

IS IT POSSIBLE TO ESTIMATE LABOUR PRODUCTIVITY IN THE CZECH HIGHER EDUCATION?

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Abstract

This paper deals with the issues of estimation of labour productivity in the Czech higher education institutions (HEIs) and also at the Faculties of Economics of the Czech HEIs. We focus on the period between the years 2006 and 2010. At first, we analyze the influence of labour productivity on the level of average wages of academic staff in 2010. In this case, we consider that the labour productivity consist of two parts – teaching productivity (the total number of students adjusted by the coefficient of economical difficulty per academic staff) and research productivity (the total number of publication points per academic staff). Secondly, we compare the changes between teaching productivity in the period between the years 2006 and 2010 and the changes between average wages adjusted of average inflation rate at the level of HEIs and at the level of the Faculties of Economics.

Key Words

Higher education institutions, correlation, labour costs, labour productivity, productivity in non-market industries

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Introduction

In 2009 the White Paper on Tertiary Education¹ was brought out and the discussion of tertiary education reform has significantly gained on importance since then. It brought questions of quality of higher education institutions (hereafter: HEIs) and academic staff as well. That is why we decided to present analyses dealing with labour productivity and labour costs at the Czech HEIs and at the Faculties of Economics.

According to The Principles and Rules of Funding of HEIs², public funds (subsidies from the Ministry of Education, Youth and Sports for educational activities of HEIs) are allocated to the level of HEIs and not to the level of faculties. Allocation of the university budget to individual faculties fully depends on autonomous decision of the Academic Senate of HEI (the Senate has to confirm the Rector's proposal of the HEI's budget³).

The main goal of the paper is to evaluate whether the allocation of HEIs' budgets on faculties leads to the significant relation between teaching and research performance of academic staff on one hand and average wages on the other hand at faculties related on economic branches of study.

Measurement of performance and productivity in non-market industries is a very demanding issue. While the productivity in *market* industries can be considered as a ratio of sales (adjusted of changes in own-produced inventories) to employment, in *non-market* industries we cannot measure sales as an output. As [a key reference](#) to an issue of non-market-industry productivity

1 <http://www.msmt.cz/reforma-terciarniho-vzdelavani/bila-kniha?highlightWords=white+paper+tertiary>

2 The Principles and Rules of Funding of HEIs, Czech language (2012d): <http://www.msmt.cz/ekonomika-skolstvi/zasady-a-pravidla-financovani-verejnych-vysokych-skol-pro>

3 Paragraph 9, the Law on Higher Education Institutions (2012c): <http://www.msmt.cz/file/22282>

we consider Atkinson Review (ONS, 2005); chapter 9 is devoted to education. Consequences of differences between market-industry productivity and non-market-industry productivity including estimates of production function for non-market industries are presented by Simpson (2006). However, both Atkinson and Simpson use British data and in relation to education they take into account mainly basic and secondary education. Productivity in higher education and approaches to its measurement are defined by Gates and Stone (1997). As most important in this paper we consider terminological differences between terms *efficiency* and *effectiveness*. Jablonsky (2011) analysed the efficiency of teaching and research activities at the level of departments using DEA methodology. Huzvar and Rigova (2012) used DEA methodology for analysis of relations between academic process and funding of public HEIs. Finally, relation between productivity and policy making is introduced by Callan (2007).

The aims of the article are (i) to estimate the relation between average wages and academic performances and (ii) to compare differences between changes in labour productivity and changes in labour costs (represented by the average wages) both at the Czech HEIs and at the Faculties of Economics between the years 2006 and 2010.

Material and Methods

For the analysis we use data from the Ministry of Education, Youth and. This data set includes data on average wages of academic staff, number of academic staff (MŠMT, 2012a), average number of students (MŠMT, 2012b) and the sum of the publication points (called "RIV points") using the "Methodology of Evaluation of Research Institutions Results and of Evaluation of Finished Programmes 2011" (RVVI, 2011). All the analyses

are presented only on the public HEIs excluding artistic HEIs which are the outliers⁴. Colleges are not included into the analysis. Due to the lack of the dataset needed for the analysis we had to exclude the Faculty of Economics of University of South Bohemia in České Budějovice and two newest non-university HEIs⁵.

