Domagoj Karacic, Ivan Miskulin, and Hrvoje Serdarusic. 2016. State investment in science and scientific productivity of universities. *UTMS Journal of Economics* 7 (1): 37–48.

Preliminary communication
(accepted October 27, 2015)

STATE INVESTMENT IN SCIENCE AND SCIENTIFIC PRODUCTIVITY OF UNIVERSITIES

Domagoj Karacic[1]
Ivan Miskulin
Hrvoje Serdarusic

Abstract
State investment in service activities of the public sector, as well as the financial returns analyzed from the aspect of service effectiveness and utilization of public goods, can be considered as one of the most significant dilemmas, especially in the field of education. When analyzing state investments, through investment in education and development of the university, we can conclude that state investments in scientific productivity of universities fall into one of the main future frameworks of measurability of universities efficiency. This criterion cannot be taken as the most important since universities are fundamentally divided into teaching and research activities. However, the concept of determination of the productivity of universities, from the aspect of the scientific activities of the teaching staff, has an increasingly important role due to the specified global criteria and conditions for career advancement of the teaching staff and positioning of the university in the education market. This paper intends to give the overview of the current situation of universities in Croatia, as well as the trends that would point out state role in financing of universities and indicate coherent criteria regarding the financing of scientific productivity of teaching stuff.

Keywords: funding, government, research productivity, university research.

Jel Classification: I22; E23; I28

INTRODUCTION

Governments of countries worldvide come to the conclusion that the research activities are the central tool for economic development and investment of the country in university research and development centers gained an acceptable logic that is used in further political discussions when it comes to science and technology topics. New knowledge created in universities has finally become established and recognized element in the

[1] **Domagoj Karacic**, PhD, Assistant Professor, Faculty of Economics in Osijek; **Ivan Miskulin**, Faculty of Medicine Osijek; **Hrvoje Serdarusic**, PhD, Assistant Professor, Faculty of Economics in Osijek, J. J. Strossmayer University of Osijek, Croatia.

economic policy of the country and the region (Hearn, McLendon, and Lacy 2013, 605). Following that initial thinking public higher education institutions in Croatia are financed mainly from the state budget. Additional sources of income come from tuition and registration fees paid by full-time or part-time students, financing instruments for research activities, market activity and donations. Private institutions are fully financed by their founders and student tuition (Doolan, Dolenec, and Domazet 2012, 27). Overall, approximately 70% of the total financing of Croatian universities comes from the state budget, and 41% to 60% of its revenues comes from tuition. Remaining amount comes from the third source (Doolan, Dolenec, and Domazet 2012, 28). Lower income from other sources, especially for research and development and commercial activities, indicates a weakness in the system of higher education (File et al. 2013, 22). According to Eurostat data, in 2009 in Croatia, public investment in higher education was 0.82% of GDP, which is below the average of 1.22% of GDP in the EU-27 for the same year. For example, in Slovenia public investment in higher education was 1.2% of GDP and in Hungary, 1.02% of GDP. When observing wider European context, only countries whose public investment in higher education in 2009 was less than 1% of GDP were Portugal (0.95%), Bulgaria (0.95%), Italy (0.86 %), United Kingdom (0.81%), Slovakia (0.81%) and Latvia (0.79%), while Sweden stands out as the country with the highest share of GDP invested in higher education (1.82%) (File et al. 2013, 22). Recent report provided by the European University Association (2014) places Croatia in the group of countries that responded to economic and financial crisis with reduction of funding to the higher education - in the range of 5% to 10%, similar to neighbouring Slovenia (EUA Public Funding Observatory 2014, 9–10). The aim of this study was to explore the interrelationship between government investments in science and scientific productivity of public universities, pointing out possible ways to enhance scientific productivity of public universities without additional financial investments in science.

