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The Road to Hell Is Paved with Good Intentions: Modeling Grant Competition between Universities

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Abstract: Competition is a core feature of science and has for some time also been viewed by institutions in the higher education sector, as well as the state, as an incentive to produce scientific output. Due to scarce financial resources third-party funding plays an increasingly important role. However, the race for the coveted grants also has its downsides and can lead to a loss of efficiency. To advance the discussion concerning grant competition we present a rent-seeking model that helps to understand the crucial factors influencing overall welfare. We show that the extent of the increase in productivity of independent research triggered by the grant competition, the extent of administrative expenses and the productivity of the research financed by the grant are decisive. Our main implications for policy-makers and university managers are that competition for third-party funding brings positive and negative effects and therefore, for the individual situation of the university, it has to be carefully considered whether scarce resources are invested in applications and that grant procedures should be designed in such a way that both a Matthew effect and a path-dependency effect are avoided.

Keywords: higher education; research; universities; rent seeking; public finance; funding; grants

JEL Classification: D69; D72; H39; I23; O31; O38

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1. Introduction

Third-party funding becomes more and more important for universities, especially in European countries with high public debts. For example, in 2018 German universities (incl. universities of applied sciences) generated 8,334,226 TEUR from third-party funding, as is shown in Table 1.

Table 1. German universities' revenues from third-party payers in 2018 (GFSO 2020, p. 28 f.).

Funding Institution Amount	(TEUR)
German Research Foundation (DFG)	2,774,537
Federation	2,295,711
Private Economy	1,505,133
EU	715,660
Foundations	516,106
Federal States	136,919
Total	8,334,266

The total revenues in 2018 consisted of contributions by students (1,348,478), revenues from economic activity and assets (20,365,934 TEUR), third-party funding (8,334,226 TEUR) and other sources (585,588 TEUR). Third-party funding accounts for 27.2% of the total

revenues. It seems to be clear that third-party funding has an important impact on the scientific system.

However, we must point out that there are fundamental differences between the scientific financing system in the United States and most European countries (Stephan 1996), while expenditures of European universities are mostly covered by the state, in the U.S. researchers are responsible for generating funding on corresponding markets. Recent developments, particularly determined by high public debts, lead to an increasing importance of third-party funding in European scientific systems as well (e.g., for Germany Musselin 2018; Sieweke et al. 2014).

This development creates competition between the universities for third-party funding which becomes more and more one of the main characteristics of the modern scientific reward system (from a sociological point of view see Merton 1968). Furthermore, the state is trying to increase the productivity of universities through a monitored competition for grants, while financial support from funding organizations—regardless of whether these are private or governmental organizations—are naturally scarce, contestants normally have to invest resources to enter the competition and their chances to finally obtain the grants obviously increase with the amount of invested resources.

While competition is generally seen as something desirable from an economic perspective, we would like to point out that grant competition in the field of research also has downsides. With our paper we focus on the aspect under which circumstance a grant competition can result in a misallocation of scarce resources. With respect to this aim, we transfer the well-known rent-seeking approach (Krueger 1974; Posner 1975; Tollison 1982; Tullock 1967, 1980) to the scientific system in general and the grant competition in particular.

Our paper is structured as follows: In Section 2 we present the theoretical background and in Section 3 the model of a monitored grant competition is presented. The discussion of the findings takes place in Section 4. In addition, the limitations of the model are outlined in Section 5. Section 6 summarizes our results.

2. Theoretical Framework and Literature

2.1. Universities, Science and Competition

The economic analysis of scientific systems and scientific behavior is not new, but compared to the sociological literature on science (e.g., Cole 1983; Fleck 1980; Kuhn 1962; Merton 1938, 1957, 1968, 1969, 1973) it seems to be underdeveloped. One reason could be that the economic behavioral model of homo economicus, which systematically reacts to incentives and contrasts the expected costs of an action with the expected benefits, appears prima facie incompatible with CUDOS norms and the ethos of science (Merton 1938). Nevertheless, a considerable amount of work on the economic analysis of the science system has developed from modern information economics (e.g., Arrow 1962). In this context we should mention for example the reward structure of science (e.g., Diamond 1986), problems of the publishing system (e.g., Frey 2020; Osterloh and Frey 2020), the impact of accreditation systems (e.g., Sánchez-Bayón and Aznar 2021), scientific misbehavior (e.g., Emrich and Follert 2019; Necker 2014, 2016), the (open) access to knowledge and data (e.g., Feess and Scheufen 2016; Mueller-Langer et al. 2020; Scheufen 2015), the job market for scientists (e.g., Ehrenberg 1991, 1992) and the determinants of scientific well-being (Feld et al. 2015). One important strand of literature is the analysis of funding regimes (as an overview see (Stephan 1996, p. 1225f.)).