Firstly, we would like to find out if the average wage of the academic staff is the function of labour productivity and if there is a correlation between these variables. Labour productivity in this case consists of two self-independent parts – teaching (number of student adjusted by the coefficient of economical difficulty per academic staff) and research (RIV points per academic staff).

Multiple regression and multiple correlation coefficients⁶ were used for the analysis. The analysis is based on the hypothesis that changes in the dependent variable y (average wage) are caused by two independent variables x_1 and x_2 (teaching productivity and research productivity) which is presented by the formula:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \quad (1)$$

By using the method of least squares we can estimate the multiple regression function

$$Y = b_0 + b_{y,x_1,x_2} x_1 + b_{y,x_2,x_1} x_2 \quad (2)$$

For the discussion about the relation between the variables the multiple correlation coefficient $r_{y,x_1,x_2 \dots xp}$ and the coefficient of determination R^2 were used.

4 The average coefficient of economical difficulty of the artistic HEIs reaches 5.9. It is much higher than the rest of the HEIs.

5 We do not have RIV points of the non-university HEIs.

6 For more information see Hindls et al (2004).

The second part of the paper is focused on the analysis of competitiveness of the HEIs and Faculties of Economics by using the condition modified to the non-market industry

$$C_1/Y_1 < C_0/Y_0 \quad (3)$$

where $C \dots$ labour costs⁷

$Y \dots$ number of students

After an adjustment we can state

$$C_1/C_0 < Y_1/Y_0 \quad (4)$$

which could be interpreted as a requirement of slower increase of labour costs in comparison with the change of number of students.

After the division of both parts of the inequation by the labour force index represented by the index of number of academic staff, we get

$$C_1/C_0 : L_1/L_0 < Y_1/Y_0 : L_1/L_0 \quad (5)$$

and after the algebraic adjustment

$$C_1/L_1 : C_0/L_0 < Y_1/L_1 : Y_0/L_0 \quad (6)$$

It means that average labour costs should increase more slowly than labour productivity⁸. Alternatively, we can consider compensation of employees as C , but in short term we can suppose the constant ratio of social contributions to wages and salaries. It implies that the inequation (4) expresses the relation between average wages and labour productivity. Since we estimate real labour productivity by using natural indicator, the average wage has to be real too. It is necessary to take into account inflation represented by consumer price index⁹.

7 Labour costs are broadly described in Jílek, Moravová (p. 129, 2007).

8 The competitiveness concept is only one of the possible approaches. In the case of an increase of the quality of education (e.g. employment more qualified academic staff) the condition would be applied vice versa.

9 See Hindls et al. (p. 381, 2004).

Results

Higher Education Institutions

For the analyses we use the data on number of students of the HEIs, the coefficient of economical difficulty, number of academic staff, average wage, RIV points (see Table 1 and Table 2).

Firstly, we discussed whether average wage is the function of labour productivity represented by teaching productivity (x_1) and research productivity (x_2).

$$y = 19\,069.8 + 303.92x_1 + 76.62x_2 \quad (7)$$

(4.64) (3.31) (4.29)

From the results we can say that increase in teaching productivity (the increase of one student per academic staff) evokes increase in average wage of 303.92 CZK. One point of increase in RIV points per person leads to increase in the average wage of 76.62 CZK.

The values of characteristics are as follows:

