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**Research Report**

## An analysis of the Excellence Initiative and its effects on the funded universities

Studien zum deutschen Innovationssystem, No. 11-2017

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# **An analysis of the Excellence Initiative and its effects on the funded universities**

Rainer Frietsch, Torben Schubert, Oliver Rothengatter

Entwurf

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**Nr. 11-2017**

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Fraunhofer Institute for Systems and Innovation Research ISI

März 2017

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## 0 Summary

Within this study we provide descriptive as well as multivariate evidence on the effects of the German Excellence Initiative on universities. Thereby, we will focus on the question whether the Excellence Initiative has led to a sharpening of the participating universities' scientific profiles in terms of technology fields they are active in.

To this end, we have created an integrated panel dataset consisting of various indicators at the level of universities. The data for the panel was collected from various sources, e.g. DESTATIS, the DFG, Web of Science by Thomson Reuters as well as PATSTAT.

The results show the funding by the Excellence Initiative has been relatively concentrated with about half of the universities. In the group of universities having received funding, a few universities, often conceived as top-performers, have been successful in acquiring a substantial number of projects in all three tracks of the Excellence Initiative. A breakdown of the graduate schools and the excellence clusters by field/subject shows that the largest share of projects was awarded mathematics/natural sciences.

Although we there a considerable differences between the funded and non-funded universities, only few effects seem to be causally driven by the funding of the Excellence Initiative, in particular as concerns quality-related bibliometric or patent indicators. We do, however, find strong evidence that the funding of the Excellence Initiative has strongly increased the subject concentration of students and the field concentration of scientific publications. It therefore stands to reason that the Excellence Initiative has contributed to sharpening the profiles of the funded universities.

## 1 Introduction

The Excellence Initiative of the Federal State in Germany is a national support program for universities which takes its root in policy initiative by the former minister of education and science Edelgard Bulmahn made public in 2004 (Kehm 2015, Fallon 2015). The funds made available through the Excellence Initiative were planned to be allocated within a Germany-wide competition between universities within different tracks.

By emphasizing the competitive element the Excellence Initiative deliberately departed from the scattershot approach of university funding which started from the fictitious state of the equality of all universities (compare Schubert 2009). Instead, by concentrating funds on selected high-performers of universities the idea was to establish an internationally visible elite of universities (Hazelkorn 2009) by increasing research productivity and performance of the selected universities (Hur and Bessey 2013).

The Excellence Initiative has now been implemented for the third time with funding rounds in 2006, 2007/2008, and 2012. In the first two rounds in total € 1.9 bn. were allocated to three tracks: graduate schools (Track 1), excellence clusters (Track 2), and future concepts (Track 3). In the last round running from 2012-2017, another € 2.7 bn. were allo-



cated to the same tracks, where some selected projects from earlier funding rounds were continued, others were discontinued and some were newly established. At the end of 2015 45 graduate schools, 43 excellence clusters, and 11 future concepts were funded.

In particular the future concepts were aimed to radically reorganize the German university system by funding innovative concepts for the reorganization of the universities. And although the calls were carefully drafted to avoid words like “elite” Fallon (2015) notes that the general public and the media came very soon to use such labels. Today, the winners in Track 3 are often referred to as elite universities. Because of the financial volume of and the high hopes associated with Excellence Initiative discussions concerning its consequences – both intended and unintended – have been ongoing. Münch (2008, 2009) argued that the Excellence Initiative would imply a detrimental tendency towards the creation of status hierarchies decoupled from actual performance as well as oligopolization of research funding. Others have emphasized the potential to performance increases through incentivization (Schubert 2008). In addition, it has been highlighted that the Excellence Initiative could help to contribute to differentiation between universities and therefore to sharper and more coherent profiles (Fallon 2015, Klumpp 2014).

Empirical studies on the effects of the Excellence Initiative on universities are however still in their infancy. As concerns bibliometric performance some studies indicate that the involvement in the Excellence Initiative did indeed tend to be associated with higher outputs and partly also impact (Hur and Bessey 2013, Möller 2016). These studies were however purely indicator based and thereby provide only descriptive evidence of the presumable effects of the Excellence Initiative. Furthermore, there is little, if at all, quantitative empirical material on the question of profile sharpening.

This study contributes to filling this gap by providing further evidence – both descriptive and multivariate – on the effects of the Excellence Initiative on universities. A particular focus will be placed on the question of whether the Excellence Initiative has led to a sharpening of the participating universities’ profiles, which we will identify by the degree that universities increasingly focus on specific fields of study or research.

## **2 Data and methodology**

### **2.1 Data**

The unit of analysis in this report is at the level of the university. Although theoretically all types of universities were eligible for funding from the Excellence Initiative we restricted the sample only to full universities, i.e. universities which possess the right to grant doctoral degrees. We retrieved the list of all full universities from DESTATIS and eventually found 104 universities meeting our selection criteria. At the level of the university we collected panel data from 2001 onwards based on various data sources.

In particular, the following variables are included in the dataset:

- Personnel and student statistics. Source: DESTATIS
  - Number of students
  - Number of students disaggregated by field of study. In particular, language/cultural sciences, sports, social sciences/economics, mathematics/natural sciences, medical sciences, engineering sciences, agricultural sciences, arts, other sciences
  - Field concentration of students (Herfindahl index). Source: DESTATIS, Fraunhofer ISI
  - Number of graduates
  - Number of university employees
- Monetary key indicators. Source: DESTATIS
  - Total investments
  - Total expenditures
  - Total third party funds
- Funding in the excellence initiative. Source: DFG, Fraunhofer ISI
  - Number of projects funded in Track 1, Track 2, and Track 3 of the Excellence Initiative
  - Number of projects funded in Track 1 and Track 2 of the Excellence Initiative disaggregated by science field (harmonized where possible with DESTATIS study field classification)
- Bibliometric data. Source: Thomson Reuters, Fraunhofer ISI
  - Number of fractionalized publications
  - Number of fractionalized publications disaggregated by science field (harmonized where possible with DESTATIS study field classification)
  - Field concentration of publications (Herfindahl index). Source: DESTATIS, Fraunhofer ISI
  - Excellence rate
  - Field-specific expected citation rate
- Patent data. Source: PATSTAT, Fraunhofer ISI
  - Number of university applied DPMA patents

All data were available at least since 2001. The most recent availability dates however depended on the type of data. Information on students was available until 2015. Monetary statistics were available until 2014. Publication information could be gathered until 2014. Patent statistics were available only until 2013. Information on past and running Excellence Initiative projects are completely up-to-date and were collected until 2015. Summary statistics on the main variables can be found in Table 1. The differences in the number of observations of many of the variables stem from the fact that university statistics are not

complete for all indicators over time. For example while data on students and graduates are almost always complete and have the longest coverage over time, the indicators relating to third party funds are available for not the whole period and partly incomplete for some universities even in years where the indicators are principally covered.

Table 1: Descriptive statistics of the main variables

Variable	Obs	Mean	Std. Dev.	Min	Max
#Graduates	2050	1,896.04	1,638.60	0.00	9,735.00
#Students	2200	14,611.30	13,195.40	0.00	80,464.00
Total investments in TEUR	1452	29,446.20	38,416.30	-4,227.00	329,040.00
Total expenditures in TEUR	1452	305,726.00	328,775.00	125.00	1,500,000.00
#Employees	1416	4,538.42	4,544.18	6.00	20,225.00
Third party funds in TEUR	677	60,241.10	58,068.10	0.00	311,409.00
Graduates per employee	1395	0.68	0.51	0.00	4.96
Total expenditures per employee in TEUR	1391	81.10	156.04	6.40	2,201.05
Students per employee	1409	4.61	4.30	0.00	59.82
Third party funds per total funds	672	0.18	0.11	0.00	0.97
Publications per employee	1081	0.09	0.07	0.00	0.77
Excellence rate	1118	0.11	0.07	0.00	1.00
Expected citation rate	1118	0.94	0.45	0.00	9.66
Patents per employee	755	0.00	0.00	0.00	0.02
Students in language and cultural sciences	2143	0.25	0.21	0.00	1.00
Students in sports	2134	0.02	0.10	0.00	1.00
Students in economic and social sciences	2144	0.32	0.26	0.00	1.00
Students in mathematics and natural sciences	2144	0.17	0.11	0.00	0.60
Students in medical sciences	2144	0.08	0.17	0.00	1.00
Students in agricultural sciences	2144	0.01	0.04	0.00	0.41
Students in engineering sciences	2143	0.12	0.20	0.00	1.00
Students in arts	2142	0.02	0.05	0.00	0.50
Students in other sciences	2143	0.00	0.00	0.00	0.06
# different teaching fields	2392	5.44	2.49	0.00	9.00
Field concentration students	2392	0.38	0.27	0.00	1.00
Publications in language and cultural sciences	1118	0.00	0.02	0.00	0.33
Publications in economic and social sciences	1118	0.05	0.11	0.00	1.00
Publications in mathematics and natural sciences	1118	0.46	0.16	0.00	1.00
Publications in medical sciences	1118	0.22	0.20	0.00	1.00
Publications in engineering sciences	1118	0.25	0.17	0.00	1.00
Publications in other sciences	1118	0.02	0.04	0.00	0.30
# different publication fields	1118	5.08	1.14	1.00	6.00
Field concentration publications	1118	0.43	0.11	0.23	1.00
EI: #projects funded by track 1	2392	0.20	0.68	0.00	7.00
EI: #projects funded by track 2	2392	0.20	0.63	0.00	5.00
EI: funded by track 3	2392	0.04	0.20	0.00	1.00

## 2.2 Methodology

The first part of the empirical analysis will mainly rely on the presentation of descriptive statistics. In this part we will first present general statistics on the characteristics and the distribution of funding in the Excellence Initiative. A key contribution is also an analysis of the decomposition of the funding by field classifications. In order to harmonize field classifications between the different data sources we decided to classify both publications and Track 1 and Track 2 funding in the Excellence Initiative according to the DESTATIS

classification in study fields. While the DFG provides a classification into Social Sciences and Economics, Mathematics and Natural Sciences, Life Sciences, and Engineering, we have created a somewhat different classification based on the subject field classification provided by DESTATIS in order to harmonize data in later analyses. The classification used by DESTATIS includes Language and Cultural Sciences, Sports, Social Sciences and Economics, Mathematics and Natural Sciences (including biology and some parts of life sciences), Medical Sciences and Pharmaceutical Sciences, Engineering, Agricultural Sciences, Arts, and other sciences. Based on topic and departmental affiliation of the projects funded in Track 1 and Track 2 we assigned each project to the DESTATIS fields. If a project was cross-disciplinary a project could be assigned to more than one discipline. Multiple assignments were counted on a fractionalized basis, implying that the total of the fractionalized figures still equals the number of existing projects.

We move then on and analyze both cross-sectional differences and differences in time trends.

