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Bastian Gawellek / Marco Sunder

**The German Excellence Initiative and  
Efficiency Change among Universities,  
2001-2011**

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# The German Excellence Initiative and Efficiency Change among Universities, 2001–2011

Bastian Gawellek      Marco Sunder

*University of Leipzig\**

**Abstract:** The “Excellence Initiative” is a prestigious third-party funding program for German universities, organized as a research contest. We investigate whether universities in this program (or that prepared an application) had different trends in terms of productivity and technical efficiency than universities that did not apply for the program, albeit these dimensions were not the target of the program. While universities became more efficient if the extra funding through the program is included, we do not find a substantially positive effect that extends beyond this funding. The evidence even suggests that applicants suffered a drop in efficiency at the time of applying. All this does not rule out, however, that research-oriented universities jointly gained productivity through increased competition between them.

**Keywords:** Efficiency, Malmquist index, German Research Foundation, DFG

**JEL classification:** I23

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\*Correspondence: Institute for Empirical Research in Economics (IEW), University of Leipzig, Grimmaische Straße 12, 04109 Leipzig, Germany; E-Mail: [gawellek@wifa.uni-leipzig.de](mailto:gawellek@wifa.uni-leipzig.de), [sunder@wifa.uni-leipzig.de](mailto:sunder@wifa.uni-leipzig.de)

# 1 Background

Most tertiary education in Germany is provided in public universities. With a relatively homogenous funding scheme, (perceived) quality differences used to be modest. While the shotgun approach may have advantages—e.g., for the student who then may not have to move (or commute) far—it may not be very successful in stimulating top-level research. In 2004, the federal government decided to increase competition among universities by introducing a research contest: the *Exzellenzinitiative* (Excellence Initiative, ExIn). Universities were invited to apply in 2006, and the winners of the first round were announced in late 2006 with funding through 2011 (Kehm and Pasternack, 2009). The purpose of the present study is not to evaluate the program as such but to investigate time trends of the productivity/efficiency dimensions that do not only take into account growth in output but also growth in input.<sup>1</sup>

While the first phase of the ExIn is already finished, a second phase is currently ongoing (2012–2017). However, we only consider a time frame from 2001 to 2011, i.e. before the ExIn up to the end of phase 1. In 2011, universities also applied for the second phase of the program, which we will have to take into account. The ExIn provides funding of research clusters (“clusters of excellence”, CE), graduate schools (GS), and university-wide development plans (“institutional strategies”, IS). The latter category is associated with the greatest prize in monetary terms (and involved also at least one CE and one GS): according to our data, ExIn-related funding constituted 7% of the budget of IS universities in 2011. There is probably also a branding aspect to a successful IS application, inasmuch as the winners would henceforth be referred to as “elite universities” in the media. Only three universities received this branding in late 2006, but in 2007 six more universities joined the club in a second round within the first phase of the program. ExIn funding is administered by the German Research Foundation (DFG). The ExIn program has also stirred some criticism (Hartmann, 2010): e.g., excellence in teaching is not rewarded and students may hardly benefit from the program.<sup>2</sup>

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<sup>1</sup>As of writing this paper, an official evaluation report is being prepared.

<sup>2</sup>The German constitution basically prohibits the federal government from interfering in teaching, as the responsibility for all public education lies with the *Bundesländer* (states).

Our choice of benchmark years 2001, 2006, and 2011 includes the year 2006 when some universities were invited to provide full applications based on previous drafts. We consider the preparation of these documents—that would allow the university to enter the research tournament—to be costly (Taylor, 1995). This may not apply so much to the CE tier, as such a cluster is more or less the brainchild of researchers from one discipline or closely related disciplines. These researchers may find it easy to cooperate, or they may even have had a similar proposal in mind irrespective of the ExIn program. The IS tier, though, requests collaboration across the boundaries of disciplines, and this may be a new mode of operation within the university that is associated with opportunity costs in the form of foregone other grant proposals. Theoretically, efficiency of the institution may suffer from preparing such an interdisciplinary grant proposal, whereas efficiency may gain afterwards if the “best” researchers from the institution were able to assemble a proposal with more potential than is usually the case in the institution. To be sure, successful realization of the project may require hiring similarly-talented researchers, on short notice, and without tenure (as funding is not permanent); this may prove difficult in some cases. Hartmann (2010) points out that the best institutions in the US hire on a world-wide basis, which may prove difficult in Germany if the German language is a requirement for teaching.

The remainder of the paper is organized as follows: section 2 provides a quick introduction to the related literature, section 3 discusses the method of Malmquist productivity index and our regression model, section 4 introduces the data. The results are presented in section 5, and section 6 provides some discussion of our results and concludes.

## **2 Related literature**

Given the public (co-)financing of higher education, there has been considerable interest in the efficiency of universities, once the tools for efficiency analysis had become available. Tomkins and Green (1988) is an early example involving data envelopment analysis applied at the accounting department level in England. Johnes (2006) conducts a cross-sectional DEA with 109

universities in England and finds a narrow distribution of efficiency scores, which may seem remarkable as efficiency was not really a goal of the university system. Outputs considered in this analysis are numbers of graduates and research grants by the Higher Education Funding Council for England. Flegg et al. (2004) and Johnes (2008) provide applications to English data with a longitudinal perspective involving the Malmquist index of productivity change. Decomposing the positive productivity growth in the period 1996–2004, Johnes (2008) documents an outward shift of the production possibility frontier but at the same time a decline in average efficiency. Abbott and Doucouliagos (2009), too, employ a longitudinal perspective, but for Australia and New Zealand. They find that increasing competition for foreign students—as a revenue source—contributed to higher efficiency only in Australia.

