Research Quality, Efficiency and Project funding in the Swedish Higher Education sector

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This report is based upon, and to a large extent coincides with a report in Swedish "Forskningskvalitet, effektivitet och extern finansiering" published by the same author. The present report is, however, to some extent adapted to an international readership.

The author would like to thank Ulf Heyman for interesting discussions in connection to the work with this report.

Abbreviations used in this report

HE – Higher Education
SCB – Statistics Sweden (Statistiska centralbyrån)
SEK – Swedish "krona" (currency)
SUHF – The Association of Swedish Higher Education Institutions
(Sveriges universitets- och högskoleförbund)
UKÄ – Swedish Higher Education Authority (Universtitetskanslersämbetet)
VR – Swedish Research Council (Vetenskapsrådet)

Abstract

This report studies the effect in Sweden of the funding of research in the HE sector. In particular, it will analyze how so-called project funding will influence the performance and quality of research. In Sweden project funding makes up 56 percent of the total funding for research. The analysis shows that the performance in terms of citations measured at a university level almost entirely depends on the total amount of research funding available. For the period studied, 98 percent of the differences between HE institutions are explained by the total amount of funding alone. This means that only two percent cannot be attributed to the amount of funding. The differences in performance between institutions corresponding to the two percent are then studied and it is shown that the relative amount of project funding has no positive effect on the performance. In fact, the data indicates a negative effect of project funding on performance. This implies that project funding will not promote quality. Finally, the effect of decreasing the project funding on performance is analyzed. A decrease in the amount of funding that is project based will lead to a quite substantial increase in performance, since it will give researchers more time to do research as opposed to applying for project funding. Our estimates show that in Sweden between ten and twenty percent loss of performance is due to time spent on applications. Consequently, by reducing the amount of project funding one can gain the same amount in performance. In money, this will represent a quality gain corresponding to four to eight billion SEK annually, a substantial amount compared to the roughly forty billion SEK that the HE institutions receive in total for research. We believe that the findings are of importance not only in Sweden, but in general for countries with project funding.

1. Introduction

Sweden is a country that has a good reputation in research. However, in recent years there have been reports showing a decline in performance. When studying citations of Swedish researchers and comparing with other countries, one finds that Sweden has been lacking behind many comparable countries. The graph below in fig. 1 shows Sweden's share of cited papers compared to a group of countries. The value 1.0 corresponds to the average of all the included countries.

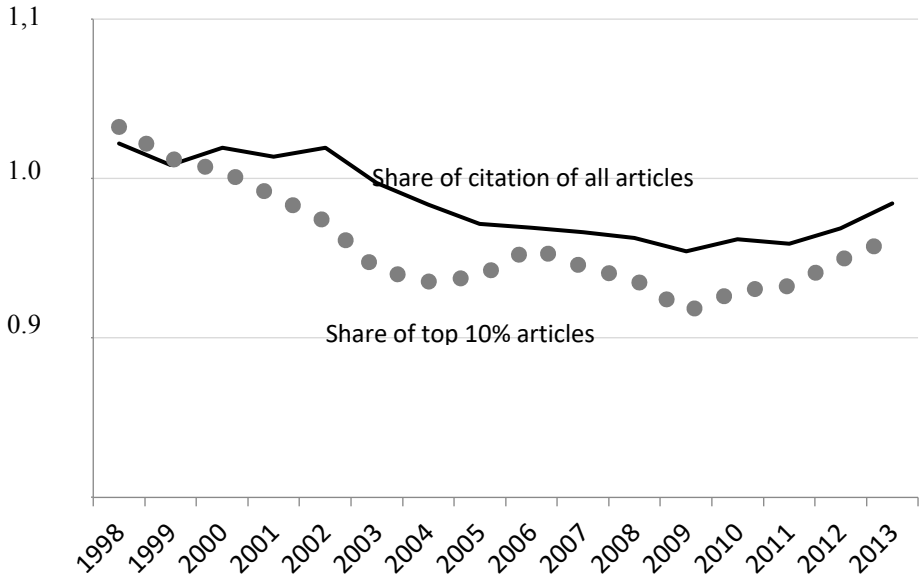


Fig. 1 Sweden's share of citations as measured by average citation (full line) or top ten percent (dotted line) of comparable countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Netherlands, Norway, Switzerland and UK. The graph is from [Heyman 2014].

These results sparked a lot of concern and discussion in Sweden. It was argued by some that Sweden needed to adopt a system similar to the REF in the UK to distribute the block grant to HE institutions. The Swedish government gave the Swedish Research Council an assignment to propose such a system. The result – called "Fokus"- was a proposal described in a report [VR 2014]. To be able to respond to this proposal, The Association of Swedish Higher Education Institutions gathered information on different systems for distributing research funding and research about the effect of such systems. The findings were published in a report [SUHF 2015]. The present author was one of the main authors of this report.

The report did not find any evidence that a system like "Fokus" would lead to higher quality. Instead, the report found results showing that the problem in Sweden could be traced to the funding of research. The graph in Fig. 1 could be correlated to a very similar graph showing that the funding of research in Sweden compared to the countries included in Fig. 1 had decreased. In fact, one could see that this close relationship between funding and performance in terms of citations is a general feature (see the figure on p. 59 in [SUHF 2015]). There is a strong linear correlation between the increase (or decrease) of citations and the increase (or decrease) in funding. This is a result of Heyman, Sandström and van Besselaar (see [Sandström-Besselaar 2018])[1].

[1] Prior to this publication a correlation between funding and performance can be found in Pan et al [Pan 2012].

Furthermore, investigations of the small departures from the linear correlation, implying performance differences between countries that cannot be attributed to funding, indicated that countries that are successful have a higher share of direct funding to the HE institutions[2] than countries that are not as successful[3]. Thus, the indication was that project funding could be affecting the performance negatively. If true, this would have important implications on how to think about the distribution of funding at a national level.

This report is sparked by these indications. Since Sweden is among the countries that have the largest share of project funding of comparative countries, about 56%, a negative impact of project funding on performance would have a large impact on performance. The aim has been to investigate the effect, if any, of the project funding on performance and then the possible implications of the present high level of project funding. Thus, we will focus on performance in terms of citations of Swedish HE institutions and compare with the total funding of research that each institution has, respectively. Then we will look at the share of project grants for research that these institutions have to see what effect, if any, the project funding has on the institution's performance. We will firstly find that there is a very strong correlation between citations and total funding. Although a correlation is to be expected, it may surprise some that the correlation is so strong, around 98 percent, i.e. about 98 percent of the differences in performance between institutions can be attributed to funding[4]. Only the remaining two percent depend on other differences between the institutions.

We will make a thorough analysis of these remaining two percent in order to see what effect, if any, project funding has on performance. We find that there is no evidence at all that project funding will have a positive impact on citation performance at the institutional level. Instead, there are clear indications of the contrary. The lack of positive impact may come as a surprise. Project funding is highly competitive and it is usually assumed that competition for grants enhances quality. Our results show that this is not the case. Quality, as measured by scientific impact in terms of citations, is not enhanced by competition, at least at an aggregated level of an institution.

With this result at hand we then analyze the effect of the system of project funding on the performance at a national level. Since applications for project funding take a lot of time, it is a costly system, which does not lead to better performance in terms of citations. We will analyze this cost and our estimates are that there is a ten to twenty percent loss of performance in the Swedish system due to project funding. This can be translated into a loss of funding which amounts to between four and eight billion SEK, which can be compared to the total funding for research at Swedish HE institutions which is forty billion SEK. It is a substantial loss of efficiency and hence, there is a lot to gain in reducing the share of project funding.

[2] By "direct funding" we will mean the proportion of funding that is distributed directly to HE institutions. We will sometimes use the term "base funding" instead of "direct funding". By "project funding" we will mean funding of research at HE institutions that is not direct funding. In most cases such funding are in the form of funding of specific projects. As an alternative term to project funding one sometimes uses the term "external funding".

[3] See [Sandström 2018] for a detailed analysis.

[4] These findings are in line with the findings in [Sandström-Besselaar 2018] for countries, but the correlation here is much stronger. The correlation factor in [Sandström-Besselaar 2018] is about 81 percent.

The report is organized as follows. In section two, an overview of the Swedish system for funding is given. In section three, the performance in terms of citations is analyzed at an institutional level and compared to the total funding for research. Then in section four the effect of project funding is analyzed. The report is concluded in section five with a discussion of our results.

2. The Swedish HE sector and funding of research

Since the reader may not be entirely familiar with the Swedish HE sector, we will briefly give an introduction of this sector. The interested reader may find the report [SUHF 2015] valuable for a more extensive description of the HE sector compared to other countries. This report contains also a summary of the research policy in Sweden between 1992-2015. Sweden has a HE sector which to a large extent is part of the state system of authorities. Most larger institutions are state owned with a few exceptions. There are 33 institutions (universities and university colleges[5]) that are state owned and, in addition, 15 more institutions that are not state owned and have the rights to award degrees in Sweden. Higher education is free in Sweden i.e. students do not pay tuition fees. This does not apply to non-European students who do pay tuition fees. To finance education for non-paying students the institutions receive a direct funding that depends on the number of students and how many study points they achieve. Each institution has a limit on how much they can receive in direct funding for education each year.

The HE institutions also get a direct funding for research. This is a separate funding from the funding for education and the HE institution may not use research funding for education activities and vice versa. The direct funding for research is received as a block grant, which is basically based on historical funding. Before the present government, the direct funding was partly based on two indicators. The first one was a bibliometric indicator and the second indicator was the share of external funding i.e. research funding that did not come directly from the government. An additional factor that the former government based its direct funding on, was the institution's involvement in the strategic research areas that the government had initiated.

The direct funding for research to different institutions is unevenly distributed. The four universities that receive most direct funding have almost fifty percent of the direct funding. The group of eleven older universities receive ninety percent of the direct funding, leaving the remaining ten percent distributed among the other 37 institutions.

The direct funding for research compose only 44% of the funding of research at HE institutions in Sweden. This may be compared with e.g. the following countries [Steen 2012 p 14] (figures apply to 2008): Switzerland 77%, Denmark 74% and The Netherlands 72%. Other countries with low direct funding is UK with 44%, Belgium 44% and Finland 47%.

The indirect funding, denoted project funding here, come from many sources. Many of these are state owned research granting bodies, some are charities and others are private contributors like corporations. Of course, some of the funding are from international sources like the EU. The diagram below shows the different sources and their respective share (see [UKÄ 2017], figures apply to 2015). As can be seen in the diagram, public funding from Sweden make up 77 percent of all funding for research, where a bulk part comes from the state with 71 percent[6].

[5] In Swedish one distinguishes between "universitet" and "högskola". For state owned institutions it is the government that decides which of the terms may be used for an institution. There are, however, no set criteria for decisions on this. It is a purely political decision. For non-state owned institutions it is the institution itself that may decide on its designation. All state owned "universitet" and many of the larger "högskola" can award PhD degrees. Hence, from an international perspective the English designation of "university" apply to both "universitet" and many "högskola", whereas the designation "university college" is more appropriate to those institutions without degree awarding rights at the PhD level.

[6] The diagram seems to indicate 78% and 72%, but this is due to an error from rounding off.

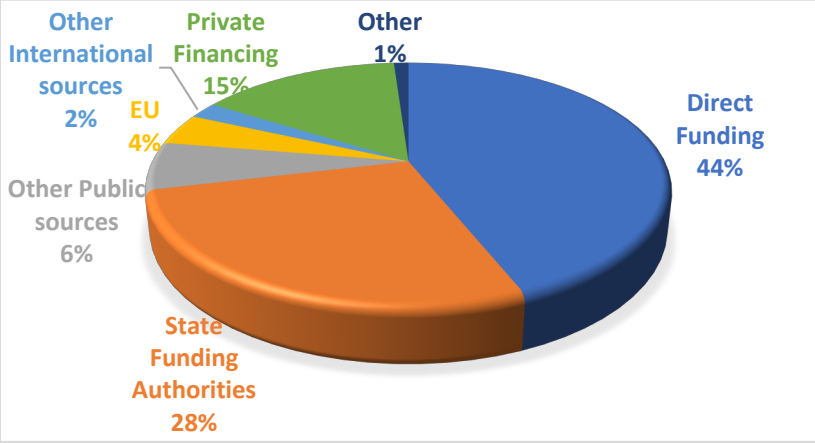


Fig. 2 The share of direct funding and project funding from different sources in Sweden 2015.

Sweden has had a positive development of funding for research during the last twenty years. The increase over the last twenty years is 111 percent in fixed monetary value. The diagram below shows the increase in absolute figures as well as in fixed monetary value.

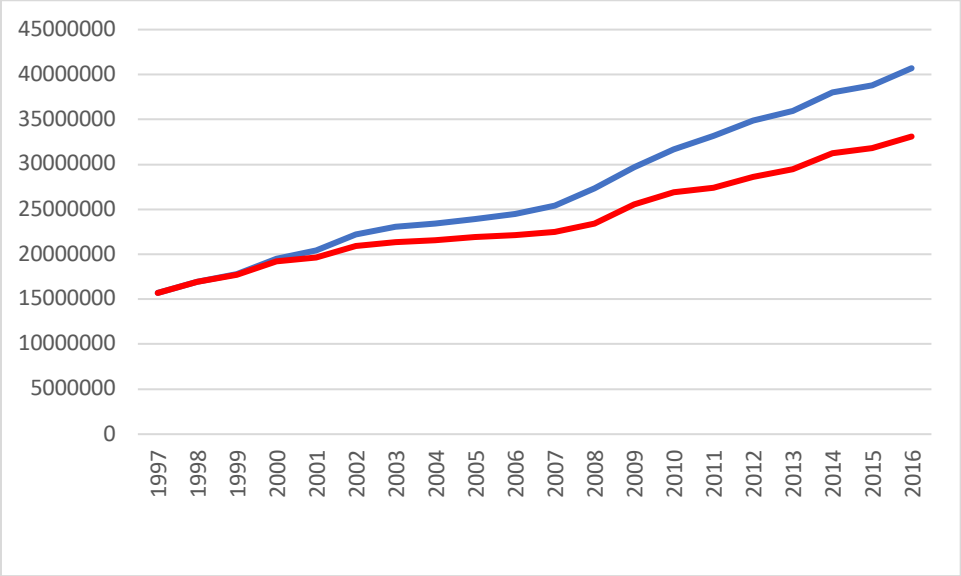


Fig. 3 Development of funding for research at HE institutions in Sweden in million SEK during 1997-2016 in absolute value (blue line) and in 1997 year's monetary value (red line). Source: UKÄ data base [UKÄ 2018].

During the same period other countries have also seen a positive development in funding of research. In fact, the development has for many years been more positive on the average for other countries. Below is a graph depicting Sweden's increase in research funding compared to the same group of countries as in figure 1 above.