Finally, to come closer to a more structural interpretation we implement multivariate analyses. In a first step, we will use methods matching methods in counterfactual analysis, where for each university funded in the context of the Excellence Initiative we define a non-funded statistical twin closely resembling the funded units in terms of observable control characteristics. By comparing the outcomes of the funded universities with their respective twins it is possible to obtain an estimate of the causal effects of Excellence Initiative under certain conditions. In order to implement the matching procedure, we use nearest neighbor matching based on the Mahalanobis distance. We use standard errors that explicitly consider the randomness of the first stage matching procedure (Abadie and Imbens, 2006). The great advantage of the matching approaches to estimating causal program effects is the flexibility in functional forms since only weak parametric assumptions are necessary. Two major problems in our context are that consistency of the matching requires that selection must be based on observables. If unobservables affect the selection process, the estimates of the causal effects will be biased. Furthermore, it is not easy to implement matching estimators for panel data. Therefore, we have relied using only a single year as the basis for the estimation. We have run one model for the evaluation of the first and second round (2006/2007) and one for the third round (2012). We have used the longest possible time lag between start of funding and evaluation allowed by our data and have tested for program effects in 2011 (for fund round 1 and 2) and 2013 (for funding round 3).

If we are willing to make stronger functional form assumptions, there are alternative regression-based ways of estimating the effects of the Excellence Initiative which can account both the panel data structure and to some degree for the issue of unobservables. In specific, we rely on the panel structure of our dataset and run a set of fixed effects (FE) regressions. FE allows us to control for correlated unobserved heterogeneity to some degree. Unobserved heterogeneity is likely to be an important feature of our data. Many unobserved factors (e.g. research capacity of the university) can be expected to be both correlated with the with the outcome variables and (because selection into the Excellence Initia-

tive was performance-based) with the funding dummies. Thus unobserved heterogeneity will usually imply (most likely upward) biased estimates, if not accounted for. However, it should be noted that FE controls out only time-constant heterogeneity. To the degree that for example the research capacities of the universities changes over time, which is a reasonable assumption given the lengths of our panel data, FE regressions will only imperfectly account for the unobserved heterogeneity, again leading to biased estimates. This also means that the results from the FE regressions may still not fully reflect causal relationships between funding in the Excellence Initiative and outcomes.

We have combined the fixed effects approach also with difference-in-difference procedures. In the difference-in-difference setting, loosely speaking, we test whether funding by the Excellence Initiative had any conceivable effect under the assumption that time trends between funded and non-funded universities would have remained constant without funding. Applying the difference-in-difference approach here was not a trivial task because the timing of the funding events was more complicated than the usually assumed two-periods setting (before and after funding). We therefore tested for the effects of the Excellence Initiative separated by the three rounds in 2006, 2007, and 2012 and included as the control group only those universities which never received funding. The structural equation for the difference-in-difference approach therefore looked as follows:

$$y_{it} = x_{it}\beta + \vartheta \cdot dt_t + \kappa \cdot df_i + \mu \cdot dt_t \cdot df_i + c_i + u_{it}$$

The term  $c_i$  represents unobserved heterogeneity and is cancelled out by the FE-methodology.  $\vartheta$  measures any existing pre-funding trends, and  $\kappa$  any pre-existing differences between funded and non-funded universities. In fact, when using FE,  $\kappa$  is not identified because time constant heterogeneity is eliminated automatically.  $\mu$  then captures the causal effect of the funding of the Excellence Initiative under the assumptions that time trends would have remained the same without funding.

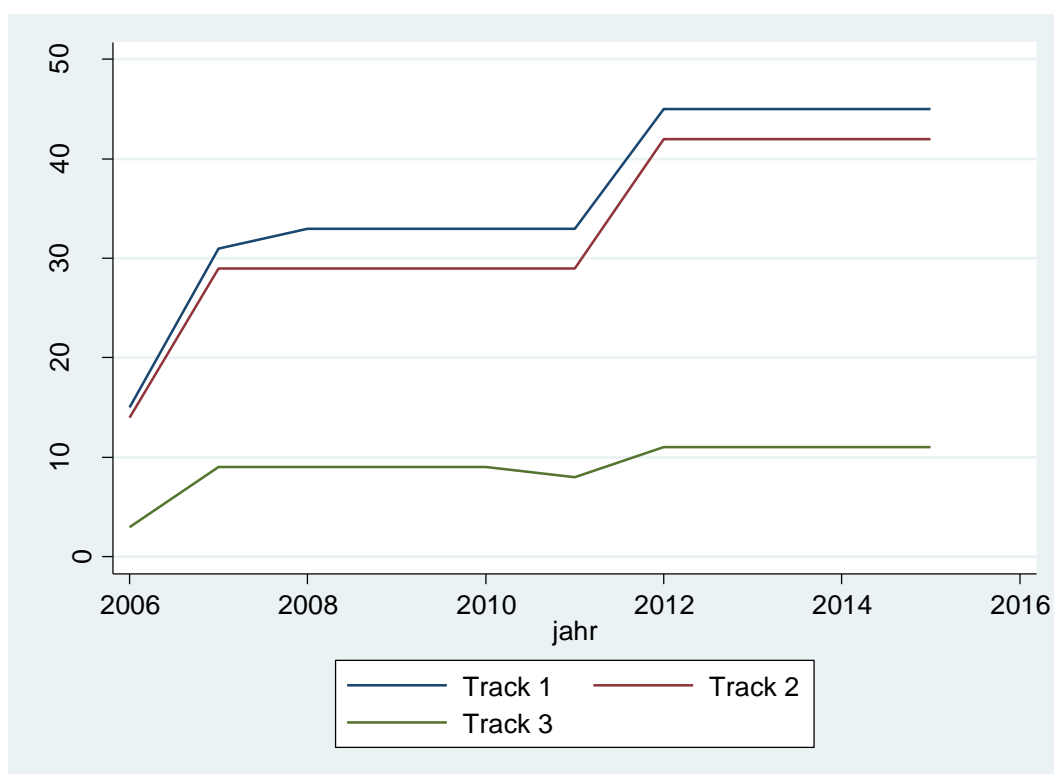
To further probe the robustness of our analyses (in terms of matching, FE, and difference-in-difference estimation) we have complemented the most important results by using instrumentation techniques building on the exploitation of heterogeneity for providing exogenous variation. The methodology follows the idea of using covariance restrictions to identify endogenous parameters. The estimation approach is explained in Lewbel (2012) and will for the sake of brevity not be described here in detail. What should be mentioned is however that estimation technique is robust to panel data settings. Also heterogeneity could be proved to be sufficiently present to warrant identification.

### 3 Descriptive results

#### 3.1 Basic statistics on the tracks

Figure 1 presents the number of projects/funding cases by track since 2006 when the Excellence Initiative started. In its first year of its existence three universities were funded under Track 3 “Zukunftskonzepte”. These were the KIT emerging as the merger of TH Karlsruhe and the Forschungszentrum Karlsruhe, TU München, and LMU München. The number of funded projects in Tracks 1 and 2 were also still relatively low with less than 20 projects. In later funding rounds in 2007 and in 2012 the numbers of projects/cases continuously rose in each of the three tracks. By 2015, there were 11 funded universities in Track 3,<sup>1</sup> and above 40 projects in each of the cases in Track 1 and Track 2.<sup>2</sup>

Figure 1: Funded projects by year



Because Track 3 comprises non-disciplinary strategic projects that usually span the whole organization or at least large parts of it, a university cannot be funded more than once in

<sup>1</sup> It should be noted that in 2011 U Freiburg, KIT, and U Göttingen were not evaluated favourably in Track 3 and lost their status as so-called Excellence University. The full list of universities listed under Track 3 in 2015 included the RWTH Aachen, FU Berlin, HU Berlin, U Bremen, TU Dresden, U Heidelberg, U Köln, U Konstanz, LMU München, TU München, and U Tübingen.

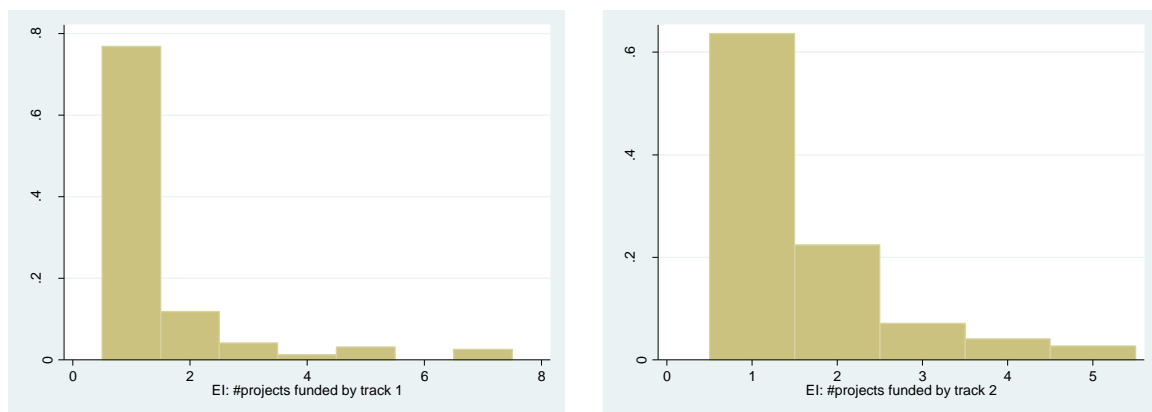
<sup>2</sup> The full lists of funded projects in Track 1 and Track 2 can be found here:

<http://www.dfg.de/foerderung/programme/listen/index.jsp?id=GSC>

<http://www.dfg.de/foerderung/programme/listen/index.jsp?id=EXC>

Track 3. As concerns Track 1 and Track 2 a university can have more than one funded project simultaneously. As we see from Figure 2, while the largest part of universities received only one graduate school (almost 80%), slightly above 10% had 2 graduate schools. The remaining 10% had even more than that, reaching a maximum of 7 schools for the FU Berlin and the HU Berlin. In the case of Track 2 “Exzellenzcluster” the figures look similar. Approximately, 60% had one Excellence Cluster, while more than 20% had two. The maximum number of 5 was reached by TU München und LMU München. We can therefore conclude that the concentration of the projects was relatively high even in 2015. In fact, out of the 104 universities in our sample 58 had not attracted projects in any of the tracks. 46 were successful in at least one of the tracks and 12 were successful in all of them simultaneously.