$$R^2 = 0.561, r_{x_1x_2} = -0.37, r_{y x_1} = 0.53, r_{y x_2} = 0.29$$

	2006			2010			RIV points
	Students	Average coeff. of the economical difficulty	Academic staff	Students	Average coeff. of the economical difficulty	Academic staff	
CTU	22 747	1.815	1 411.7	22 517	1.865	1 500.4	211 795.95
CULS	16 748	1.611	498.7	20 877	1.584	586.0	39 260.67
USB	9 984	1.530	566.9	12 593	1.506	588.0	65 244.23
MU	32 483	1.417	1 335.1	39 500	1.406	1 414.9	197 255.59
MENDELU	8 769	1.881	416.6	10 440	1.758	507.4	37 075.97
UO	8 485	1.458	354.3	9 967	1.505	446.8	23 416.61
SU	5 524	1.253	214.5	8 811	1.243	290.9	12 795.60
TUL	8 178	1.433	516.0	9 453	1.404	549.9	25 652.96
UHK	7 303	1.372	351.7	8 910	1.438	388.8	10 505.59
UJEP	9 106	1.669	395.5	10 575	1.663	458.0	13 999.44
CU	46 101	1.256	3 219.3	49 775	1.238	3 465.3	513 337.71
UPA	8 567	1.503	467.4	10 604	1.485	513.0	56 924.88
PU	18 887	1.688	1 034.9	21 935	1.631	1 143.3	122 834.71
TBU	9 906	1.555	309.4	13 113	1.617	396.5	22 529.43
UVPS	2 552	3.164	221.8	2 919	3.162	259.3	18 838.34
VŠB-TUO	21 451	1.509	910.0	22 353	1.498	1 016.3	52 307.64
VŠE	16 012	1.084	566.3	19 271	1.089	582.5	24 029.97
ICT	3 973	2.745	416.9	3 647	2.721	414.5	79 556.49
BUT	20 736	1.701	971.2	22 211	1.690	997.6	134 933.71
UWB	15 650	1.301	764.6	16 469	1.360	822.1	62 430.50

Tab. 1: Number of students, the average coefficient of economical difficulty, number of academic staff, RIV points, public HEIs, 2006 and 2010¹⁰

¹⁰ All the abbreviations are described in appendix.

From the results and the t-statistics (presented under the regression model) we can see that both the variables are significant (5 % level of significance). There is positive correlation between average wage and teaching productivity and there is positive correlation between average wage and research productivity. It means that increase in teaching productivity (represented by students per academic staff) causes the increase in average wage and increase in research productivity cause the increase in average wage as well. There is no multicollinearity¹¹ (there is weak negative correlation between teaching productivity and research productivity, which means that increase in teaching productivity cause decreasing at the research productivity). It means that the model is estimated right. It is necessary to note that this model presents only part of the average wage.

The second part of the analysis focuses on the average labour costs (represented by real average wage) and teaching productivity (measured as the ratio of students adjusted by the coefficient of the economical difficulty per academic staff) among Czech HEIs between the years 2006 and 2010.

From the results (see table 3) one can see that there are some differences in teaching productivity and average labour costs among 20 Czech HEIs. The biggest difference between teaching productivity and labour costs during the period 2006 and 2010 was achieved at the Institute of Chemical Technology Prague (ICT). The total gap in 4 years was about 19 per cent. On the other hand teaching productivity increased more quickly than labour costs especially at the University of Hradec Králové (UHK). Teaching productivity increased of 15.68 per cent in the period in question. Average labour costs at the University of Hradec Králové decreased of 12.38 per cent.

11 5 % level of significance

	average wage			average wage	
	2006	2010		2006	2010
CULS	43 085	48 654	SU	30 363	35 161
ICT	35 218	43 697	VŠB-TUO	34 209	35 155
MU	36 528	42 958	USB	29 830	34 625
CTU	35 988	40 677	UO	29 401	34 317
BUT	35 267	38 986	TBU	31 378	33 840
VŠE	34 411	38 239	UJEP	27 977	33 165
MENDELU	34 205	36 547	UWB	30 718	33 135
UPA	33 887	36 152	TUL	25 606	32 321
PU	30 136	35 849	UVPS	29 707	30 474
CU	29 020	35 424	UHK	28 854	28 340

Tab. 2: Average wage, public HEIs, 2006 and 2010

When we compare this result with the first estimation presented in Fischer, Vltavská (2011) which was done for the period between the years 2004 and 2009 we can see that the biggest difference between teaching productivity and labour costs during the period in question was achieved at the University of Ostrava. The total gap in 5 years was about 31 per cent. On the other hand teaching productivity increased more quickly than labour costs especially at the University of Economics in Prague. Teaching productivity increased of 23.81 per cent in the period in question. Average labour costs at the University of Economics increased of 6.82 per cent.

