THE SUCCESS OF PEER REVIEW EVALUATION IN UNIVERSITY RESEARCH FUNDING – THE CASE STUDY FROM SLOVAKIA

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Abstract: *Public funding mechanism for excellence is widely used mostly due its aim to raise the performance of higher education institutions to an excellent level since the reallocation is based on competitiveness of institutions or researchers. The approaches which are currently used for research evaluation are either peer review or bibliometric techniques. Peer review is based on deep expertise of committees and experts. However, its application is questioned to some extent, especially due to its ineffectiveness and inefficiency. In Slovakia, peer review process is applied to selection of projects by the Scientific Grant Agency. This paper identifies whether there is a relationship between peer review score of project proposals and research productivity. Case study is applied to the Scientific Grant Agency and its grant selection in year 2009 when the results of peer review process are for the first time available to the public. Our results show that peer review in most fields failed to predict the success of projects. Moreover, we observed potential gender bias in peer review and grant selection mechanism.*

Key words: *peer review, funding for excellence, university research*

1. INTRODUCTION

Public funding mechanism for excellence aims to raise the performance of higher education institutions to an excellent level. However, there are differences seen in its application. On one hand, we talk about initiatives directed straight to universities on competitive basis, which though do not have a nature of project funding. Rather they are aimed at development of institutional strategies and such cases are observed in Germany or France [6]. On the other hand, we talk about typical reallocation of funds based on project proposals including set of activities. The most common objective of excellence funding is to improve competitiveness of the system´s research landscape. It enhances the international visibility of research system and improves system with some quality objectives as well as position of higher education institutions in international ranking. Moreover, excellence funding also increases funding efficiency [6]. For such a mechanism, it is very important to properly set the rules, which should be known in advance and remain unchanged during the process. Transparent selection of proposals with all criteria known by all parties should be implemented [6]. The approaches which are currently used for research evaluation are either peer review or bibliometric techniques [2]. Bibliometric techniques include indicators such as quantity of research outputs measured by scientific articles but there is also an aspect of quality captured by the number of citations received and impact factor of journal. Some argue that metrics should not be seen as a substitute for peer review bur rather support it [19]. Peer review is based on deep expertise of committees and experts. Usually it is applied to assessing of applications for funding but also to review journal manuscripts or career promotions. In case of grant applications, judgement is made in accordance with certain parameters like relevance of topic, originality, quality or socio-economic impact that research could potentially bring [2]. For

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project funding, the peer review approach is currently the more widespread [2]. Its application is questioned to some extent, though, especially due to its ineffectiveness and inefficiency [10]. First of all, there is a general concern of what defines best science and whether good research can be simply predicted by the evaluation of proposal [15] [13]. Moreover, applying same criteria to evaluation may biased some fields such as technology or applied science [15] [13]. In this sense, peer review may favour researchers, whose outcomes are guaranteed rather than give a room to those, whose ideas cannot promise success [15] [3]. Additionally, when researchers approach a topic differently, their proposal may not be accepted. Alternatively, if the field is small, the few researchers will probably tend to accept project proposal just because they believe it is worthy of realization. If the field is new and needs to grow up, it may be for the best to provide a room for improvement. However, if there is no interest in it from outside or the field has shrunk, then the peer-review fails. The second concern is connected with subjectivity. Peer review evaluation depends on opinion and qualitative judgements of the reviewers and thus risks biases [9] [10]. Firstly, a selection of the reviewers themselves predicts a success of the proposal [15]. Naturally, it brings the question of qualification, expertise and capacities that reviewer should have and who then determines who is qualified to perform an evaluation [20]. Moreover, this system brings into the evaluation a pattern of behaviour leading to dishonesty. There is possible conflict of interests, thus unhealthy competition rises. Reviewers are potentially stimulated to purposefully provide negative review if their own proposal is in jeopardize [15] [10]. On the other side, if the submitting leader is considered to be an incumbent, a submission may be probably accepted regardless of its contribution. Some studies found variation among scores and disagreement in review criteria [8] [1]. Others also found gender bias [18] and nepotism [16] in peer review process. In order to find out whether peer review can predict applications which are most likely to be productive, existing research in this area has focused on understanding whether there is a correlation between good peer-review scores and successful research outcomes and yields mixed results. [4] found no correlation between obtained score and publication productivity of grants or citation productivity [5]. On the other side, [7] found that better peer review score is positively correlated with greater productivity. This paper thus tries to identify whether there is a relationship between peer review score of project proposals and research productivity in grants in Slovakia. Moreover, we are wondering, if there is potential institutional or gender bias in peer review process. Case study is applied to the Scientific Grant Agency and its grant selection in year 2009.