Figure 2: Number of funded projects by university (Track 1: left, Track 2: right)



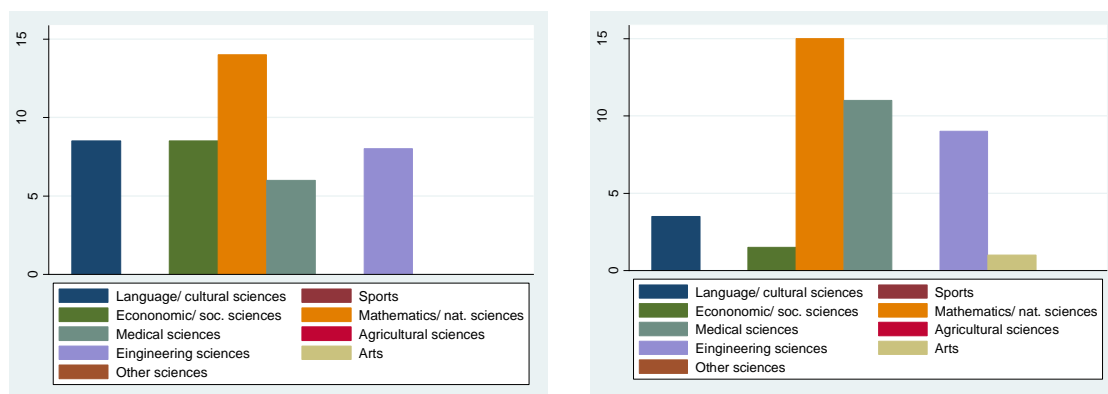
The impression of relatively high concentration of projects is further corroborated by the co-occurrence between the tracks as illustrated by the correlations (Table 2). For Track 1 and Track 2 the correlation is lowest with 0.34. It is 0.49 for Track 1 and Track 3 and 0.54 for Track 2 and Track 3. The higher correlations with Track 3 are however also partly built into the selection procedure because being successful in Track 3 required the successful acquisitions of both graduate schools and Excellence Clusters.

Table 2: Correlation between funding decisions in different tracks

	Track 1	Track 2	Track 3
Track 1	1		
Track 2	0.3408***	1	
Track 3	0.4905***	0.5438***	1

As argued, because Track 3 usually applies to the university as whole, disciplinary distinctions are usually at least ambiguous but mostly impossible to implement. However, for Track 1 and Track 2 it is possible to derive disciplinary breakdowns. We use the classification as described in Section 2.2. The results can be found in Figure 3.

Figure 3: Funded projects by field (Track 1: left, Track 2: right)



We see that the majority graduate schools fell into the broad field of natural sciences. This breakdown differs considerably from the DFG provided figures, which list the life sciences as more important than mathematics and natural sciences. The reason for the divergence is that we assign graduate schools referring to biological sciences as belonging to natural sciences, while the DFG classification subsumes biology under the field of life sciences together with medical sciences. Mathematics and natural sciences in the here used definition are followed by economics and social sciences as well as language and cultural sciences each accounting for the same number of projects. Thus, social sciences/economics/humanities account for almost half of all graduate schools and taken together represent the highest share of all projects under Track 1. Finally, engineering ranks fourth followed by medical sciences. No projects were assigned to sports, agricultural sciences and arts.

A very notable difference in terms of disciplinary breakdown with respect to Track 2 is the vastly diminishing importance of humanities and the social sciences/economics. While both fields taken together were the largest group among the graduate schools, even their aggregate in terms of Excellence Clusters makes it only on place 4 after mathematics and natural sciences (15), medical sciences (11) and engineering (9). In that respect, while the social sciences and humanities were indeed relatively successful in Track 1, their weight in Track 2 is very low. Interestingly, although there was no graduate school assigned in the field of arts, there was an excellence cluster (Bild, Wissen, Gestaltung) assigned jointly run by FU Berlin, TU Berlin, and HU Berlin (as well as a number of non-university partners and art colleges not in the sample).

### 3.2 Difference before and after funding

Further descriptives on the evolution of the core variables since the implementation of the Excellence Initiative can be computed by comparing how the average values differed for the universities before and after receiving funding. While these figures still do not imply any causality, they tell at least whether the sample averages were higher or lower before and after the funding decisions. The results can be found in Table 3-Table 6, where the values in the cells represent the difference between post-funding and pre-funding averages.



A positive value thus indicates that the respective means were higher before than after funding. As a general summary of the results we find that funded universities in either of the three tracks have considerably increased their size as measures by almost all variables. We also find some descriptive evidence that the relative performance measures in Table 4 are higher after as compared to before the funding, although the results are not significant for all variables (e.g. publications per employee). Interestingly, we do observe that the teaching load as measured by students per employee has decreased for Track 2 and Track 3 universities. The results in Table 5 further show that universities successful in the Excellence Initiative have experienced an increase in the share of students from mathematics and natural sciences while in particular the share of students from economics/social sciences, language/cultural sciences, and arts have decreased. We also observe that the field concentration in terms of students has increased for all three tracks. Weakest are the results for variables relating to a disciplinary breakdown of the publications. One of the few consistent observations is that despite the share of students has decreased the share of publications in economics and social sciences increased. Another observation is that the total number of disciplinary categories increased. Thus, there is some indication that publication activities have actually become broader.

Table 3: Descriptives before and after funding I

Variable	Track 1		Track 2		Track 3	
	Obs	difference (post-pre)	Obs	difference (post-pre)	Obs	difference (post-pre)
#Graduates	758	1,327 ***	758	1,307 ***	308	1,530 ***
#Students	791	1,805 **	791	76	321	477 ***
Total investments in 1000€	512	14,965 ***	513	19,308 ***	209	19,827 ***
Total expenditures in 1000€	512	144,758 ***	513	180,644 ***	209	132,646 ***
#Employees	510	1,159 ***	521	1,678 ***	210	2,008 ***
Third party funds in 1000€	279	48,205 ***	279	52,332 ***	111	44,519 ***
#Publications	455	110 ***	455	159 ***	182	244 ***

Table 4: Descriptives before and after funding II

Variable	Track 1		Track 2		Track 3	
	Obs	difference (post-pre)	Obs	difference (post-pre)	Obs	difference (post-pre)
Graduates per employee	509	0.1434 ***	520	0.1008 ***	225	0.0787 ***
Total expenditures per employee in 1000€	501	6.5680 **	513	2.5300	224	-2.0371
Students per employee	509	-0.2011	520	-0.5875 ***	225	-0.4956 **
Third party funds per total funds	275	0.0498 ***	275	0.0405 ***	119	0.0304 *
Publications per employee	442	0.0037	452	-0.0005	195	0.0028
Excellence rate	455	0.0105 ***	455	0.0171 ***	195	0.0187 ***
Expected citation rate	455	0.0496 **	455	0.0706 ***	195	0.1327 ***
Patents per employee	394	0.0001 ***	422	0.0006 ***	192	0.0000

Table 5: Descriptives before and after funding III

Variable	Track 1		Track 2		Track 3	
	Obs	difference (post-pre)	Obs	difference (post-pre)	Obs	difference (post-pre)
Students in language and cultural sciences (share)	791	-0.1812 *	780	-0.0277 ***	344	-0.0198
Students in sports (share)	791	0.0001	780	-0.0022 **	344	0.0009
Students in economic and social sciences (share)	791	-0.0281 ***	780	-0.0245 ***	344	-0.0302 **
Students in mathematics and natural sciences (share)	791	0.0145 ***	780	0.0195 ***	344	0.0336 ***
Students in medical sciences (share)	791	0.0128	780	0.0219	344	-0.0037
Students in agricultural sciences (share)	791	0.0021	780	0.0039	344	-0.0055
Students in engineering sciences (share)	791	0.0200	780	0.0140	344	0.0258
Students in arts (share)	791	-0.0052 ***	780	-0.0061 ***	344	-0.0037 *
Students in other sciences (share)	791	0.0012 ***	780	0.0012 ***	344	0.0027 ***
# different teaching fields	805	-0.0277	805	-0.3079 ***	345	-0.3696 ***
Field concentration students	805	0.0178 **	805	0.0328 ***	345	0.1658 ***

Table 6: Descriptives before and after funding IV

Variable	Track 1		Track 2		Track 3	
	Obs	difference (post-pre)	Obs	difference (post-pre)	Obs	difference (post-pre)
Publications in language and cultural sciences (share)	455	0.0006 **	455	0.0005 ***	195	0.0022
Publications in economic and social sciences (share)	455	0.0072 *	455	0.0089 ***	195	0.0059 ***
Publications in mathematics and natural sciences (share)	455	0.0213 *	455	0.0011	195	0.0022
Publications in medical sciences (share)	455	-0.0248	455	0.0032	195	0.0053
Publications in engineering sciences (share)	455	-0.0067	455	-0.0177 **	195	-0.0129
Publications in other sciences (share)	455	0.0021	455	0.0039 **	195	-0.0007
# different publication fields	455	0.2679 ***	455	0.2448 ***	195	0.1423 ***
Field concentration publications	455	-0.0017	455	-0.0075	195	-0.0044

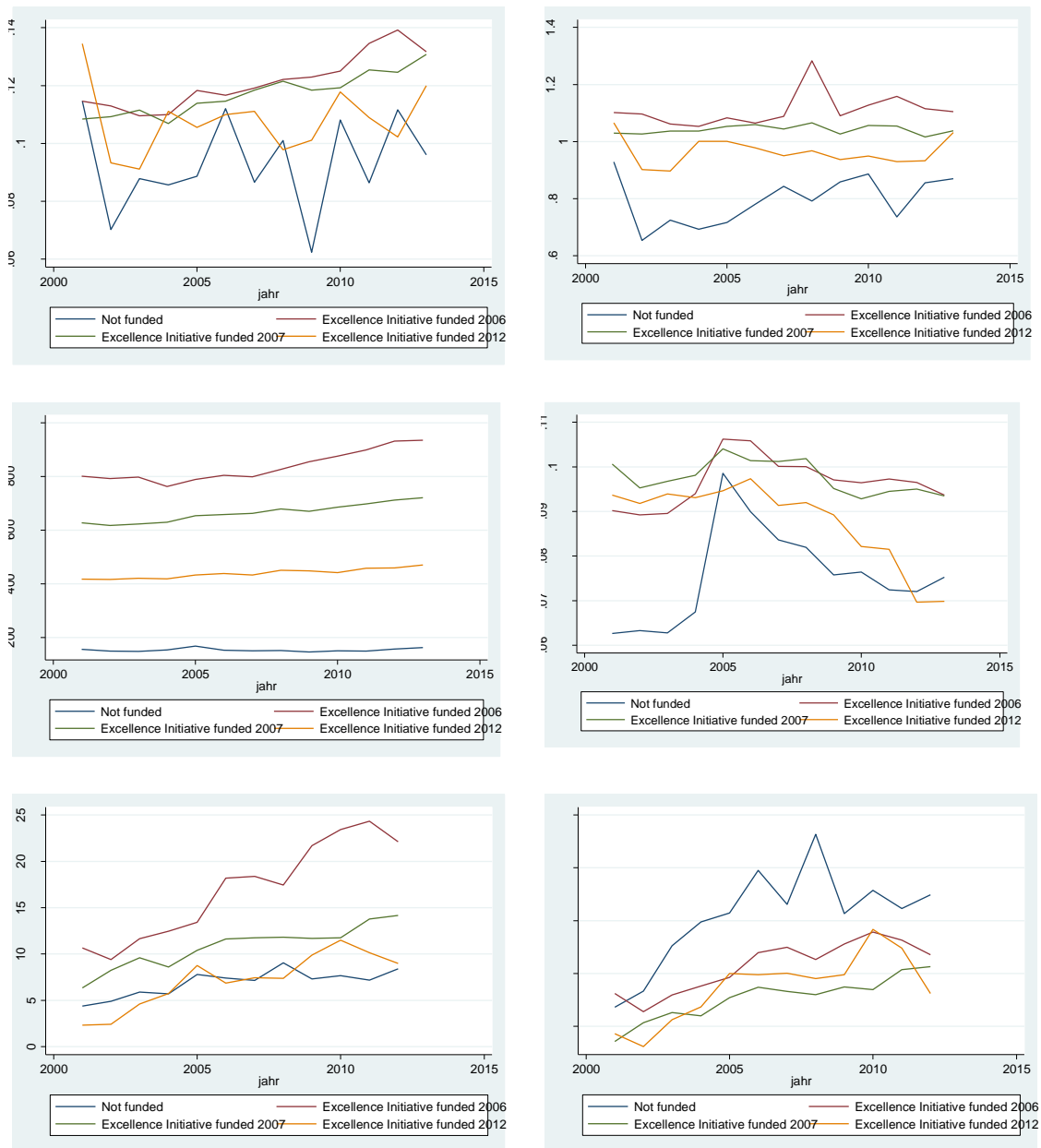
## 4 Descriptive and multivariate analyses of the effects

### 4.1 Differences in time trends between non-funded universities and the universities funded in the three round in 2006, 2007, and 2012

One way to obtain descriptive insights into the likely effects of the Excellence Initiative on universities is to analyze the differences in time trends between funded and different rounds. An analysis of difference in time trends still does not yet control for simultaneity and also leaves heterogeneity issues unaccounted, but it gives insights into how funded and non-funded universities differed before the excellence initiative and how they differ after funding. The results can be found in Figure 4.