	costs	productivity	difference		costs	productivity	difference
UHK	-12.38	15.68	28.6	CULS	0.74	4.32	3.58
VŠE	-0.87	17.49	18.36	VŠB-TUO	-8.33	-7.38	0.94
UPA	-4.83	11.42	16.25	MENDELU	-4.69	-8.66	-3.97
USB	3.55	19.76	16.21	PU	6.12	1.59	-4.53
SU	3.31	16.73	13.43	CTU	0.83	-4.29	-5.12
TBU	-3.79	7.48	11.27	UJEP	5.75	-0.08	-5.83
MU	4.91	13.88	8.97	TUL	12.60	6.31	-6.29
UVPS	-8.49	-2.27	6.22	UO	4.13	-3.90	-8.03
UWB	-3.77	2.33	6.10	CU	8.89	-1.11	-10.01
BUT	-1.38	3.62	5.00	ICT	10.69	-8.50	-19.19

Tab. 3: Change in real teaching productivity and average real labour costs, public HEIs (2006 – 2010, annual growth, %)

Faculties of Economics

The dataset used for the analyses contain number of students of the Faculties of Economics of public HEIs, the average number of academic staff, average wage, RIV points (see Table 4 and Table 5).

First part of the analysis is devoted to the analyses of the relationship between teaching productivity (x_1) and research productivity (x_2).

$$y = 14\,085 + 508.4x_1 + 67.6x_2 \quad (8)$$

(1.87) (1.24) (2.81)

We can conclude that the increase in the education part of teaching productivity by one causes the increase in average wage by 508.4 CZK. One point of increase in RIV points per person leads to the increase in the average wage by 67.6 CZK (both under the condition of *ceteris paribus*).

The values of characteristics are as follows:

$$R^2 = 0.37, r_{x_1x_2} = -0.072, r_{y x_1} = 0.56, r_{y x_2} = 0.21$$

The t-statistics (presented under the regression model) show that variable “teaching productivity” is statistically significant at 10 % level of significance. A weak negative correlation between teaching productivity and research productivity was traced. That means that an increase in the teaching productivity caused a decrease in the research productivity represented. On the other hand, there is a positive correlation between average wage and the teaching productivity and average wage and research productivity. One can see the link between the results of the HEIs and the Faculties of Economics. There is no multicollinearity (10 % level of significance).

Faculty	University	2006		2010		RIV points
		Students	Academic staff	Students	Academic staff	
of Social Sciences	CU	3 128.5	125.8	4 104.5	137.3	14 136
of Social and Economic Studies	UJEP	2 080.5	55.6	2 199.5	67.2	321
of Economics and Administration	MU	3 520.0	86.6	4 452.5	92.8	3 060
School of Business Administration in Karvina	SU	2 635.0	95.0	4 384.5	107.6	2 581
of Economics	UWB	2 208.5	62.6	2 311.5	61.2	492
of Economics	TUL	1 386.0	71.4	2 080.5	83.1	2 037
of Economics and Administration	UPA	2 381.5	69.4	2 638.5	78.5	3 925
of Business and Management	BUT	2 185.5	63.7	2 758.0	81.2	1 961
of Economics	VŠB-TUO	5 594.0	175.0	6 539.0	175.5	4 995
of Management and Economics	TBU	3 197.0	72.3	3 418.5	83.9	2 927
of Finance and Accounting	VŠE	2 576.0	79.5	3 176.0	81.6	5 392
of International Relations	VŠE	3 835.0	170.3	4 712.5	171.8	5 252
of Business Administration	VŠE	3 260.5	91.5	3 778.0	105.9	3 435
of Informatics and Statistics	VŠE	2 575.5	111.1	3 332.0	100.3	4 809
of Economics	VŠE	2 231.5	55.8	2 571.5	65.2	3 936
of Management	VŠE	1 284.5	39.5	1 436.5	38.6	1 201
of Economics and Management	CULS	7 144.0	168.6	9 462.0	185.7	5 276
of Business and Economics	MENDELU	2 831.5	96.9	3 658.0	113.9	5 636

Tab. 4: Average number of students, average number of academic staff, RIV points, Faculties of Economics, 2006 and 2010

The productivity analysis represents the second part of the paper. We estimated the average labour cost (real average wage) and teaching (labour) productivity (the ratio of students adjusted by the coefficient of the economical difficulty per academic staff) among the Faculties of Economics between the years 2006 and 2010.