German universities have also attracted some attention in the literature. Warning (2004) conducts a cross-sectional DEA, whereas Kempkes and Pohl (2010) apply a longitudinal perspective for the period 1998–2003 and find that East-German universities were catching up in terms of productivity to the West-German counterparts. Both studies have in common that they are confined to research-oriented universities, i.e. they exclude a second, more teaching-oriented branch of the German higher education system, the so-called “Universities of Applied Sciences”. These studies differ somewhat with respect to inputs and outputs considered for DEA. While they both have the number of graduates as an output, Warning (2004) also considers publication data for the natural sciences and social sciences whereas Kempkes and Pohl (2010) have research grants as an additional output. In terms of input variables, Warning (2004) considers staff expenditure and other expenditure, and Kempkes and Pohl (2010) use technical staff, research staff, and expenditure minus wages. While our approach is closely related to the one of Kempkes and Pohl (2010), we do not provide an update of their results (that involve several techniques for productivity analysis) but focus only on the distinction of universities according to their role in the first phase of the ExIn program.

### 3 Method

We obtain information on change in efficiency within the framework of data envelopment analysis (DEA), particularly the Malmquist index and its decomposition. We provide a short exposition of the technique before discussing the actual data involved.

This concept assumes that various decision making units (DMUs) translate inputs into outputs according to some production function, but with varying degrees of (technical) efficiency. An efficient DMU would be one that could not increase output further at its combination of input factors, i.e. it operates on the frontier of the production possibility set.<sup>3</sup> In order to illustrate the main concept, consider that decision making units (DMU) produce one type of output ( $y$ ) from one type of input ( $x$ ), see Figure 1. Assume that in period  $t$ , some DMU  $i$  produces at point A. The average productivity with which DMU  $i$  produces its output is  $y_i^t/x_i^t$ , reflected by the slope of the black dotted line in the figure. Consider that in period  $t + 1$ , DMU  $i$  shifted its production to point B. Our goal is now to trace the development over time, so we might relate productivity in period  $t + 1$  to productivity in  $t$ :

$$\frac{y_i^{t+1}/x_i^{t+1}}{y_i^t/x_i^t}$$

In terms of Figure 1, this quantity would be the ratio of slopes of the gray and the black dotted lines.

However, we also want to trace the change in efficiency, which is not possible without information on other DMUs. We therefore have to consider the production possibility set of each period. The frontier of the production possibility set is constructed as a convex hull from the observed  $(x, y)$  pairs of all DMUs. The hulls for both periods are plotted in the figure as black ( $f_v^t(x)$ ) and gray ( $f_v^{t+1}(x)$ ) broken lines, respectively, where the  $v$  stands for the implicit assumption of variable (non-increasing) returns to scale (VRS). Production is only possible on or below these frontiers. The frontiers are not estimated—as would be the case with stochastic

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<sup>3</sup>Notice that this concept takes the combination of input factors as given without regard to their relative prices, whereas a concept of allocative efficiency would stipulate an appropriate mix of inputs.

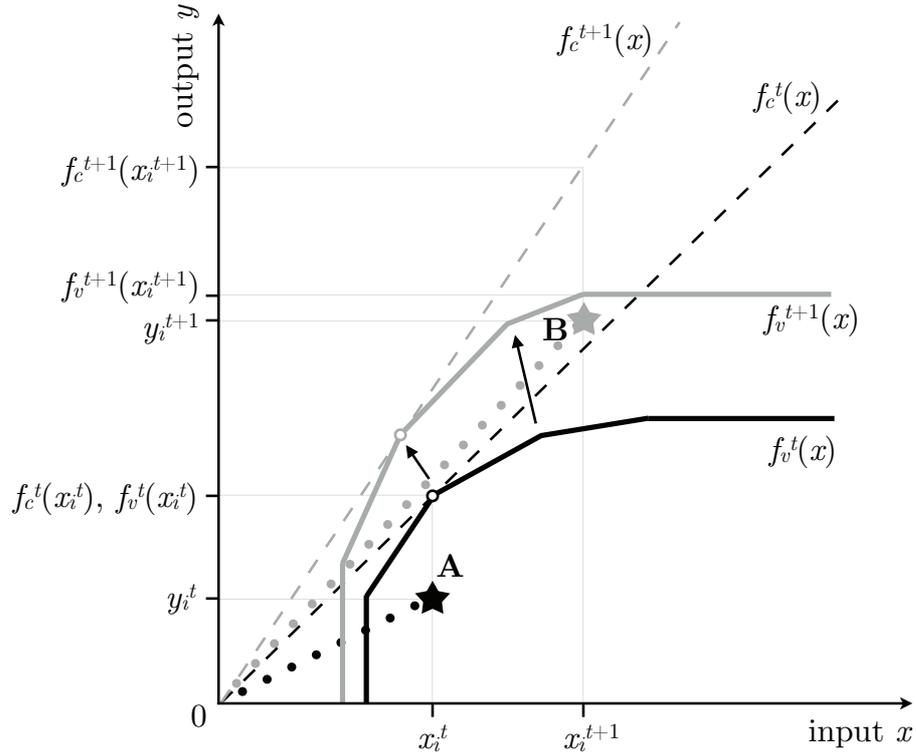


Figure 1: Production possibility sets of two periods, one input/one output case.