The results seem to be mixed depending on the variables under consideration. In fact, in most cases we find that the funded universities have higher values than their non-funded counterparts irrespective of whether the funding started in 2006, 2007, or 2012. Yet in most cases there is little evidence suggesting that the differences in levels or in time trends are strongly associated with the funding events. In several cases the time trends were diverging already before the funding by the Excellence Initiative occurred (e.g. for the excellence rate and the number of patents). The figures on the field normalized citation rate and the publications per employee do not give any evidence of a positive program effect because trends appear to be largely parallel and any observable differences were present already before 2006. We also find that the non-funded universities performed better in terms of patent-intensities. Our time trend analysis (bottom right) confirms that. At the same time there does not seem to be strong evidence of causal negative program effects as the trends are after 2005 relatively constant for both groups. Contrary to that finding, the absolute numbers seem to increase for the funded universities by more than for the non-funded both in terms of publications and patents. Particularly suggestive is the figure for publications where trends are parallel up to 2005 and then diverge. The divergence is particularly conspicuous for the universities funded in the first and second round in 2006 and 2007. As concerns patents the trend was steeper already before 2005 implying that causal association need not be given.

Figure 4: Time trends by funding status (top left: Excellence rate. top right: citation rate. Middle left: #Publications. Middle right: Publications per employee. Bottom left: Patents. Bottom right: Patents per employee.



## 4.2 Nearest neighbor-matching

The descriptive results have indicated that there are considerable differences between universities having received funding by the Excellence Initiative and those which did not. As already argued, descriptively observable differences can be the result of both the selection mechanisms and of causal effects, where even the comparisons over time may be confounded by autonomous time-trends. If we are interested in telling apart selection from program effects, we therefore have to consider more structural econometric approaches. We start our analysis with the presentation of the results from the nearest neighbor matching, which assumes that the selection is based on observable characteristics. As control

variables we use the number of employees as a measure of size, the investment per employee, the students per employee, and the expenditure per employee. Furthermore, we control for field shares as measured by students.

The results are presented in Table 7 (funding round 1 and 2) and Table 8 (funding round 3). The effects for funding round 1 and 2, while mostly positive, appear to be fairly unsystematic as concerns significance. Only relatively few effects are significant and these are not consistent over the tracks (patents per employees in Track 1; field concentration for students in Track 2; publications and publications per employee in Track 3). A little bit more pronounced are the effects after funding round 3 in 2012. Overall we see that all estimates are positive indicating that even after controlling for the program selection (on observables) the effects of the Excellence Initiative are positive. While, most effects are non significant, we see some effects that remain consistent over the funding rounds. For the publications per employee (Tracks 1 and 2) and for the patents per employee (all tracks) we observe significant performance increases. In addition, we observe an increase of the field concentration in terms of students (Track 2 and 3) and slight increase in field concentration in terms of publications (Track 2).<sup>3</sup>

Table 7: Program effects on outcomes based on nearest neighbor matching for 2011

	Track 1		Track 2		Track 3	
	Obs	difference	Obs	difference	Obs	difference
Expected citation rate	87	0.0045	87	-0.0157	87	-0.0144
Excellence rate	87	-0.0012	87	-0.0085	87	-0.0011
#Publications	87	1.8528	87	122.1128	87	289.5355 *
Publications per employee	87	0.0120	87	0.0095	87	0.0164 ***
Patents per employee	87	0.0012 **	87	0.0007	87	0.0009
Field concentration students	87	0.0298	87	0.0579 *	87	0.0245
Field concentration publications	87	0.0255	87	0.0309	87	0.0216

Table 8: Program effects on outcomes based on nearest neighbor matching for 2013

	Track 1		Track 2		Track 3	
	Obs	difference	Obs	difference	Obs	difference
Expected citation rate	88	0.1051	88	0.1317	88	0.0825
Excellence rate	88	0.0143	88	0.0166	88	0.0108
#Publications	88	19.1582	88	67.3090	88	224.5525
Publications per employee	88	0.0135 *	88	0.0121 **	88	0.0117
Patents per employee	88	0.0015 ***	88	0.0012 ***	88	0.0013 **
Field concentration students	88	0.0102	88	0.0403 *	88	0.0408 ***
Field concentration publications	88	0.0017	88	0.0255 *	88	0.0153

<sup>3</sup> An important issue in matching concerns the assumption of common support which loosely speaking means that it is possible to find an adequate match for each treated unit. In propensity score methods it is customary to restrict the sample to overlapping intervals in the propensity scores. In nearest neighbor matching the decision needs to be based on a maximum allowable distance. By setting the caliper option it could be determined that adequate matches could be found. Other matching approaches were used as well, however, again with fairly weak results.

### 4.3 Difference-in-difference estimations

The difference-in-difference approach has the big advantage that it is fully compatible with a panel-data setting. Thus, there is no need to restrict the analyses to a single year as was necessary for the matching approach. A drawback is that difference-in-difference estimations require the clear separability of the data into a pre and post-funding period. We have therefore decided to separate the funding events by the consecutive rounds in the 2006, 2007, and 2012. The control groups always reflect the universities that never received any funding. The results can be found in Table 9-Table 11. Overall, we see that for almost all of the output indicators as concerns publications and patents the causal effect of the funding is non-significant. Only for the number of publications we see that there was a positive effect of Excellence funding at least for the funding rounds in 2006 and 2007. In addition, a small and hardly significant effect on the publications per employee was discernible for the third funding round in 2012. These findings indicate that the effect of the Excellence Initiative on the research capacities probably limited, if normalized by size and in terms of quality. More effects, at least as concerns number of publications, effects seem to be apparent. Thus, one effect of the funding of the Excellence Initiative may have been to increase the volume of the output, though not efficiency or quality.

A relatively consistent effect, however, emerges with respect to concentration of the activities. In particular, the with respect to students by study fields we find that the first and second round increased the overall concentration significantly. For the first round we also find a positive effect on the concentration in terms of field of publication.

Table 9: Difference-in-difference estimates of the funding effects for the first round of the Excellence Initiative

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
After year 2006	-0.1279 (-1.39)	-0.0029 (-0.22)	15.5644* (1.65)	0.0098* (1.80)	0.0007 (1.61)	-0.0075 (-1.52)	-0.0439*** (-2.64)
(After year 2006)*(Excellence funding in Round 1)	-0.0256 (-0.34)	0.0014 (0.13)	44.2406*** (5.78)	-0.0021 (-0.48)	0.0002 (0.80)	0.0150*** (3.90)	0.0410*** (3.04)
#Employees	0.0000 (0.58)	0.0000 (1.62)	0.0534*** (28.17)	-0.0000*** (-6.26)	-0.0000 (-0.14)	-0.0000*** (-4.14)	-0.0000** (-2.13)
Students per em- ployee	0.0289 (1.64)	0.0080*** (3.20)	6.6391*** (3.69)	0.0048*** (4.57)	0.0003* (1.76)	-0.0008 (-1.65)	-0.0018 (-0.56)
Investments per total expenditures	0.8322** (2.53)	0.0856* (1.83)	-7.8175 (-0.23)	-0.0476** (-2.44)	0.0033** (2.17)	0.0775*** (5.07)	-0.0776 (-1.31)
Total expenditures per employee in TEUR	-0.0000 (-0.27)	-0.0000 (-0.34)	0.0846*** (5.12)	0.0002*** (19.30)	0.0000** (2.42)	-0.0000*** (-4.73)	0.0000 (0.89)
Constant	-1.0658 (-0.17)	0.2939 (0.34)	-813.7474 (-1.30)	-0.1018 (-0.28)	0.0274 (1.27)	0.8179** (2.56)	2.9444*** (2.67)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	789	789	789	789	516	1053	789
#Groups	67.0000	67.0000	67.0000	67.0000	55.0000	79.0000	67.0000
R2	0.0364	0.0541	0.6683	0.5312	0.1739	0.5199	0.0723
F-stat	1.0517	1.5943	56.1626	31.5905	3.6707	37.9800	2.1728

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 10: Difference-in-difference estimates of the funding effects for the second round of the Excellence Initiative

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
After year 2007	-0.1177 (-1.12)	-0.0194 (-1.20)	23.8472*** (3.89)	0.0036 (0.60)	0.0021*** (3.67)	-0.0175*** (-3.32)	-0.0037 (-0.19)
(After year 2007)*(Excellence funding in Round 2)	-0.1020 (-1.08)	0.0069 (0.47)	13.8231** (2.51)	0.0072 (1.29)	0.0003 (0.69)	0.0126*** (2.63)	0.0276 (1.51)
#Employees	0.0000 (0.82)	0.0000 (1.05)	0.0175*** (6.53)	-0.0000*** (-10.24)	-0.0000 (-1.01)	0.0000 (0.86)	-0.0000 (-0.08)
Students per em- ployee	0.0350* (1.86)	0.0086*** (2.94)	0.8101 (0.74)	0.0027** (2.44)	0.0002 (0.98)	-0.0005 (-1.09)	-0.0016 (-0.44)
Investments per total expenditures	1.1340*** (3.09)	0.1051* (1.85)	-32.8420 (-1.54)	-0.0614*** (-2.83)	0.0074*** (3.70)	0.0900*** (5.68)	-0.1183* (-1.66)
Total expenditures per employee in TEUR	-0.0000 (-0.20)	-0.0000 (-0.00)	0.0123 (1.10)	0.0002*** (13.56)	0.0000** (2.42)	-0.0000*** (-3.42)	0.0001 (1.53)
Constant	1.6232 (0.14)	0.5485 (0.31)	478.9636 (0.72)	0.0918 (0.14)	0.0314 (0.66)	-1.1132** (-2.11)	6.3935*** (2.88)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	634	634	634	634	367	876	634
#Groups	56.0000	56.0000	56.0000	56.0000	44.0000	68.0000	56.0000
R2	0.0497	0.0562	0.3522	0.5897	0.1877	0.5003	0.0931
F-stat	1.1558	1.3160	12.0259	31.7909	2.7536	28.9555	2.2716