1. THE SYSTEM OF UNIVERSITIES IN THE REPUBLIC OF CROATIA

Based on Article 3 of the Law on Scientific Activities and Higher Education, universities will perform scientific, artistic and developmental research, particularly implementing research programs of strategic interest for Croatia. Also, universities will conduct artistic and professional work, undergraduate, graduate and postgraduate education. Universities achieve their tasks in accordance with the needs of the community (NG 123/03, 198/03, 105/04, 174/04, 2/07-Constitutional Court Decision, 46/07, 45/09, 63/11, 94/13, 139/13). In accordance with the previously mentioned task, under Article 53 of the Law on Scientific Activities and Higher Education, universities are educational institutions that, with linking of scientific research, artistic creativity and teaching, are developing science, vocation and art. Universities are preparing students for professional activities on the basis of scientific knowledge and methods; they are teaching artistic values, educating scientific and artistic youth, participating in achievement of social interests of students and promoting international, particularly European, cooperation in higher education and scientific and artistic activities (Official Gazette 123/03, 198/03, 105/04, 174/04, 2/07-Constitutional Court Decision, 46/07, 45/09, 63/11, 94/13, 139/13). University network in Croatia is composed of eight public (University of Zagreb, University of Rijeka, University of Split, Josip Juraj Strossmayer University in Osijek, University of Zadar, University of Dubrovnik, University of Pula, University North) and

two private universities (Croatian Catholic University in Zagreb and DIU Libertas private international university in Dubrovnik). Analysis of the existing network of higher education institutions and programs in Croatia, conducted in 2011 (when Croatia had seven public and three private universities), concluded that with seven public universities Croatia reached the feasible maximum. This conclusion took into account available scientific and educational potential in present and in the next 10–15 years. The same document concluded that establishment of three new private universities, in a relatively short period, is not in line with common practice in developed countries of European Union. More developed countries do not support establishment of universities ab ovo. That should be conducted in long and demanding process of transformation of already existing institution of higher education into the university, at a time when ready to perform doctoral studies.

In addition, document concludes that recently established universities have only, or mainly, social and humanistic character, which is not satisfactory. This is justified by the fact that the establishment of the social studies require smaller funds (National Council for Higher Education 2011, 12). Despite all these findings, in May 2015 Croatia received the eighth public university, the University North. This reveals, among other, potential problems and challenges in the higher education system in Croatia. The number of students on public and private universities in the period from 2008/2009 academic year until 2013/2014 academic year is presented in Table 1. The table shows that, among all universities, University of Zagreb has the highest number of students (during observed academic years' number of students ranged from 70,000 to 78,000). Other three larger Croatian universities (Rijeka, Split and Osijek) are founded around the same time (the 70s of the 20th century). Number of students in observed period ranged from 17,000 to 22,000. Finally, there is a group of the youngest universities, established in the early 21st century (University of Zadar, Dubrovnik and Pula), with number of students ranging from 2,000 to 7,000. Looking at private universities (Croatian Catholic University, DIU International University and the University North – eight public universities in Croatia from May 2015) it can be concluded that the number of students attending private universities is significantly lower than the number of students attending public universities. That number ranged from only 20 attending DIU International University, and just fewer than 3,000 students enrolled at the University North in academic year 2013/2014.

Table 1. Number of students in public and private universities in academic years between 2008/2009 and 2013/2014.

Institutions	Academic year					
	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
J.J Strossmayer University of Osijek	21.336	21.063	20.421	21.258	20.432	18.634
J. Dobrila University of Pula	3.222	2.577	2.993	2.986	3.061	3.294
University of Dubrovnik	2.172	2.207	1.975	1.952	1.808	1.818
University of Rijeka	19.133	19.663	20.013	18.861	17.608	17.030
University of Split	21.109	22.319	21.879	22.473	22.275	21.363
University of Zadar	7.865	5.395	5.293	5.906	5.802	5.231
University of Zagreb	76.083	75.657	76.946	78.170	76.588	70.479
DIU International University	-	20	27	39	29	54
Catholic University of Croatia			40	77	206	307
University North						2.988
Total:	150.920	148.901	149.587	151.722	147.809	141.198

Source: Croatian Agency for Science and Higher Education. https://www.azvo.hr/hr/statistike/1120-broj-studenata-na-vu-prema-vlasnistvu-za-akademske-godine-2008-09-do-2013-14 (ccessed August 18, 2015).