In previous research in the field of competition between universities, two main areas can be identified:

In a first area, general management issues relating to a competition between the universities are preferably addressed. This branch of research includes questions of organizational realignment (e.g., Clark 1998), strategic positioning (e.g., Fumasoli et al. 2020) and the acquisition of students. For example, (De Fraja and Iossa 2002; Del Rey 2003) and (Geiger 2002) evaluated the competition for students and how their mobility attitudes determine their favored university. In addition, there are empirical studies of an efficiency comparison

between the universities (e.g., Bowrey and Clements 2020)—even on the departments' level (e.g., Halkos et al. 2012)—that use data envelop analysis (DEA), for example.

In the second area of research, which could be referred to as "grants and universities in competition", two main research strands can be identified: On the one hand, some studies deal with the effects of funding on the universities' structures and resources. For example, (Hoenig 2018) empirically investigates the effects of funding from the European Research Council (ERC) on public universities from the perspective of researchers towards their institutions. The effects on the scientific career and mobility of researchers as well as on the research content are examined. On the other hand studies deal empirically with a possible bias in the award of grants. For example, (Murray et al. 2016) found for a Canadian grant program that applicants from smaller universities are apparently disadvantaged.

Even if competition between universities is obviously of growing interest, the research on grant systems is astonishingly unelaborated. What has been completely missing so far in this context, however, is an examination of the efficiency of a competition for research grants.

2.2. Effects of a Competition between Universities

Universities could be interpreted as "capitalistic state-enterprises" (Weber 1951; Emrich 2014, p. 8) that produce knowledge (Emrich and Thieme 2017; Weber 1951). Competition between universities as well as research institutes is central for their organizational shift that can be fruitful but also detrimental to the overall academic and scientific progress. From a political perspective, scientific competition should lead to a systematic analysis of actual research findings which undergo a beneficial peer review that can enhance its quality (on problems that result from these incentives see, e.g., Osterloh and Frey 2020). Furthermore, this can promote a fair judgement, open examination and also productivity in the knowledge production process (Anderson et al. 2007). Many authors such as (Ben-David 1960; Hagstrom 1974 and Ben-David and Zloczower 1962) emphasize competition in sciences as a driving force in innovation progress and estimate its burden as rather low in comparison to its benefits. Besides this, the competition between universities has stimulating effects on university teaching (see, e.g., Poyago-Theotoky and Tampieri 2016). Sánchez-Bayón and Aznar (2021) show how the competition between business schools has been stimulated by the accreditation system in Spain. Through this the Spanish business schools improved their international ranking immensely, which, however, came with downsides like a substantial increase in costs.

In addition to these advantages, there are also some disadvantages from competition between universities. The rivalry can hamper scientific progress. Whereas these detrimental aspects are often discounted as academic gossip, some authors have elaborated this topic more seriously. Blumenthal et al. (2006) report on high degrees of competition in the life sciences and how this affects the behavior of scientists. Following this argumentation, they are often very concerned about opportunism from their scientific peers and hence are prone to withhold data and results which includes delayed publication, omitting information, etc. From the point of view of the individual researcher, such behavior is rational, because otherwise he would run the risk of his findings being published in another researcher's article before he publishes them himself. However, from an aggregated perspective such attitudes could hamper scientific progress and may lead to duplicated research as it might be hard to evaluate findings someone else already made when not all information is available. A system that heavily relies on grants to finance its research is very likely to be even more affected by this development as competition and rivalry as well as opportunism are enhanced (Anderson et al. 2007).