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 11: Difference-in-difference estimates of the funding effects for the third round of the Excellence Initiative

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
After year 2012	-0.1419 (-1.27)	-0.0252 (-1.44)	25.2205*** (4.30)	0.0112* (1.70)	0.0014* (1.84)	-0.0229*** (-4.17)	-0.0550** (-2.56)
(After year 2012)*(Excellence funding in Round 3)	-0.0345 (-0.24)	-0.0141 (-0.62)	-4.7089 (-0.62)	0.0160* (1.85)	0.0006 (0.77)	-0.0010 (-0.15)	0.0310 (1.11)
#Employees	0.0000 (0.66)	0.0000 (1.30)	0.0113*** (5.66)	-0.0000*** (-9.70)	-0.0000 (-0.37)	0.0000 (1.13)	0.0000 (0.03)
Students per em- ployee	0.0365* (1.88)	0.0087*** (2.85)	0.4838 (0.47)	0.0025** (2.16)	0.0002 (0.69)	-0.0005 (-1.00)	-0.0016 (-0.42)
Investments per total expenditures	1.0990*** (2.84)	0.1043* (1.72)	-30.5533 (-1.50)	-0.0620*** (-2.69)	0.0081*** (3.32)	0.0827*** (5.02)	-0.1183 (-1.58)
Total expenditures per employee in TEUR	-0.0000 (-0.18)	-0.0000 (-0.01)	0.0043 (0.42)	0.0002*** (13.90)	0.0000** (2.16)	-0.0000*** (-3.95)	0.0001 (1.54)
Constant	2.2048 (0.18)	0.4481 (0.24)	688.6390 (1.09)	0.1535 (0.21)	0.0096 (0.47)	-1.1921** (-2.17)	6.5771*** (2.83)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	595	595	595	595	318	830	595
#Groups	52.0000	52.0000	52.0000	52.0000	40.0000	64.0000	52.0000
R2	0.0538	0.0603	0.3021	0.5903	0.1738	0.4897	0.0924
F-stat	1.1779	1.3287	8.9680	29.8498	2.1288	26.2681	2.1105

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



## 4.4 FE regressions

If we are interested to analyze to effects of the funding by track a more convenient way than using difference-in-difference estimations is to use plain FE regressions because the FE regressions do not require splitting the sample in a pre and posting funding period. We will see that the main effects between FE and difference-in-difference estimations are relatively consistent, which is why we will from now on continue with the simpler FE models. If we are, however, ready to assume that this heterogeneity driving the selection is at least roughly time-constant, FE regressions are expected to be able to account for at least some of the purely selection-induced differences. It should however be noted that even the FE results should not necessarily reflect true causal program effects. Most importantly, if unobserved heterogeneity is time-varying the correction implemented by FE models is not complete. Also the performance-funding relationship is simultaneous, which can be expected, because of the inherent selection process, then endogeneity issues are likely to remain.

In Table 12 we present the FE regressions analyzing the influence of the number of Track 1 projects on a variety of performance and concentration measures. Very interestingly we find, as concerns performance, in no case any significant effects of Track 1 funding. It is fairly likely that this conclusion would prevail when trying to control for other sources of endogeneity by IV-approaches, because endogeneity issues remaining in the FE regressions are likely to bias the estimates upwards instead of downwards.

Contrary to the funding effects on performance measures we do see strong effects on the Herfindahl concentration measures both for students and for publications. The positive effect on concentration indicates that the funding in the first track of the Excellence Initiative has considerably concentrated student enrollment and publication output. This observation is interesting in several respects. First, although we found that funded universities show lower concentration rates in terms of teaching subject and publication field coverage, Track 1 funding in the Excellence Initiative nonetheless appears to have increased concentration for the funded universities. Second, high concentration ratios can be interpreted as being indicative of sharper profiles. In that respect, although there seems little evidence that the Excellence Initiative has – at least until now – considerably increased performance, it indeed contributed to more focused activity portfolios. The conclusion of increased publication and student concentration also holds for Track 2 funding (Table 13) where again in both regressions the number of Track 2 projects is significantly positive. We also note that in the Track 2 models the effect of funding is about 50% larger for the publication concentration, whereas both effects were of about equal size for Track 1. A relatively larger effect of Track 2 funding for publication concentration is in any case reasonable because Track 2 funds thematically focused clusters of research excellence. With respect to Track 3 (Table 14) we see that the positive effect on student concentration prevails. The effect on publication concentration however disappears.

It should also be noted that unlike the conclusion that there was no performance effect of Track 1 funding, we do observe some effects as concerns Track 2 and Track 3 funding.

The Excellence Clusters seem to be associated with higher numbers of publications and also higher numbers of publications per employee. For the Future Concepts at least the number of publications is positively affected. Nonetheless, whether these effects are truly causal program effects or the result of unaccounted endogeneity remains speculative. Furthermore, since no effects of Track 2 and Track 3 funding are observable for any of the other output measures – in fact for patents Track 3 funding the effect is even negative – the performance effects are fairly likely very limited at the level of the university.

Table 12: Effects of Track 1 funding on performance and concentration measures

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
EI: #projects fund- ed by track 1	-0.0103	0.0014	3.4608	-0.0002	0.0001	0.0106***	0.0105**
	(-0.39)	(0.36)	(1.10)	(-0.13)	(0.51)	(7.39)	(2.21)
#Employees	0.0000	0.0000*	0.0473***	-0.0000***	-0.0000	-0.0000**	-0.0000
	(0.66)	(1.91)	(26.77)	(-8.15)	(-0.21)	(-2.48)	(-1.18)
Students per em- ployee	0.0286*	0.0075***	7.9707***	0.0046***	0.0002*	-0.0006	-0.0013
	(1.94)	(3.52)	(4.53)	(5.29)	(1.87)	(-1.36)	(-0.48)
Investments per total expenditures	0.7385***	0.0719*	-16.7657	-0.0492***	0.0046***	0.0634***	-0.0541
	(2.80)	(1.87)	(-0.53)	(-3.13)	(3.75)	(4.81)	(-1.13)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0617***	0.0002***	0.0000***	-0.0000***	0.0000
	(-0.25)	(-0.25)	(3.68)	(22.15)	(2.69)	(-5.22)	(0.78)
Constant	0.3612	0.2812	-891.4501	-0.0716	0.0066	-0.1478	2.1328**
	(0.06)	(0.34)	(-1.33)	(-0.21)	(0.53)	(-0.47)	(2.10)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0321	0.0478	0.5704	0.5316	0.1890	0.4926	0.0596
F-stat	1.2487	1.8925	50.0339	42.7664	5.9554	44.3432	2.3866

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 13: Effects of Track 2 funding on performance and concentration measures

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
EI: #projects fund- ed by track 2	-0.0042	0.0040	24.4884***	0.0034**	0.0001	0.0079***	0.0113**
	(-0.16)	(1.01)	(7.79)	(2.11)	(0.51)	(5.16)	(2.31)
#Employees	0.0000	0.0000*	0.0450***	-0.0000***	-0.0000	-0.0000***	-0.0000*
	(0.71)	(1.71)	(26.05)	(-8.42)	(-0.32)	(-3.89)	(-1.73)
Students per em- ployee	0.0286*	0.0074***	6.9856***	0.0045***	0.0002*	-0.0005	-0.0016
	(1.94)	(3.44)	(4.08)	(5.12)	(1.81)	(-1.13)	(-0.62)
Investments per total expenditures	0.7311***	0.0689*	-40.7007	-0.0534***	0.0046***	0.0671***	-0.0545
	(2.77)	(1.80)	(-1.33)	(-3.41)	(3.76)	(5.03)	(-1.14)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0736***	0.0002***	0.0000***	-0.0000***	0.0000
	(-0.19)	(-0.20)	(4.59)	(22.84)	(2.69)	(-6.07)	(0.61)
Constant	-0.3099	0.3038	-1119.4439*	-0.1535	0.0070	0.5073*	2.6839***
	(-0.06)	(0.39)	(-1.83)	(-0.49)	(0.56)	(1.70)	(2.81)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0319	0.0487	0.5959	0.5338	0.1890	0.4814	0.0600
F-stat	1.2435	1.9302	55.5588	43.1443	5.9555	42.3876	2.4059

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 14: Effects of Track 3 funding on performance and concentration measures

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
EI: funded by track 3	0.0659	0.0044	30.3055***	0.0024	-0.0005*	0.0214***	0.0079
	(0.96)	(0.44)	(3.71)	(0.60)	(-1.95)	(5.45)	(0.63)
#Employees	0.0000	0.0000*	0.0461***	-0.0000***	0.0000	-0.0000***	-0.0000
	(0.54)	(1.80)	(26.04)	(-8.17)	(0.21)	(-3.87)	(-1.47)
Students per em- ployee	0.0275*	0.0075***	7.5692***	0.0046***	0.0002**	-0.0005	-0.0013
	(1.86)	(3.49)	(4.32)	(5.24)	(2.22)	(-1.09)	(-0.48)
Investments per total expenditures	0.7107***	0.0725*	-19.8174	-0.0500***	0.0048***	0.0711***	-0.0434
	(2.71)	(1.90)	(-0.64)	(-3.20)	(3.97)	(5.37)	(-0.91)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0608***	0.0002***	0.0000**	-0.0000***	0.0000
	(-0.12)	(-0.31)	(3.73)	(22.71)	(2.51)	(-6.48)	(0.35)
Constant	-1.2507	0.3252	-1030.9810	-0.1184	0.0066	0.3782	2.8046***
	(-0.23)	(0.42)	(-1.63)	(-0.37)	(0.53)	(1.26)	(2.90)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0329	0.0479	0.5761	0.5318	0.1934	0.4826	0.0551
F-stat	1.2804	1.8952	51.1988	42.7954	6.1302	42.6002	2.1972

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

In summary, our results do not show strong evidence that funding in the Excellence Initiative has had strong effects on publication related performance. However, the effects on concentration both in terms of enrollment in educational subjects as well as in terms of thematic publication portfolios are large. We now intend to dig deeper into the causes of the increased concentration by analyzing fields. The results for student enrollment can be found in Table 15 (Track 1), Table 16 (Track 2), and Table 17 (Track 3) and can be summarized as follows: either of the Track 1, Track 2, and Track 3 funding have considerably increased the share of mathematical and natural science students as well as engineering students. Funding by the Excellence Initiative has also contributed to reducing the share of students in social sciences and economics and (because of the relatively high importance of projects in medical sciences) also the share of enrollment in medicine. Thus, it appears that funding by the Excellence Initiative has led to refocusing of teaching activities towards mathematics/natural sciences and engineering. The reasons for this observation must remain speculative. One reason may indeed be a strategic reorientation away from social sciences toward hard sciences. Another reason could be the research-oriented Track 2 funding which had a strong weight on natural sciences/engineering projects increased the prestige and visibility of the funded universities implying a rise in student numbers.

