac{UT}{OE},$$

[1]   According to the algorithm formula its variable part (35%) is subject to (in 20%) the weighted impact of research, empowerment and exchange factors. The data are included in Attachment 1 to the Directive of Minister of Science and Higher Education of 23 March 2015 concerning the method of allocating state budget subsidies for public and non-public universities, Journal of Laws of 2015, Item 463.

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with:

W_1 – human resources structure index,

UT – number of university teachers,

OE – number of other university employees.

The higher the value of this index is, the more effective the administration and service staff are. The value of the index might fluctuate because of the specifics of a university. Therefore, lower values should have been expected in case of universities of technology and universities of medicine. However, the situation has been different: the values of this index are more dependent on the ratio of the number of students per one faculty member.

The second indicator illustrates the share of individual faculty members (researchers) in the total number of academic teachers:

$$W_2 = \frac{IR}{UT},$$

with:

W_2 – index of advancement of academic teachers careers,

IR – number of individual researchers.

The higher the value of this index is, the higher the quality of human resources. The recent changes to the institutional framework regulating the Carter path of scholars and researchers resulted in the fact that the share of individual researchers in higher education system has been growing. The pace of the growth within specified groups of universities is of much significance to this research.

The third index presents the number of students per one academic teacher:

$$W_3 = \frac{NS}{UT},$$

with:

W_3 – index of effectiveness of didactics,

NS – number of students.

This index may be treated as the measurement of performance of didactics at a university. Unfortunately, in the current version of the algorithm of subsidy allocation, the importance of the index has been reversed. However, within the timespan under review, high values of the index should be evaluated positively.

The fourth index refers to the share of international students in the overall students' number:

$$W_4 = \frac{NIS}{NS},$$

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with:

W_4 – index of internationalization of didactics,

NIS – number of international students.

The following three indices concern the dynamics of the advancement of scientific career of faculty members:

$$W_5 = \frac{P}{UT}, \quad W_6 = \frac{H}{UT}, \quad W_7 = \frac{D}{UT},$$

with:

W_5 – index of full-time professor honors' degree,

P – number of professor honors' degree awarded by the employing entities,

W_6 – index of habilitations,

H – number of habilitations awarded by the employing entities,

W_7 – index of PhD honors degrees,

D – number of PhD honors degrees awarded by the employing entities.

The value of these indices benchmarked against the total number of academic teachers employed in individual groups of universities proves the intensity of the progress in the scientific career paths.

The Wight index concerns the share of payroll costs in the total amount of revenue from didactic and scientific activities:

$$W_8 = \frac{EC}{RT + RS},$$

with:

W_8 – index of the share of employees' cost in the revenue,

EC – cost of employees (payroll),

RT – revenue from didactics (teaching),

RS – revenue from scientific activities.

The interpretation of this index might not be unanimous. On the one hand, it presents the amount of the burden the cost of employees' earning is for a university. On the other hand, it indicates the importance of human resources among other revenue generating factors. If the revenue was generated from other sources than teaching and scientific activities (space rental, business activity), the share of the payroll in total revenue would be lower. The author of the article tends to approve the latter interpretation claiming that the higher the W_8 index value is, the higher the human potential of university.

The ninth index is the relationship between the average monthly wage at a university and the country's average wage (in economy of the country):

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$$W_9 = \frac{WU}{WE},$$

with:

W_9 – relative wage index,

WU – average monthly wage (gross) in a group of universities calculated as a yearly cost of the payroll divided by the number of employees multiplied by twelve,

WE – average monthly wage (gross) in the country's economy.

The value of this index presents the rank of an employee in the selected group of universities by means of the value of employee's relative wage.

The last index concerns the activity of employees in acquiring grants for scientific researches:

$$W_{10} = \frac{RP}{RS},$$

with:

W_{10} – share of scientific researches grants in revenue from research activity,

RP – amount of the acquired grants for research projects.