The well-known reward structure in science rewards priority and takes the form of a winner-takes-all contest in research races (e.g., Stephan 1996). As well as every human, scientists and universities have to allocate their scarce resources in an efficient way based on their personal preferences (in general, e.g., Follert et al. 2020; Mises 1998). In allocating those resources in the best way to fulfill their target function, the players are restricted, e.g.,

through (external) incentives set by their institutions or the political agents. Additionally, only small differences in input factors such as human capital, time and other resources result in huge differences in the distribution of economic rewards (Cook and Frank 1996) that include research funds, reputation and the overall career trajectory. Therefore academic competition can also result in self-exploiting and opportunistic behavior of scientists in order to be the first who publishes about a certain field of research and win the race for tight money.

However, on the other side a system which relies on priority will also provide non-market incentives such as reputation and a quasi-form of intellectual property right. This knowledge might have never been produced otherwise because of a too low incentive structure to undertake this kind of research (Dasgupta and David 1987; Stephan 1996). Hence, it is hard to evaluate the overall outcome of an academic winner-takes-all system as it can reinforce secrecy in the scientific landscape but also may increase the effort to produce and publish at least the majority of knowledge that was produced. In spite of these shortcomings, the competition between universities seems to be fruitful.

2.3. Reasons for the Growing Importance of Research Grants

There is high anecdotal evidence that there is an increasing importance of third-party funding and research grants within the scientific systems around the world, even in countries where we can observe a close relationship between state and science. Several reasons are discussed for this development. According to (Polster 2017) who analyzes the academic landscape of Canada, the main reason is a shift in the understanding of a university's role in society. Whereas the traditional tasks of a university lay in the field of teaching and research with only minor direct connections to industry and commercial applications, it is nowadays expected that universities become a central player in regional innovation systems (Gunasekara 2006). Hence, universities should help to enhance the competitiveness of domestic companies and of states in a global market that is more and more driven by a knowledge-based economy (Polster 2017). This understanding of the university as a central player in a market for knowledge implies that the university is financially supported by the beneficiary companies for its achievements.

There is also a deep belief that in order to enhance the mentioned international competitiveness a national competition system has to be established as well. This mindset involves the academic sector and might be one reason for the growing importance of research grants.

A particular reason is to increase the research productivity of universities, particularly through a monitored grant competition. For example, the German program of the Excellence Strategy has the goals of sustainably strengthening the science location, strengthening the universities by promoting top scientific achievements, profiling and cooperation in the science system, training top performers in research and promoting the quality of the science location on a broad basis (BMBF 2019).

2.4. Potential Effects of a Grant Competition

The introduction of a competition for research grants intensifies the competition between universities just described. In this way, the research output of the universities could increase. At the same time, however, the negative effects of such competition, such as the reluctance to publish research results or self-exploitation, are likely to intensify as well. All in all, welfare gains could be expected from such intensified competition. However, a competition for grants changes the behavior of researchers. On the one hand, (1) resources are invested in obtaining grants that would otherwise be used for research projects. Furthermore, on the other hand, (2) a grant competition leads to a change in the research portfolio in such a way that research is increasingly directed into areas that are promising in obtaining grants.

Ad (1) A grant application can be interpreted as a specific form of rent seeking (an overview of the relevant theoretical approaches such as the new-institutionalism approach

and other heterodox approaches is given by (Sánchez-Bayón and Aznar 2021 and Sánchez-Bayón et al. 2022). As the classical rent-seeking literature (e.g., Posner 1975; Tullock 1967, 1980) shows, considerable resources are channeled into generating rents. This fact is reflected in a loss of welfare. However, Abbott and Brady (Abbot and Brady 1991) who have examined rent-seeking contests in depth argue that general competition for rents may create products and markets that might not exist without rent-seeking activity. Their argumentation clearly reduces the assumed welfare losses due to rent seeking. Applied to a universities' competition for grants this would mean that without a grant competition particular scientific findings might never be elaborated. However, it seems doubtful whether Abbott and Brady's argument applies to a grant competition, because grants are often awarded for application-oriented research and less for basic research. This leads us to the second aspect.