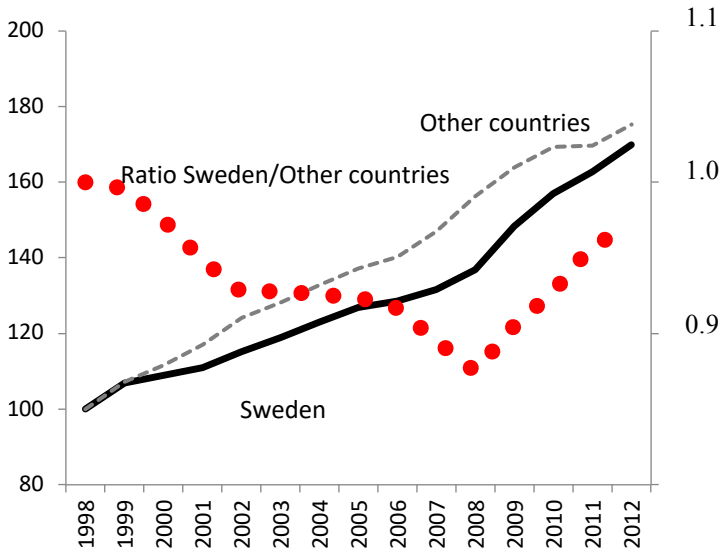


Fig. 4 The development of research funding since 1998. The vertical left-hand axis shows in percent the relative change in funding, where the value 100 percent is set for 1998. The right-hand vertical axis shows the ratio between Sweden's funding and the average of the other countries. The full line in black shows Sweden's change of funding, the dotted black line the change of funding for the other countries and the dotted red line depicts the ratio of the change of funding in Sweden to the group of other countries. The graph is from [Heyman 2014].

As remarked above in section one, there is clear similarity between the graphs in figure 1 and figure 4 (red dotted line). This similarity expresses the close correlation between performance in citations and the funding for research, which Heyman, Sandström and van Besselaar found (see [Sandström-Besselaar 2018]) and prior to this was noted in by Pan, Kaski and Fortunato [Pan 2012]. We will see an even closer relationship in next section when analyzing this correlation in great detail for HE institutions in Sweden.

The increase of funding in Sweden is a result of an increase in direct funding as well as project funding. Below there is a graph depicting the change of funding of the different sources since 1999.

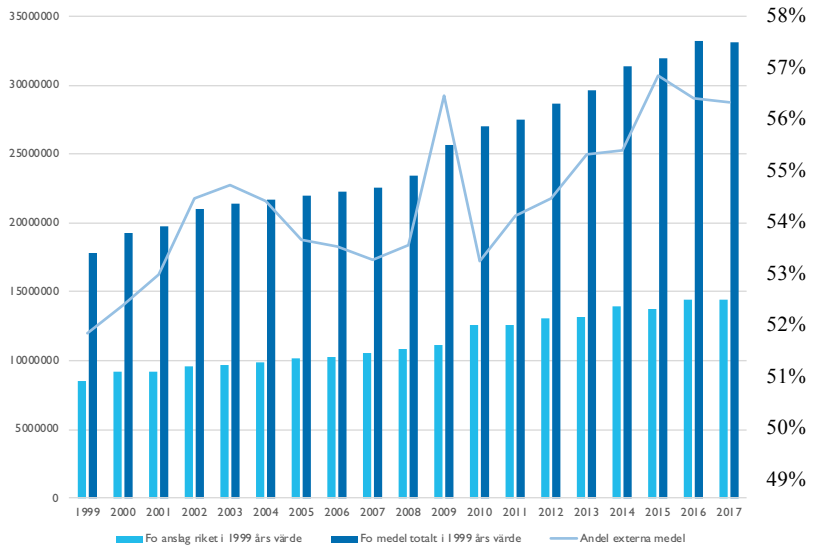


Fig. 5 The development of the direct funding (light blue stacks), total resources of funding (dark blue stacks) and share of project funding (full blue line). The values on the vertical axis on the left show million SEK. The values on the vertical axis to the right show percent. All values of funding have been given in 1999 year's monetary value. The graph is based on data from the database of UKÄ [UKÄ 2018].

The increase in funding has not been uniform in Sweden. During the period 1999-2016 the older universities increased their funding with 18.5 billion SEK and the remaining HE institutions by 4.3 billion SEK. The largest relative increase among the older universities was for Karolinska institutet with 172 percent increase and Stockholm University with 133 percent increase. The graphs below show the increase for older universities[7].

[7] Chalmers University of Technology will in this report be included in the group of older university. For technical reasons, mainly due to that this university is not state owned, it is not included in the graph in figure 6 and most other graphs in this section.

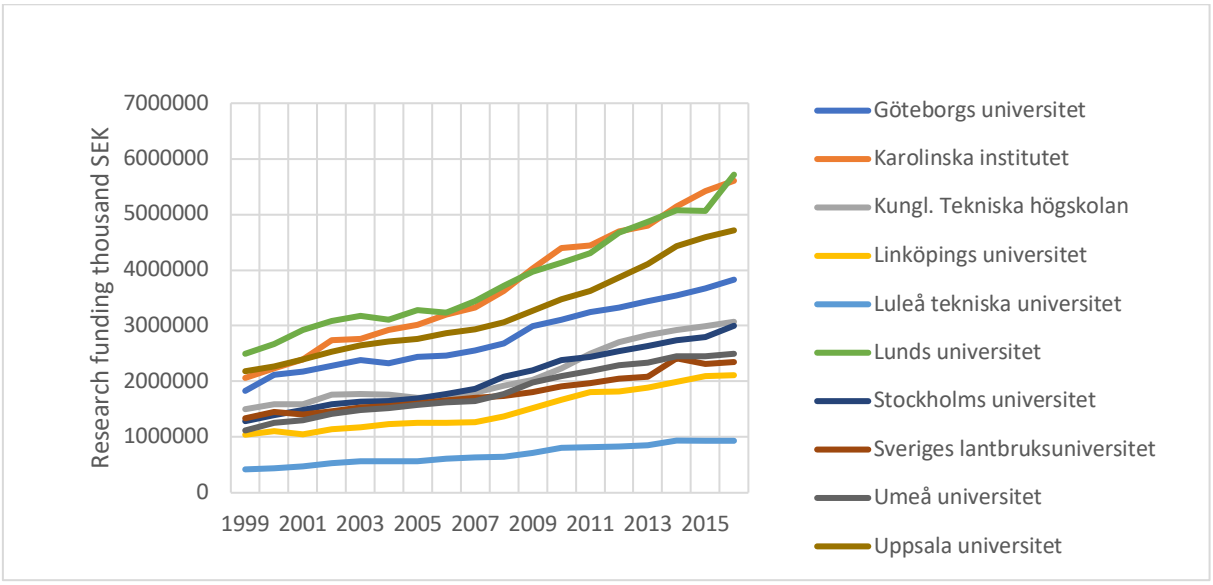


Fig. 6 The increase in total funding of research (in thousand SEK) for older universities. The graphs are based on data from the database of UKÄ [UKÄ 2018].

The share of project funding is different for different HE institutions. The graph below shows the share for the universities in figure 6.

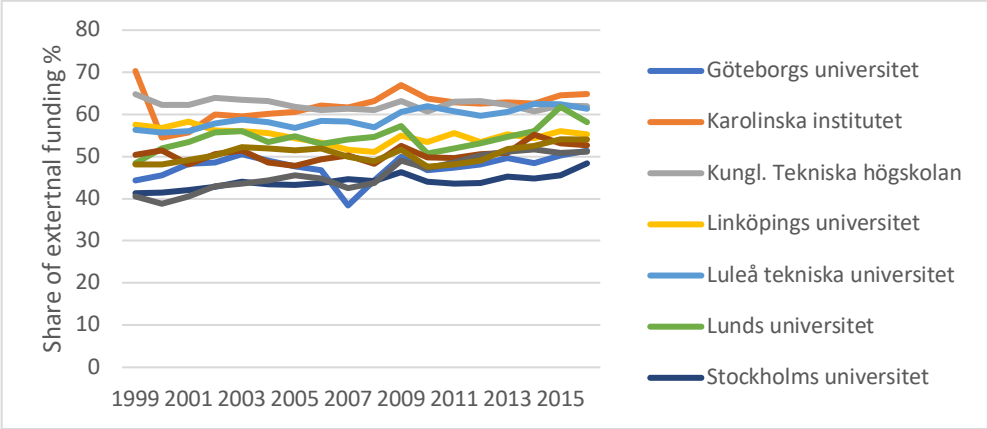


Fig. 7 Share of external funding in percent for older universities. The graphs are based on data from the database of UKÄ [UKÄ 2018].

Most of the project funding are in terms of research grants. 85 percent of the project funding are in terms of grants that are given for a fixed period, often three to four years. The system of external grants leads to a surplus of research funding in the system. One reason for this is that grants are often decided a short time before the project starts and, therefore, one starts the project some time later than planned. This gives a surplus that is pushed forward. If there is a new grant at the period's end, then this is repeated, resulting again that funding is pushed forward etc. In addition, due to the unsteady nature of grants, there is a tendency to save some grant money for as long as possible. The surplus of funding is quite substantial. The graphs below show the amount of funding not used at older universities.

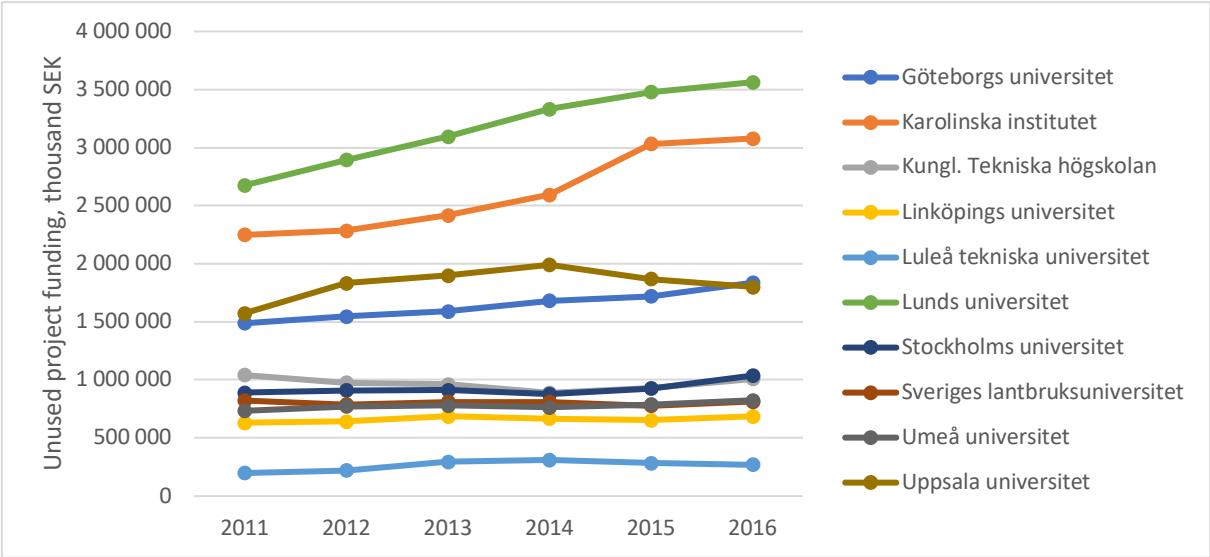


Fig. 8 Unused grant funding at older universities between 2011-2016 in thousand SEK. The graphs are based on data from the database of UKÄ [UKÄ 2018].

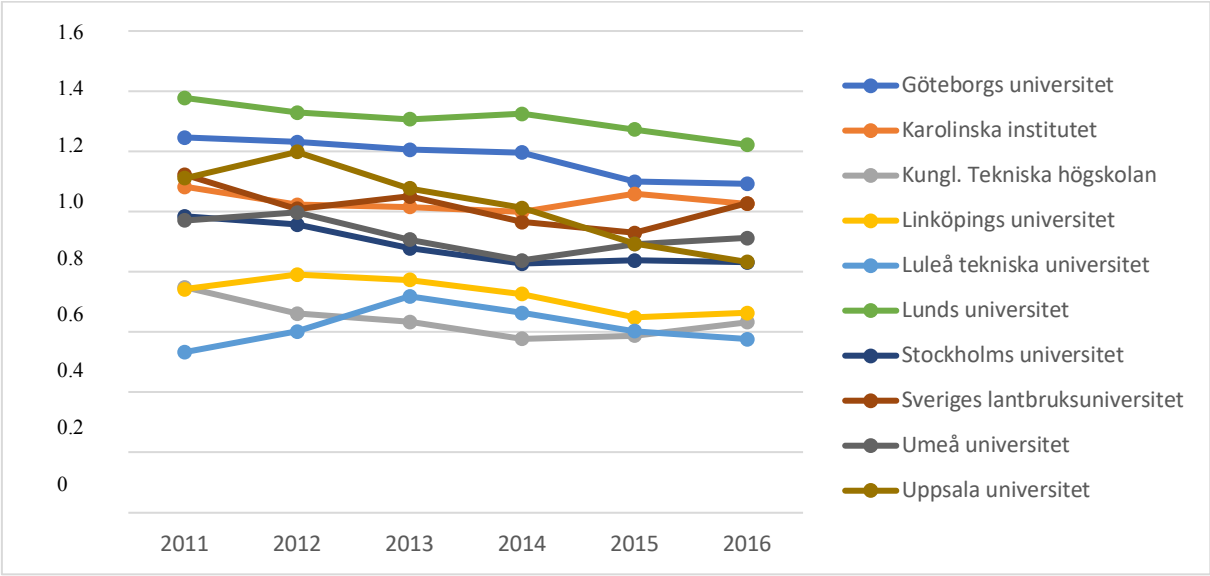


Fig. 9 Ratio between unused grants and grant funding at older universities. The graphs are based on data from the database of UKÄ [UKÄ 2018].

We can sum all the contributions for HE institutions. The result is depicted in the graphs below.

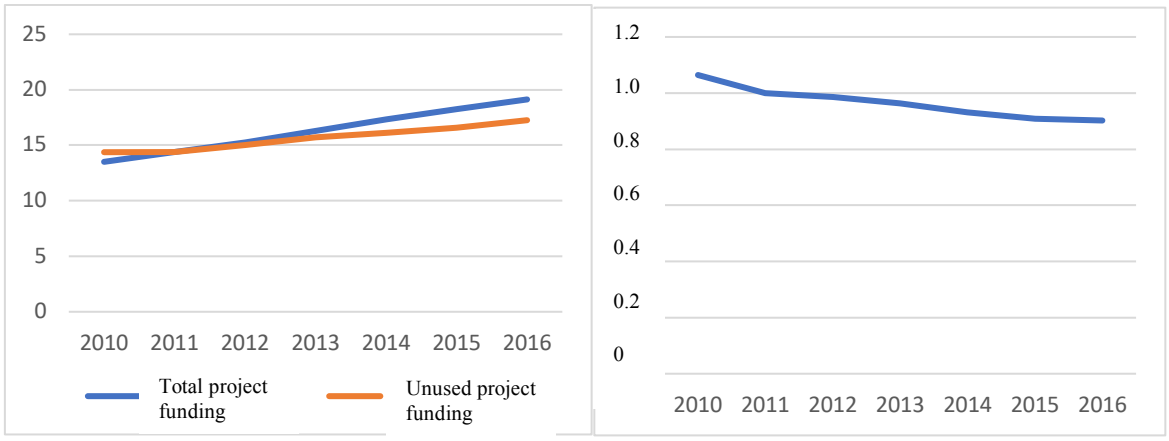


Fig. 10 The figure on the left shows graphs of the grant funding (blue line) and unused grant money (orange line). The right hand figure shows the ratio between unused and total project funding.