2. PEER REVIEW BY THE SCIENTIFIC GRANT AGENCY

Scientific Grant Agency (SGA) is the supreme body of the Minister of Education and the auxiliary body of the Slovak Academy of Science's presidency. Its role is to assist in scientific grant selection in order to reallocate funds within institutional funding of universities based in this case on excellence funding. SGA is composed of four main bodies: Presidency of SGA, Chairman and Vice Chairman of SGA, Enlarged Presidency and Committees of SGA. Specifically, 13 committees are established in line with the science and technology fields and divided as follows: 1. mathematical sciences, computer and informatics science and physical science; 2. science of Earth and space, environmental science (including earth resources); 3. chemical science, chemical engineering and biotechnology; 4. biological science; 5. electrical, automation and control systems and related fields of communication technologies; 6. civil engineering (construction, transport and geodesy) and environmental engineering including mining, metallurgy and water management; 7. engineering and related fields of information and communication technology and material engineering; 8. agricultural, veterinary and timber sciences; 9. medical science and pharmaceutical science; 10. historical science and social

science (philosophy, sociology, political science, theology); 11. human science (psychology, pedagogy, sports science); 12. science of art, aesthetics and linguistics; 13. economic and legal sciences. Committees have usually 14 – 20 members and are responsible for evaluation of the project proposals that research teams submit after the call is announced on yearly basis [11]. Initial evaluation of the proposals is carried out within two rounds. In the first round, evaluation focuses on formal requirements of the proposal as well as identifying whether proposal has a nature of basic research. Committee also assesses a quality of publications of the project leader and adequacy and relevance of the finances required. When proposal meets all these criteria, it is proceeded to the second round of evaluation. Committee then selects three reviewers who are not members of the committee in which a proposal is evaluated, when at least one must be from abroad. Reviewer is in this sense anonymous to the research team as well as to the submitter. At least two peer reviews are needed in order to take final decision by the committee. Members of the committee take into consideration mainly these criteria: originality, ethical aspects, complexity and cross-sectional solutions of the issue, potential contribution to the scientific area, potential contribution to economic and social area, quality of the scientific part of the proposal, professional competence of the project leader and research team, feasibility, time schedule, adequacy of the required budget, conclusions of the reviewers. Every member of committee then anonymously assigns points to each proposal in a range from 0 to 100, when more is better. Member of committee does not vote in case he belongs to research team of the proposal or is in close relationship with anyone from research team. Before the points are cumulated, the votes with the highest and the lowest points are cut off and the average value is then calculated from n-2 members. A ranking of proposals is then made in accordance with average points that each proposal obtained. Committee then determines the line under which the projects should not be funded and proceeds the ranking list to the Presidency of VEGA, which is then responsible for approving it [14]. When project finishes in particular year, research team must submit Final report for the entire project lifetime and enclose supplement with 5 most significant research outputs from the project. Members of committee then evaluate achieved results of the project and focus mostly on: meeting the scientific objectives of the project, assessment of the results, scientific contribution based on quality of accepted and published articles in indexed journals, contributions to economic and social area and effectiveness and efficiency of funding used in project. Committee includes into evaluation only publications with acknowledgement and evidence code of the project. Similarly, publications must be related to the focus of the project [14].