Cumulative overview of the number of students and number of employees of all public universities in Croatia, in addition to the newly established University North, is shown in Table 2. Table shows that with the number of enrolled students (over 72,000), but also with number of employees (nearly 7,000) University of Zagreb is largest university. University of Zagreb is followed by a group of three other larger Croatian universities (Rijeka, Split and Osijek) with approximately same number of students (in the range of 18.00 to 21.000) and employees (in the range from about 1,550 to about 1,650). Finally, there is a group of three smaller and younger Croatian public universities (Zadar, Dubrovnik and Pula) established at the beginning of the 21st century, with the number of students ranging from 2500 to 5300, a number of employees ranging from 250 to 550.

When looking at the structure of employees in all public universities it is visible how share of employees in the scientific and academic vocation ranged from 24.3% (Dubrovnik) to 47.5% (Zagreb), while share of employees in position of associates ranged from 40.6% (Dubrovnik) to 23.4% (Zagreb). This division is in direct connection with the longevity of each university. It is evident that the older Croatian universities (Zagreb, Rijeka, Split and Osijek) developed its scientific and teaching stuff during the longer period, with share from 40.9% (Osijek) to 47.5% (Zagreb). Younger Croatian universities (Zadar, Dubrovnik and Pula) have share of scientific and teaching stuff from 24% (Dubrovnik) to 39% (Pula). Consequently, share of employees in position of associates in younger universities ranged from 27.2% (Pula) to 40.6% (Dubrovnik), while in the older public universities this percentage ranged from 23.4% (Zagreb) to 32.7% (Rijeka). When observing share of technical and administrative staff in the total number of employees at the universities, it is visible that in all public universities it ranged from 26.2% (Rijeka) to 35.1% (Dubrovnik), with the exception of the University of Pula, where it was 49.4%.

Table 2. Number and structure of employees of public universities except newly found University North

Name of the University	Number of employees			Number of students	
	N			N	
the academic year for which the data presented	Employees in the scientific and academic titles	Employees in associate professions	Technical and administrative staff	Full-time students	Associate students
	N (%)*	N (%)*	N (%)*	N (%)*	N (%)*
University of Dubrovnik; ac. y.2010. /2011.	58 (24,3%)	239 97 (40,6%)	84 (35,1%)	2.532 1.557 (61,5%)	975 (38,5%)
Universtiy of Zagreb; ac.y. 2011. /2012.	3.209 (47,5%)	6.760 1.585 (23,4%)	1.966 (29,1%)	72.480 -	-
J.J Strossmayer University of Osijek; ac. y. 2011. /2012.	644 (40,9%)	1.574 393 (25,0%)	537 (34,1%)	19.532 13.924 (71,3%)	5.608 (28,7%)
University of Zadar; ac. y. 2011./2012.	396 (70,5%)	562	166 (29,5%)	5.295 3.704 (70,0%)	1.591 (30,0%)
J. Dobrila University of Pula; ac. y. 2011./2012.	97 (39,4%)	246 67 (27,2%)	82 (49,4%)	3.328 2.226 (66,9%)	1.102 (33,1%)
University of Rijeka; ac. y. 2011./2012.	675 (41,1%)	1.642 537 (32,7%)	430 (26,2%)	18.270 12.578 (68,8%)	5.692 (31,2%)

Table 2. (*continued*)

Name of the University	Number of employees N			Number of students N	
the academic year for which the data presented	Employees in the scientific and academic titles N (%)*	Employees in associate professions N (%)*	Technical and administrative staff N (%)*	Full-time students N (%)*	Associate students N (%)*
University of Split; ac. y. 2011./2012.	664 (43%)	1.544 417 (27%)	463 (30%)	21.291 -	-

*share in total number

Source: Authors overview based on data from the Final report of ASHE on the results of the external audit of the quality of some Croatian universities

2. SOURCES AND METHODS OF FINANCING OF UNIVERSITIES IN THE REPUBLIC OF CROATIA

Possible sources of funding of universities in Croatia are defined by Article 107 of the Act on Science and Higher Education, which states that higher education institutions, institutes and other scientific organizations are financed from:

- Founders resources
- Croatian budget
- budgets of counties, towns and municipalities
- Croatian Science Foundation
- own market revenues from tuition fees, research, artistic and professional projects, analyses, expertise, publishing and other activities
- other foundations, profits of companies and other legal entities established by the University in accordance with the Act on Science and Higher Education
- Direct investments of individuals, companies and other legal entities; donations and other sources.