The unused project funding is a substantial resource which 2016 was 17 billion SEK. This can be compared with the direct funding of research that amounts to 17.7 billion SEK i.e. about the same amount. Since 2010 the amount of unused project funding has increased by twenty percent.

In addition to saving project funding, HE institutions that are state owned have the possibility to save direct funding for research and education. We will refer to these savings as "saved capital". Since funding for education and research are kept apart, this applies also to the saved capital. Non-state HE institutions have other rules that apply, which we will not consider here. The graphs below show the saved capital for older universities.

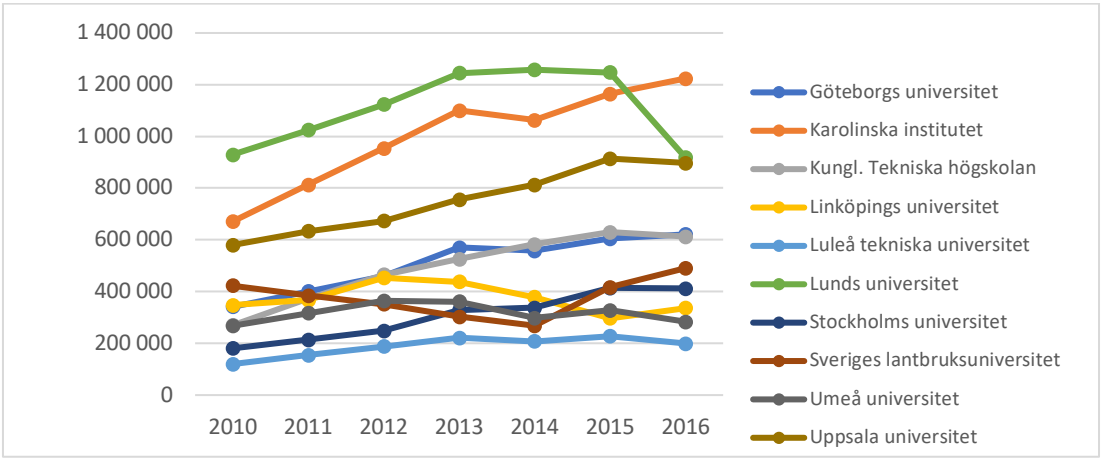


Fig. 10 The saved capital for research for older universities in thousand SEK between 2010 and 2016. Source: The data base of UKÄ [UKÄ 2018].

If we sum all contributions of state owned HE institutions we get the graph below.

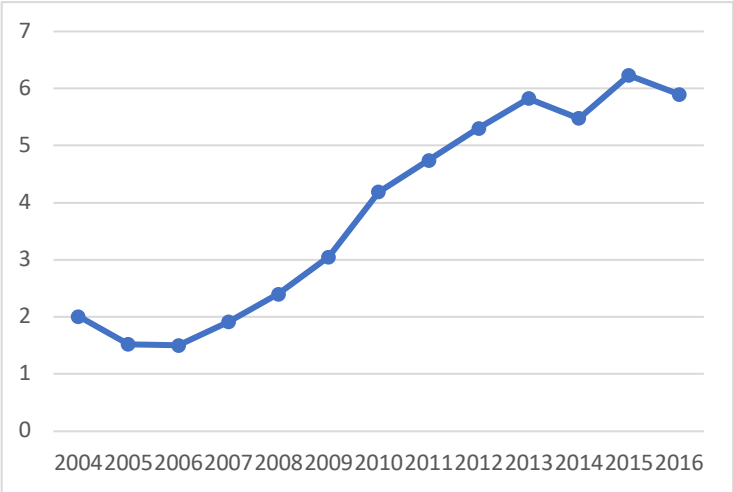


Fig. 11 The saved capital for research in billion SEK summed for all state owned HE institutions during 2010-2016. Source: The data base of UKÄ [UKÄ 2018].

We see from the graph that the saved capital has increased more or less continuously since 2006, when it was 1.5 billion SEK, to 2016 when it was 5.9 billion SEK. A large part of the increase in saved funding can be attributed to the increase in project funding, as the graph below shows. The correlation *R* is 97 percent, as can be seen from the graph and a linear best fit.

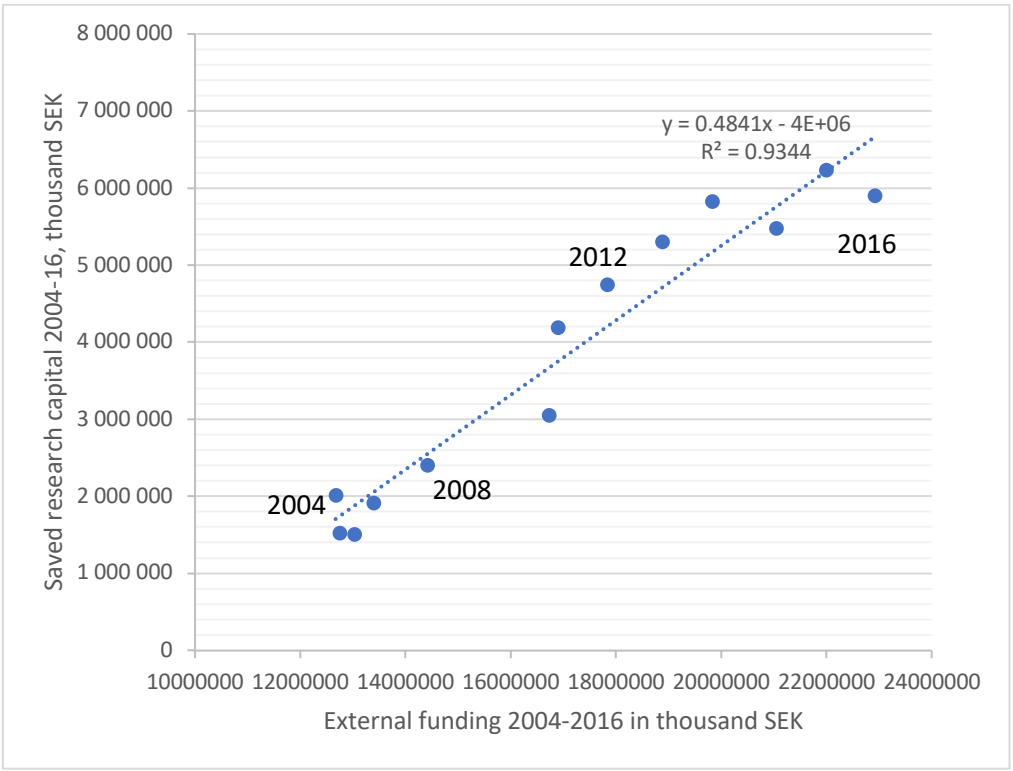


Fig. 12 Saved capital for research as a function of external funding in thousand SEK. Each dot represents the value at a certain year in the period 2004 to 2016.

However, before drawing some conclusions from this, it should be noted that there is a slightly higher correlation between the saved capital for research and the total funding for research. But it seems reasonable that project funding is a major reason for the large amount of saved capital.

Concluding this section, we have learned that project funding leads to a substantial amount of unused money. The figure 10 (right) shows that, by decreasing the amount of project funding by some factor, there will be a decrease by roughly the same factor. For example, if we were to reduce the project funding to half its value, this will lead to freeing 8.5 billion SEK that can be used for research. This amount is a one-time source of funding, but still is quite substantial. If one halves the project funding over ten years one can increase research funding by 850 million SEK each year for ten years. We expect also that a decrease in project funding will decrease the saved capital.

3. Research Quality

In this section we will analyze the research performance of HE institutions in terms of citations and how this performance relates to the funding available. We will, in particular, interest ourselves if and how project funding affects the performance. Research quality may, however, mean much more than just how well publications are cited, but here we only focus on citations. At an institutional or national level, this is often used in the literature as an indicator of quality. At the level of a research group or even an individual researcher a single indicator like citations is never enough to assess quality.

When dealing with HE institutions in Sweden one has to take into account the differences in size and profile. There are large and small comprehensive HE institutions. There are large and small specialized HE institutions. This means that one must take care when analyzing citations, so that one properly takes into account differences to be able to correctly compare different institutions with each other.

Fortunately, there exists a bibliometric indicator that has been used in Sweden that fulfills this requirement. In 2010, the Swedish Research Council was given a commission by the Swedish government to develop a bibliometric indicator, that could be used in a funding formula for part of the direct funding to HE institutions. There are certain challenges in finding such an indicator. Different areas of research have different traditions of citation. In many areas in the social sciences and humanities one does not have a tradition of citations in the same way as in e.g. medicine or natural sciences. Furthermore, researchers in different areas have different publication traditions.

The bibliometric indicator that the Swedish Research Council developed, called the bibliometric index, takes into account, as far as possible, all these differences. It analyzes the citation of 34 different areas of research and, therefore, distinguishes between different institutions' area profiles in a detailed way. For publications in the Humanities only the publication volume is measured, since the fraction of publications that have citations is so small. A more complete and thorough description (in Swedish) can be found in [VR 2010]. The indicator is based on work by Sandström [Sandström 2008]. In [Heyman 2012] there is a thorough discussion on the effect of the governments model for funding. The Swedish Research Council has annually published data since its commission in 2010. The latest data was done in 2018 and covers the period 2013-2016. All these data can be found on the web page of the Swedish Research Council [VR2018]. The table below shows the latest data.

Institution	Volume	Average citation		
Blekinge Tekniska Högskola	164	1,1	214	0%
Chalmers Tekniska Högskola	3025	1,1	2799	5%
Gymnastik- och idrottshögskolan	61	1,1	57	0%
Göteborgs universitet	4646	1,2	5209	10%
Högskolan Dalarna	153	0,7	144	0%
Högskolan i Borås	234	0,8	177	0%
Högskolan i Gävle	205	0,7	202	0%
Högskolan i Halmstad	119	1,0	159	0%
Högskolan i Jönköping	288	0,9	351	1%
Högskolan i Skövde	132	0,8	105	0%
Högskolan Kristianstad	107	0,7	106	0%
Högskolan Väst	133	0,7	107	0%
Karlstads universitet	423	0,8	557	1%
Karolinska Institutet	6380	1,3	6073	11%
Kungl. Tekniska högskolan	4481	1,1	4435	8%
Linköpings universitet	3394	1,2	3801	7%
Linnéuniversitetet	567	0,9	702	1%
Luleå tekniska universitet	1065	0,9	940	2%
Lunds universitet	6916	1,1	7008	13%
Malmö högskola	460	1,1	584	1%
Mittuniversitetet	399	0,9	371	1%
Mälardalens högskola	226	1,1	309	1%
Stockholms universitet	3894	1,2	5001	9%
Sveriges lantbruksuniversitet	2609	1,3	2857	5%
Södertörns högskola	170	0,9	386	1%
Umeå universitet	3138	1,1	3221	6%
Uppsala universitet	6735	1,2	7101	13%
Örebro universitet	677	1,0	811	2%

Table 1 The bibliometric data from the Swedish Research Council [VR2018]. [8]

The bibliometric index will be used as an indicator of the performance of a HE institution in terms of citations. We will now study how this index depends on the total funding for research at the institution. The best way to compare different institutions is to study the relative share of the bibliometric index at each institution (the last column above) and see how this correlates with the share of Sweden's total research funding for the same institution. The figure below shows exactly this. Each point represents an institution. There is a shift of one year between the data of funding and bibliometry, as it is expected that funding takes at least one year to give rise to a publication. Later we will also see the result of a two-year shift.

[8] The figures here are rounded off for convenience. The data used in the analysis below are based on more exact figures given in [VR2018].

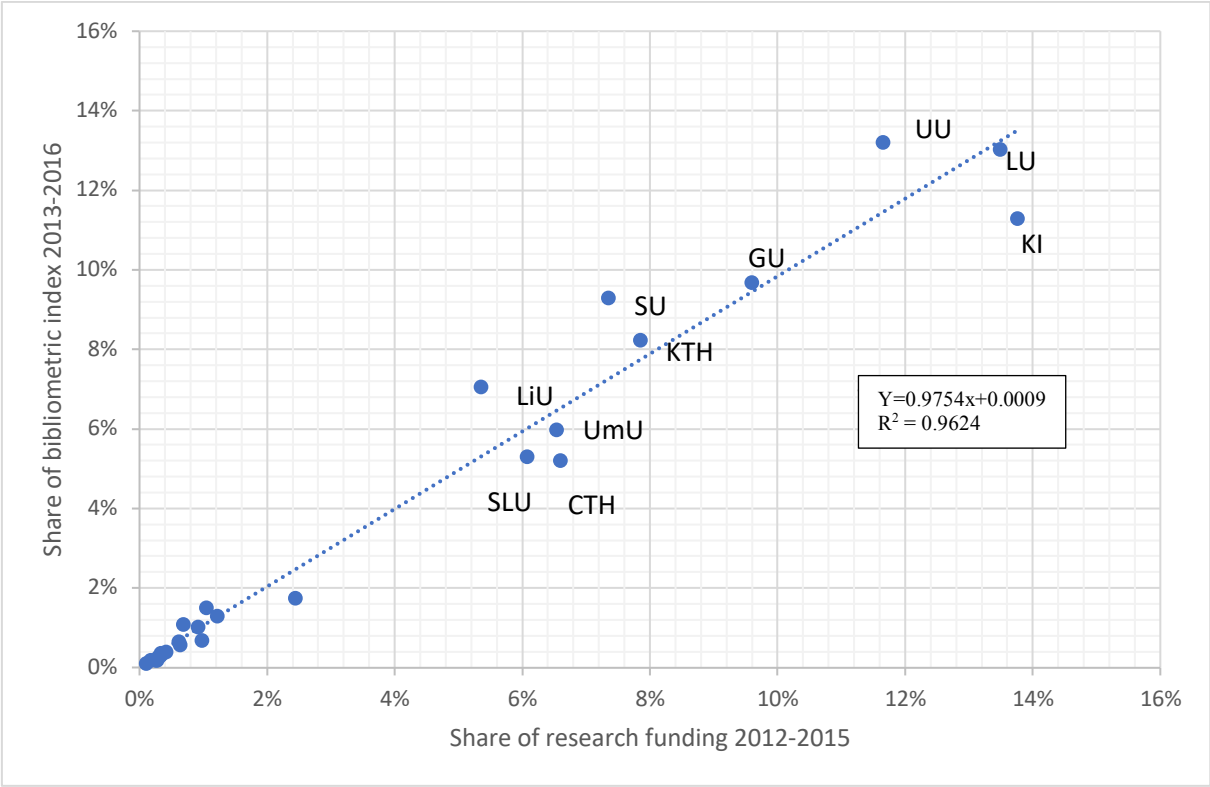


Fig. 13 The share of bibliometric index 2013-2016 (vertical axis) as a function of share of research funding 2012-2015 (horizontal axis) for HE institutions. Each point represents an institution. The bibliometric index is based on all citations of an institution. Bibliometric data from [VR2018]. Funding data from [UKÄ 2018]. The older universities are marked by their abbreviations. The abbreviations are LU=Lund University, KI= Karolinska Institutet, UU=Uppsala University, GU=Göteborg University, SU=Stockholm University, KTH=Royal Institute of Technology, LiU=Linköping University, UmU=Umeå University, CTH=Chalmers University of Technology, SLU=Swedish University of Agriculture Sciences.