3. METHODOLOGY

For these purposes, we focus on grant allocation of the Scientific Grant Agency. This agency provides research funding to researchers in Slovakia on competitive basis and focuses on support of public universities and Slovak Academy of Science (SAS). Agency reallocates every year over 9 million euro and supports significant number of projects from all universities [12]. In this paper, we include into the analysis only projects proposed by the public universities. Thus we excluded proposals of SAS which operates under different conditions than public universities. We analysed only applications proposed in 2009 by all public universities. It is actually a first year when the data about peer review score and approval or rejection of proposal are available on the website of the agency. We thus have data about peer review score of each proposal, institution, project leader, duration of project, approval/rejection of the proposal and committee. Data about research staff within each proposal were provided by the Ministry of Education upon request. To measure success of a project, we identify research productivity within each funded grant. These data were also provided by the Ministry of Education upon request. They were gathered from final reports of each project and following peer review of at

least one person from the agency in accordance with the rules of SGA in a year when project finished. Some of grants were peer-reviewed at the end by more than one person from the agency and their final evaluation in not consistent, thus we excluded 26 grants when dealing with research productivity. In the rest of grants, we were able to distinguish the categories of publication and identified three groups of research outputs: 1. total number of research outputs from grant (including monographies, chapters, articles, patents etc.), 2. total number of articles that acknowledged grant support (including publications in Scopus or Web of Science databases but also those published in regular/not-indexed journals) and 3. patents that cite grant. We look at the group of articles separately and it is due to the fact that articles in journals (of better quality) are highly valuable even for final evaluation of project but they are also important for institution within performance-based funding. Thus, there could be some incentives to publish more in this group. Similarly, group of patents is typical just for some universities and particular fields. Our first research question is as follows: *Does better score of research proposal yield in greater research productivity?* For measuring the relationship between peer review score and research productivity, we imply correlation like [4] [5] [7] did and we support it also be regression analysis. Second research question focuses on selection of projects and peer review of universities: *Did any universities obtain significantly higher score in peer review process?* We answer this question by looking at distribution of peer review score and funded projects. The last research question concerns selection of proposals based on gender: *Did women as project leaders obtain significantly lower score comparing to men?* We explore this by looking at the distribution of funds by gender.

4. RESULTS

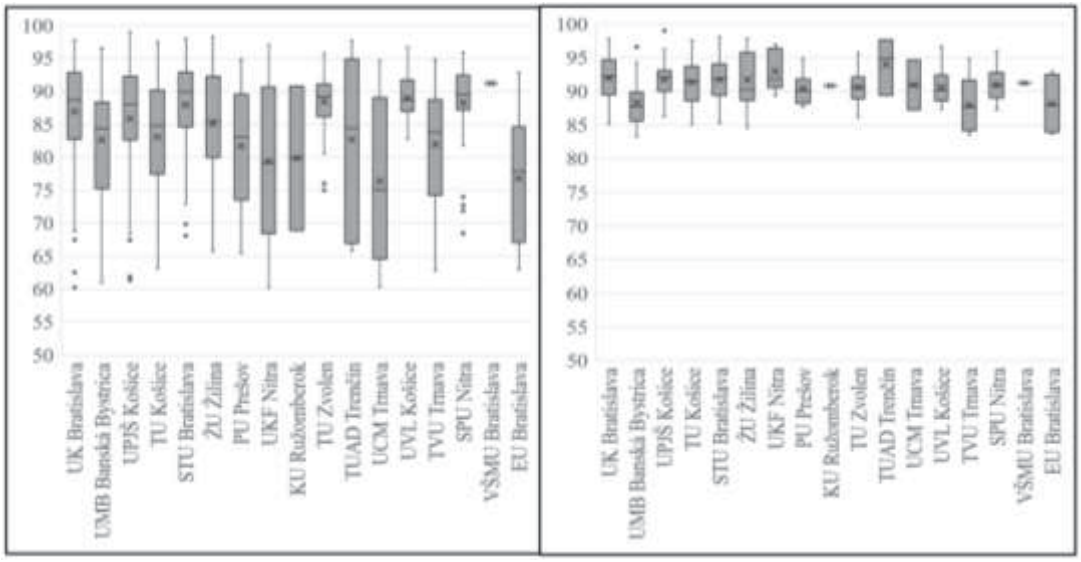
In 2009, SGA received 1 103 research proposals [17]. Almost 77 % of them was proceeded to the second round of assessment. Most of proposals in second round was submitted by public universities. From 632 proposals of public universities, 44 % was rejected, thus the number of new funded projects starting in 2010 is 357. Out of 357 projects, 87 % was carried out for 2 years, 2 % for 1 year and 11 % for 3 years. Among the universities with the highest amount of proposals proceeded to the second round belong the biggest public higher education institutions in Slovakia – UK Bratislava and then STU Bratislava. UK Bratislava submitted 148 proposals representing 23 % of all research proposals. Checking for correlation coefficient between the number of all proposals of each institution and a rate of rejection of each institution, r = -0,05. Thus it indicates very modest decrease of rate of refused proposals per institution as the amount of proposals per institution increases. However, the coefficient is still very low and there is almost no relationship between variables. The most proposals were approved for UK Bratislava and STU Bratislava in a sense of quantity. Some universities like KU Ružomberok, TUAD Trenčín, UCM Trnava or VŠMU Bratislava carried out only small number of projects. It was 50 % or less of all applications they submitted.