It was furthermore stressed that universities, polytechnics, colleges and public scientific institutes can be financed only from sources that do not affect their independence and dignity, while own revenues may only be realized in activities that do not harm the achievement of primary objectives of universities, polytechnics, colleges and public research institutes (Official Gazette 123/03). In terms of the Act on Science and Higher Education, financing from state (budget) includes financing from the central government budget, the budget of local government units and Croatian Science Foundation, while financing from own sources includes financing from founders' resources, own revenues, university and other foundations, donations (domestic and foreign), other sources, as well as the private sector and individuals (Farnell 2010, 18). According to the report of the Ministry of Science, Education and Sports in 2007, financing from state budget constituted 70% of universities income sources, while 30% of the income came from other sources (Badjari et al. 2007, 94). Studies show that in the period from 2003 to 2007, universities generated their own revenue predominantly from the tuition at undergraduate, graduate and postgraduate studies and part-time students. Income from tuition fees during this period averaged approximately 38% of income of all Croatian universities (Farnell 2010, 18). The current model of financing of higher education through program contracts will be finalised during the academic year

2014/2015 with first three-year cycle. Evaluation of advantages and disadvantages of currently used financing model is still to be conducted.

In connection with this financing system, it has already been highlighted how positive development of programming contracts reflects on securing multi-annual funding. It brings reliable and clear framework for subsidizing, it lowers administrative burden and it also provides framework for programming of the work at higher education institutions. This is conducted in accordance with the objectives of the development of higher education system in Croatia. It is also important to stress other positive results, including development of competencies for project programming at institutions for higher education, development of cooperative relations between representatives of higher education institutions, students and the Ministry, exchange of experiences and views on the need to improve the system of higher education, as well as the development of a legislative framework (http://public.mzos.hr/default.aspx?sec=3329). Considering the total amount of funds designated to the universities by the Ministry of Science, Education and Sports in 2014 and 2015, and projections for 2016 and 2017, it is visible that most funds, in the range of 1.1 to 1.6 billion, are directed towards University of Zagreb. Approximately equal amount, in the range of 230 to 340 million, is directed to University of Rijeka, Split and Osijek. Lowest amount is directed toward University of Zadar (in range of 90 to 140,000,000 million), University of Dubrovnik (in range 36 to 49,000,000 million) and the University of Pula (in range 35 to 48,000,000 million) (Table 3).

Table 3. Amounts designated for financing of regular activities of Croatian public universities, according to the financial plan of the Ministry of Science, Education and Sports of the Republic Croatian, for 2014–2016 and 2015–2017.

Institutions	The amount of financing of regular activities of the University (in HRK)			
	The proposed budget for 2014.	The proposed budget for 2015.	Projected budget for 2016.	Projected budget for 2017.
Zagreb	1.164.886.744	1.556.370.945	1.092.716.360	1.062.602.190
Rijeka	241.889.085	329.766.475	239.390.049	232.792.698
Osijek	242.001.720	338.633.283	251.509.560	244.578.208
Split	236.292.389	315.989.316	234.411.901	227.951.743
Zadar	95.128.343	142.756.887	92.670.878	90.116.961
Dubrovnik	46.346.875	49.751.772	37.798.806	36.757.109
Pula	39.787.858	48.161.053	36.142.390	35.146.342

Source: Ministry of Science, Education and Sports of the Republic Croatian. http://public.mzos.hr/Default.aspx?art=13093&sec=3331 (accessed August19, 2015).

3. THE SCIENTIFIC ACTIVITY OF UNIVERSITIES IN CROATIA

According to the Act on Science and Higher Education, scientific activity implies scientific and development research and presents special interest for the Republic of Croatia. Same as higher education, it is integral part of international, particularly European, scientific, artistic and educational space. Scientific work is based on: freedom and autonomy of creativity, ethics of scientists, transparency of work, interaction with the education system, international quality standards, promotion and respect for specific national issues and intellectual property protection. According to the Act on Science and Higher Education, scientific activity in the Republic of Croatia is performed by universities and their constituent units, public scientific institutes, scientific institutes, Croatian Academy of Sciences and Arts as well as other legal persons and their organizational units registered in the Register of Scientific Organizations (Official