frontier analysis (SFA)—but they are calculated by means of linear programming (Charnes et al., 1978).<sup>4</sup> With the assumption of constant returns to scale (CRS), the corresponding frontier  $f_c^t$  (or  $f_c^{t+1}$ ) is defined by the DMU with the steepest ray towards the origin in period  $t$  (or  $t + 1$ ), as indicated by the circle on the frontier in the figure.

Figure 1 also suggests that DMU  $i$  produces (in period  $t$ ) only half of the output that would be possible on the frontier with the input  $x_i^t$  (in this case irrespective of the assumption with respect to returns to scale). This relative “efficiency” can be expressed by the **distance function**  $D_c^t(x_i^t, y_i^t) \equiv \frac{y_i^t}{f_c^t(x_i^t)}$  for CRS or  $D_v^t(x_i^t, y_i^t) \equiv \frac{y_i^t}{f_v^t(x_i^t)}$  for VRS. A value of 1 would indicate a DMU is fully efficient, whereas smaller values indicate inefficiencies.

While the distance function itself is a (static) measure of efficiency, the ratio  $\frac{D_c^t(x_i^{t+1})}{D_c^t(x_i^t)}$  gives an account of productivity change. One might as well use the  $t + 1$  period as a reference

<sup>4</sup>To be sure, this approach does not account for an “error term”. Ignoring statistical error could be a problem inasmuch as a random sampling scheme does not ensure that the most efficient DMUs (that would define the frontier) are included in the sample. In the present case, the inclusion of almost all universities partially alleviates this concern.

for technology, and the *Malmquist index* of productivity change is actually a (geometrically weighted) average of the productivity comparison with either period as reference (Caves et al., 1982; Färe et al., 1994):

$$m_i^{t+1} = \left( \frac{D_c^t(x_i^{t+1})}{D_c^t(x_i^t)} \cdot \frac{D_c^{t+1}(x_i^{t+1})}{D_c^{t+1}(x_i^t)} \right)^{1/2} \quad [\text{Malmquist index}] \quad (1)$$

An index value above unity indicates productivity growth. Notice that this formula only involves the CRS assumption. This does not mean, however, that we ignore the possibility of a VRS type of frontier for actual production, as will soon become clear.

In Figure 1, the productivity change of DMU  $i$  associated with the move from point A to point B could be thought of as a combination of three factors: first, the production technology changed and resulted in an outward shift in the frontier (**technical change**); second, DMU  $i$  became more efficient in the sense that point B is relatively closer to the VRS frontier of period  $t + 1$  than point A was to the VRS frontier of period  $t$  (**pure efficiency change**); third, the scale of production changed and is no longer efficient in terms of economies of scale inasmuch as the gray circle could not be reached at an input level of  $x_i^{t+1}$  (**scale efficiency change**). While the second and third aspect are related to efficiency, our analysis focuses on “pure efficiency change”. In the case of DMU  $i$ , technical change and pure efficiency change had a positive effect on productivity change, while scale efficiency change exerted a negative effect. Ray and Desli (1997) propose that the Malmquist index should be decomposed (by means of expansion and re-arrangement of terms) such as to reflect all three changes over time:

$$\underbrace{m_i^{t+1}}_{\text{productivity change}} = \underbrace{\left( \frac{D_v^t(x_i^t, y_i^t)}{D_v^{t+1}(x_i^t, y_i^t)} \cdot \frac{D_v^t(x_i^{t+1}, y_i^{t+1})}{D_v^{t+1}(x_i^{t+1}, y_i^{t+1})} \right)^{1/2}}_{\text{technical change}} \times \underbrace{\frac{D_v^{t+1}(x_i^{t+1}, y_i^{t+1})}{D_v^t(x_i^t, y_i^t)}}_{\text{pure efficiency change}} \times \underbrace{\left( \frac{D_c^t(x_i^{t+1}, y_i^{t+1})/D_v^t(x_i^{t+1}, y_i^{t+1})}{D_c^t(x_i^t, y_i^t)/D_v^t(x_i^t, y_i^t)} \cdot \frac{D_c^{t+1}(x_i^{t+1}, y_i^{t+1})/D_v^{t+1}(x_i^{t+1}, y_i^{t+1})}{D_c^{t+1}(x_i^t, y_i^t)/D_v^{t+1}(x_i^t, y_i^t)} \right)^{1/2}}_{\text{scale efficiency change}} \quad (2)$$

Note that this decomposition does consider the VRS assumption for the production technology.

Linear programming can also be used to construct the convex hull (and thus compute the Malmquist index and its decomposition) in the case of several inputs and several outputs, whereas the researcher would have to resort to one output with (output-oriented) SFA.