Ad (2) Often grants are awarded for application-oriented research, which is particularly true for research grants offered by the industry. That means that grants are often tendered to specific problems with a narrow applicability. Such applied research has usually a limited range of usage and therefore lower scale effects in comparison to more basic research approaches. Applicable research leads to faster usages in end products whereas basic research might have a broader range of potential fields of application but normally cash out in the long run. Often it is even hard to draw a direct linkage between the basic research performed and the economic welfare gains that emerge with a long time lag. Furthermore, the economic outcomes generated by basic research have in many instances a rather indirect character and its producer might never be able to generate any economic payoff. Frequently basic research generates learning effects or the development of byproducts that were originally used to perform the research tasks and are later applied in other fields (David et al. 1992). Unfortunately basic research rarely leads to any patents which could be licensed or otherwise commercial used. Additionally, basic research answers all too often unposed questions (Stephan 1996) that are normally not covered by the majority of grants which discriminate against this type of knowledge production in comparison to applied research.

This observation lets us argue that in the majority of cases investments in grant competitions are less valuable for society than if they would be invested in non-grant related research. Nevertheless, grants are highly esteemed among regulators from politics and academia.

3. Modeling the Effects of a Monitored Grant Competition between Universities

A strict methodological individualism (see Agassi 1960; Gellner 1968) would regard the individual researcher as the decisive agent who, e.g., strives for a high income and a good reputation through publications and the acquisition of grants. However, the realization of such an objective and thus the success of the research largely depends on the institution that creates the material and personnel environment relevant for research. Universities can be seen as such institutions that create crucial conditions for research. The aim of these institutions is to achieve the highest possible research output, as this increases on the one hand the reputation of the institution, which has a positive effect on the attractiveness of the same for other researchers. On the other hand, this improves the legitimacy of this institution in the public discourse, which is of considerable importance against the background of public funding. In this respect we leave the purely individual perspective, abandon the strict methodological individualism and regard universities as the decisive agents, which acquire an anthropomorphic character in this context.

Against this background we want to examine the effects of a monitored grant competition between universities by using a model based on rent-seeking theory. In particular, we want to analyze the conditions under which a grant competition can lead to welfare gains or losses. In this model it is assumed that the state awards one grant for which universities can apply. We assume that the competition initiated as a result is designed as a winner-takes-it-all competition. Universities invest in the application for this grant and one of these universities is awarded by receiving it.

3.1. Research before Grants

Let us assume that there are N universities. University i ($1 \leq i \leq N$) has a budget B_i. If the specific university is irrelevant, we will also denote the budget of a university just by B. We assume that the budget dedicated to teaching is fixed for all universities and therefore can be ignored.

Before the introduction of grants and neglecting all further costs, the budget B_i of university i reserved for free research is F_i. The utility function of a university is

$$U_i(F_i) = c_f F_i,$$

where the constant factor c_f is assumed to be equal for all universities.

We assume that the sum of the universities' utility is equivalent to the total welfare

$$U = \sum_{i=1}^{N} U_i \,.$$

The overall budget of the government spent for research is $\mathcal{B} = \sum_{i=1}^{N} B_i$.

3.2. Introduction of Grants

Now the government introduces a grant—without increasing the overall budget. That means the universities' budgets are reduced by a factor r. The new budget of university i is equal to $B^{(i)}$, where

$$B_i = (1-r)B_i^{prev} \,,$$

and B_i^{prev} is the research budget of university i before the introduction of grants.

The government announces a call for a research grant of amount G which will be given to a *single* university. The ratio r of the overall budget $\mathcal{B}$ is dedicated to this grant G and its administrative costs. That is, the grant is equal to $G = s\mathcal{B}$, where $0 < s < r$.

Each university distributes its budget B_i into the shares F_i and A_i, where F_i is spent for free research and A_i is spent for acquiring grants. Together, $B_i = F_i + A_i$.

We want to focus on the relationship between a grant application and free research. The grant application may lead to an increase in efficiency in the free research, i.e., the factor c_f increases. This means that the introduction of grants leads to a higher marginal utility of free research.

With the introduction of grants, the new utility function of university i ($1 \leq i \leq N$) is

$$U_i(A_i) = c_f F_i + c_b G_i = c_f(B_i - A_i) + c_b G_i,$$

where c_f is the increased marginal utility and c_b is another constant with $c_b < c_f$ which stands for the marginal utility of grant financed research. G_i is the amount of grants of the university.