The figure above shows a strong connection between the bibliometric index and the research funding for an institution. The linear correlation has a correlation factor *R* of 98 percent. The figure includes all analyzed institutions in table 1. However, due to the large difference in size it is difficult to distinguish smaller institutions in the figure. The very large correlation between the bibliometric index and the funding means basically that the amount of research funding explains almost all the differences in citation performance between the institutions, larger as well as smaller. Only less than two percent of the variation in performance between institutions cannot be explained in terms of funding.

In order to see how robust the results above in figure 13 are, we have also analyzed the outcome if we double the period of publication and funding. This means that we study the bibliometry during the period 2009-2016 and the funding during 2008-2015. The result is depicted in the figure below.

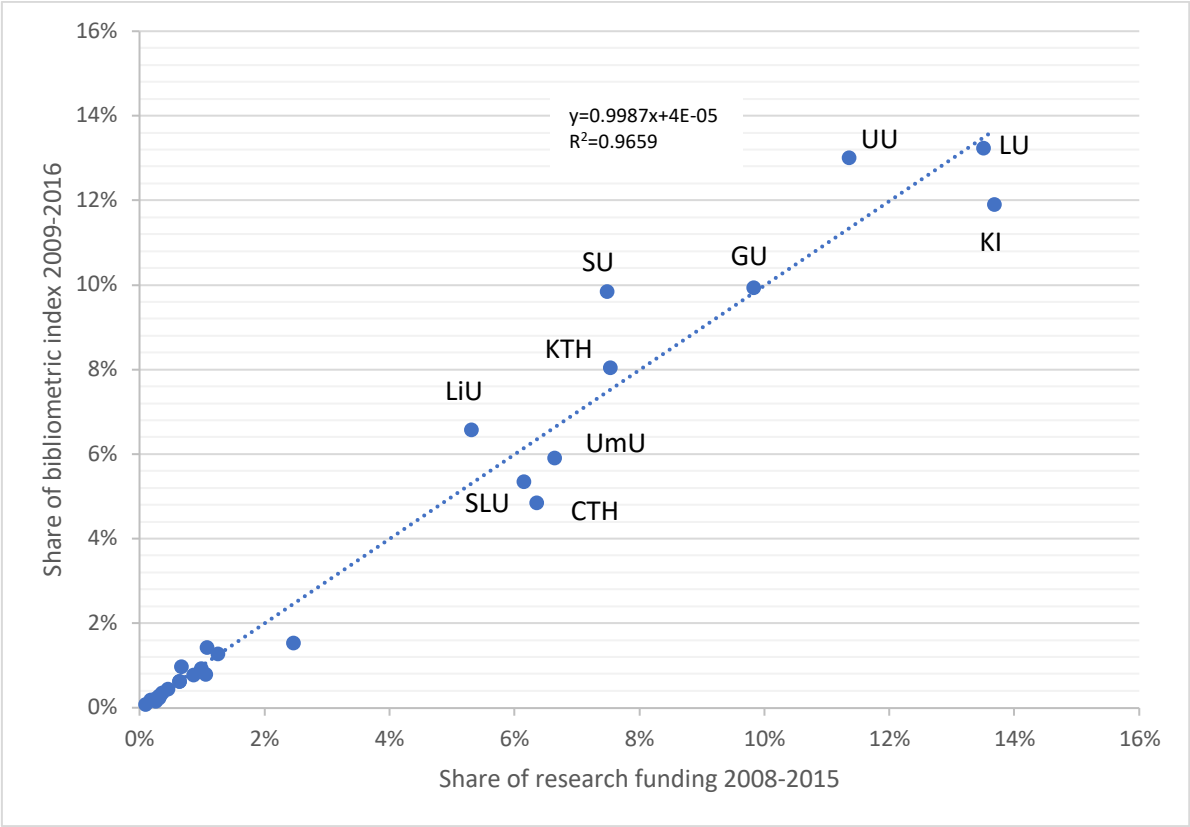


Fig. 14 The share of bibliometric index 2009-2016 (vertical axis) as a function of share of research funding 2008-2015 (horizontal axis) for HE institutions. Each point represents an institution. The bibliometric index is based on all citations of an institution. Bibliometric data from [VR2018]. Funding data from [UKÄ 2018].

As can be seen in the figure the linear correlation is robust under a doubling of the interval. The institutions have also the same mutual positions. We have also made another variation to test the robustness of our results, namely to look at a two-year shift between funding and citations instead of a one-year shift. The figure below shows the result of how the bibliometric index during the period 2013-2016 depends on the funding during 2011-2014. As can be seen below the result is unchanged compared to a one-year shift.

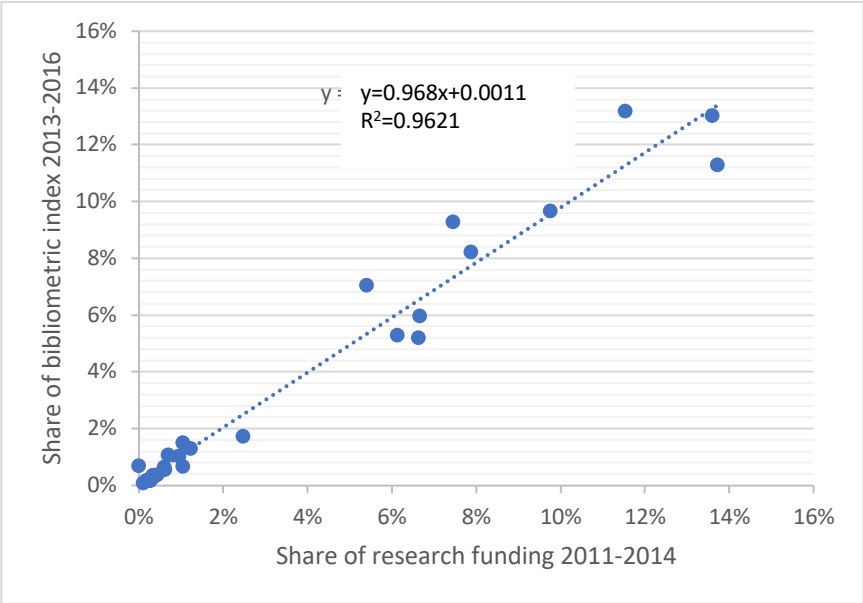


Fig. 15 Share of bibliometric index 2013-2016 as a function of share of research funding 2011-2014. Each point represents an institution.

We have as a final variation studied publications that are among the ten percent best cited in each area. The corresponding bibliometric index for 2013-2016 as a function of the funding 2012-2015 is depicted in the figure below[9]. The result is an even stronger correlation – over 99% - compared to above when all publications are included. The mutual positions of the institutions have also shifted slightly.

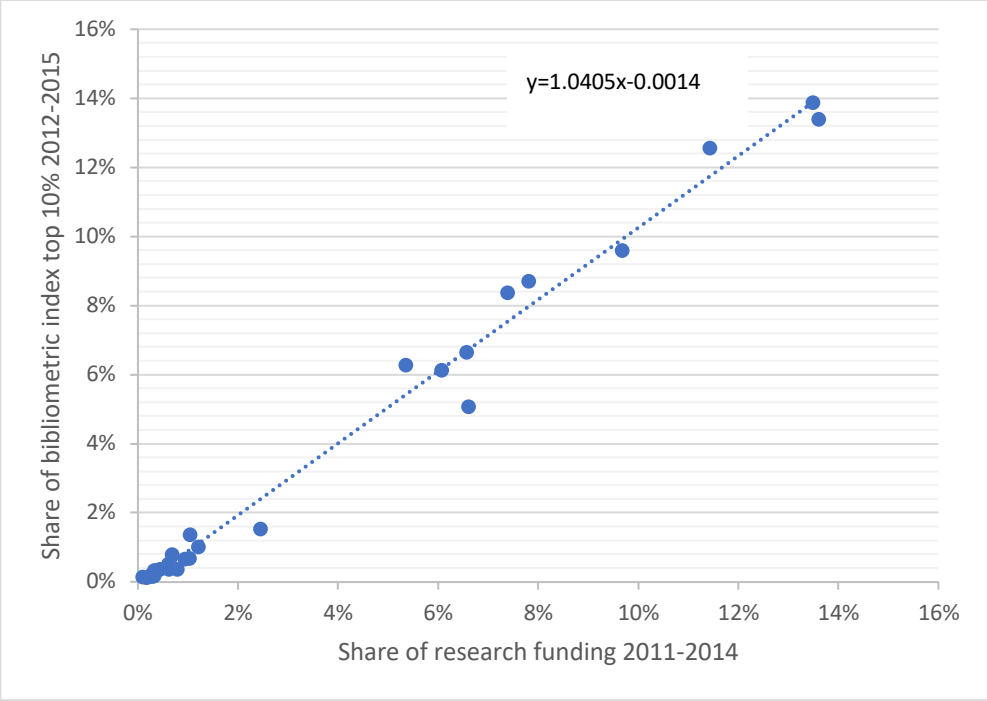


Fig. 16 Share of bibliometric index corresponding to the top 10% best cited publications 2012-2015 as a function of the share of research funding 2011-2014. Each point represents an institution.

[9] The two figures 14 and 16 do not have the same periods. This is due to the fact that the bibliometric data from the Swedish Research Council for top 10% are only publicly available for the period 2012-2015.

Concluding the results so far, there is a correlation between citations and funding which is extremely strong and this result is robust. The result does not change if we double the period of publications and funding, change from one to two year shift between funding and citations, or include only the ten percent most cited publications.

The different institutions lie, as can be seen from the figures above, both above and below the trend line. The institutions that lie above the trend line i.e. with higher vertical values than the trend line, have better bibliometric performance than the institutions that lie below the trend line. The higher the vertical value the better the performance. We will now, as a next step, analyze how different institutions lie in relation to the trend line. One difficulty in this respect is the large difference in size between institutions. This is clear from the figures above, where there are a number of institutions grouped close to the origin. If we use the trend line to analyze differences the result for small institutions is very sensitive to small numerical errors. We have, therefore, chosen to look at the ratio between the share of bibliometric index and the share of research funding. We believe that this a more reliable way to analyze the differences between the institutions.[10]

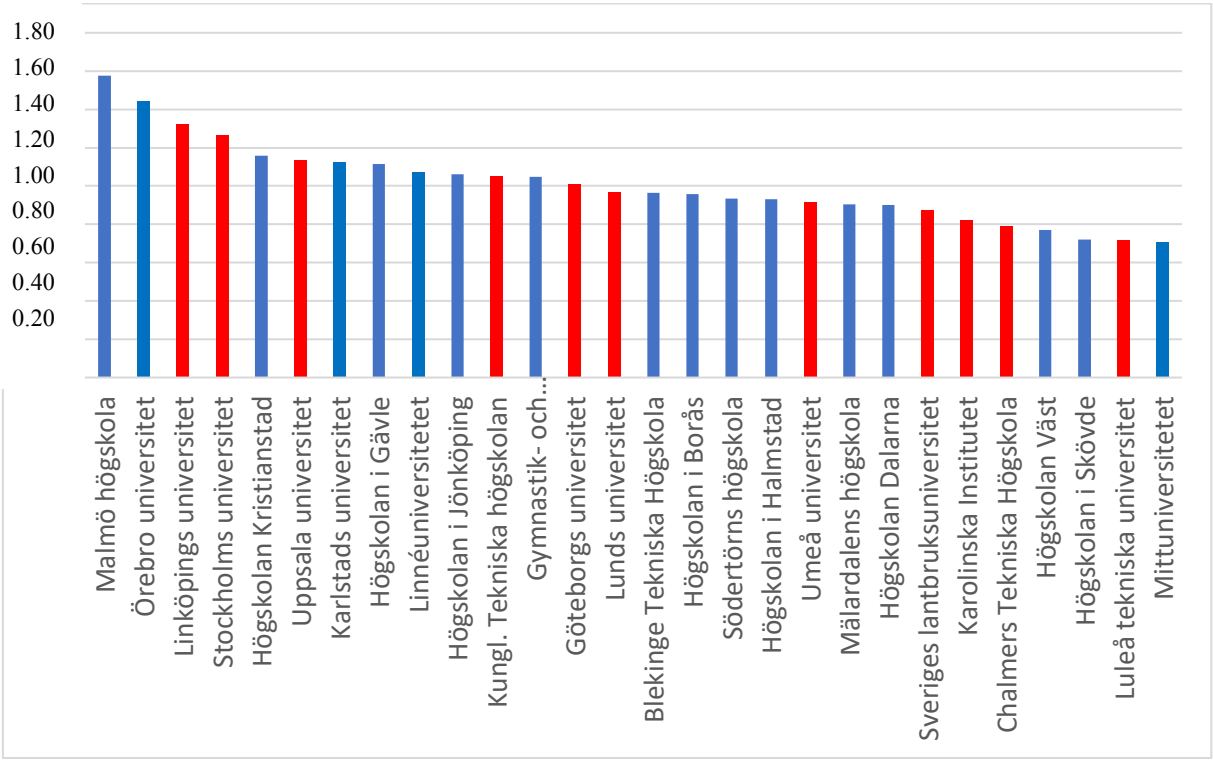


Fig. 17 The ratio between the share of bibliometric index 2013-2016 and the share of research funding 2012-2015. The older universities are marked in red.

The figure above shows the result of the ratio of the relative share of bibliometric index for 2013-2016 and the relative share of research funding 2012-2015. The institutions to the left have, therefore, a better performance than the institutions to the right. One can see that there is no obvious order between the older universities and other institutions. There are high and low performers in both groups.

[10] In Appendix 2 we have, for completeness, used the distance to the trend line to compare the differences. The conclusions in this and the next section hold irrespectively of the choice of method.

We will end this section by showing some additional relations of interest. The first one is the correlation between research volume measured in terms of publications and research funding. The figure below shows this correlation.