With data for three separate years (2001, 2006, 2011), we calculate the Malmquist index and its constituents for the year pairs 2001/2006 (“ $t=1$ ”) and 2006/2011 (“ $t=2$ ”) at the level of the university ( $i = 1, \dots, n$ ).<sup>5</sup> The resulting balanced panel is used to estimate—by least squares—models of the form

$$\begin{aligned} \ln y_{it} = & \alpha_0 + \alpha_1 UAS_i + \beta_1 D06_i + \beta_2 A06_i + \beta_3 D11_i + \beta_4 A11_i + \beta_5 W_i \\ & + \alpha_2 T_t + \alpha_3 (T_t \cdot UAS_i) + \beta_6 (T_t \times D06_i) + \beta_7 (T_t \times A06_i) \\ & + \beta_8 (T_t \times D11_i) + \beta_9 (T_t \times A11_i) + \beta_{10} (T_t \times W_i) + \varepsilon_{it} . \end{aligned} \quad (3)$$

Definitions of the regressor variables are given in Table 1;  $\varepsilon$  constitutes an error term, and we calculate clustered standard errors at the university level.<sup>6</sup> For the dependent variable  $\ln y$ , we define  $y$  either as the Malmquist index (productivity change) or its component, pure efficiency change.

In order to reduce the complexity of the actual ExIn application process somewhat, we consider only part of the program within a model. In particular, the dummies related to the

Table 1: Definitions of explanatory variables and means for the sample of 164 universities

$T$	dummy for the second year pair, 2006/11	0.500	
$UAS$	dummy for University of Applied Sciences	0.537	
		cluster of excellence	institutional strategies
$D06$	dummy for draft in 2006	0.335	0.152
$A06$	dummy for application in 2006	0.165	0.061
$D11$	dummy for draft in 2011	0.329	0.140
$A11$	dummy for application in 2011	0.213	0.098
$W$	dummy for winner in first phase	0.165	0.055

<sup>5</sup>Computations of the Malmquist numbers and decomposition are conducted with the program package *FEAR: Frontier Efficiency Analysis with R version 2.0* (Wilson, 2008), and the rest of the empirical analysis is conducted with *Stata* (StataCorp., 2013).

<sup>6</sup>In the present setting, a fixed effects model would yield the same results for the coefficients  $\beta_6, \dots, \beta_{10}$ .

ExIn reflect either only clusters of excellence (CE) or the institutional strategies (IS), but we do not distinguish “CE without IS” from “CE with IS”.<sup>7</sup> Furthermore, these dummies do not distinguish if a university submitted only one application for a cluster of excellence or several applications. Of course, more applications may have been associated with more workload in the application process, so our approach is a simplification.<sup>8</sup>

To be sure, many variables influencing productivity are omitted in this regression model; e.g., one could imagine that cultural amenities in a region attract productive researchers (Falck et al., 2011). To the extent that the variables only affect the *level* of productivity (or efficiency), we feel their omission is not a concern inasmuch as our outcome measures already reflect change over time. This and the fact that the dependent variable is expressed in logarithmic form implies that, e.g., coefficient  $\alpha_1$  approximates the difference in the five-year *growth rate* from 2001 to 2006 of productivity (or efficiency) between Universities of Applied Sciences and “full”, i.e. research-oriented, universities; the respective growth rate for the 2006 to 2011 period is calculated as  $(\alpha_1 + \alpha_3)$ , as  $\alpha_3$  measures the change in the growth rate from the first to the second year pair. If winning the “excellence” status was associated with a boost in productivity and if the program had no other effects, we would expect:

$$\beta_1, \dots, \beta_9 = 0 \quad , \quad \beta_{10} > 0 \quad \text{[Hypothesis 1]}$$

Another hypothesis would be that observation of the program exerted a productivity boost among full universities in general as departments realized that their eligibility for related programs in the *future* will increasingly depend on a successful track record. Assuming that this argument applies more to full universities than to Universities of Applied Sciences (which may have remained at their previous growth rate), we would expect:

$$\alpha_2 > 0 \quad , \quad \alpha_3 < 0 \quad \text{[Hypothesis 2]}$$

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<sup>7</sup>We do not consider the graduate schools part of the program. While they may constitute a re-arrangement of teaching activities, they do not require the design of new research agendas at the time of application.

<sup>8</sup>We also considered the raw numbers of applications instead of the dummy, but did not obtain superior results.

It is not difficult to imagine a combination of the two hypotheses such that full universities gained productivity relative to Universities of Applied Sciences, and that winners had the largest gains. Notice that these hypotheses paint a relatively optimistic picture with regard to the ExIn program.

When it comes to pure efficiency change, the interpretation of results may become less clear-cut if the winners were on (or very close to) the frontier to begin with—which received some support by preliminary static DEA results (results not shown). If they then shifted the frontier further outward than would have been the case without winning, and if other institutions could not keep pace with them, the result would be that those institutions lost efficiency, i.e.  $\alpha_2 < 0$ . Nonetheless, we might again use the Universities of Applied Sciences as benchmark by checking if  $\alpha_3 < 0$ , which would indicate that the non-participating full universities fared at least better than this group.