The total welfare after introducing grants is equal to

$$U = \sum_{i=1}^{N} U_i(A_i) \,.$$

3.3. Rent-Seeking Model and Total Welfare

Each university dedicates the amount A_i of its budget to get the grant, with probability $p(A_i)$ the university will get the grant. We assume the symmetric case: the probability function is the same for all universities. Additionally, we have:

$$\sum_i p(A_i) = 1,$$

where the sum runs over all universities. Thus, the expected grant budget of the university i is $p(A_i)G = p(A_i)s\mathcal{B}$ and therefore the utility function of university i ($1 \leq i \leq N$) can be reformulated as

$$U_i(A_i) = c_f(B_i - A_i) + c_b G p(A_i)\,.$$

University i will devote an optimal amount A_i^* of the budget to get the grant, subject to the constraints

- $U_i(A_i^*) = \max_{A_i}\{U_i(A_i)\}$, where $0 \leq A_i \leq B_i$,
- $c_b G p(A_i^*) > c_f A_i^*$.

The meanings of the two constraints are: The first inequality expresses the fact that the university chooses A_i^* in such a way that it maximizes its generated utility. The second inequality requires that the university will only spend parts of the budget for grant acquiring if the utility function of the university increases.

Assuming that the competition for the grant can be modeled as a rent-seeking contest according to (Tullock 1980) where the probability that university i gets the grant is assumed to be determined by the logit function

$$\frac{A_i^\gamma}{\sum_j A_j^\gamma}\,.$$

for an unkown exponent γ. Kooreman and Schoonbeck (Kooreman and Schoonbeek 1997) discuss that under certain reasonable conditions the logit function is the natural and unique function which determines this probability.

The FOC of this maximization problem is

$$U_i'(A_i) = -c_f + c_b G \frac{\gamma A_i^{\gamma-1}}{\left(\sum_j A_j^\gamma\right)^2} \sum_{j\neq i} A_j^\gamma = 0\,.$$

Rearranging gives

$$c_b G A_i^{\gamma-1} \sum_{j\neq i} A_j^\gamma = c_f \left(\sum_j A_j^\gamma\right)^2.$$

Given symmetry (c_f and c_b are the same for all universities), for small values of γ there will be a Cournot–Nash equilibrium resulting into $A_j = A^*$ for all $1 \leq j \leq N$ with the optimal budget to devote to get the grant proposal being

$$A^* = \gamma \frac{c_b}{c_f} \frac{N-1}{N^2} G\,.$$

In general, denoting with c_f^{prev} the value of c_f before the introduction of grants, comparing total welfare before and after introduction of grants

$$\Delta U = U - U^{prev},$$

resolves in

$$\Delta U = \mathcal{B}\left(c_f - \frac{c_f^{prev}}{1-r} + s c_b \left(1 - \gamma \frac{N-1}{N}\right)\right).$$

If the number of competing universities is large, ΔU is approximately

$$\Delta U = \mathcal{B}\left(c_f - \frac{c_f^{prev}}{1-r} + s c_b (1-\gamma)\right).$$

4. Discussion

Based on our model we can identify crucial factors indicating whether there will be a welfare gain or loss:

1. The relative size of the grant compared to the overall universities' budget s;
2. The marginal utility of the grant financed research c_b;
3. The share r of the overall universities' budget which is retained by the government;
4. The proxy of the discriminatory power of the CSF γ (Szymanski 2003, p. 1141);
5. The marginal utility of free research before introducing grants c_f^{prev};
6. The marginal utility of free research after introducing grants c_f.

The following findings can now be drawn from the formula for ΔU: Assuming that the relative size of the grant compared to the overall universities' budget s stays constant, then the higher r—the share of the overall universities' budget which is retained by the government—the lower the growth of total welfare through the introduction of grants. This means that as soon as the difference between r and s, which makes up the costs for the administration or management of the grants, becomes too large, the overall welfare will be reduced through the introduction of a grant competition.