Regarding the number of researchers in grants per institution, there is strong positive relationship with the number of funded projects on institution. Moreover, research productivity per institution are also strongly correlated with the research staff working on grants within institution. In case of total number of articles and total number of outputs from grants per institution, r = 0,98 in both cases and indicates that publication outputs of grants in institution increase as the research staff working on projects increases. When we focus on total number of patents, r = 0,51 and also confirm positive linear correlation with research staff on grants. Strong correlation is observed also when we explore the number of funded proposals and the number of outputs with coefficient r =0,92.

University	Average score of funded proposals	Total No. of funded proposals	Total No. of researchers	Total No. of articles	Total No. of patents	Total No. of outputs from grants
EU Bratislava	88,15	6 (35%)	62	27	0	102
KU Ružomberok	90,81	1 (50%)	5	10,5	0	17,5
PU Prešov	90,41	14 (41%)	97	55,6	0	230,3
SPU Nitra	90,92	32 (80%)	486	273,9	1	664,1
STU Bratislava	91,72	62 (68%)	973	704,6	9	2237,8
TU Košice	91,34	27 (41%)	377	293,2	15	766,6
TU Zvolen	90,59	26 (74%)	349	192,1	0	584,7
TUAD Trenčín	93,99	3 (43%)	59	33,5	0	75,3
TVU Trnava	87,92	9 (56%)	88	27,5	0	193,8
UCM Trnava	90,92	2 (33%)	15	21	0	48
UK Bratislava	91,99	87 (59%)	749	650,2	1	1608
UKF Nitra	92,97	7 (32%)	57	40	0	150
UMB Banská Bystrica	88,35	13 (57%)	98	36,1	0	148,6
UPJŠ Košice	91,73	29 (54%)	270	241,5	0	608,9
UVL Košice	90,58	17 (77%)	241	128	2	361
VŠMU Bratislava	91,2	1 (100%)	1	4	0	7
ŽU Žilina	91,73	21 (44%)	267	177,3	0	453,5
Total/Average	91,26	357 (56%)	4194	2916	28	8257,1

Table 1: Overview of project selection of SGA in 2009 for public universities

As we see on Figure 1, proposals of universities were given quite high scores by peer review. It ranges from 59,58 to 99 points in case of all proposals and from 83,23 to 99 in case of only funded proposals. Almost half of all funded proposals by universities obtained score in interval 85 – 95.



a) b)

Figure 1: Box plots of scores obtained for research proposals to SGA in 2009 for public universities a) peer review scores for all proposals, b) peer review scores for only funded proposals

The average score of all proposals was 86,42 taking into account all proposals and 91,26 when dealing only with funded proposals. Looking at Figure 1 a), we see that there were some universities which were given quite high scores for 75 % of all proposals. Particularly, these are UK Bratislava and STU Bratislava which also submitted 40 % of all proposals. Then there is also UPJŠ Košice, TU Zvolen, UVK Košice and SPU Nitra. However, looking at the medians, STU Bratislava seems to have 50 % of proposals awarded by 90 points and more. Comparing to Figure 1 b), TUAD Trenčín has the top position. At the same time, this university submitted only 7 applications. Looking at the correlation between average score of proposal per institution in Table 1 and total number of outputs from grants per institution, r = 0,24 in case of all publications, and r = 0,28 in case of only articles. When dealing with patents, r = 0,13. These coefficients indicate modest increase of publication outputs from grants as score given to proposals increases.