Gazette 123 / 03, 198/03, 105/04, 174/04, 2/07-Constitutional Court Decision, 46/07, 45/09, 63/11, 94/13, 139/13). With natural persons preforming scientific research, subjects of scientific activity are also National Council, Ministry, Croatian Academic and Research Network (CARNet), Croatian Science Foundation (hereinafter the Foundation) and, in accordance with the law and their regulations, educational bases of medical, dental, veterinary medicine and pharmacy universities, polytechnics, colleges, scientific associations, museums, archives and other legal persons and their organizational units that carry out scientific activities. Scientific activities in Croatia are financed from the state budget of Republic of Croatia in line with the model of dedicated multiannual institutional funding of scientific activities. This model is the result of a joint annual effort of the Ministry and the academic and scientific community. In June and July 2013, agreements for multiannual dedicated institutional funding of scientific activity for 2013, 2014 and 2015 were signed with the directors of public research institutes and the rectors of public universities in Croatia.

Specifically, transparent funding, publishing of results and encouraging partnerships between universities and research institutes with the economy stand as one of the objectives of the Programme of the Croatian Government for period 2011–2015. Ministry of Science, Education and Sport is implementing this objective with development of science as a driver of long-term economic and social growth. Based on that, but also based on strong and reasoned remarks of the scientific community on the previous model of financing of scientific activities, the Ministry of Science, Education and Sports has proposed a structured and balanced model of financing scientific activities. This model is based on the good practices of developed western countries. Most of the funding will be directed to the competitive projects of the Croatian Science Foundation, and additionally to the financing of salaries and "overhead" cost for institutions in the system, the smaller part will be provided for steady dedicated multiannual institutional funding of scientific activities.

The total annual amount provided for multiannual institutional funding of scientific activities is allocated, in accordance with the performance indicators, to seven public universities (in the new cycle, from 2016 onwards, eighth universities - newly established University North) and twenty-five public research institutes. Resources from the multiannual institutional fund are designated to basic research activities, while the funds for the implementation of scientific projects are ensured through Croatian Science Foundation. Therefore, scientists will, as it was so far, have the opportunity to apply projects to Croatian Science Foundation, the Fund "Unity through Knowledge" and to contest for international projects (http://public.mzos.hr/Default.aspx?sec= 3521). Taking into account the specificities of scientific areas and types of scientific institutions, and in order to facilitate maximum comparability of institutions operating in the same field, following indicators of the implementation of scientific activity and difficulty have been agreed: scientific productivity—ponder 60%; national and international competitive research projects and the mobility of researchers—ponder 25%; popularization of science—ponder 5%; Science cooperation with businesses, government bodies and local and regional authorities, civil society and non-governmental organizations—ponder 10%.

In the field of natural, technical, biotechnical and biomedical sciences, it was agreed that the number of scientific papers published in journals in Web of Science database and citations of articles in magazines in Web of Science database, is considered as

indicator of scientific productivity. Indicator of scientific productivity in the area of social sciences and humanities, are number of scientific papers published in journals in Web of Science and SCOPUS database, other works in the categories A1 and A2, and the number of citations in above mentioned databases in the last five years. Furthermore, in the field of social sciences and humanities, number of published books is also considered as indicator of scientific productivity. Ponders for public universities and public research institutes vary due to the specifics of their activities, which is based on the request of leaders of these institutions.

The coefficients for each area of science are determinate, namely: Natural sciences – coefficients = 2.7; Engineering – coefficients = 2.5; Biomedical Sciences – coefficients = 2.7; Biotechnology – coefficients = 2.6; Social Sciences – coefficient = 1.2 and Humanities and Arts – coefficient = 1.2.

The basis for the calculation of financial resources to fund scientific activities is determined based on the number of scientists in full-time equivalent (FTE), the coefficients for the field of science and the amount of funds allocated from the State Budget. Amount per scientist, in full-time equivalent for institution, is calculated on the basis of performance indicators of scientific activity, "ponder" of each indicator and the base salary in HRK with respect to the field of science.