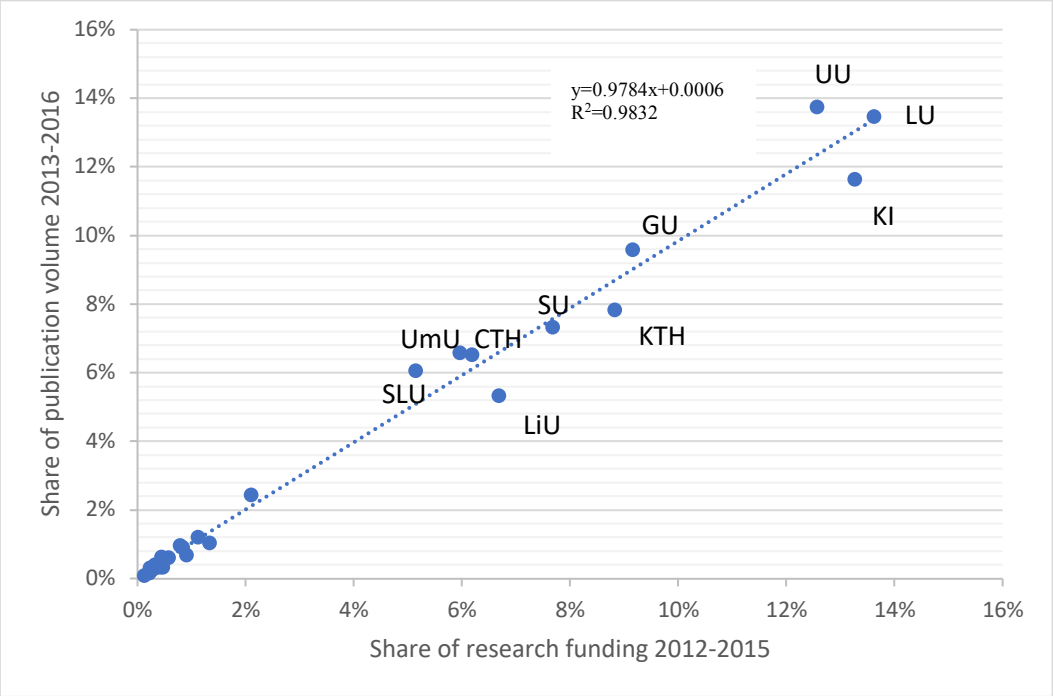


Fig. 18 Share of publication volume 2013-2016 as a function of share of research funding 2012-2015.

The figure above shows that there is a large correlation – more than 99% -between publication volume and research funding. This correlation is even higher than between average citation and research funding and approximately the same as the correlation between top ten percent citations and funding.

Our next relation of interest is between publication volume and citations. This is shown in the figure below.

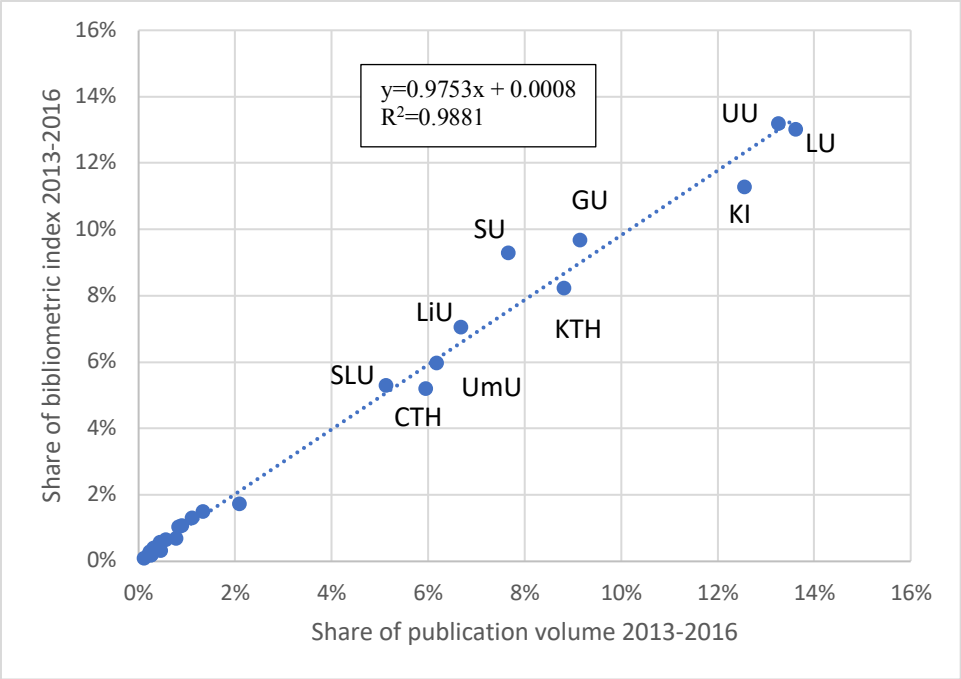


Fig. 19 Share of bibliometric index 2013-2016 as a function of share of publication volume 2013-2016.

The correlation between volume and citations is, as can be seen, even larger than between funding and citations. The number of publications is, therefore, the most significant factor for high quality. It is more significant than the amount of funding available. Of course, the different factors are not independent. We have the following chain of relations.

RESEARCH FUNDING ⇒ PUBLICATION VOLUME ⇒ CITATIONS

Logically, one can understand that the publication volume is closely related to the number of citations. What may be more surprising, however, is the very high correlation of over 99 percent. There is little room, less than one percent, for factors other than volume that can enhance quality.

Given the huge correlation between volume and citations, it may be interesting to see how this looks at the institutional level. One can, therefore, study the ratio between the bibliometric index and the publication volume. Figure 20 below shows the result.

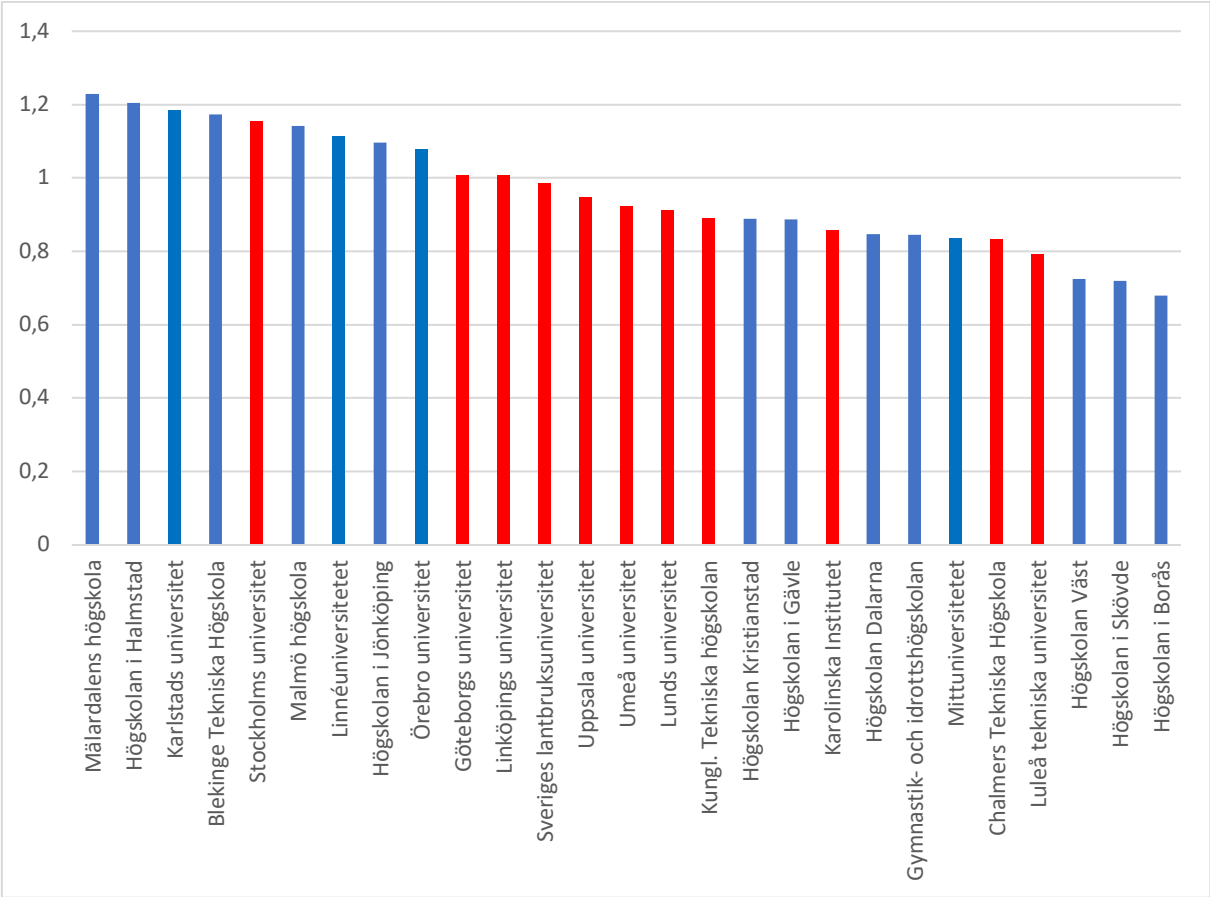


Fig. 20 Ratio between the relative share of bibliometric index and the relative share of publication volume 2013-2016. Older universities are marked in red.

Comparing figure 20 with figure 17 we see that there are some surprising and large differences at the institutional level. As an example, we can look at Mälardalen university. This university is now at the top with a ratio of 1.22. In figure 17 the same university is well below average at a value 0.90. Universities that like Mälardalen university are far better here compared to figure 17, have a larger cost per publication combined with a larger average number of citations per publication. An opposite example is Linköping University, which has the third largest value 1.32 in figure 17, but in figure 20 there is a drop to a more average value of 1.01. Universities like Linköping University have a lower cost per publication in comparison to the average citation per publication. Another explanation for a drop like this one, could be that there are resources for research that is not accounted for as funding. Then the ratio between the share of bibliometric index and the share of funding is larger than if all resources are taking into account. This may be the case when universities have researchers with double affiliations, where one affiliation is outside academy like a hospital. This means that researchers could be funded by the resources of the hospital and are not accounted for in the statistics. We believe that this may be the case for several universities, especially those connected to medical areas.

The final relation that we will discuss is to show how the Norwegian publication point system correlates with funding. The Norwegian system, as we will refer to it, is a system developed in Norway that attributes points to every scientific publication that has a undergone a referee procedure prior to publication. The number of points depends on the type of publication. For example, a scientific article gives one point, a scientific book or monograph gives five points.

The system has two quality levels. Level one corresponds to ordinary publications. Level two corresponds to publication channels, i.e. particular journals or publishers, where in total twenty percent of the best publication are published. Level two publications are given higher points, for example, three points for an article or eight points for a monograph or book. The determination of level one and level two channels is done through an open process, where researchers can nominate channels and also take part in an anchoring process. A similar system has been introduced in Denmark and Finland. In the latter case there are three levels, instead of two. The Norwegian system has a clear advantage in that it includes all scientific areas on the same footing[11]. This is not the case when using citations, where many areas are poorly covered by counting citations (but this can be taken into account, as is done by The Swedish Research Council in their bibliometric index).

The data for our analysis covers only nine universities [12] and includes the compensating factors that make the Norwegian point system neutral, as explained in the footnote below. The result of the analysis is shown in figure 21 below. The figure shows a clear linear correlation between the publication points at the university level and the funding. The correlation is high, 97%. It is almost as high as the correlation using the bibliometric index. We believe that the slightly lower correlation is due to the data covering a smaller number of universities. In particular, many of the largest universities are not included. If we compare figure 21 with figure 13, we see that different universities show a similar behavior in both figures. This shows that the Norwegian system compares well with the bibliometric analysis, even though the former is much simpler. In fact, an analysis shows that the bibliometric index and the Norwegian points for the analyzed institutions are 99.4% correlated.

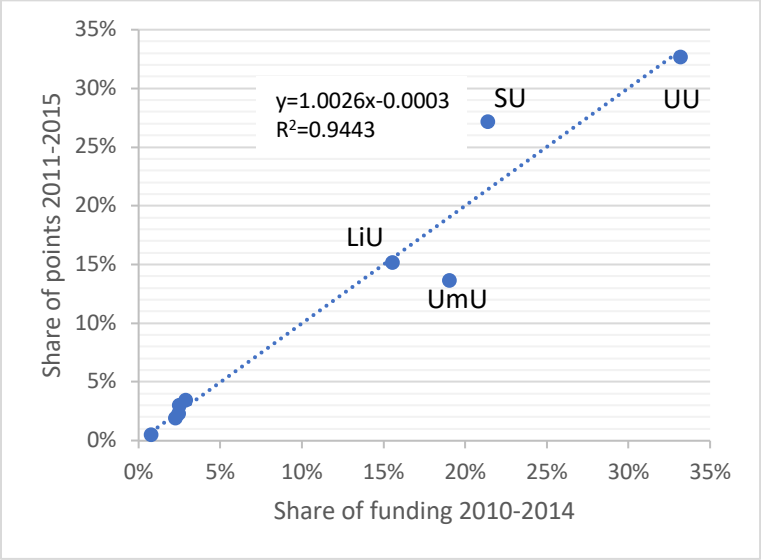


Fig. 21 The relative share of points for publications 2011-2015 in the Norwegian system for nine universities as a function of the relative share of funding 2010-2014.

[11] The Norwegian model gives a higher weight to publications in humanity and social sciences than in engineering and natural sciences, which in turn has a higher weight than in medical and health sciences. In order to make the model neutral one should multiply the points in humanities-social sciences by 0.77, engineering and natural sciences by 1.00 and medicine- health by 1.08.

[12] The universities are Uppsala University, Stockholm University, Linköping University, Umeå University, Linnaeus University, Örebro University, Mid-Sweden University, Karlstad University and Halmstad University. The data for all institutions except Halmstad University was collected and analyzed by Rickard Danell, Umeå University as a commission from the present author.

4. The effect of project funding

In this section we will analyze the effect of project funding on HE institution's research performance. We have in the previous chapter analyzed how well different HE institutions succeed using the bibliometric index and how the index varies for different HE institutions. More than 98% of the differences between HE institutions depend on how much funding they receive, respectively. The remaining approximately two percent give rise to differences that cannot be attributed to funding, which was depicted in figure 17. In the previous section we used the ratio between the relative share of the bibliometric index and the relative share of research funding as a measure of research performance of an institution. We will now analyze the data to see if there is any correlation with the share of project funding of the total funding in HE institutions. Starting with the result in figure 17 and comparing with the share of project funding one arrives at the following figure.

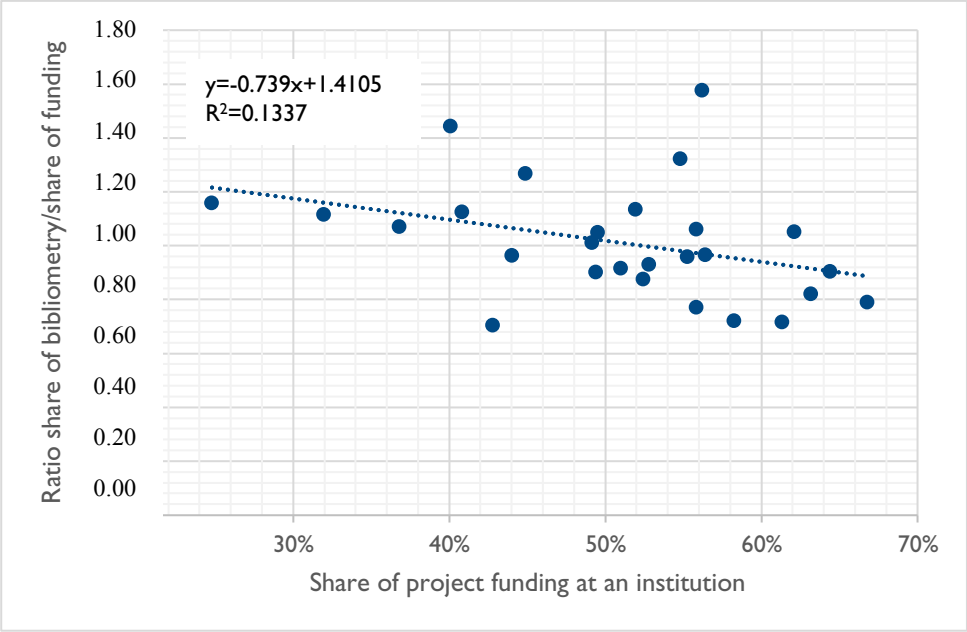


Fig. 22 Research quality, as measured by the ratio between bibliometry 2013-2016 and funding 2012-2015, as a function of the share of project funding of the total funding in HE institutions 2012-2015. Each point represents an institution.