Looking at funded proposals from the point of view of committees, we see in Table 2 that the highest number of grants was carried out in Agriculture and Veterinary, where 81 % of projects was approved. Correlation coefficient between the number of proposals and the rate of rejected proposals is r = 0,15, thus modestly predicts that the more the project proposals within the field, the more likely they were rejected.

Committee	Average score of Funded Proposals	Total No. Of Funded Proposals	Total No. of Researchers	Total No. of Articles	Total No. of Patents	Total No. of outputs from grants
Math, IT, Physics	92,89	25 (56%)	273	305,6	0	663,5
Earth and Space	91,77	22 (67%)	182	271,4	0	494,1
Chemistry	92,34	26 (84%)	308	274,2	4	769,1
Biology	91,64	24 (77%)	234	160,3	2	390,3
Electrical, automation and control Systems	90,06	36 (78%)	630	473,4	2	1354
Civil and environmental engineering	92,37	23 (46%)	305	190,7	3	720,6
Engineering and ICT, material engineering	92,86	37 (49%)	578	342,3	16	963,4
Agriculture and veterinary	90,63	74 (81%)	1052	592,6	1	1609,3
Medical Science and Pharmacy	93,42	24 (56%)	142	84	0	172
History and Social Sciences	88,77	12 (24%)	85	33	0	161
Human Sciences	89,24	10 (24%)	70	40,5	0	253,8
Art and Linguistics	92,86	21 (72%)	112	45	0	322
Economics and Law	87,35	23 (35%)	223	103	0	384
Total/Average	91,31	357(56%)	4194	2916	28	8257,1

Table 2: Overview of project selection of SGA in 2009 for public universities by committees (field of science)

Strong positive relationship is again observed between the number of funded proposals and the number of researchers as well as between the number of researchers and research productivity within the field. Very low but positive correlation coefficient is also between average score of each field and research productivity within the field, r = 0,05.

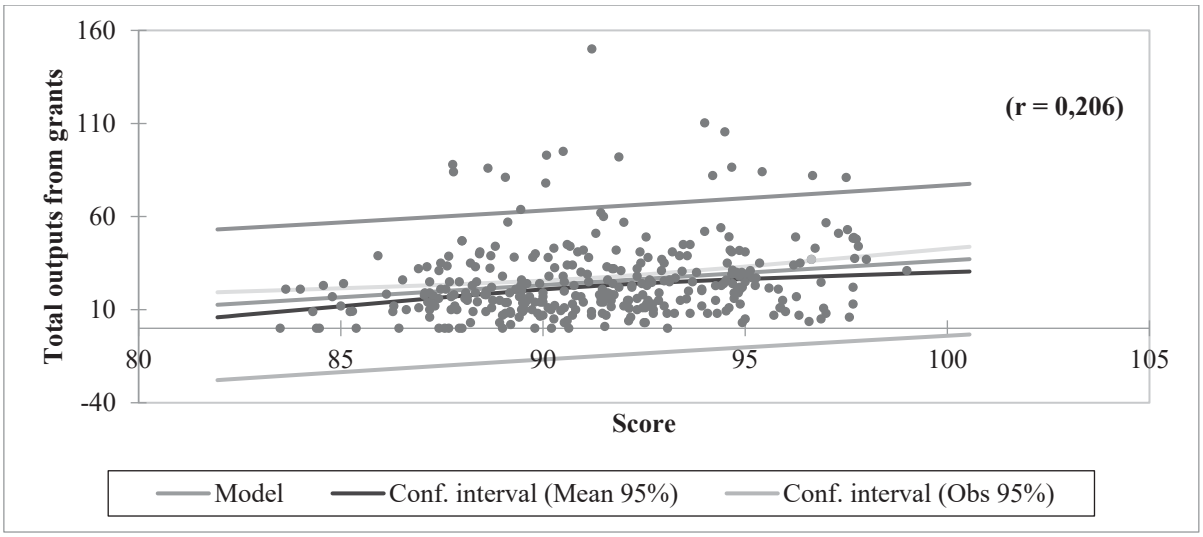


Figure 2: Research productivity as a function of peer review score for 357 projects