The larger the faculty members' activity in acquiring funds for research project is, the higher the index value is.

All the indices calculated in the above way for groups of universities and for the years within the timespan under review have undergone the process of standardization so that the homogenous index could be constructed basing in various values expressed in various measurement units. To his end, each index value – for the set group of universities and the set year under review – has been divided by the maximum index value for the set year. Thus, the group of universities that reached the highest index value has the standardized value of 1. The values for the remaining groups are, thus, lower than I according to the formula:

$$S_{i,u,t} = \frac{W_{i,u,t}}{\max_{1 \le u \le} W_{i,u,t}},$$

with:

$S_{i,u,t}$ – standardized value of i-th index in the year t for a group universities u,

$W_{i,u,t}$ – primary value of i-th index in the year t for a group of universities u.

The adopted standardization formula allows to make comparisons between groups of universities with the consecutive years. However, it does not allow to determine the changes in time. Nonetheless, if the objective of the research is examining the relationships between the human potential weighted index and

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the share in subsidy allocation, the research method in this area is the most appropriate one. The algorithm of the subsidy allocation, like the standardized index considers relative values of the factors, and not their changes in time.

The next step of the research was the calculation of the average weighted index of human potential:

$$SPI_{u,t} = \sum_{i=1}^{i=10} w_i S_{i,u,t},$$

with:

$SPI_{u,t}$ – human resources index of group of universities u In the year t,
w_i – weight attributed to index i.

The formula of weighted index requires weight establishing. In DEA models weights are selected automatically so that indices of high position of the subject have been included into the average with high weight. In the applied research method there is a necessity of establishing weights, therefore the research author, while doing so, aimed at reflecting the differences in the significance of indices.

Table 1. Weights attributed to indices

Index	Weight	Value
human resources structure index	w_1	5%
index of faculty members career advancement	w_2	15%
index of didactics performance	w_3	15%
index of internationalization of didactics	w_4	5%
index of professor titles	w_5	15%
index of habilitations	w_6	10%
index of PhD degrees	w_7	5%
index of payroll share in revenue	w_8	5%
index of relative wage	w_9	10%
index of efficiency of employees in acquiring grants for scientific research	w_{10}	15%

Source: Author's own.

Tyree values of weights have been indicated: 5%, 10% and 15%. The highest weight has been attributed to three key indices in the area "science": w_2, w_5 and w_{10}, and to one in the area of "didactics": w_3. In the author's opinion the lowest weights should have been attributed to indices w_1, w_4, w_7 and w_8. The first of them regards functioning of employees in the administration and service

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units. Internationalization of didactics and the share of payroll in revenue only partly depend on the performance and efforts of faculty members. The index of PhD degrees has been considered less weighted than the habilitations and professor titles.

The average weighted human resources potential index for each group of the universities researched has been made an independent variable in the presented research. A dependent variable has been a year delayed share of a group of universities in the amount of the subsidy received by all the universities examined:

$$SS_{ut} = \frac{S_{ut}}{\sum_{u=1}^{u=5} S_{ut}},$$

with:

SS_{ut} – share of a group of universities u in the amount of subsidy for all the university groups in year t,

S_{ut} – subsidy to a group of universities u in year t.

Such a selection of variables will allow to examine whether there is a relationship between a change to a relative value of human potential index and the share in the amount of subsidy in the following year.

In order to attain a full array of institutional factors determining the subsidy allocation, it should be stressed that medical universities take part in the allocation of other part of funds than the remainder groups of universities. They are included in the subsidy for medicare and the share of each University in allocating the subsidy from this specific pool has been decided upon by the algorithm depended only on the number of students[2]. Contradictory to the algorithms regarding other university groups, in case of medical universities there is a substantial share of the cost formula with no reference to the issues connected with the university performance. Therefore, including the universities of medicine into the research will enable a comparison, of interest to the author, of the existing relationships in four university groups, where the algorithm of subsidy allocation was – to some extent – dependent on the university performance as well as in one university group, where the cost formula has been assumed for the considerable part of the subsidy.