## 4 Productivity data

The Federal Statistical Office in Germany publishes data on tertiary education institutions on a regular basis, including the number of students or graduations, number of professors, and funding. Some additional information on the composition of funding was obtained through personal communication. While we sought to cover most universities, we exclude small institutions with less than 300 students as they may easily constitute outliers. Furthermore, some universities with missing information or with a major reorganization are excluded. In case hospitals were associated with the university in the official statistics, we took care to isolate only the core university for our analysis. Where this was not possible, we dropped the institution from the analysis, and we also dropped a few independent institutions that consist only of a hospital or medical faculty.

Table 2 lists the input and output variables that we employ in the construction of Malmquist index value and the pure efficiency change component. Funding by the German Research Foundation (*Deutsche Forschungsgemeinschaft, DFG*) is usually directed towards promising

Table 2: Input and output variables for Malmquist index calculations

Input variables	Output variables
number of professors	number of students
basic funding (minus estimated salary of professors)*	third-party funding by DFG (including <i>or</i> excluding ExIn funding)*
	third-party funding other than DFG*

\* EURO values converted to real figures with the consumer price index

projects of basic research, whereas “third-party funding other than DFG” also includes funding by companies. We split the two apart because it is not obvious how to treat the money that winners of the ExIn received through the DFG. While this money is included in the third-party funding figures, it is somewhat obvious that a winner tends to have more from this pool, so that winners pass the “efficiency gain” perhaps all too easily. Then again, even though we are indeed interested in the effect of winning on *further* success, one has to acknowledge that the winners have to realize the projects they applied for in the first place. So we decided to present results in which the funding from the ExIn is included (broad definition of DFG funding) and results in which this funding is excluded (narrow definition).

We have experimented with other combinations of inputs and outputs, in particular we used the number of graduates instead of students as output, or graduates per student. Admittedly, both the number of students and graduates do not come without flaws for our purposes. On the one hand, students may include individuals who are enrolled but do not actually pursue studies or write exams.<sup>9</sup> On the other hand, the Bologna process replaced the diploma degrees by degrees in bachelor and master, which likely had a sophisticated effect over time on the number of graduates during the period under study. In this case we opted for the number of students as the less problematic variable. It would be desirable to have other output measures related to scientific success, in particular the number of publications or publications weighted by some sort of impact. Unfortunately, official statistics do not publish bibliometric accounts at the university level, and an attempt at constructing such indices across all disciplines may

<sup>9</sup>This may be related to the fact that there are virtually no study fees at public institutions and that the student status warrants some amenities. However, a few states had mild study fees in effect in 2011.

be questionable due to differences in publication habits not only by location but by discipline (and different “weights” of disciplines across universities).

We distinguish two kinds of tertiary education institutions, Universities of Applied Sciences (UAS) and traditional universities. Traditionally, UAS are more teaching-oriented with higher teaching workloads for professors. In turn, these institutions are not the target of the ExIn program; they are even not entitled to apply. We consider these institutions as a benchmark insofar as they were not directly affected by the program but underwent other developments in a similar way, in particular the implementation of the “Bologna process” with which the new study programs were introduced.

Sample means for the Malmquist index and its components are presented in Table 3. These are simply unweighted arithmetic means in our sample of universities and not calculated for the aggregate. We notice, however, that universities typically experienced substantial increase in productivity—the Malmquist value of 1.2988 would imply a 30% increase in productivity for the typical university between 2001 and 2006; technical change and efficiency change were both important in this development, whereas changes in the size of the universities contributed to comparatively negligible scale efficiency change. For the second period, technical change was much larger, whereas efficiency declined for the typical university. The next section then takes the logarithms of the values from the “productivity change” or “pure efficiency change” columns as dependent variable for regression analysis.

Table 3: Malmquist index and its decomposition for 164 universities, sample arithmetic means

Period	Productivity change	Technical change	Pure efficiency change	Scale efficiency change
2001/06	1.2988	1.1523	1.1114	1.0160
2006/11 (incl. ExIn)	1.3535	1.4825	0.8959	1.0159
2006/11 (excl. ExIn)	1.3056	1.4167	0.9057	1.0133

## 5 Results

We first consider results from a model in which the dummy variables for draft, application, and winning are coded according to “cluster of excellence”. There is a strong correlation between application in 2006 and obtaining a grant, but we treat these variables as separate nonetheless.<sup>10</sup> The results from regression models of the form of equation 3 are presented in Table 4, with the logarithm of productivity change or the logarithm of efficiency change as the dependent variable. In columns 3 and 4, the funding received through the ExIn is subtracted from the original data on third-party funding. However, this only makes a difference for the second period, i.e. all coefficients for the first period are the same between columns 1 and 3 or 2 and 4. The reference category in these models is a full university (in the period 2001/06) that did not submit a draft for a cluster of excellence in 2006 or 2011. The (statistically significant) intercept term  $\alpha_0$  indicates an increase in both productivity and efficiency for such an institution.<sup>11</sup> In the second period, productivity growth was slightly (but not statistically significantly) larger, whereas efficiency growth turned negative, as  $\alpha_0 + \alpha_2 < 0$  suggests.