As can be seen from the figure, there is a decreasing linear correlation between the research performance of institutions and the share of project funding of the total funding, i.e. the performance decreases with a growing share of project funding. The correlation factor is -37%. If one instead focuses on the older universities one finds the following figure.

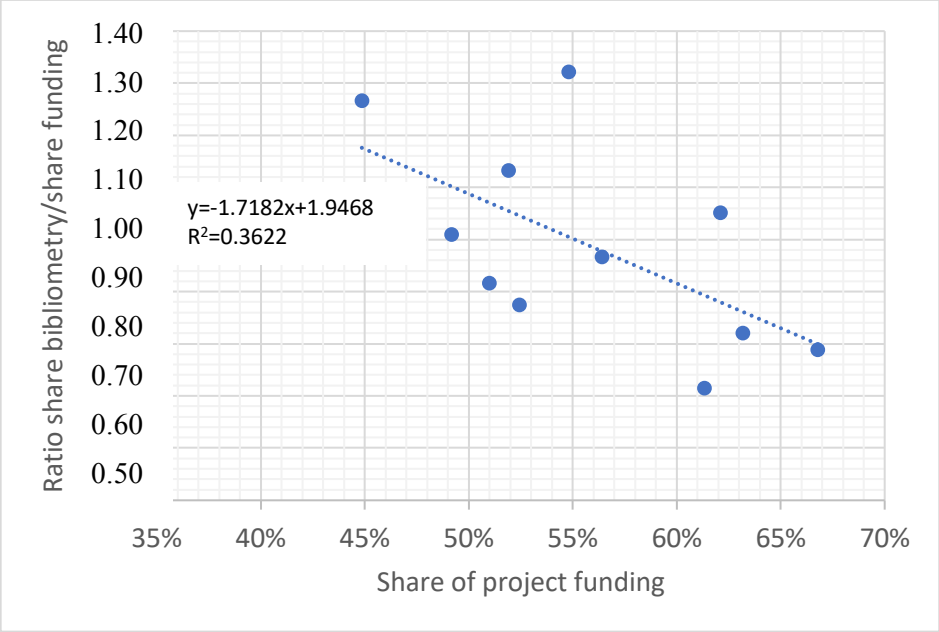


Fig. 23 Research quality, as measured by the ratio of shares between bibliometry 2013-2016 and funding 2012-2015, as a function of the share of project funding of the total funding for research at HE institutions 2012-2015. The points represent the older universities.

In this case one sees a much clearer decreasing behavior of the research performance when the share of project funding is increased. The negative correlation is about 60%. We have also analyzed the publications for the period 2009-2016. In this case the negative correlation is 64%. One can, in addition, look at the ten percent top cited publications. Here the negative correlation is weaker, only 19%. Finally, one can consider the ratio between the bibliometric index and the publication volume for 2013-2016. This ratio may be viewed as an alternative performance indicator for research quality. If one plots this ratio as a function of the share of project funding, one finds for all institutions included almost no negative correlation. The correlation factor in this case is about 19%. However, considering only the older universities one gets the following figure.

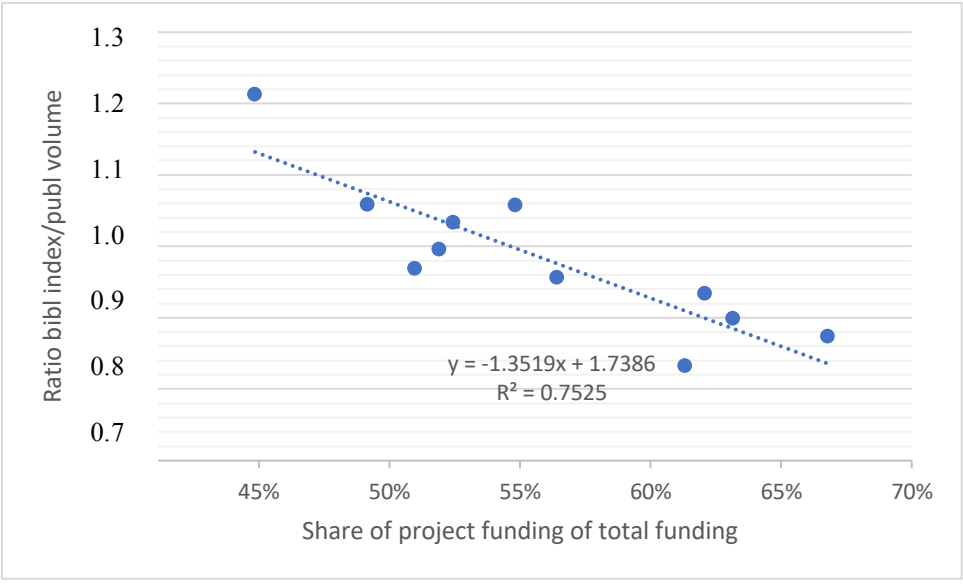


Fig. 24 The ratio between the bibliometric index and the publication volume for 2013-2016 (vertical axis) as a function of the share of project funding 2012-2015 (horizontal axis). Each point represents an institution and only the older universities are represented.

Concluding the analysis this far, it shows that are many indications supporting a negative linear correlation between how well an institution performs in research as measured by citations and the amount of project funding. This becomes much clearer if one measures all citations, not only the best ten percent, and if only the older universities are included. One needs more investigations to say more exactly how high the correlation is. However, it is absolutely clear from the data that there is no positive correlation between research performance and the share of project funding. This means that project funding does not promote research quality in the form of citations at the institutional level!

This conclusion may come as a surprise. One of the most important arguments usually invoked in favor of project funding is that competitive funding promotes quality. Most of the project funding in Sweden is highly competitive and an extensive process with experts are often used to select the most qualified applications. The results here show that this process does not lead to a higher quality at the institutional level. This will be discussed further below. It should be pointed out that the results are consistent with the results in [Eyre-Walker and Stoletsky 2013]. In this paper it is shown that the peer-review process achieves poorly in judging the future success of a paper in terms of citations. The results are also consistent with [Sandström-Besselaar 2018], where the effect of research funding is studied. It was found there a negative correlation of about 30 percent between citations and project funding at the national level.

In the rest of this section, we will study the effect of project funding on the Swedish research system. More specifically, we will look at how much resources are used in project funding i.e. the resources connected to the application of project funding as well as resources used for the processing the applications. Our main focus will be in the former. The aim is that this estimation together with the results above will give an estimation of the effect that the high level of project funding has on research performance in Sweden and what the result would be if the level was lowered.

Statistics Sweden (SCB) is the official Swedish authority for collecting statistical data on Sweden. SCB have gathered data [SCB 2018] on how different staff categories use their time at Swedish HE institutions for different work tasks. Interesting for our purposes is the data on how much time is used to apply for research project funding. Data are available for 2013 and 2015. The data for 2015 can be summarized by the following table, which shows the share of time in full-time equivalents used for project funding applications for different staff categories.

With PhD	Share of time for applications	Without PhD	Share of time for applications
Professor	22.1%	Research Assistent	4.1%
Post Doc	19.5%	Ph D Student	2.5%
Senior Lecturer	16.6%	Lecturer	5.9%
Researcher	13.3%		

For all categories above the average share of time used for project funding applications is 10.3%[13]. If we only include the categories of researchers with a PhD, the average share of time is 16.6% of the total time used for research activities. For 2013 the corresponding figures are 10.2% and 17.4%, respectively. Hence, the difference between 2013 and 2015 is marginal. SCB gives an error estimate of ± 11% for all categories of staff i.e. for 2015 the figures are 10.2% ± 1.1% and 17.4% ± 1.8%. This means that the interval should be 9.1-19.2%, which is rounded off to 9-19%. The question is which value in the interval 9-19% is relevant here? Since the value will be used to estimate the effect of project funding on performance, it is our belief that the relevant value is closer to 19% than 9%. This belief is based on the assumption that it is the more senior researchers who are mainly responsible for publications with many citations. This is, however, a belief that needs verification. We will, however, proceed by not assuming anything particular i.e. which value in the interval that is relevant.

The time used by a researcher to apply for project funding is time taken from actual research i.e. time that produces results and publications. The analysis in the previous section showed that there is a very strong correlation between the total funding for research at an institution and how well the institution performs in terms of citations. The analysis showed an even stronger correlation between research volume and citations. If one reduces the time spent on applying for project funding it will mean that time available for actual research will increase. It is fair to assume that there will be a corresponding increase in the publication volume, which in turn will lead to an increase in citations. Our analysis in the previous section showed a one-to-one relation between the increase in research volume and the increase in citations. More precisely, one can see from figure 19 that the slope of the line is 0.99 i.e. if the volume increases by 10% the bibliometric index increases by 9.9%. With the level of precision that we are working with here, one can take this to be 10%. One can, furthermore, assume that there is a one-to-one correspondence between the time allocated to actual research and the research volume i.e. if the time increases by 10% the volume increases by 10%.

Given these starting points one can now evaluate the effect of a decrease in project funding. As it has been shown that project funding is not enhancing the quality (but rather seems to do the opposite), it follows that transferring funding from project funding to direct funding in HE institutions will not lead to a quality effect in itself[14]. However, transferring the funding will free time for the researchers as they can do actual research instead of applying for project funding. This gives an indirect quality enhancing effect that we can estimate. Assume, for example, that one decreases the project funding so that it is half as much as before. One will then decrease the time used to apply for project funding by a factor of two. This will free half of the time 9-19% spent on applying i.e. one will free 4.5-9.5%. According to the reasoning above, this gives an increase in the research volume by 4.5-9.5% and a corresponding increase in citations by 4.5-9.5%. In this estimation, not all the resources needed to process all the applications using, for example, a peer review process have been taken into account. This makes an estimation of 5-10% more realistic.

An increase of citations by 5-10% is relatively speaking quite a substantial increase. Comparing with figure 1, one can notice that for the year 2013 Sweden had an average degree of citations that

[13] In order to calculate this one needs to know the share of total research time for each category. This can found as well in the SCB data.

[14] If we on the other hand have, as we have seen clear indications of in our data, that there is a negative correlation between performance and project funding we will get a quality enhancement through transferring funding.

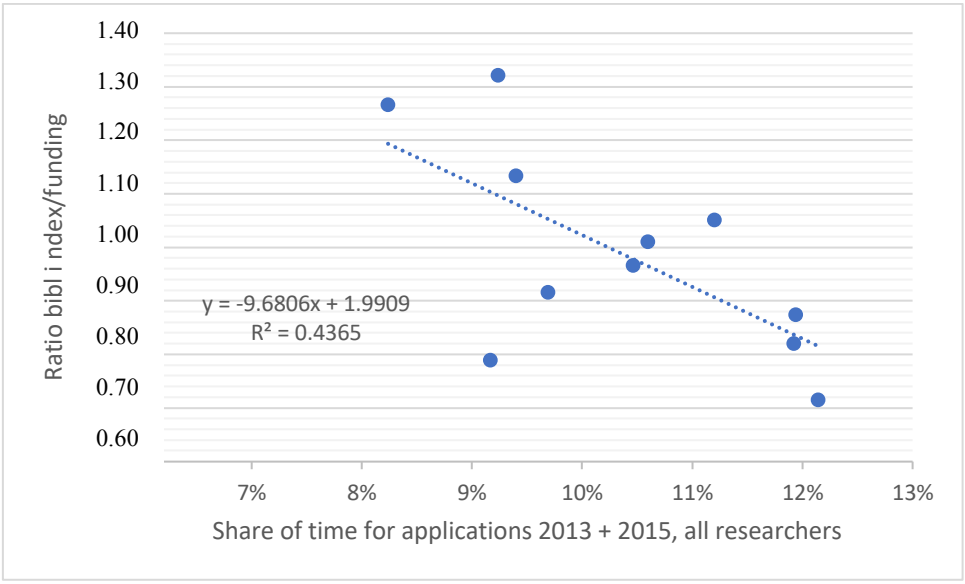
was 98% of the average for comparable countries. By an increase of citations of the order 5-10% Sweden will lie somewhere in the interval 103-108% above the average of comparable countries i.e. well above instead of slightly below the average! According to our discussion concerning researchers with and without PhD, we are more likely to be close to 10% than 5%. In terms of funding an increase by 5-10% in citations can be accomplished with the present level of project funding by increasing the total yearly funding for research by 2-4 billion SEK. The total loss of efficiency due to project funding corresponds to twice this sum i.e. 4-8 billion SEK.

A crucial point in this reasoning is our result that external funding does not promote quality at an institutional level. Without this result one cannot reach the conclusions concerning the effect of reducing the project funding. If the analysis instead had shown that project funding enhanced quality it could have resulted in a compensation for the loss of efficiency that project funding gives rise to. But, as has been stated several times, project funding is not quality enhancing. Instead we see clear indication of the opposite, leading to even larger losses in performance than the figures 10-20%. There is implicitly, in the reasoning above, an assumption that time freed is really used for actual research and that the resulting publications are of the same quality as before. These are, of course, assumptions but we believe them to be reasonable.

Throughout the discussion above, there has been no mentioning of indirect costs associated with research. This is because the data from SCB give us the cost in time at the researcher's level used to apply for funding. This time can be translated into costs at the institutional level by adding to the cost for salaries for the researchers, the costs of infrastructure, administrative support etc.

One can also study how the time used for application for project funding differs between the older universities. The average for the years 2013 and 2015 varies between 8.2% for Stockholm University to 12.1% for Luleå University of Technology for all categories of researchers. If one limits oneself to researchers with a PhD one gets a span between 14.9% for Stockholm University to 28.2% for the Royal Institute of Technology.

One may perform a correlation analysis between the time spent for applications and the research performance in terms of citations. The result of this analysis is shown below. As can be seen the research performance decreases linearly with the amount of time used for applying for project funding. Somewhere between 55% and 65% of the difference in performance between HE institutions can be attributed to the amount of time used for applications. This time is taken from the researcher's time for producing research results and publications and leads to a measurable effect, as the figure clearly depicts. One can also see that the correlation is higher when one includes all staff categories, not only those with a PhD. This appears to contradict the assumption above that staff with a PhD are more important for producing citations. More analysis is needed here.