Public universities and public institutes once a year - by 15 February - are required to submit to the Ministry report on the activities and achieved results. This has to be signed and submitted in the form for submission of the data on scientific activities for the previous year. Financial reports are submitted to the Ministry within the timeframe for the submission of the Report on revenues and expenditures, receipts and expenses. This is submitted on official forms under the Ordinance on Financial Reporting in Budgetary Accounting (Official Gazette, 03/15, 93/15). Calculation of base salary and amount per scientist in full-time equivalent paid by the Ministry to particular institution in current year, is prepared on basis of received reports, and respectively, achieved results. Model of dedicated multiannual institutional funding of scientific activity does not interfere to the autonomy of public universities and public research institutes. Decisions on allocation of the funds are made autonomously (http://public.mzos.hr/Default .aspx?sec=3521). Amounts designated to research activities of public universities in the Republic of Croatia during 2013 are shown in Table 4.

Table 4. Amounts deisgnated to research activities of public universities in the Republic of Croatia during 2013

Name of public universities	The number of scientists employed in full-time equivalent (FTE)	Amount (in HRK)
University of Zagreb	2777,28	25.856.667,31
University of Rijeka	562,77	6.226.633,37
University of Split	520,475	5.083.265,86
J.J Strossmayer University of Osijek	483,1	2.931.506,70
University of Zadar	149,8	671.313,48
University of Dubrovnik	54,73	469.573,73
J. Dobrila University of Pula	73,0	328.576,75
Total	4621,155	41.567.537,20

Source: Ministry of Science, Education and Sports of the Republic Croatian, http://public.mzos.hr/Default .aspx?art=13093&sec=3331 (accessed August 20, 2015).

Table 4 shows that funds for support of research activities of public universities in Croatia in 2013, are in largest part designated to University of Zagreb, with the amount approximately four times larger than amount designated to University of Rijeka. Looking at the next group of universities (Rijeka, Split, Osijek), established at similar same time, with a similar, and thus comparable number of scientists, it is clearly visible from the table that University of Osijek is falling behind in the amount of funding. This can be partly attributed to a small number of scientists employed in full-time equivalent at the University of Osijek when compared to Split and Rijeka, and also lower performance indicators of scientific activity at the University of Osijek. In last group of youngest Croatian university (Zadar, Dubrovnik, Pula), during 2013, lowest amount of financing for scientific activities was allocated to University of Pula. When compared with University of Zadar, most likely reason for this is small number of researchers employed in full-time equivalent at University of Pula, and also lower performance indicators of scientific activity at the university in relation to University of Zadar. On the other hand, if we analyse relation between Pula and Dubrovnik, we can see that University of Dubrovnik has approximately 20 researchers employed in full-time equivalent less than Pula, but in 2013, received approximately 150,000.00 HRK higher amount of funding. It can be concluded that implementation indicators of University of Pula are probably lower than same indicators in Dubrovnik, directly leading to the differences in the amount of financing.

4. THE SCIENTIFIC PRODUCTIVITY OF UNIVERSITIES IN THE REPUBLIC OF CROATIA — INDICATORS

The indicators of scientific productivity of universities can be interpreted in several ways and, unrelated to the defined implementation indicators of scientific activity, the fact is that the ratios of financing of universities and indicators of scientific productivity can be compared with specific quantification. Interpretation of indicators of scientific productivity includes an analysis of the overall scientific activities of the university, analysis of individual components within the university and analysis of each indicator according to the selected type. When compared to the positioning of the university in a competitive market, this analysis can generate indicators showing current funding and possible proposals for future funding. Current funding model works in two ways, because through “capitations” it determines funding of educational activities, which mainly influenced decrease of income within the university. On the other hand, it provides the possibility to increase income if performance of scientific productivity is improved. The scientific productivity of public universities in Croatia in 2013 is presented as number of published scientific papers of each public university in indexed journals (as presented in Table 5). These data cover all three areas of science:

- area of natural, technical, biotechnical sciences and biomedicine and health
- area of social sciences and humanities, and interdisciplinary field of science
- Arts.

Table 5. The scientific productivity of public universities in Croatia in 2013 presented as number of published scientific papers of each public university in indexed journals

Name of public university	The number of scientists employed in full-time equivalent (FTE)	Number of papers in indexed journals
University of Zagreb	2777,28	3.885,6
University of Rijeka	562,77	1.085,2
University of Split	520,475	1.003,2
J.J Strossmayer University of Osijek	483,1	883,8
University of Zadar	149,8	421,2
University of Dubrovnik	54,73	94,8
J. Dobrila University of Pula	73,0	185,834
Total	4621,155	7.559,634

Source: the authors examine data, http://www.unizg.hr/; https://www.uniri.hr/; http://www.unist.hr/; http://www.unios.hr/; http://www.unizd.hr/; http://www.unidu.hr/; http://www.unipu.hr/ (accessed September 20, 2015).