How did universities that applied for the program in 2006 differ from this group? As an application requires a prior draft, the effect in question is measured by  $\beta_1 + \beta_2$ , which is positive for both productivity and efficiency growth, albeit not statistically significantly positive. Here we abstract away from application in 2011, which has a puzzling negative effect for the first period. The group of institutions that would later receive funding for a cluster of excellence had an even larger productivity growth, which differed significantly from the group without draft in 2006 ( $\beta_1 + \beta_2 + \beta_5$ ), whereas differences in efficiency were less pronounced. In the second period, the results in column 1 indicate that institutions that received funding in the CE part of the program experienced more rapid productivity growth compared to the non-applicants (+0.253) and to the non-winning applicants ( $0.253 - 0.037 = 0.216$ ). These figures are smaller

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<sup>10</sup>While Table 1 gives the impression of a perfect correlation (with the same means for *A06* and *W*), the correlation coefficient between these variables is 0.82, with a few projects rejected and a few projects from the second round being granted.

<sup>11</sup>We refer to the concept of statistical significance here, but the reader should consider that the analysis is based on almost the entire population of universities so that the concept of significance is not all that relevant here.

Table 4: “Cluster of excellence” regression results

		incl. funding from ExIn		excl. funding from ExIn	
		Productivity	Efficiency	Productivity	Efficiency
		(1)	(2)	(3)	(4)
constant	$\alpha_0$	0.2607 *** (0.0682)	0.1505 ** (0.0684)	0.2607 *** (0.0682)	0.1505 ** (0.0684)
<i>UAS</i>	$\alpha_1$	0.0010 (0.0762)	-0.0667 (0.0762)	0.0010 (0.0762)	-0.0667 (0.0762)
<i>D06</i>	$\beta_1$	0.0442 (0.0781)	0.0425 (0.0643)	0.0442 (0.0781)	0.0425 (0.0643)
<i>A06</i>	$\beta_2$	0.0721 (0.0590)	0.0214 (0.0580)	0.0721 (0.0590)	0.0214 (0.0580)
<i>D11</i>	$\beta_3$	-0.1727 ** (0.0771)	-0.1573 ** (0.0632)	-0.1727 ** (0.0771)	-0.1573 ** (0.0632)
<i>A11</i>	$\beta_4$	-0.1408 * (0.0790)	-0.1327 * (0.0702)	-0.1408 * (0.0790)	-0.1327 * (0.0702)
<i>W</i>	$\beta_5$	0.0761 (0.0718)	0.0746 (0.0671)	0.0761 (0.0718)	0.0746 (0.0671)
<i>T</i>	$\alpha_2$	0.0702 (0.1050)	-0.2517 ** (0.1025)	0.0791 (0.1044)	-0.2181 ** (0.1036)
<i>T</i> × <i>UAS</i>	$\alpha_3$	-0.2347 * (0.1267)	-0.0465 (0.1230)	-0.2451 * (0.1263)	-0.0800 (0.1239)
<i>T</i> × <i>D06</i>	$\beta_6$	0.0010 (0.1605)	-0.0591 (0.1372)	-0.0089 (0.1592)	-0.0480 (0.1334)
<i>T</i> × <i>A06</i>	$\beta_7$	-0.0804 (0.0997)	-0.0002 (0.0741)	-0.1243 (0.1080)	-0.0063 (0.0823)
<i>T</i> × <i>D11</i>	$\beta_8$	0.1391 (0.1713)	0.0814 (0.1410)	0.1403 (0.1700)	0.1276 (0.1372)
<i>T</i> × <i>A11</i>	$\beta_9$	0.0703 (0.1551)	0.1352 (0.1280)	0.0592 (0.1634)	0.1149 (0.1402)
<i>T</i> × <i>W</i>	$\beta_{10}$	0.1399 (0.1367)	0.0509 (0.1096)	-0.0163 (0.1524)	-0.0613 (0.1282)
$R^2$		0.127	0.165	0.081	0.153
$\beta_1 + \beta_2$		0.116	0.064	0.116	0.064
$\beta_1 + \beta_2 + \beta_6 + \beta_7$		0.037	0.005	-0.017	0.010
$\beta_1 + \beta_2 + \beta_5$		0.192 *	0.138	0.192 *	0.138
$\beta_1 + \beta_2 + \beta_5 + \beta_6 + \beta_7 + \beta_{10}$		0.253	0.130	0.043	0.023
p-values of hyp. tests:					
$\beta_1 = \dots = \beta_9 = 0$		0.172	0.026	0.119	0.049
$\beta_{10} \geq 0$		0.846	0.679	0.458	0.317
Hypothesis 1 (approx.) <sup>a)</sup>		0.426	0.088	0.213	0.080
Hypothesis 2 (approx.) <sup>a)</sup>		0.958	0.031	0.967	0.072

Remarks: standard errors are given in parentheses, clustered at the university level; \*\*\*/\*\*/\* indicates statistical significance at the 1/5/10 % level. Each model is estimated with 328 observations. <sup>a)</sup> p-value derived from Fisher’s method.

for efficiency growth, and they almost melt away if the third-party funding is calculated net of the contribution through the ExIn, which arguably constitutes a more relevant comparison (columns 3 and 4).