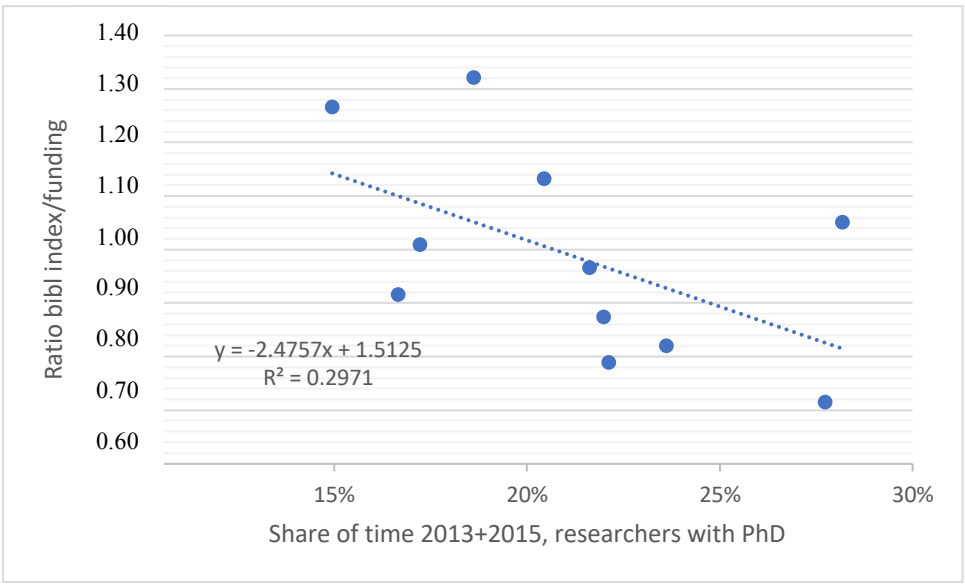
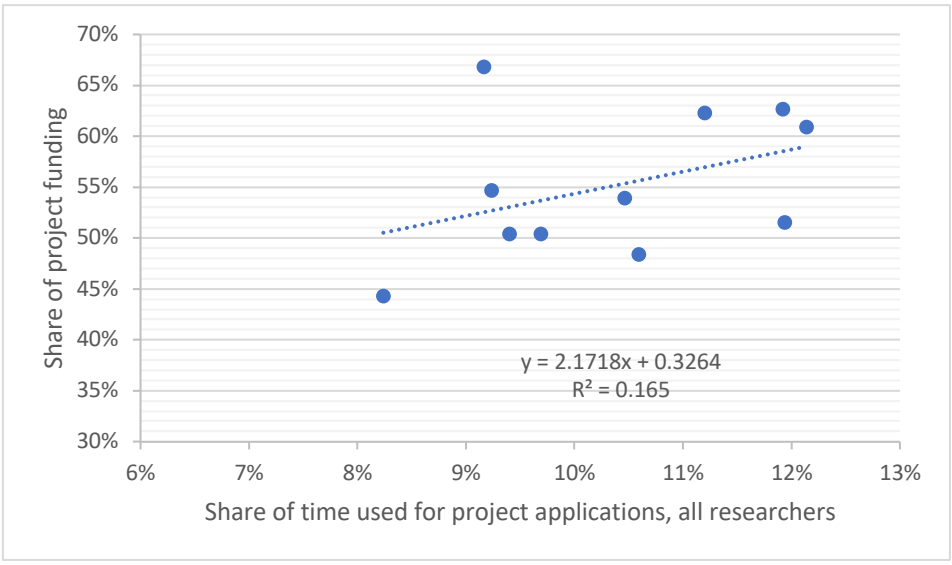


Fig. 25 a and b The performance of the older universities (as measured by the ratio of bibliometric index 2013-2016 and the funding 2012-2015) as a function of the share of research time 2013+2015 used for applying for project funding. Each point represents a university. For the top figure (a) all categories of researchers are included and in the bottom figure (b) only those with a PhD are included.

A correlation analysis between the amount of time used for applications and the share of project funding of the total funding has also been done. The result of the analysis is shown below.



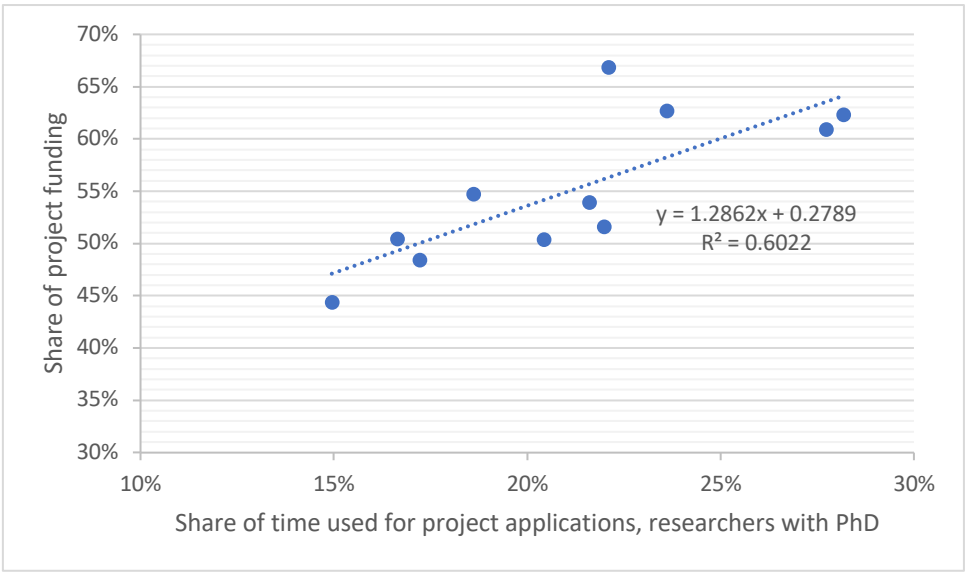


Fig. 26 a and b Share of project funding of total funding 2011-2014 as a function of the time researchers spend for applications. In the top figure (a) all researchers are included and in the bottom figure (b) only those with a PhD. Only older universities are included and each point represents a university.

The analysis above shows a clear connection between how much time is spent on applying for project funding and how much a university receives in funding. For all categories of researchers the correlation is 41%. For researchers with a PhD the correlation is much higher and reaches a value of 78%. This implies that project funding is to a higher degree due to the efforts of more senior researchers, which perhaps is not so surprising. The results also give a qualitive explanation to the negative correlation between research performance and project funding. Since project funding increases with increasing time used for applications, this implies that project funding increases with decreasing time for actual research. This in turns leads to a lower production of publications and, finally according to our results in this report, lead to a lower number of citations.

This explanation should, however, be compared with the results shown in figure 24, which shows a strong negative correlation between the ratio bibliometric index/publication volume and the share of project funding in an institution. If the explanation had been the only cause for the negative correlation between research performance and project funding, then the correlation in figure 24 would not have been present or at least would have been much weaker. This implies that the mechanisms behind the negative correlation is more complex. In fact, figure 24 implies that the quality of the publications are lower when the share of project funding is high. In the next section we discuss different factors that might be responsible for lowering the quality of research funded by project funding.

One can also discuss the effect of decreasing unused project funding, which also follows from decreasing project funding. The analysis in section two showed that one would free funding of the order of 8.5 billion SEK if one would reduce the share of project funding by a factor of two. This sum corresponds to approximately one fifth of one year's funding of research in Sweden. By reducing the project funding during a ten year period then the release of saved funding would increase by two percent during ten years. One would, therefore, see a 7-12% increase during the first ten years and then a permanent increase of 5-10% after that.

5. Discussion

This report has as its primary aim to analyze the effect of project funding in Sweden at the institutional level. By analyzing the bibliometry at Swedish HE institutions, larger as well as smaller, and comparing with total funding of the respective institutions, we arrived at the following main results.

1. The citation performance at the institutional level depends to an overwhelming extent on how much total funding the institution has. This explains about 98% of the differences in performance between institutions for the time period studied.
2. The analysis of the approximately two percent that remain after the effect of the total funding has been taken away, shows no positive correlation between citation performance and the relative amount of project funding in an institution. Instead there are clear indications of the opposite i.e. that project funding has a negative impact on performance.

We are confident that these conclusions hold and we have made a number of checks of the robustness of the conclusions by e.g. doubling the time interval studied, changing to the top ten percent best cited papers and changing the time lapse between funding and citations. In section four the costs of the system of project funding, in particular the costs for applying for funding, was analyzed. It was found that a realistic estimation of the costs were in the range 10-20% of the total resources for research activities. Since project funding does not enhance performance, these costs are pure losses in the system and correspond to losses of 4-8 billion SEK yearly. This amount can be compared with the total direct funding for research given directly to HE institutions in Sweden, which 2017 was 18 billion SEK. For example, by increasing the direct funding to institutions by reducing the project funding by a factor of two, then our estimations imply a gain in citation performance by 5-10%. This would mean that Sweden, in an international comparison, would move from a position two percentage units below the average of comparable countries, to a position which is three to eight percentage units above the average.

Given these results it is obvious that Sweden has everything to gain in terms of better citation performance, if the share of project funding would decrease. But it is not possible to entirely eliminate project funding. It is probably not even desirable. Part of the project funding is not government funding, but rather come from private or European funding bodies. In 2015, 27.6% [UKÄ 2017] of the total funding for research was given as project funding from government funding bodies. Together with the direct funding to HE institutions it will add up to 71% of the total funding for research. This is, therefore, an upper limit of how high the direct funding of HE institutions can reach. One can compare this figure with other comparable countries with a high degree of direct funding [Steen 2012 p. 14] (valid 2008): Switzerland 77%, Denmark 74%[15] and The Netherlands 72%. To come close to these figures one needs first to turn all government project funding into direct funding. In addition, to reach Switzerland's position one needs to increase the direct funding to HE institutions by 10 billion SEK annually, given that the rest of the project funding is not changed[16]. To reach Denmark's position 2008 one needs about four billion SEK more.

[15] The share of project funding quoted here are for 2008. Denmark has since then changed its funding for research and probably the direct funding is now lower.

[16] An increase in the direct funding would probably also lead to an increase in project funding from non-governmental sources. This means that the figures given to reach Switzerland's or Denmark's levels are probably higher.

A more realistic goal for the project funding would be that it should not exceed 40% at the national level. Then there would still be room for project funding from governmental sources. In order to increase from the present level of 43.4% direct funding to 60% direct funding one would need to decrease funding from governmental funding bodies from the present level of 27.6% to 11%. This would mean a transfer of 6.4 billion SEK from funding bodies to direct funding for HE institutions. The effect of such a transfer would be an increase in research performance of the order of 3-6%. If our reasoning is correct we believe that it would be closer to 6% than 3%. This scenario would move Sweden internationally to a position which is three units of percentage above the average of comparable countries. This is the same effect as a yearly increase in research funding of 2.4 billion SEK.

To this increase one can add the one-time effect due to a decrease in saved project funding. Our analysis shows that about 6.4 billion SEK are released in addition to the yearly increase above. Taken over ten years the total increase in performance would be 7% every year for the first ten years and then 5% increase after that.

Even though most of the differences in performance can be related to the total funding at the HE institutional level, the small remaining part, two percent for our period, show differences between different institutions. Surprisingly enough, there is no obvious difference in performance between small and large institutions although there is a huge difference in the amount of funding available.

One should be a bit cautious before drawing too far-reaching conclusions from the differences. In Appendix 2 an analysis is made using the deviation from the trend line rather than from the ratio between the share of bibliometric index and the share of funding. Although basic features are the same comparing figure 17 and figure 27 i.e. institutions that are doing well in one case are doing well in the other etc., the mutual relations between institutions are changed as well as how well they are doing quantitatively. This shows that the actual value of performance is somewhat sensitive to the indicator used to measure performance.

Different HE institutions will always be performing differently and their performance will vary with time. This depends on the fact that citations, especially publications with many citations, will vary with time at an institution. The smaller the production of publications is, the greater the possible variation. Large universities have with their large volume of publication a greater stability, but even in these cases there can be substantial changes due to particular publications. Still we have found a linear relation between citations and research funding independently of the size of the institution. Since the smaller HE institutions contained in this study are comparable in size research wise to faculties of large HE institutions, it is expected that there is a linear correlation between performance and funding at a faculty level of a larger university. Indeed we have information that this has been noticed in at least one university in Sweden.[17]

There may be a number of possible sources of error in our analysis. One such source is The Swedish Research Council's bibliometric data, which we have used heavily in our analysis. As has been argued, this data is reliable and relevant. The data take into account, as far as possible, different factors that are important to be able to compare different HE institutions citation performance fairly. But, of course, the bibliometric index has a limit of validity.

[17] Private communication with Staffan Edén, Gothenburg University

Another possible source of error comes from correctly accounting for the resources that contribute to the publications of a HE institution. As has been discussed above, this can happen in areas that have research personnel with double affiliations with one affiliation outside academia. If this outside affiliation is funding part of the salary of the researcher it would imply a higher volume of research resources than is officially accounted for and leads to a seemingly higher performance than is actually the case. Such double affiliations are common at institutions with medical areas, where researchers are also employed by the local hospital. For large institutions this may be a smaller relative effect, whereas for smaller institutions it could play a larger role. [18]

A further source of error is that funding that is used for education in reality is used for research. It is common in Sweden that some resources for education are used for developing a teacher's competence. Part of this competence development are in many cases research and again leads to a seemingly too high performance. All this taken together leads to the conclusion that the performances of individual HE institutions should be interpreted with some caution especially when it comes to smaller institutions. Our comments relating to fig. 20 in relation to fig. 17 illustrate this. Finally, the data taken from SCB regarding time spent on applications for funding is based on the researchers' own estimates of time spent. Estimates like this may differ from the actual time spent. SCB have given margins of error that hopefully take this into account, but some caution is probably wise.

We have shown an almost perfect correlation – over 99% - between publication volume and citations (cf. fig. 19 in section three). It may come as a surprise that there is almost no room for anything else contributing to performance besides the number of publications. The large correlation can be explained if one assumes that citations on a high enough aggregated level are randomly distributed. With a random distribution of citations in every subject area, respectively, the number of citations will be linearly dependent on the number of publications. The thought that citations should follow a law of randomness is very strange from a researcher's point of view. Still, most researchers are probably aware that results with high impact are difficult to predict. We believe that the randomness property that is seen here, is due to this difficulty in predicting scientifically important results combined with the fact that we are studying data at a highly aggregated level.

The analysis presented shows clear indications that project funding affects research performance negatively. Our data is not entirely conclusive here, which is the reason that we are not pushing this forward as a completely proven fact. In the end of the last section, a plausible explanation of the negative correlation between performance and project funding was given. It followed from showing a connection between how much time is spent on applications and how much project funding an institution has. More time spent on applications gives less time spent on actual research and publications, which in turn leads to less citations. This logical reasoning cannot be the complete answer, as explained in the previous section. Fig. 24 shows a negative correlation with project funding even after publication i.e. there is an actual difference in the quality of the publication which decreases with increasing project funding.