In parts the results remain stable when analyzing the publication shares by discipline (Table 15-Table 20). Throughout medical science publications are associated with a decrease in the funding by the Excellence Initiative. The share of engineering publications rises. We observe a positive effect on mathematics/natural sciences only for Track 1 funding. No effect can be discerned for the publication share of social sciences/economics for neither of the funding tracks.

Table 15: Effects of Track 1 funding on student shares by field

	(1) Students in language and cultural sci- ences in %	(2) Students in sports in %	(3) Students in economic and social sciences in %	(4) Students in mathematics and natural sciences in %	(5) Students in medical sci- ences in %	(6) Students in engineering sciences in %	(7) Students in arts in %
El: #projects fund- ed by track 1	-0.0020 (-1.16)	0.0009** (1.97)	-0.0032* (-1.67)	0.0090*** (7.06)	-0.0097*** (-8.75)	0.0042** (2.55)	0.0000 (0.07)
#Employees	-0.0000 (-1.17)	0.0000 (0.30)	-0.0000*** (-4.14)	0.0000 (1.54)	0.0000*** (6.84)	0.0000 (1.51)	0.0000 (0.57)
Students per em- ployee	-0.0016*** (-3.49)	0.0004*** (3.52)	-0.0056*** (-10.99)	-0.0005 (-1.43)	0.0059*** (20.48)	-0.0002 (-0.41)	0.0014*** (17.92)
Investments per total expenditures	-0.0262 (-1.48)	-0.0032 (-0.69)	0.0153 (0.76)	0.0108 (0.82)	0.0152 (1.32)	0.0015 (0.09)	-0.0117*** (-3.68)
Total expenditures per employee in TEUR	0.0000 (0.31)	0.0000 (0.28)	0.0000 (0.80)	0.0001*** (7.82)	-0.0001*** (-15.26)	0.0000*** (3.39)	-0.0000 (-0.86)
Constant	0.2652*** (39.53)	0.0212*** (11.84)	0.3841*** (50.46)	0.1436*** (28.83)	0.0421*** (9.68)	0.1060*** (16.63)	0.0187*** (15.54)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0499	0.0409	0.1226	0.1459	0.3709	0.1197	0.2768
F-stat	3.4559	2.7877	9.1896	11.2409	38.7820	8.9420	25.1820

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 16: Effects of Track 2 funding on student shares by field

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Students in language and cultural sciences in %	Students in sports in %	Students in economic and social sciences in %	Students in mathematics and natural sciences in %	Students in medical sciences in %	Students in engineering sciences in %	Students in arts in %
El: #projects funded by track 2	-0.0046**	0.0006	-0.0056**	0.0110***	-0.0078***	0.0066***	0.0002
	(-2.38)	(1.23)	(-2.57)	(7.76)	(-6.15)	(3.61)	(0.58)
#Employees	-0.0000	-0.0000	-0.0000***	-0.0000	0.0000***	0.0000	0.0000
	(-0.65)	(-0.18)	(-3.52)	(-0.67)	(8.98)	(0.60)	(0.48)
Students per employee	-0.0016***	0.0004***	-0.0056***	-0.0005	0.0060***	-0.0002	0.0014***
	(-3.49)	(3.48)	(-10.98)	(-1.56)	(20.36)	(-0.45)	(17.93)
Investments per total expenditures	-0.0234	-0.0028	0.0178	0.0094	0.0119	-0.0009	-0.0119***
	(-1.32)	(-0.60)	(0.89)	(0.72)	(1.02)	(-0.05)	(-3.74)
Total expenditures per employee in TEUR	0.0000	0.0000	0.0000	0.0000***	-0.0001***	0.0000***	-0.0000
	(0.37)	(0.09)	(0.91)	(7.34)	(-14.33)	(3.25)	(-0.86)
Constant	0.2626***	0.0217***	0.3806***	0.1511***	0.0358***	0.1102***	0.0188***
	(38.96)	(12.05)	(49.76)	(30.28)	(8.07)	(17.23)	(15.52)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0532	0.0390	0.1252	0.1527	0.3520	0.1243	0.2770
F-stat	3.6950	2.6585	9.4183	11.8526	35.7312	9.3303	25.2059

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



Table 17: Effects of Track 3 funding on student shares by field

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Students in language and cultural sciences in %	Students in sports in %	Students in economic and social sciences in %	Students in mathematics and natural sciences in %	Students in medical sciences in %	Students in engineering sciences in %	Students in arts in %
EI: funded by track 3	-0.0018	0.0004	-0.0197***	0.0154***	-0.0128***	0.0207***	-0.0001
	(-0.35)	(0.32)	(-3.48)	(4.10)	(-3.84)	(4.38)	(-0.09)
#Employees	-0.0000	-0.0000	-0.0000***	-0.0000	0.0000***	0.0000	0.0000
	(-0.94)	(-0.05)	(-3.42)	(-0.13)	(8.56)	(0.52)	(0.58)
Students per employee	-0.0015***	0.0004***	-0.0055***	-0.0005	0.0060***	-0.0002	0.0014***
	(-3.46)	(3.47)	(-10.95)	(-1.63)	(20.26)	(-0.52)	(17.92)
Investments per total expenditures	-0.0283	-0.0022	0.0159	0.0187	0.0058	0.0019	-0.0117***
	(-1.61)	(-0.47)	(0.80)	(1.41)	(0.49)	(0.11)	(-3.69)
Total expenditures per employee in TEUR	0.0000	0.0000	0.0000	0.0000***	-0.0001***	0.0000***	-0.0000
	(0.45)	(0.05)	(0.99)	(6.96)	(-14.00)	(3.15)	(-0.88)
Constant	0.2644***	0.0215***	0.3801***	0.1484***	0.0374***	0.1104***	0.0187***
	(39.22)	(11.95)	(49.90)	(29.30)	(8.37)	(17.33)	(15.46)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0490	0.0380	0.1291	0.1236	0.3401	0.1285	0.2768
F-stat	3.3886	2.5814	9.7489	9.2806	33.9116	9.6946	25.1822

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 18: Effects of Track 1 funding on publication shares by field

	(1)	(2)	(3)	(4)	(5)
	Publications in language and cultural sciences in %	Publications in economic and social sciences in %	Publications in mathematics and natural sciences in %	Publications in medical sciences in %	Publications in engineering sciences in %
EI: #projects funded by track 1	-0.0002	-0.0002	0.0083*	-0.0215***	0.0121**
	(-0.35)	(-0.06)	(1.71)	(-6.04)	(2.49)
#Employees	-0.0000	0.0000	-0.0000***	0.0000***	0.0000
	(-1.44)	(0.52)	(-3.59)	(3.22)	(1.34)
Students per employee	-0.0010**	0.0036	0.0005	0.0018	-0.0041
	(-2.43)	(1.55)	(0.16)	(0.85)	(-1.40)
Investments per total expenditures	-0.0037	0.1175***	-0.1711***	0.0803**	-0.0022
	(-0.49)	(2.75)	(-3.15)	(2.03)	(-0.04)
Total expenditures per employee in TEUR	0.0000	-0.0000	-0.0000	-0.0000	0.0000
	(0.02)	(-0.29)	(-0.95)	(-0.52)	(1.60)
Constant	0.0089**	0.0102	0.5427***	0.1821***	0.2294***
	(2.53)	(0.51)	(21.36)	(9.87)	(9.08)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0227	0.0323	0.0466	0.0721	0.0578
F-stat	1.3198	1.8962	2.7775	4.4137	3.4889

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 19: Effects of Track 2 funding on publication shares by field

	(1)	(2)	(3)	(4)	(5)
	Publications in language and cultural sciences in %	Publications in economic and social sciences in %	Publications in mathematics and natural sciences in %	Publications in medical sciences in %	Publications in engineering sciences in %
EI: #projects funded by track 2	-0.0003	-0.0037	0.0084	-0.0209***	0.0157***
	(-0.36)	(-0.88)	(1.56)	(-5.31)	(2.92)
#Employees	-0.0000	0.0000	-0.0000***	0.0000***	0.0000
	(-1.35)	(0.65)	(-4.06)	(4.82)	(0.58)
Students per employee	-0.0010**	0.0037	0.0003	0.0022	-0.0045
	(-2.41)	(1.60)	(0.10)	(1.04)	(-1.53)
Investments per total expenditures	-0.0037	0.1211***	-0.1706***	0.0785**	-0.0050
	(-0.49)	(2.83)	(-3.14)	(1.98)	(-0.09)
Total expenditures per employee in TEUR	0.0000	-0.0000	-0.0000	-0.0000	0.0000
	(0.05)	(-0.33)	(-1.10)	(-0.02)	(1.45)
Constant	0.0087**	0.0077	0.5506***	0.1623***	0.2430***
	(2.44)	(0.38)	(21.50)	(8.69)	(9.56)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0227	0.0331	0.0461	0.0643	0.0601
F-stat	1.3202	1.9433	2.7477	3.9067	3.6343

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 20: Effects of Track 3 funding on publication shares by field

	(1)	(2)	(3)	(4)	(5)
	Publications in language and cultural sciences in %	Publications in economic and social sciences in %	Publications in mathematics and natural sciences in %	Publications in medical sciences in %	Publications in engineering sciences in %
El: funded by track 3	-0.0003	-0.0046	0.0070	-0.0282***	0.0254*
	(-0.14)	(-0.42)	(0.50)	(-2.75)	(1.83)
#Employees	-0.0000	0.0000	-0.0000***	0.0000***	0.0000
	(-1.37)	(0.59)	(-3.92)	(4.46)	(0.70)
Students per employee	-0.0010**	0.0036	0.0005	0.0019	-0.0043
	(-2.42)	(1.57)	(0.17)	(0.87)	(-1.45)
Investments per total expenditures	-0.0039	0.1182***	-0.1635***	0.0628	0.0058
	(-0.52)	(2.78)	(-3.01)	(1.57)	(0.11)
Total expenditures per employee in TEUR	0.0000	-0.0000	-0.0000	0.0000	0.0000
	(0.07)	(-0.29)	(-1.18)	(0.24)	(1.31)
Constant	0.0088**	0.0090	0.5468***	0.1690***	0.2391***
	(2.47)	(0.45)	(21.34)	(8.96)	(9.38)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0226	0.0325	0.0440	0.0445	0.0551
F-stat	1.3135	1.9068	2.6139	2.6481	3.3126

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

#### 4.5 Robustness checks: using heterogeneity as a source of identification

The previous sections have shown that the largest effects of the Excellence Initiative were related to an increase in the concentrations as measured by students and publications. The effects on performance measures instead were mostly small and, if significant, instable. In order to assess the robustness of the results relating to the concentration measures we reran the analyses relating to them in Table 12-Table 14 using heterogeneity-based instruments. The need to use instrumental variables to obtain consistent estimates can in our context be argued to arise from the nature of the selection process, i.e. more capable universities are more likely to be selected into participation in the Excellence Initiative. But to the degree that the universities capabilities and their concentration both in terms of publications and students are correlated, the funding becomes endogenous. Although it is hard to find ordinary exclusion restrictions, Lewbel (2012) shows how heterogeneity in the data generating process can be exploited to derive covariance restrictions identifying the endogenous variables. The results are presented in Table 21, where we indeed find great stability of the results. In all cases, funding was significant and positive on both concentration measures. Furthermore, the coefficients appear to be roughly of a magnitude comparable to the results in the FE regressions. We note heterogeneity was in all cases sufficient to warrant strong instruments. Thus the identification can be assumed to be of reasonable quality.