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[2] Details are included in Appendix No. 9 to the Directive of Minister of Science and Higher Education of 27 March 2015 on the method of allocating state budget subsidies for public and non-public universities, Journal of Laws of 2015, Item 463.

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Research findings

First of all, the value of independent variable of human potential index in five groups of universities with 2002–2015 ($SPI_{u,t}$) has been calculated. The graphic presentation of the changeability of the variable allows to distinguish universities of economics and universities of life sciences. The former have recorded the largest increase in the value of the index that moved them upwards from the last but one position in 2002 to the first ranking position in 2015. The change in reverse direction – a fall from the first to the last ranking position – has been experienced within the same timespan by the universities of life sciences.

Graph 1. Values of human resources potential index of selected university groups within 2002–2015
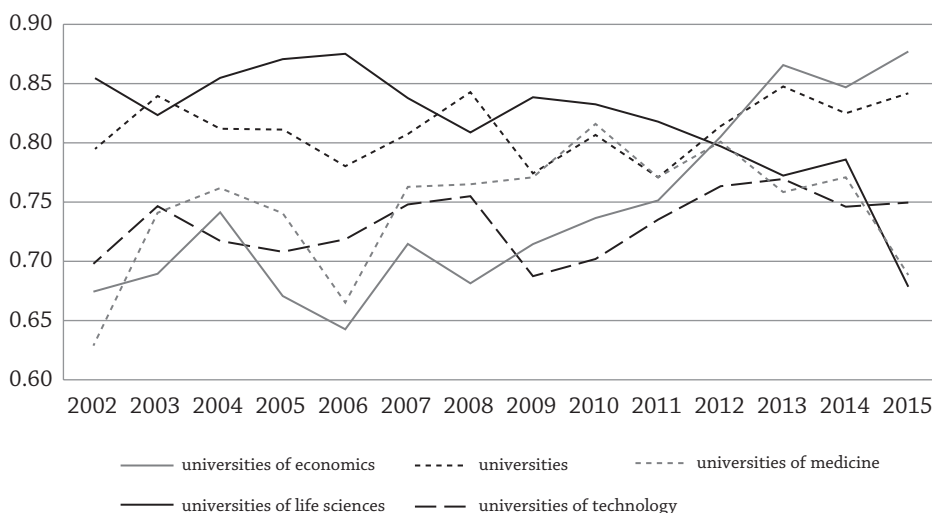
Source: Author's own calculation.

"Non-profile" universities maintained the first or second position in the ranking (except for the year 2010). Yet, universities of medicine recorded a significant drop in their ranking position within 2011–2015, preceded by an advancement from the last to the second place within 2002–2010. Universities of technology fluctuated between the third and fifth place in the ranking.

The rudimentary statistics of the independent variable prove the dominant position of life sciences universities that – prior to their decline from the first to the last position within 2011–15 – had maintained the first or, more seldom, the second ranking position. The comparison of the average values of the index

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of human resources potential confirms a strong position of universities, which is
additionally enhanced by its stability (the lowest standard deflection).

Table 2. Basic statistics of SPI_{ut} variable

	N valid	Average	Minimum	Maximum	Standard deflection
economics universities	14	0.7439	0.6426	0.8763	0.0763
universities	14	0.8123	0.7710	0.8483	0.0258
life sciences universities	14	0.8184	0.6811	0.8757	0.0498
technology universities	14	0.7320	0.6878	0.7704	0.0263
medical universities	14	0.7462	0.6306	0.8168	0.0511

Source: Author's own calculations.