This quality difference, if it is actually there as the data indicates, can be an effect of the way the research is pursued when it is project funded. Project funding are by their character more short

[18] Cf. the discussion in connection with fig. 20.

termed driven research, since projects are in most cases limited to a project time of three or four years. Therefore, researchers need to suggest projects that can produce results in this time span, and if given funding, need to pursue the research accordingly. In addition, as many Swedish researchers, even full professors, need the project funding for their own salaries as well as for the salaries of their more junior members of the research group, there is a substantial pressure on being successful in securing project funding. This may lead to a strategy of "safe research, which may not be the most innovative research and may reduce the impact of the research.

The reason why project funding is so high in Sweden compared to many other countries is not clear. But there are reasons why project funding is regarded as a positive feature of the research financing system. We believe that one of the main reasons is the belief that funding gained though competition will promote quality. As we have shown here, this is not the case, at least if quality is measured by citations.

Another reason in favor of project funding is the political steering mechanism behind this funding. The government have in the past had clear political ambitions to steer some research funding to certain strategic areas. In order to do this, the often used procedure has been to give suitable governmental funding bodies the commission to distribute specific funding for the purposes in mind. This saves the government the trouble to figure out how the funding should be distributed among the HE institutions and, furthermore, there is a legitimacy and political objectiveness in the procedure, as the government are not interfering directly with any specific HE institution. There are, however, other ways to proceed and there are several international examples of this, as can be seen in the international overview [SUHF 2015].

There are several reasons, apart from the performance gains that has been shown here, why a smaller share of project funding would be positive for Swedish research. The high share of short-termed funding makes it difficult for HE institutions to strategically and with a long-term planning develop the institution. The project funding also limits the strategic freedom since some of the direct funding is often used to help fund project funded research. Many of the funding bodies, even governmental, require the HE institution to add some of their direct funding in support of the project funding, if the institution is to receive the project funding. As mentioned above, many of the academic positions, even full professors and senior lecturers, need project funding to be able to fund their own salary. Furthermore, due to the high level of project funding there are many time-limited positions in Sweden. This means that project funding may, as remarked above, be crucial for keeping one's job and this is probably not favorable for a creative research environment. Neither is it positive for more long-term independent research.

We mean, in conclusion, that there are no actual obstructions to lowering the level of project funding in Sweden. On the contrary, there are many very good reasons that speak in favor of lowering the level, not the least that it will lead to substantial performance gains. It is all about a political will. I hope that this report can help in this respect.

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Appendix 1: Table with data

HE Institution	Bibliom. Index 2013-15	Share of Bibl index	Research funding 2012-15	Share of research funding	Ratio share bibl/funding	Share of project funding 2013-15
Blekinge Tekniska Högskola	214	0,40%	604	0,41%	0,96	44,03%
Chalmers Tekniska Högskola	2799	5,20%	9625	6,59%	0,79	66,78%
Gymnastik- och idrottshögskolan	57	0,11%	148	0,10%	1,05	49,50%
Göteborgs universitet	5209	9,68%	13994	9,59%	1,01	49,15%
Högskolan Dalarna	144	0,27%	434	0,30%	0,90	49,38%
Högskolan i Borås	177	0,33%	500	0,34%	0,96	55,25%
Högskolan i Gävle	202	0,38%	492	0,34%	1,12	31,95%
Högskolan i Halmstad	159	0,30%	463	0,32%	0,93	52,80%
Högskolan i Jönköping	351	0,65%	897	0,61%	1,06	55,83%
Högskolan i Skövde	105	0,20%	397	0,27%	0,72	58,25%
Högskolan Kristianstad	106	0,20%	248	0,17%	1,16	24,80%
Högskolan Väst	107	0,20%	376	0,26%	0,77	55,80%
Karlstads universitet	557	1,03%	1342	0,92%	1,13	40,83%
Karolinska Institutet	6073	11,29%	20070	13,75%	0,82	63,15%
Kungl. Tekniska högskolan	4435	8,24%	11447	7,84%	1,05	62,08%
Linköpings universitet	3801	7,07%	7806	5,35%	1,32	54,80%
Linnéuniversitetet	702	1,31%	1780	1,22%	1,07	36,80%
Luleå tekniska universitet	940	1,75%	3563	2,44%	0,72	61,30%
Lunds universitet	7008	13,03%	19677	13,48%	0,97	56,40%
Malmö högskola	584	1,09%	1006	0,69%	1,58	56,18%
Mittuniversitetet	371	0,69%	1426	0,98%	0,71	42,78%
Mälardalens högskola	309	0,57%	928	0,64%	0,90	64,38%
Stockholms universitet	5001	9,30%	10714	7,34%	1,27	44,85%
Sveriges lantbruksuniversitet	2857	5,31%	8866	6,07%	0,87	52,43%
Umeå universitet	3221	5,99%	9534	6,53%	0,92	50,98%
Uppsala universitet	7101	13,20%	17004	11,65%	1,13	51,90%
Örebro universitet	811	1,51%	1525	1,04%	1,44	40,08%

Appendix 2 Deviation from trend line

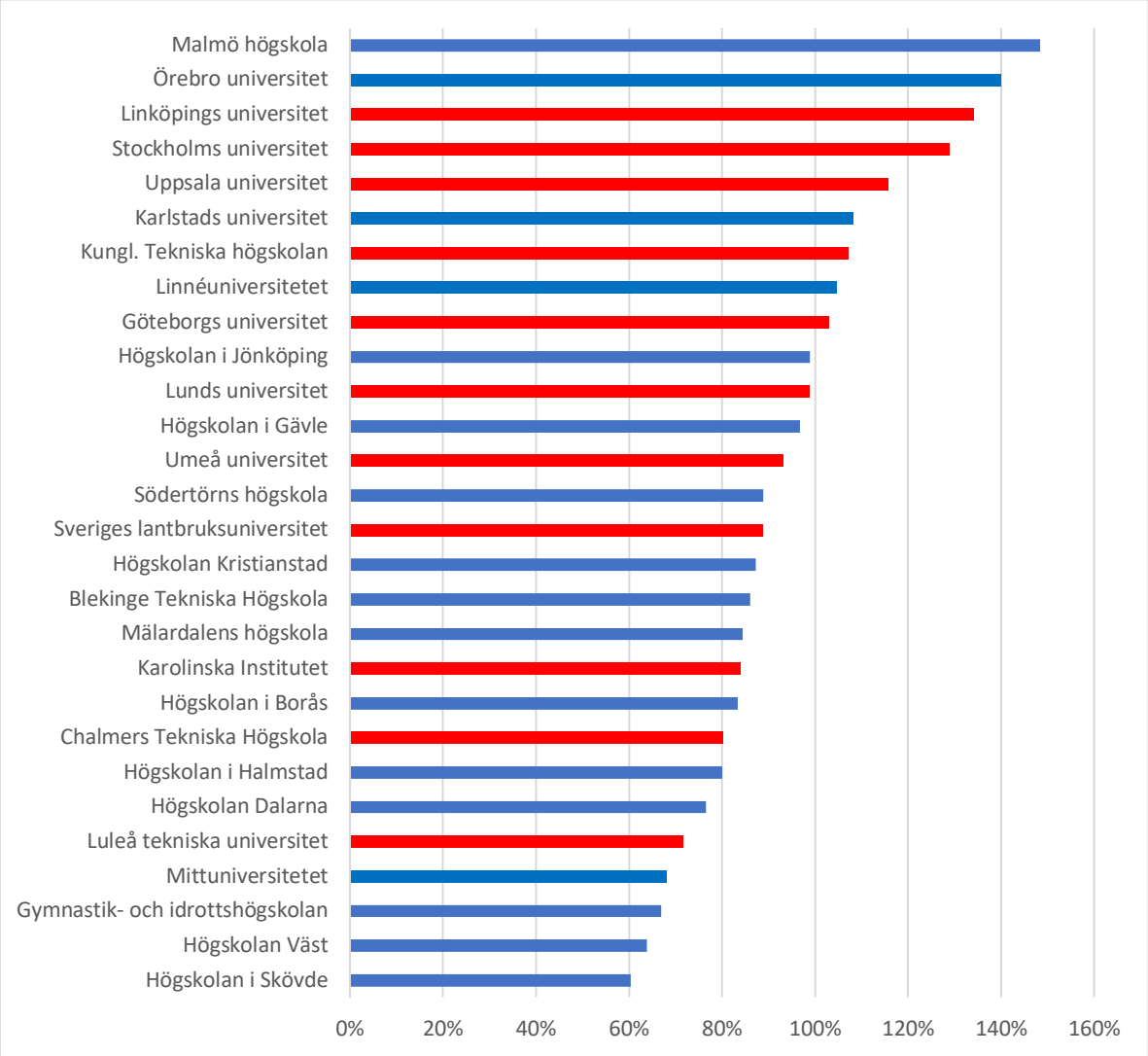

Fig. 27 Deviation from the trend line in fig. 13 for HE institutions. Data are the relative share of bibliometric index for 2013-2016 as a function of the relative share of research funding 2012-2015 for each institution. The value 100% corresponds to a value on the trend line. Older universities are marked in red.

The above figure shows the vertical deviation from the trend line in figure 13 normalized so that 100% corresponds to the value of the relative share of the bibliometric index on the trend line. The result can be compared with figure 17, which uses the ratio between the relative share of bibliometric index and the relative share of research funding as a performance indicator. One can see that the performance of certain institutions change when comparing the two different ways of analyzing.

Below it is shown the deviation from the trend line and the dependence on the level of project funding. If we include all HE institutions one sees no correlation, whereas for the older universities there is a negative correlation with factor R=-51%.

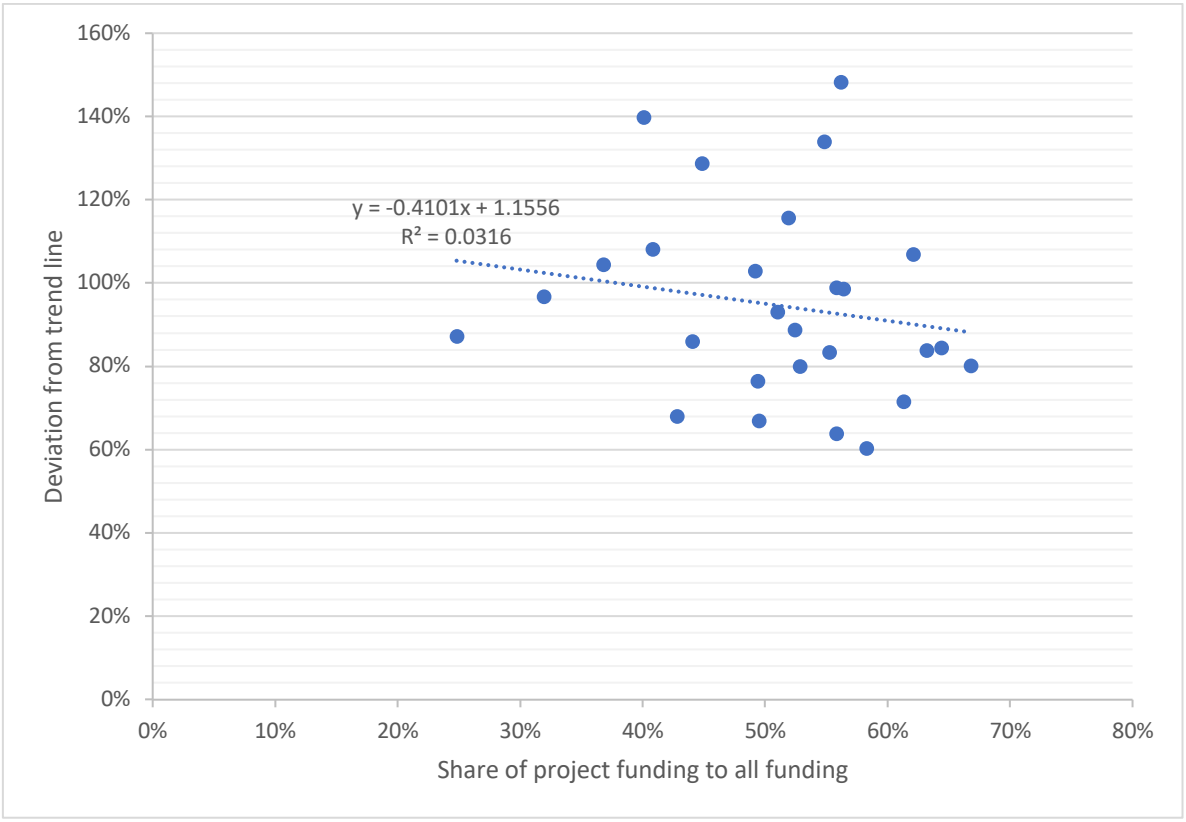

Fig. 28 Vertical deviation from trend line (values as in fig. 27) as a function of the share of project funding to all funding. Each point represents an institution.

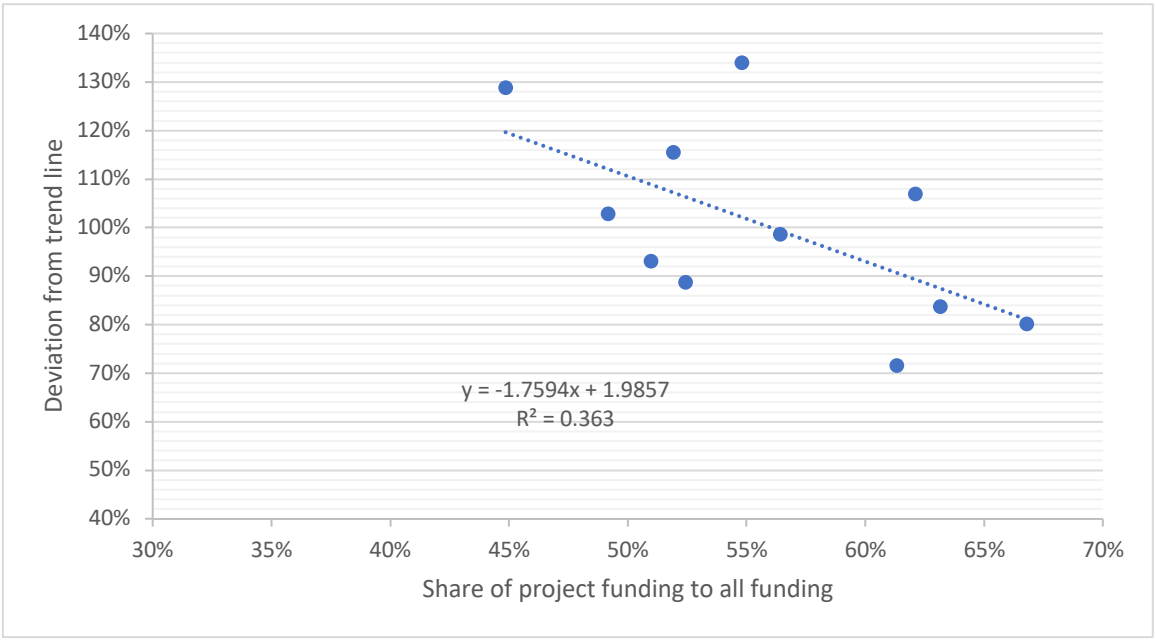

Fig. 29 Vertical deviation from trend line (values as in fig. 27) as a function of the relative amount of project funding. Each point represents an institution. Only older universities are included.

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