Table 21: Influence on the concentration measures using heterogeneity based instrumental variables

	(1) Field concentration students	(2) Field concentration students	(3) Field concentration students	(4) Field concentration publications	(5) Field concentration publications	(6) Field concentration publications
EI: #projects funded by track 1	0.00868*** (2.92)			0.00474** (2.06)		
EI: #projects funded by track 2		0.0204*** (4.80)			0.00614* (1.76)	
EI: funded by track 3			0.0552*** (5.94)			0.0123** (1.96)
#Employees	-0.0000157*** (-10.57)	-0.0000170*** (-10.04)	-0.0000185*** (-13.79)	-0.00000824*** (-8.94)	-0.00000892*** (-8.76)	-0.0000101*** (-13.21)
Students per employee	-0.0112*** (-6.81)	-0.0114*** (-6.90)	-0.0111*** (-6.92)	-0.00111 (-0.91)	-0.00167 (-1.35)	-0.00280** (-2.15)
Investments per total expenditures	-0.290*** (-3.47)	-0.276*** (-3.45)	-0.245*** (-3.28)	-0.144*** (-3.72)	-0.162*** (-4.04)	-0.190*** (-4.73)
Total expenditures per employee in TEUR	0.00000488 (0.26)	-0.00000257 (-0.13)	-0.0000135 (-0.72)	0.0000250** (2.31)	0.0000321*** (3.15)	0.0000191** (2.04)
Publications in language and cultural sciences in %	-0.691* (-1.93)	-0.620* (-1.83)	-0.451 (-1.20)	-0.687*** (-2.73)	-0.598** (-2.31)	-0.452* (-1.71)
Publications in economic and social sciences in %	0.794*** (5.33)	0.635*** (4.34)	0.651*** (4.75)	0.207* (1.90)	0.135 (1.40)	0.158* (1.83)
Publications in mathematics and natural sciences in %	-0.141 (-1.06)	-0.247* (-1.89)	-0.216* (-1.74)	0.523*** (6.40)	0.509*** (6.13)	0.605*** (7.58)
Publications in medical sciences in %	0.217* (1.78)	0.134 (1.14)	0.178 (1.52)	0.408*** (5.46)	0.372*** (4.99)	0.481*** (6.65)
Publications in engineering sciences in %	0.272** (2.17)	0.178 (1.47)	0.189 (1.64)	0.472*** (7.55)	0.487*** (7.76)	0.543*** (8.63)
Constant	0.438*** (3.46)	0.537*** (4.33)	0.524*** (4.48)	0.00996 (0.14)	0.0401 (0.58)	-0.0245 (-0.36)
Observations	1073	1073	1073	1073	1073	1073

## 5 Conclusion

The study has uncovered a couple of key findings. First, as intended by the Excellence Initiative, funding has been relatively concentrated with about half of the universities not having received any funding. In the group of universities having received funding a few universities often conceived as top-performers have been successful in acquiring a substantial number of projects in all three tracks of the Excellence Initiative. The FU Berlin and the HU Berlin have for example jointly acquired 7 doctoral schools and 3 excellence clusters. The TU München and LMU München acquired 4 doctoral schools and 5 excellence clusters. All of the four universities were also successful in Track 3 “Future Concepts”.

A breakdown of the graduate schools and the excellence clusters by field/subject shows that the largest share of projects was awarded to mathematics/natural sciences. The importance of mathematics/natural sciences holds both for Track 1 and Track 2. An interesting observation is that in particular in Track 1 (“Graduate Schools”) humanities and the social sciences have been quite successful. About 40% of all graduate schools have a background in either humanities or social sciences. At the same time humanities/social sciences play only a very minor role as concerns the excellence clusters.

We can show that substantial differences between funded and non-funded universities exist in a variety of indicators. Funded universities mostly show higher performance levels as compared to their non-funded counterparts. Also we showed that most of the performance indicators increased for the funded universities in pre-post-funding comparison. From the descriptive differences it is however unclear whether causal effects of the Excellence Initiative can be deduced because in particular selection into funding was highly performance-based.

A clear effect however seems to be related to changes in terms of concentration of both teaching and publications activities. Although the funded universities tended to be less concentrated offering a wider portfolio of teaching activities (mainly as a result of their larger size), our results indicated that that funding by the Excellence Initiative led to growing concentration rates both in teaching and publication activities. These findings remain relatively robust for the matching approach, the fixed effects regressions, the difference-in-difference approach, and the instrumentation approach based on the exploitation of heterogeneity. Moreover, our results provide some indication that funding in the Excellence Initiative was associated with shifting focus towards engineering and mathematics/natural sciences, while both medical sciences and – as concerns teaching activities – social sciences/economics have lost weight.

Nonetheless, we clearly stress that the multivariate analyses do not guarantee that identification of causal effects because all models rely on certain assumptions. The matching approach requires that selection is based on unobservables. The Fixed Effects regressions rely on strong functional assumptions and on the time-constancy of the unobserved heterogeneity. Difference-and-difference methods require that time trends would have remained unchanged without funding. The Lewbel approach requires complicated distributional as-

sumptions, which may or may not be met in the specific context. Thus, the results should be interpreted as indicative of potential effects but not clear cut evidence of causal program effects.

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## **7 Appendix – Analysis of the Lag Structures**

In this appendix we copy the results for regression Table 13-Table 20 introducing a one period time lag between funding events and outcome variables. The results are almost identical.



Table 22: Effects of lagged Track 1 funding on performance and concentration measures

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
L.EI: #projects funded by track 1	-0.0002	0.0028	5.6065*	0.0005	0.0000	0.0106***	0.0099**
	(-0.01)	(0.71)	(1.70)	(0.32)	(0.07)	(7.13)	(1.98)
#Employees	0.0000	0.0000*	0.0473***	-0.0000***	-0.0000	-0.0000***	-0.0000
	(0.70)	(1.91)	(26.86)	(-8.16)	(-0.24)	(-2.88)	(-1.31)
Students per em- ployee	0.0285*	0.0075***	7.9291***	0.0046***	0.0002*	-0.0005	-0.0013
	(1.93)	(3.51)	(4.51)	(5.28)	(1.89)	(-1.29)	(-0.49)
Investments per total expenditures	0.7265***	0.0708*	-18.0513	-0.0500***	0.0047***	0.0657***	-0.0512
	(2.76)	(1.85)	(-0.57)	(-3.19)	(3.80)	(4.98)	(-1.07)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0629***	0.0002***	0.0000***	-0.0000***	0.0000
	(-0.17)	(-0.20)	(3.78)	(22.37)	(2.59)	(-5.47)	(0.68)
Constant	-0.3779	0.1528	-1089.4420	-0.1292	0.0188	-0.2184	2.1063**
	(-0.07)	(0.18)	(-1.60)	(-0.38)	(0.91)	(-0.68)	(2.04)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0319	0.0482	0.5712	0.5317	0.1886	0.4911	0.0586
F-stat	1.2425	1.9080	50.1893	42.7737	5.9430	44.0768	2.3464

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 23: Effects of lagged Track 2 funding on performance and concentration measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Expected cita- tion rate	Excellence rate	#Publications	Publications per employee	Patents per employee	Field concen- tration stu- dents	Field concen- tration publi- cations
L.EI: #projects funded by track 2	-0.0020	0.0050	27.3669***	0.0038**	0.0000	0.0082***	0.0118**
	(-0.07)	(1.23)	(8.51)	(2.29)	(0.44)	(5.30)	(2.34)
#Employees	0.0000	0.0000	0.0444***	-0.0000***	-0.0000	-0.0000***	-0.0000*
	(0.70)	(1.63)	(25.71)	(-8.48)	(-0.33)	(-4.04)	(-1.80)
Students per em- ployee	0.0286*	0.0073***	6.6250***	0.0044***	0.0002*	-0.0005	-0.0018
	(1.93)	(3.39)	(3.89)	(5.06)	(1.78)	(-1.13)	(-0.66)
Investments per total expenditures	0.7286***	0.0678*	-43.9168	-0.0538***	0.0046***	0.0672***	-0.0550
	(2.76)	(1.77)	(-1.44)	(-3.43)	(3.75)	(5.05)	(-1.15)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0714***	0.0002***	0.0000***	-0.0000***	0.0000
	(-0.18)	(-0.21)	(4.50)	(22.88)	(2.68)	(-6.18)	(0.55)
Constant	-0.3519	0.2799	-1200.2913**	-0.1648	0.0072	0.4920*	2.6643***
	(-0.07)	(0.36)	(-1.97)	(-0.52)	(0.57)	(1.65)	(2.78)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0319	0.0492	0.6006	0.5342	0.1889	0.4820	0.0602
F-stat	1.2427	1.9506	56.6597	43.2145	5.9522	42.4893	2.4118

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 24: Effects of lagged Track 3 funding on performance and concentration measures

	(1) Expected cita- tion rate	(2) Excellence rate	(3) #Publications	(4) Publications per employee	(5) Patents per employee	(6) Field concen- tration stu- dents	(7) Field concen- tration publi- cations
L.EI: funded by track 3	0.0842	0.0043	43.0106***	0.0039	-0.0007**	0.0222***	0.0086
	(1.15)	(0.40)	(4.96)	(0.89)	(-2.36)	(5.44)	(0.64)
#Employees	0.0000	0.0000*	0.0453***	-0.0000***	0.0000	-0.0000***	-0.0000
	(0.44)	(1.76)	(25.43)	(-8.18)	(0.54)	(-4.08)	(-1.49)
Students per em- ployee	0.0268*	0.0075***	7.1592***	0.0046***	0.0003**	-0.0005	-0.0013
	(1.81)	(3.47)	(4.10)	(5.18)	(2.45)	(-1.16)	(-0.50)
Investments per total expenditures	0.7091***	0.0726*	-21.4261	-0.0503***	0.0049***	0.0717***	-0.0433
	(2.70)	(1.90)	(-0.69)	(-3.22)	(4.01)	(5.41)	(-0.91)
Total expenditures per employee in TEUR	-0.0000	-0.0000	0.0605***	0.0002***	0.0000**	-0.0001***	0.0000
	(-0.13)	(-0.32)	(3.74)	(22.73)	(2.49)	(-6.55)	(0.34)
Constant	-1.5140	0.3259	-1209.1009*	-0.1385	0.0262	0.3561	2.7932***
	(-0.28)	(0.42)	(-1.91)	(-0.43)	(1.35)	(1.18)	(2.88)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Field shares	YES	YES	YES	YES	YES	YES	YES
Observations	1056	1056	1056	1056	741	1361	1056
#Groups	89.0000	89.0000	89.0000	89.0000	77.0000	101.0000	89.0000
R2	0.0333	0.0479	0.5808	0.5320	0.1957	0.4826	0.0551
F-stat	1.2970	1.8937	52.2135	42.8332	6.2177	42.5902	2.1978