Correlation coefficient for all 357 projects and research productivity regardless of the institution or field is r = 0,206 as shown in Figure 2. Considering research productivity as a function of the score given to application, results show that there is a positive relationship between score and research productivity. However, the scatter may be influenced by many factors including different conditions for publishing in different research fields.

Committee	Correlation coefficient Total No. of outputs from grants	Correlation coefficient Total No. of Articles	Correlation coefficient Total No. of Patents
Math, IT, Physics	0,13	0,34	-
Earth and Space	0,14	0,14	-
Chemistry	0,59	0,46	-0,10
Biology	0,07	0,31	-0,33
Electrical, Automation and Control Systems	0,17	-0,01	0,29
Civil and environmental engineering	0,05	0,24	0,10
Engineering and ICT, Material engineering	0,24	0,28	0,23
Agriculture and Veterinary	0,19	0,22	0,09
Medical Science and Pharmacy	0,65	0,51	-
History and Social Sciences	0,73	0,70	-
Human Sciences	0,25	0,56	-
Art and Linguistics	0,44	0,41	-
Economics and Law	0,48	0,53	-

Table 3: Correlation coefficients of research productivity and proposal scores individually for each committees of SGA

Because particular fields of science may differ in a sense of publication conditions, we are looking at relationship of variables separately for each field. Looking at correlation coefficients in Table 3, we can observe that almost all coefficients obtained positive value. Thus, it indicates that there is usually at least a modest increase in the productivity metric as the score increases. Some exceptions may be seen in projects belonging to the field of electrical, automation and

control systems, when the linear relationship between score and articles is negative, but still very close to zero.

Quite higher negative values can be also observed in patent activity and particularly in the field of biology and chemistry. Positive linear relationship between variables with value higher than r = 0,5 is seen in particular committees such as chemistry, medical science and pharmacy, history and social sciences when we measure total number of outputs coming from the projects so total research productivity. Focusing only on articles, positive correlation coefficient is observed in medical science and pharmacy, history and social sciences, human sciences and economics and law.

Answering the question whether there was a gender bias in peer review mechanism, we are looking at the score of all proposals and distribution of funded proposals among men and women as the project leaders. In 2009, women as project leaders submitted only 177 proposals which is 28 % of all applications proceeded to the second round of evaluation. Out of 177 proposals, 53 % was rejected. Looking at the rate of rejection in case of men as project leaders, they were more successful and 60 % of all proposals was approved. Looking at particular fields, women and men carried out the most projects in a field of agriculture and veterinary but then we see some differences. Women focused mostly on economics and law while men carried out most projects in more technical fields.

	Female			**Male**		
Committee	**Average score of all Proposals**	**No. Of Funded Proposals**	**% of Denied Proposals**	**Average score of all Proposals**	**No. Of Funded Proposals**	**% of Denied Proposals**
Math, IT, Physics	84,08	2	60%	86,50	23	43%
Earth and Space	84,38	2	50%	88,18	20	31%
Chemistry	93,02	4	0%	90,58	22	19%
Biology	87,02	4	56%	90,97	20	9%
Electrical, Automation and Control Systems	92,02	4	0%	87,61	32	24%
Civil and environmental engineering	83,36	4	71%	86,49	19	47%
Engineering and ICT, Material engineering	82,98	4	60%	86,41	33	50%
Agriculture and Veterinary	89,68	24	14%	89,11	50	21%
Medical Science and Pharmacy	89,01	8	50%	90,50	16	41%
History and Social Sciences	78,01	3	79%	77,14	9	75%
Human Sciences	77,16	3	86%	78,72	7	67%
Art and Linguistics	88,07	7	50%	91,58	14	7%
Economics and Law	77,04	14	59%	76,86	9	71%
Total/average	83,49	83	53%	86,16	274	40%