Previous tables presented in this paper are showing shares of financing of universities. Similar figures are generated when observing the ratio of the number of employees (teaching staff with full-time equivalent) and the number of papers published in indexed journals. It is evident that it is necessary to make a detailed analysis of the actual effectiveness, but also to further review quality of magazines regarding the frequency of indexing criteria.

Table 6 provides a more analytical review of the scientific productivity of public universities according to levels which are divided into the following activities: the number of published papers and books, the number of competitive research projects, the number of institutional projects and activities related to the popularization of science. In this case, the reference is made by the scientific productivity in the area social and human sciences and interdisciplinary areas of science.

Table 6. The scientific productivity of public universities in the Republic of Croatia

Indicators	DUBROVNIK	OSIJEK	PULA	RIJEKA	SPLIT	ZADAR	ZAGREB
Number of published papers and books	79	758,2	187,034	1371,8	840,6	460,8	5232
Number of competitive research projects	0,6003	19,8013258	2,4009189	63,00249	15,6013	10,754108	140,2026919
Number of institutional projects	1,20152	9,6042945	1,60487242	11,00307	17,0344	4,803805	31,8013532
Activities related to the popularization of science	7	122,2	62,6	93,8	120,4	105,8	174,2

Source: the authors examine data, http://www.unizg.hr/; https://www.uniri.hr/; http://www.unist.hr/; http://www.unios.hr/; http://www.unizd.hr/; http://www.unidu.hr/; http://www.unipu.hr/ (accessed September 20, 2015).

Table 6 shows that the interpretation of the scientific productivity is not defined in precise correlations, since there are different performances of feasibility, and the categorization of the value of each activity can be variously interpreted.

CONCLUSION

In the past decade, sources of financing scientific activities of universities have changed in many countries. The share of direct funding by the state is gradually decreased, while the share of financing from foreign funds and economic capital increased. In parallel, funding by the state has undergone a major change. Some countries establish funds to finance scientific activities, funds being remitted to universities on the basis of their

scientific excellence. Despite all of the above, financing of scientific activities by the state is still the predominant source of financing scientific activities of the university (Auranen and Nieminen 2010, 822). Understanding the sources and ways of financing scientific activities of universities is especially important taking into account the impact of scientific research on technological change and economic development (Goldfarb 2008, 42). However, recent studies have shown that there is surprisingly little evidence regarding the effectiveness of government expenditures in research and development (Jacob and Lefgren 2011, 1168). Considering the previsously mentioned fact, the university research environment has been undergoing profound change and one of the many novelties the performance-based research funding systems were introduced (Hicks 2012, 251). Fundamental starting point of previously mentioned ways of financing is that the funds should be directed at those higher education institutions with strongly visible scientific productivity, following which will further encourage those who are successful in this regard but also encourage those less successful at improving their quality (Hicks 2012, 253). Experts have further noted that there are multiple and complex linking between ways of science financing, inter-institutional cooperation, and scientific productivity. In this regard, they considered that precisely inter-institutional cooperation plays a major role in increasing the scientific productivity both through maintening the process of knowledge creation and the increasing division of tasks, which ultimately provides more balanced distribution of research activities between the more and less scientifically productive institutions (Defazio, Lockett, and Wright 2009, 293).

Considering the above described situation in Croatia it is obvious that in our country there are several similar processes as in the rest of the European countires as well as in the USA. One must bear in mind that inclusion of the science into the conception of development of society and state in general is a long process, which requires more active role of universities and individual institutional entities. In todays world universities have positioned themselves as key stakeholders of the economies of the developed countries because they generate knowledge and make it available to the industry and society in general, by providing the highest level of education for the population. Because of the strategic importance of universities, their scientific productivity and cost-effectiveness of achieving their results has emerged today as one of the extremely important questions of state policy makers.