The table also provides clues with respect to our two hypotheses, at least if we formulate the null in congruence with the respective hypothesis. Both hypotheses are composites of two tests, and we combine them due to Fisher’s method.<sup>12</sup> This is approximate at best and should therefore be interpreted cautiously because this method would require independence of the constituent tests. While the productivity specifications are indeed consistent with our hypotheses—which obviously does not prove them true—, we have to reject both hypotheses at the 10% level for efficiency change. As argued before, we should still be able to treat the Universities of Applied Sciences as a benchmark in the efficiency change equation, to the extent that the ExIn did not appeal to them. While  $\alpha_3$  is indeed negative and thus the benchmark group experienced worse efficiency change than the full universities without grant proposal, this effect is quite modest and not statistically significant both in column 2 and column 4. In other words, support for the notion that the ExIn brought about an efficiency increase in the system of full universities as a whole, is quite limited here.

Yet, a clearer pattern may emerge if we focus specifically on the large-scale funding scheme, “institutional strategies”. Table 5 repeats the exercise with the dummies defined according to this part of the program. Remarkably, some of the findings are reversed. Application—irrespective of success—for the program in 2006 was associated with lower productivity and efficiency growth in the first period than was the case among universities that did not apply. This time we find a stronger positive effect of winning for the winners on both productivity and efficiency in the second period ( $\beta_{10}$  in columns 1 and 2), and winners experienced significantly larger growth than universities that did not apply. Of course, the greater strength of the association (compared to the respective results in Table 4) may simply be due to the fact that the amount of funding for “institutional strategies” is relatively large. Interestingly, if we

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<sup>12</sup>Fisher’s method combines the p-values of  $k$  individual (independent) tests according to  $\tau = -2 \sum_{j=1}^k \ln p_j$ . If all null hypotheses are true,  $\tau \sim \chi_{2k}^2$ . We report as p-value the area in the tail of the respective  $\chi^2$  distribution.

Table 5: “Institutional strategies” regression results

		incl. funding from ExIn		excl. funding from ExIn	
		Productivity	Efficiency	Productivity	Efficiency
		(1)	(2)	(3)	(4)
constant	$\alpha_0$	0.1568 *** (0.0410)	0.0559 (0.0394)	0.1568 *** (0.0410)	0.0559 (0.0394)
<i>UAS</i>	$\alpha_1$	0.1048 * (0.0533)	0.0279 (0.0517)	0.1048 * (0.0533)	0.0279 (0.0517)
<i>D06</i>	$\beta_1$	0.0326 (0.1265)	0.0413 (0.0920)	0.0326 (0.1265)	0.0413 (0.0920)
<i>A06</i>	$\beta_2$	-0.1819 * (0.0967)	-0.1655 *** (0.0437)	-0.1819 * (0.0967)	-0.1655 *** (0.0437)
<i>D11</i>	$\beta_3$	-0.0526 (0.0909)	-0.0619 (0.0684)	-0.0526 (0.0909)	-0.0619 (0.0684)
<i>A11</i>	$\beta_4$	0.1632 (0.1247)	0.0751 (0.0622)	0.1632 (0.1247)	0.0751 (0.0622)
<i>W</i>	$\beta_5$	-0.0356 (0.1169)	-0.0192 (0.0670)	-0.0356 (0.1169)	-0.0192 (0.0670)
<i>T</i>	$\alpha_2$	0.1896 *** (0.0684)	-0.1909 *** (0.0606)	0.1878 *** (0.0687)	-0.1327 ** (0.0620)
<i>T</i> × <i>UAS</i>	$\alpha_3$	-0.3542 *** (0.0985)	-0.1073 (0.0911)	-0.3538 *** (0.0989)	-0.1654 * (0.0920)
<i>T</i> × <i>D06</i>	$\beta_6$	0.0104 (0.1992)	-0.0265 (0.1551)	0.0340 (0.2066)	-0.0075 (0.1431)
<i>T</i> × <i>A06</i>	$\beta_7$	0.1075 (0.1094)	0.0731 (0.0680)	0.2612 (0.1853)	0.2295 ** (0.1017)
<i>T</i> × <i>D11</i>	$\beta_8$	0.0758 (0.1523)	0.0533 (0.1173)	-0.0602 (0.1492)	-0.0143 (0.1124)
<i>T</i> × <i>A11</i>	$\beta_9$	-0.2288 * (0.1204)	-0.0710 (0.0974)	-0.2230 (0.1375)	-0.0573 (0.0949)
<i>T</i> × <i>W</i>	$\beta_{10}$	0.3488 ** (0.1530)	0.2741 ** (0.1074)	-0.1567 (0.2147)	-0.1010 (0.1368)
$R^2$		0.117	0.156	0.076	0.143
$\beta_1 + \beta_2$		-0.149	-0.124 *	-0.149	-0.124 *
$\beta_1 + \beta_2 + \beta_6 + \beta_7$		-0.031	-0.078	0.146	0.098
$\beta_1 + \beta_2 + \beta_5$		-0.185	-0.143 *	-0.185	-0.143 *
$\beta_1 + \beta_2 + \beta_5 + \beta_6 + \beta_7 + \beta_{10}$		0.282 **	0.177 **	-0.046	-0.022
p-values of hyp. tests					
$\beta_1 = \dots = \beta_9 = 0$		0.276	0.000	0.260	0.000
$\beta_{10} \geq 0$		0.988	0.994	0.233	0.231
Hypothesis 1 <sup>a)</sup>		0.627	0.003	0.231	0.000
Hypothesis 2 <sup>a)</sup>		1.000	0.007	1.000	0.083