Table 4: Overview of funded proposals of SGA in 2009 distinguishing gender

Considering average score of only funded projects, men obtained on average 91,44 points and women 90,66. In case of average score of all proposals, women were given on average lower score by almost 3 points as shown in Table 4. Women obtained better scores than men in a field of chemistry, electrical, automation and control systems, slightly in agriculture and veterinary, history and social sciences and economics and law. Comparing correlation coefficients of number of applications and the rate of rejection, r = -0,45 in case of women and r = -0,02 in case of men. This indicates that the more proposals in field, the more likely they were rejected, especially when a project leader was woman.

5. DISCUSSION

To answer first research question: *Does better score of research proposal yield in greater research productivity?* we found that overall peer review ranking can weakly predict greater research productivity. Moreover, peer review score explained only very little of variability of total research productivity in grants. These observations suggest that despite the overall ability of reviewers to distinguish between stronger and weaker grant applications, they are quite limited to predict research productivity of grants in the future. However, looking separately on each field of science, we found that some committees were able to select proposals which produced greater research productivity. This was mostly the case of history and social sciences, medical science and pharmacy and chemistry. The strongest relationship between variables was observed in history and social sciences. There were only 12 projects carried out and together with the field of human sciences, the selection process was the strictness and approved only 24 % of all submitted applications for funding. Still, these proposals were given one of the lowest peer review scores among all disciplines. This may indicate that committee identified even among less strong applications those with some potential. On contrary, all proposals in the field of chemistry and medical science and pharmacy were awarded by quite high score, thus the applications were probably strong. In these cases, committees were to some extent able to select proposals with the greater future research productivity. Moreover, committees identified some potential also in case of focus only on number of articles. On the other hand, observations in patent activity within grants do not confirm ability of committees to predict future research productivity in this area. However, patent activity in Slovakia is still very under-developed. Our results thus to some extent confirm that some committees and peer review mechanism were able to identify applications with potential. This in in line with study of [7] which also found positive correlation of peer review and greater productivity. Still, there were more fields where committees failed to predict success of grants and these results are in line with studies of [4] [5]. However, almost all correlation coefficients were positive and in some cases also predicted weak relationship between variables. Concerning another research question *Did any universities obtain significantly higher score in peer review process?,* it seems that universities were awarded by quite high score in all cases. There were some universities which proposals were more likely approved but they are the biggest and most productive universities in Slovakia, thus their applications were probably very competitive. To answer our last research question

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Did women as project leaders obtain significantly lower score comparing to men?, we found that this could be confirmed. Although women did submit much less applications, they were more likely rejected than grants submitted by man as a project leader. They were also given lower peer review score; thus we can potentially talk about gender bias which was found also by [18]. We even confirmed moderate negative correlation which means that the more projects women submitted, the higher the rate of their rejection was across the fields. However, their applications could be also less competitive comparing to others. This is a challenge for next research.

6. CONCLUSION

We analyzed the bibliometric outcomes of 357 grants of different fields that were approved for funding in year 2009 from Scientific Grant Agency according to peer review ranking. We found that peer review mechanism was to some extent in particular fields able to predict the success of the applications. In this sense, the higher the score of application, the greater the research productivity in grant. This was confirmed only in few committees though. In most fields, reviewers were not able to accurately predict future productivity of applications and peer review by its meaning failed to some extent. Looking at distribution of funds among public universities, we found that most grants was carried out by the biggest and most productive universities in Slovakia. Thus competitive funding of excellence fulfilled its goal. However, all universities were awarded by quite high score in committees. We also found that there was a potential gender bias in peer review and grant selection mechanism. However, we do not know the nature of all these projects, thus we cannot estimate their competitiveness among others. This is a challenge for next research which can be extended by interviews with reviewers. Next research should also include more years of grant selection from SGA into analysis.

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