REFERENCES

Auranen, Otto, and Mika Nieminen. 2010. University research funding and publication performance: An international comparison. *Research Policy* 39 (6): 822–834.

Badjari, Josipa, Sandra Milovanovic, Ana Ravnic Perfido, and Janja Trkulja. 2007. *OECD Thematic review of tertiary education, country background report for Croatia*. Zagreb: Ministry of Science, Education and Sport.

Defazio, Daniela, Andy Lockett, and Mike Wright. 2009. Funding incentives, collaborative dynamics and scientific productivity: Evidence from the EU framework program. *Research Policy* 38 (2): 293–305.

Deluka Tibljas, Aleksandra, Christiane Gaehtgens, Suncica Uhitil, Vesna Dodikovic Jurkovic, and Miho Obradovic. 2013. *The final report on the results of the external independent periodical assessment of quality of University in Zagreb*. Zagreb: The Croatian Agency for Science and Higher Education.

Doolan, Karin, Danijela Dolenec, and Mladen Domazet. 2012. *Hrvatski sustav financiranja visokog obrazovanja u europskom kontekstu: Komparativna studija*. Zagreb: The Institute for the Development of Education.

European University Association. 2014. *The EUA Public Funding Observatory*. Brussels: European University Association.

Farnell, Thomas. 2010. *The model of financing of higher education in Croatia*. Zagreb: The Institute for the Development of Education.

File, Jon, Thomas Farnell, Karin Doolan, Dusan Lesjak, and Ninoslav Scukanec. 2013. *Higher Education Funding and the Social Dimension in Croatia: Analysis and Policy Guidelines*. Zagreb: The Institute for the Development of Education.

Gaehtgens, Christiane, Darko Loncaric, Nenad Mrzlecki, Goran Briski, and Danijel Brletic. 2013. *The final report on the results of the external independent periodical assessment of quality of University in Zadar*. Zagreb: The Croatian Agency for Science and Higher Education

Goldfarb, Brent. 2008. The effect of government contracting on academic research: Does the source of funding affect scientific output? *Research Policy* 37 (1): 41–58.

Hearn, C. James, Michael K. McLendon, and T. Austin Lacy. 2013. State-Funded "Eminent Scholars" Programs: University Faculty Recruitment as an Emerging Policy Instrument. *Journal of Higher Education* 84 (2): 601–639.

Hicks, Diana. 2012. Performance-based university research funding systems. *Research Policy* 41 (2): 251–261.

Jacob, Brian A., and Lars Lefgren. 2011. The impact of research grant funding on scientific productivity. *Journal of Public Economics* 95 (9–10): 1168–1177.

Kozak, Drazan, Lembit Nei, Mihaela Zamolo, Vesna Dodikovic Jurkovic, and Goran Djurdjevic. 2013. *The final report on the results of the external independent periodical assessment of quality of University in Rijeka*. Zagreb: The Croatian Agency for Science and Higher Education.

Pinter Ljiljana, Franc Cus, Vesna Dodikovic-Jurkovic, Bozidar Ljubic, and Ivan Bota. 2012. *The final report on the results of the external independent periodical assessment of quality of University in Dubrovnik*. Zagreb: The Croatian Agency for Science and Higher Education

Pinter, Ljiljana, Hans-Ulrich Heiss, Davorka Androic, Olga Sajdohar Padjen, and Marija Rogoznica. 2013. *The final report on the results of the external independent periodical assessment of quality of University Jurja Dobrile in Puli*. Zagreb: The Croatian Agency for Science and Higher Education.

Slapnicar, Ivan, Jan Cornelis, Nina Puhac Bogadi, Davorka Androic and Stipe Tolic. 2013. *The final report on the results of the external independent periodical assessment of quality of University Josip Juraj Strossmayer in Osijek*. Zagreb: The Croatian Agency for Science and Higher Education.

The National Council for Higher Education. 2011. *The network of higher education institutions and academic programs in Croatia*. Zagreb: Republic of Croatia: The National Council for Higher Education.

Turkovic, Vera, Ben Van Camp, Bozica Horvat-Vlasic, Goran Briski, and Sven Pal. 2014. *The final report on the results of the external independent periodical assessment of quality of the University of Split*. Zagreb: The Croatian Agency for Science and Higher Education.