Table 3. t Test for the dependent samples[3]

	Average	Standard deflection	Margin	Margin standard deflection	Statistics t	p
economics universities: 2002–2008	**0.6882**	**0.0323**				
economics universities: 2009–2015	**0.7997**	**0.0657**	**−0.1115**	**0.0814**	**−3.6253**	**0.0110**
universities: 2002–2008	0.8130	0.0228				
universities: 2009–2015	0.8117	0.0303	0.0013	0.0368	0.0939	0.9282
life sciences universities 2002–2008	**0.8470**	**0.0240**				
life sciences universities 2009–2015	**0.7898**	**0.0537**	**0.0572**	**0.0486**	**3.1161**	**0.0207**
technology universities: 2002–2008	0.7276	0.0225				
technology universities: 2009–2015	0.7364	0.0307	−0.0088	0.0360	−0.6442	0.5433
medical universities: 2002–2008	0.7240	0.0538				
medical universities: 2009–2015	0.7684	0.0403	−0.0444	0.0704	−1.6690	0.1462

Source: Author's own calculations.

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[3] Values bolded are statistically relevant on the level α=0.05.

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In order to check if the observed changes to the index of University groups human resources potential had the feature of statistical relevance, their values have been compared in two sub-timespans of 2002–2008 and 2009–2015. To this end, a simple t-Student test for the average has been uses[4]. Test t indicated that only in case of universities of economics and life sciences universities there is a statistically relevant margin of the average in two sub-timespans.

In case of the first sub-timespan the average has grown significantly whereas in the case of the second one it dropped. The comparison of the average values enables drawing conclusions in terms of changes to the performance of human resources of selected groups of universities in Poland. The analysis has revealed some statistically relevant trends. However, to fully accomplish the research objective it should be investigated how the change to the index of human resources potential of university group in the year t impacted the share of the said group in the amount of the subsidy in the year t+1. Thus, the subsidy amount for the selected university groups has undergone the structure analysis that revealed a dominant position of universities and universities of technology, who obtained 70%–74% of the total subsidy amount. The smallest but steadily growing share was the one of universities of economics. An increase of the share was also recorded in case of universities whereas universities of medicines and notably life sciences universities experienced a decline in their share in the total amount of subsidy. The relative value of subsidy for technology universities has remained on stable level.

Table 4. Structure of subsidy amount for selected university groups

year	economics universities	universities	life sciences universities	technology universities	medical universities
2002	4.35%	38.46%	9.76%	32.50%	14.92%
2003	4.35%	38.44%	9.72%	32.14%	15.34%
2004	4.31%	38.68%	9.71%	32.16%	15.14%
2005	4.27%	39.98%	9.69%	31.94%	14.12%
2006	4.20%	39.86%	9.65%	31.59%	14.69%
2007	4.29%	40.68%	9.58%	31.63%	13.81%
2008	4.34%	41.26%	8.77%	31.42%	14.21%

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[4] Because of the fact that the tests of normality distribution resulted in ambiguous findings, the Wilcoxon parameter test of the pair sequence was also conducted. In this case the same results were also obtained and the statistical relevance was characteristic for the margin of life sciences and economics universities.

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year	economics universities	universities	life sciences universities	technology universities	medical universities
2009	4.55%	42.89%	8.12%	30.47%	13.96%
2010	4.51%	42.98%	8.10%	30.36%	14.05%
2011	4.43%	41.77%	7.92%	32.03%	13.84%
2012	4.43%	41.80%	7.88%	31.98%	13.92%
2013	4.47%	42.24%	7.70%	31.96%	13.63%
2014	4.51%	42.55%	7.57%	31.85%	13.52%
2015	4.61%	42.69%	7.47%	31.81%	13.42%

Source: Central Statistical Office in Poland, 2002–2015.

In order to determine the intensity of the researched relationship correlation coefficients have been calculated between the SPI_t variable advancing the SS_{t+1} variable by a year. Doing so, to some extent the question concerning the character of the algorithm of subsidy allocation could be answered. Is the algorithm of pro-performance or cost nature? If the statistically relevant correlations led to such regression equations as well, then a conclusion of pro-performance nature of the algorithm could be drawn.