When comparing the development of teaching productivity and average labour costs, the differences between the individual quantities may take the form of percentage. This proved better for our purposes since it clearly illustrates the change in the growth. In 2010, the highest average wage is reached at the Faculty of Economics and Management of the Czech University of Life Sciences Prague (CULS), followed by the Faculty of Economics and Administration of Masaryk University and the Faculty of Finance and Accounting of the University of Economics, Prague (see Table 5). On the other hand, the wage is the lowest at Faculty of Economics of the West Bohemia University (UWB). Also some methodological issues mentioned above such as additional workloads complicate the analysis and interpreting of its results.

Faculty	HEI	average wage	
		2006	2010
of Economics and Management	CULS	43 963	54 551
of Economics and Administration	MU	39 288	44 654
of Finance and Accounting	VŠE	38 933	43 823
of Economics and Administration	UPA	38 353	38 214
of Business Administration	VŠE	34 919	37 060
of Economics	VŠE	34 030	36 554
of Informatics and Statistics	VŠE	32 374	36 442
of Business and Economics	MENDELU	35 634	36 105
of Management	VŠE	35 326	35 682
of Social Sciences	CU	30 258	35 096
School of Business Administration in Karvina	SU	26 585	34 769
of International Relations	VŠE	30 361	34 482
of Economics	VŠB-TUO	31 941	33 936
of Economics	TUL	27 559	32 614
of Social and Economic Studies	UJEP	29 477	32 570
of Business and Management	BUT	28 837	31 074
of Management and Economics	TBU	26 080	28 079
of Economics	UWB	32 472	27 335

Tab. 5: Average wage, Faculties of Economics, 2006 and 2010

Table 6 presents the results of productivity analysis. One can see that there are some differences in teaching productivity and average labour costs among Faculties of Economics. At almost all Faculties of Economics, increase in teaching productivity is higher than in average wages. It could be explained by three

causes. Firstly, the increase in number of students recorded between 2006 and 2010 had started at the beginning of 2000s. Secondly, due to the economic recession and fiscal restrictions the total budget for public universities decreased from 2009. Thirdly, the increase in number of students is realized mainly in economic branches of studies. But, there is a difference between individual Faculties of Economics. The highest difference between teaching productivity and real labour costs is higher than 40 percentage points (Faculty of Informatics and Statistics, University of Economics, Prague), but, on the other hand, at two faculties the decrease in productivity is higher than decrease in real labour costs.

Faculty	HEI	Costs	Productivity	Difference
of Informatics and Statistics	VŠE	0.42	43.24	42.82
of Economics	UWB	-24.90	7.12	32.02
School of Business Administration in Karvina	SU	16.67	46.86	30.19
of Management	VŠE	-9.89	14.34	24.23
of Economics	TUL	5.57	29.03	23.45
of Economics	VŠB-TUO	-5.22	16.59	21.81
of International Relations	VŠE	1.32	21.83	20.52
of Finance and Accounting	VŠE	0.41	20.15	19.74
of Business and Economics	MENDELU	-9.61	9.88	19.49
of Social Sciences	CU	3.47	20.19	16.72
of Economics and Administration	MU	1.39	18.01	16.62
of Economics and Management	CULS	10.69	20.26	9.57
of Economics and Administration	UPA	-11.11	-2.00	9.12
of Business Administration	VŠE	-5.32	0.08	5.40
of Business and Management	BUT	-3.87	-1.01	2.87
of Economics	VŠE	-4.18	-1.45	2.72
of Management and Economics	TBU	-3.95	-7.88	-3.92
of Social and Economic Studies	UJEP	-1.43	-12.47	-11.04