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 25: Effects of lagged Track 1 funding on student shares by field

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Students in language and cultural sciences in %	Students in sports in %	Students in economic and social sciences in %	Students in mathematics and natural sciences in %	Students in medical sciences in %	Students in engineering sciences in %	Students in arts in %
L.EI: #projects funded by track 1	-0.0025	0.0009*	-0.0031	0.0086***	-0.0092***	0.0041**	0.0001
	(-1.43)	(1.85)	(-1.57)	(6.62)	(-8.08)	(2.47)	(0.19)
#Employees	-0.0000	0.0000	-0.0000***	0.0000	0.0000***	0.0000	0.0000
	(-1.16)	(0.20)	(-4.07)	(1.18)	(7.32)	(1.40)	(0.59)
Students per employee	-0.0016***	0.0004***	-0.0056***	-0.0005	0.0059***	-0.0002	0.0014***
	(-3.50)	(3.52)	(-10.98)	(-1.44)	(20.42)	(-0.41)	(17.92)
Investments per total expenditures	-0.0261	-0.0030	0.0145	0.0131	0.0126	0.0024	-0.0117***
	(-1.48)	(-0.64)	(0.73)	(0.99)	(1.10)	(0.14)	(-3.70)
Total expenditures per employee in TEUR	0.0000	0.0000	0.0000	0.0001***	-0.0001***	0.0000***	-0.0000
	(0.30)	(0.24)	(0.84)	(7.66)	(-15.01)	(3.35)	(-0.85)
Constant	0.2651***	0.0213***	0.3838***	0.1445***	0.0411***	0.1064***	0.0187***
	(39.58)	(11.90)	(50.48)	(28.99)	(9.42)	(16.72)	(15.55)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0504	0.0405	0.1223	0.1420	0.3655	0.1195	0.2768
F-stat	3.4942	2.7638	9.1712	10.8852	37.8899	8.9176	25.1841

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 26: Effects of lagged Track 2 funding on student shares by field

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Students in language and cultural sciences in %	Students in sports in %	Students in economic and social sciences in %	Students in mathematics and natural sciences in %	Students in medical sciences in %	Students in engineering sciences in %	Students in arts in %
L.EI: #projects funded by track 2	-0.0046**	0.0005	-0.0055**	0.0116***	-0.0077***	0.0056***	0.0003
	(-2.36)	(0.98)	(-2.48)	(8.00)	(-5.96)	(3.00)	(0.86)
#Employees	-0.0000	-0.0000	-0.0000***	-0.0000	0.0000***	0.0000	0.0000
	(-0.59)	(-0.17)	(-3.45)	(-0.91)	(9.06)	(0.61)	(0.41)
Students per employee	-0.0016***	0.0004***	-0.0056***	-0.0005	0.0060***	-0.0002	0.0014***
	(-3.47)	(3.47)	(-10.97)	(-1.60)	(20.38)	(-0.47)	(17.93)
Investments per total expenditures	-0.0237	-0.0027	0.0173	0.0095	0.0112	0.0007	-0.0120***
	(-1.34)	(-0.57)	(0.86)	(0.73)	(0.96)	(0.04)	(-3.78)
Total expenditures per employee in TEUR	0.0000	0.0000	0.0000	0.0000***	-0.0001***	0.0000***	-0.0000
	(0.41)	(0.07)	(0.96)	(7.22)	(-14.21)	(3.17)	(-0.86)
Constant	0.2623***	0.0217***	0.3804***	0.1520***	0.0355***	0.1100***	0.0189***
	(38.82)	(12.01)	(49.59)	(30.42)	(7.96)	(17.13)	(15.54)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0531	0.0386	0.1249	0.1551	0.3508	0.1215	0.2772
F-stat	3.6895	2.6286	9.3913	12.0766	35.5492	9.0901	25.2359

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 27: Effects of lagged Track 3 funding on student shares by field

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Students in language and cultural sciences in %	Students in sports in %	Students in economic and social sciences in %	Students in mathematics and natural sciences in %	Students in medical sciences in %	Students in engineering sciences in %	Students in arts in %
L.EI: funded by track 3	-0.0041	0.0006	-0.0161***	0.0179***	-0.0145***	0.0159***	0.0002
	(-0.77)	(0.45)	(-2.72)	(4.55)	(-4.17)	(3.21)	(0.20)
#Employees	-0.0000	-0.0000	-0.0000***	-0.0000	0.0000***	0.0000	0.0000
	(-0.85)	(-0.08)	(-3.41)	(-0.34)	(8.71)	(0.56)	(0.53)
Students per employee	-0.0015***	0.0004***	-0.0055***	-0.0006*	0.0060***	-0.0002	0.0014***
	(-3.45)	(3.46)	(-10.92)	(-1.67)	(20.32)	(-0.53)	(17.91)
Investments per total expenditures	-0.0279	-0.0022	0.0145	0.0187	0.0057	0.0035	-0.0117***
	(-1.59)	(-0.48)	(0.73)	(1.41)	(0.49)	(0.21)	(-3.70)
Total expenditures per employee in TEUR	0.0000	0.0000	0.0000	0.0000***	-0.0001***	0.0000***	-0.0000
	(0.46)	(0.04)	(1.03)	(6.92)	(-13.96)	(3.10)	(-0.88)
Constant	0.2640***	0.0216***	0.3803***	0.1492***	0.0368***	0.1100***	0.0188***
	(39.05)	(11.94)	(49.69)	(29.41)	(8.22)	(17.16)	(15.46)
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	1371	1363	1371	1371	1371	1370	1371
#Groups	102.0000	101.0000	102.0000	102.0000	102.0000	102.0000	102.0000
R2	0.0493	0.0380	0.1258	0.1263	0.3415	0.1224	0.2768
F-stat	3.4149	2.5870	9.4642	9.5091	34.1184	9.1668	25.1844

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 28: Effect of lagged Track 1 funding on publication shares by field

	(1) Publications in language and cultural sci- ences in %	(2) Publications in economic and social sciences in %	(3) Publications in mathematics and natural sciences in %	(4) Publications in medical sci- ences in %	(5) Publications in engineering sciences in %
L.EI: #projects funded by track 1	-0.0002 (-0.34)	0.0005 (0.12)	0.0074 (1.45)	-0.0212*** (-5.72)	0.0124** (2.45)
#Employees	-0.0000 (-1.43)	0.0000 (0.54)	-0.0000*** (-3.72)	0.0000*** (3.54)	0.0000 (1.23)
Students per em- ployee	-0.0010** (-2.43)	0.0036 (1.54)	0.0005 (0.16)	0.0018 (0.85)	-0.0041 (-1.41)
Investments per total expenditures	-0.0037 (-0.50)	0.1169*** (2.74)	-0.1684*** (-3.10)	0.0754* (1.91)	0.0003 (0.00)
Total expenditures per employee in TEUR	0.0000 (0.03)	-0.0000 (-0.26)	-0.0000 (-1.01)	-0.0000 (-0.39)	0.0000 (1.56)
Constant	0.0089** (2.52)	0.0101 (0.50)	0.5440*** (21.43)	0.1791*** (9.70)	0.2310*** (9.15)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0227	0.0323	0.0458	0.0685	0.0576
F-stat	1.3194	1.8968	2.7279	4.1811	3.4756

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 29: Effects of lagged Track 2 funding on publication shares by field

	(1) Publications in language and cultural sci- ences in %	(2) Publications in economic and social sciences in %	(3) Publications in mathematics and natural sciences in %	(4) Publications in medical sci- ences in %	(5) Publications in engineering sciences in %
L.EI: #projects funded by track 2	-0.0003 (-0.37)	-0.0030 (-0.70)	0.0082 (1.48)	-0.0204*** (-5.03)	0.0150*** (2.71)
#Employees	-0.0000 (-1.33)	0.0000 (0.64)	-0.0000*** (-4.08)	0.0000*** (4.90)	0.0000 (0.53)
Students per em- ployee	-0.0010** (-2.40)	0.0037 (1.60)	0.0002 (0.08)	0.0024 (1.10)	-0.0045 (-1.55)
Investments per total expenditures	-0.0037 (-0.48)	0.1203*** (2.81)	-0.1703*** (-3.13)	0.0777* (1.96)	-0.0041 (-0.08)
Total expenditures per employee in TEUR	0.0000 (0.05)	-0.0000 (-0.31)	-0.0000 (-1.13)	0.0000 (0.09)	0.0000 (1.39)
Constant	0.0086** (2.42)	0.0079 (0.39)	0.5512*** (21.45)	0.1608*** (8.57)	0.2439*** (9.55)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0227	0.0328	0.0459	0.0616	0.0589
F-stat	1.3206	1.9254	2.7327	3.7291	3.5581

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 30: Effects of lagged Track 3 funding on publication shares by field

	(1)	(2)	(3)	(4)	(5)
	Publications in language and cultural sciences in %	Publications in economic and social sciences in %	Publications in mathematics and natural sciences in %	Publications in medical sciences in %	Publications in engineering sciences in %
L.EI: funded by track 3	-0.0005	-0.0046	0.0063	-0.0332***	0.0301**
	(-0.24)	(-0.39)	(0.43)	(-3.03)	(2.03)
#Employees	-0.0000	0.0000	-0.0000***	0.0000***	0.0000
	(-1.34)	(0.60)	(-3.90)	(4.60)	(0.58)
Students per employee	-0.0010**	0.0037	0.0005	0.0021	-0.0044
	(-2.41)	(1.58)	(0.16)	(0.96)	(-1.52)
Investments per total expenditures	-0.0039	0.1181***	-0.1632***	0.0629	0.0057
	(-0.51)	(2.77)	(-3.01)	(1.58)	(0.11)
Total expenditures per employee in TEUR	0.0000	-0.0000	-0.0000	0.0000	0.0000
	(0.07)	(-0.28)	(-1.19)	(0.27)	(1.29)
Constant	0.0087**	0.0088	0.5470***	0.1662***	0.2416***
	(2.44)	(0.44)	(21.23)	(8.77)	(9.43)
Year dummies	YES	YES	YES	YES	YES
Observations	1073	1073	1073	1073	1073
#Groups	90.0000	90.0000	90.0000	90.0000	90.0000
R2	0.0226	0.0324	0.0439	0.0461	0.0558
F-stat	1.3157	1.9053	2.6097	2.7446	3.3597

*t* statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$