Table 5. Pearson' r correlation co-efficient for SPI_t and SS_{t+1} variables

	economics universities	universities	life sciences universities	technology universities	medical universities
r	**0.6294**	0.0444	**0.8116**	0.1279	**−0.5721**

Source: Author's own calculations.

The statistically relevant correlation co-efficients have been obtained for universities of economics, life sciences and medicine. Astonishing is the fact that in case of the latter ones the correlation is negative. In case of universities and universities of technology the correlation is weak and statistically irrelevant. The correlation relationship has occurred in case of such groups of universities where significant changes to the value of human resources potential index was recorded[5]. The good results of the correlation analysis for three groups of universities have provided the basis for the estimation of the regression equations:

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[5] The Granger cause test (1964) is a more powerful test of correlation between the variables. The zero hypothesis was the statement: the human resources potential index for a group of universities in the year t is not the cause in terms of Granger of the group's share in the amount of subsidy in the year $t + 1$. Unfortunately, no basis has been identified to reject the hypothesis in any of the analyzed cases.

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$$SS_{u,t+1} = a + bSPI_{u,t} + \varepsilon$$

with:

a – free word,

b – direction co-efficient,

ε – random error.

Table 6. Regression of analysis for the examined variables

parameter	value	etandard error	$t(11)$	p	R^2
economics universities					
a	0.0358	0.0031	11.5925	0.0000	0.3962
b	0.0113	0.0042	2.6864	0.0212	
life sciences universities					
a	−0.1124	0.0431	−2.6084	0.0243	0.6588
b	0.2395	0.0520	4.6081	0.0008	
medical universities					
a	0.1917	0.0219	8.7720	0.0000	0.3273
b	−0.0672	0.0291	−2.3135	0.0410	

Source: Author's own calculations.

The index of human resources potential advancing by a year explains to the largest extent the share of life sciences universities in the amount of the subsidy. It is of less significance in the group of universities of economics and medical universities. The latter group are characterized with a negative direction co-efficient, mainly because of the fact that within 2002–2010 the values of human resources potential index were growing in medical universities, concurrently with the decline in the subsidy share. One of the reasons for the above must have been the fact that universities of medicine had the zero weight of their exchange index, with the share of informational students in overall students' number being the largest one. In this respect the universities of medicine had a large advantage over the others. Moreover, the universities of medicine owed a part of subsidy to their activity in health care system that depended exclusively on the number of students within their time of studying.

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Conclusions

The calculation of the human resources potential index has allowed to indicate statistically relevant changes. Firstly, universities of life sciences have recorded a drop in the index value within the timespan under analysis. Secondly, universities of economics have experienced a significant advancement in hierarchy – from the last position in 2003 and 2005–2008 to the first position within 2013–15. Universities of medicine recorded better performance in the second analyzed sub-timespan, however, a downturn was recorded within that time. In case of universities, the stabilization on a high level was sustained, while universities of technologies recorded medium-level stabilization.

Variability of the human resources potential index has considerably impacted the share in the overall amount of subsidy in universities of life sciences and economics. Therefore, a thesis could be risked that the observed correlation occurs when the change in the cause is intensive and statistically relevant. Funding of higher education is in line with the performance when the performance is changing substantially. The reason for the "cushioning" of the impact was the high so called "transfer constant". Further researches into the discussed issues should focus on extending the list of elements of the human resources potential index with, e.g. the number of points scored for the number of publication per one faculty member. Additionally, it could be interesting to observe how the situation in the analyzed timespan with change in comparison with the future years when a new algorithm will be compulsorily applicable.

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Sławomir Kalinowski, PhD

Faculty member in the Chair of Microeconomics at the University of Economics in Poznań. His didactic activity focuses on microeconomics, management economics and corporate finance. His research activity includes market structure economics, experimental economics, corporate finance and performance of economic entities.