Remarks: standard errors are given in parentheses, clustered at the university level; \*\*\*/\*\*/\* indicates statistical significance at the 1/5/10 % level. Each model is estimated with 328 observations. <sup>a)</sup> p-value derived from Fisher’s method.

subtract this part of the funding (in columns 3 and 4), winning is associated with *lower* (though not statistically significantly lower) growth in productivity and efficiency when compared to applicants that did not win or full universities that did not apply. Again, our two hypotheses are not rejected for productivity growth, with hypothesis 2 receiving even more support than before. However, we again reject both hypotheses for efficiency growth. This time, the more pronounced and negative time trend for Universities of Applied Sciences ( $\alpha_3$ ) relative to full universities without grant proposal provides some more evidence in favor of the notion that full universities as a whole may have benefited from the program.

## 6 Discussion and conclusion

The goal of the ExIn program is to pick the best institutions and help them catch up towards the world leaders. This could be seen as an output-oriented goal, whereas our analysis, through the lens of efficiency, addresses the relationship between output and input. Admittedly, this is not the intention of the program, but then again this relationship should not be ignored entirely in a publicly funded program. While the program is not tailored for the more teaching-oriented universities, we include them in the analysis as a “benchmark”. Our results suggest that the label “excellence” was costly to obtain. Institutions that prepared an application in 2006 lost considerably in terms of efficiency along the way. The costs may have been relatively large because the proposal had to be prepared as a joint effort of researchers of various disciplines (from the same university) who may not have been accustomed to working together.<sup>13</sup>

According to our results, universities with an unsuccessful application recuperated almost fully in terms of productivity *growth* to those universities that did not apply (but a level effect may have remained). In contrast, winners experienced more rapid productivity growth in the second period under study than what they lost in the first period, and this also translated into more efficiency growth. However, this is only true as long as we include the funding received

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<sup>13</sup>In an alternative specification (not shown here) that did not consider any third-party funding by DFG, we did not find the pronounced negative effect of application. This could imply that fewer “regular” DFG grant proposals were submitted as researchers were busy preparing the “institutional strategies” proposal.

through the ExIn program; efficiency declined and remained lower if we subtract these funds from the third-party funding by DFG. In other words, the program may not help winners to be more efficient in the future once funding from the program comes to an end.<sup>14</sup> However, if one subscribes to the idea that full universities and teaching-oriented universities should have followed the same efficiency growth pattern in the absence of the ExIn program, then our results provide some hint to the possibility that the system of full universities as a whole gained from the program in terms of productivity (hypothesis 2) and efficiency (negative  $\alpha_3$ ).

As Kempkes and Pohl (2010) we see the need to track changes in efficiency over time. A fortiori, a purely cross-sectional perspective in which the most efficient institution is sought may even be misleading against the background of a very heterogenous set-up of universities with respect to their relative sizes of individual departments (some of which are closer to industrial applications than others) or their relative focus on teaching. Instead, the Malmquist approach inherently allows for a “fixed effect” at the level of the university in that only changes are quantified. However, this study clearly has some limitations. First and foremost, input and output variables have to be chosen, and results depend, to some degree, on this somewhat arbitrary choice. While our variables are in line with an earlier study by Kempkes and Pohl (2010) on German tertiary education, several studies from other countries (especially those focused on certain academic fields) have considered publication-based figures from bibliometric accounting exercises as an additional or alternative dimension of output. We believe that our study does not entirely miss out on scientific accolades inasmuch as research grants reflect not only a proposal’s potential in the eyes of the donor but also a recent track record of the applicant. A further limitation is the disregard of a stochastic component in the data envelopment framework, which in turn demands a high level of precision from the data that may not be met in practice. This may not jeopardize the productivity analysis, especially as we only look at groups of universities rather than individual ones. Yet, errors in the data may lead to an erro-

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<sup>14</sup>One might worry that DFG reduced the funding of “regular” projects at universities that already benefited from “institutional strategies” in the sense that they raised the bar for applications from such institutions. In a specification of the Malmquist index that disregarded any third-party funding by DFG, we did not find a significant effect on efficiency change in the second period, which suggests that universities with “institutional strategies” did not become more efficient with respect to other sources of third-party funding.

neous accounting of the components of productivity change—and thus efficiency change—as the definition of the frontier may be affected by extreme data points. We also do not trace the development from year to year but used only three years as the basis of our calculations, at the risk of missing out on some interesting fluctuations in between. In addition, some effects of the program (and the “excellence” label) may only materialize in a longer perspective, and potentially have a lasting imprint even after the end of the program. That is to say, our estimates may be lower-bound estimates. We also do not take the international perspective into account and the question, whether universities were on a route to catch up to some international frontier.<sup>15</sup> Finally, our regression-based approach does not necessarily tease out the causal effect of the program. Apart from measurement error, one may worry that a good efficiency record in the past supported a positive grant decision, or that “excellent” universities would have gained efficiency compared to the rest of the institutions even without the program. As far as *changes* in efficiency are concerned, though, our results (Table 5, col. 4) do not corroborate such a concern.

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<sup>15</sup>In general, it may be difficult to come up with internationally compatible input and output variables, but see Agasisti and Pohl (2012) for a two-country application.

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