Tab. 6: Change in real labour productivity and average real labour costs, Faculties of Economics (2006 – 2010, annual growth, %)

Discussion

At the analysis of relations between wages and productivity of the *faculties* we can see significantly lower level of R^2 comparing to the analysis at the level of (whole) HEIs. From our point of view it is possible to explain lower R^2 by several reasons. Firstly, there could be some redistributive processes within HEIs (support of weaker faculties). Secondly, there are some methodological issues which can influence the average wage. For example, from some research projects the benefits from staff has the form of additional money (bonuses), from other projects the benefits has the form of additional money and also the additional workload. If we increase both wage and formal workload, the average wage will not raise. Thirdly, the total subsidy for the student is influenced not only by the coefficient of economic difficulty, but also by so-called qualitative and performance indicator (“VKM”). Fourthly, using RIV points we measure the research output, while the average wage is influenced by research inputs (institutional and specific support of research). It means that there could be a weak correlation between inputs and outputs. Finally, maybe the RVVI Methodology (RVVI, 2011) is not so good for comparison of research performance among Faculties of Economics.

If we compute research productivity of the Czech HEIs (at the level of HEIs) we would conclude that the research productivity is higher in more heterogeneous institutions (Charles University, Masaryk University) and in institutions which are more focused on technical and science branches (Czech Technical University). On the other hand, more homogeneous (University of Economics, Prague) and HEIs oriented on humanities and social sciences (University of Hradec Kralove, Jan Evangelista Purkyne University in Usti) are less efficient. These conclusions are in accordance to the results of Huzvar and Rigova (2012).

The results can be partly explained by the method of evaluation of research activities (so-called coffee-mill) by RVVI (2011) which prefer technical and science research.

Conclusion

In this paper we presented two parts of analysis of labour productivity at higher education institutions. Firstly, variance in average wage at 20 HEIs could be explained by variance in labour productivity divided into teaching productivity (measured by adjusted number of students per academic staff) and research productivity (RIV points per academic staff). By this relation, where number of students is adjusted by the coefficients of economic difficulty, 56.1% of variance could be explained. In comparison with the results for the period between the years 2004 and 2009 (66.5 %) we explained smaller part of differences in average wages at HEIs.

From the point of view of the Faculties of Economics the variance in average wage could also be explained by variance in teaching productivity and research productivity. This model explained only 37 % of the variance which was a smaller part of variance of average wage than a similar model of public HEIs. The underlying reasons could be detected in some redistribution processes, methodological issues, influence of qualitative indicators (so-called VKM), weak correlation between research money and research output and unsuitability of RVVI Methodology for comparisons among faculties of economics.

Second part of the analysis focused on the comparison of teaching productivity and labour costs of the Faculties of Economics. Almost all Faculties showed higher increase in teaching productivity than in labour costs. The highest difference was achieved at the Faculty of Informatics and Statistics, University

of Economics in Prague (42.82 %). Unfortunately, as a reverse part of the pressure on teaching productivity we should consider the issues of quality of an educational process.

Analyses of HEIs gain more importance these days. We will continue our work in this area analysing the relationship between the structure of academic staff and the structure of RIV points for instance.

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Appendix

Abbreviation	University
ČTU	Czech Technical University in Prague
CULS	Czech University of Life Sciences Prague
USB	University of South Bohemia in České Budějovice
MU	Masaryk University
MENDELU	Mendel University in Brno
UO	University of Ostrava
SU	Silesian University in Opava
TUL	Technical University of Liberec
UHK	University of Hradec Králové
UJEP	Jan Evangelista Purkyně University in Ústí nad Labem
CU	Charles University in Prague
UPA	University of Pardubice
PU	Palacký University Olomouc
TBU	Tomas Bata University in Zlín
UVPS	University of Veterinary and Pharmaceutical Sciences Brno
VŠB-TUO	VŠB – Technical University of Ostrava
VŠE	University of Economics, Prague
ICT	Institute of Chemical Technology Prague
BUT	Brno University of Technology
UWB	University of West Bohemia