The change in the marginal utility of free research also plays a major role. It can be seen that a positive welfare effect can be expected from the introduction of the grant competition, especially if the marginal utility of free research is increased by the grant competition. This could be suggested by the fact that reducing the resources available for free research increases the efforts of researchers, because they have certain goals for their free research that they absolutely want to realize or it could be a reduction of the existing university's X-inefficencies (Leibenstein 1966). However, by applying for grants, funds could be diverted to an extent that no longer allows independent research to tackle larger projects in the university in question, as the larger investments required for this (such as in laboratories, etc.) can no longer be carried out.

In addition, the reduction in the funds available for free research could lead to a demotivation of researchers. If the marginal utility of free research falls through the grant competition, it is to be expected that the overall welfare effect of the grant competition will be negative.

The marginal utility of the grant financed research deserves further attention. It should be obvious that the smaller the marginal utility of grant financed research is compared to the marginal utility of free research, the more likely it is to be assumed that grant competition leads to a loss of welfare. Effects of this kind are likely to occur in the long term, since the grant competition and the associated application and review processes lead, on the one hand, to a focus of research on certain areas. On the other hand, it is to be expected that an effect comparable to logrolling will occur in the assessment process: Since a complete double-blind assessment is hardly possible, groups of researchers can form that assess their applications favorably. In this way, less promising research projects would also be better enforced at the expense of the burden. In addition, it can be assumed that the success of the research can only be inadequately assessed by an assessment committee, which necessarily applies certain standards.

A significant effect on the change in overall welfare results from the proxy of the discriminatory power of the CSF (γ). As (Szymanski 2003, p. 1141), notes, "a high γ implies that even slightly higher effort than one's rivals ensures a high probability of winning the prize, while a low value of γ implies that differences in effort have little impact on outcomes." The higher the value of γ, the lower the increase in welfare due to the grant competition. So if even marginal increases in the expenditure for applying for the grant lead to a strong increase in the probability that the grant can be won, then universities invest a larger part of their budget in applying for the grant. In turn, the value of γ depends on the design of the assessment process. If the universities assess the review process as largely opaque and therefore conclude that higher effort does not necessarily increase the likelihood of winning the grant, they will tend to invest fewer resources in applying for the

grant. Paradoxically, a more transparent award with transparent criteria leads to a high γ and thus a lot of resources are directed into the application process. Since this represents sunk cost for all universities, this leads to a decrease in welfare due to the grant competition.

The following economic and educational political implications can be derived from these relationships: On the one hand, the administrative costs in connection with the grant competition must be kept low. On the other hand, the model suggests to make the award process non-transparent; this prevents universities from investing too many resources in applying for the grant. The introduction of a grant competition should be avoided if the increase in the marginal utility of free research is low or even negative, i.e., if the productivity of free research is not stimulated by the grant competition in the universities. Likewise, from the point of view of general welfare, the grant competition does not make sense if the marginal utility of the grant financed research is low compared to free research. The stimulating effect of the grant competition on free research must therefore compensate for the administrative costs and the lower productivity of the grant financed research, otherwise the grant competition leads to a loss of welfare.

5. Limitations

The model is based on the idea that the utility of universities can serve as a measure of overall welfare. In this respect, the utility function of the universities could also be interpreted as a production function. Of course, these assumptions result in limitations of the model. The model assumes that there is symmetrical competition between the universities (Szymanski 2003), that is, that marginal utility—or marginal productivity—of research is equal in all universities. In fact, however, the marginal utility of both independent research and grant-funded research is likely to differ considerably from university to university (Mammadov and Aypay 2020). In addition, it can be assumed that at some universities the marginal utility of research financed by grants is less than that of free research and that at others exactly the opposite occurs. Asymmetrical competition could mean that universities that see themselves as having no chance in the grant competition do not take part in the competition at all. Thus, the grant competition could lead to—of course depending on the design of the selection process—resources being withdrawn from research-weaker universities and more resources being made available to the more research-intensive universities.

Another problem is the concept of utility. The model assumes that, on the one hand, the utility results from the amount of resources invested—in other words, if more resources are used for research, the utility of the research increases. This implies the existence of an innovation production function (Griliches 1979); however, (Schrerer 1992) already shows that there is apparently no significant correlation between R&D activity and the rate of innovation, which means that the existence of a production function for innovations must be completely called into question. The benefits in the model result from the "earnings" of research, commonly known as the production of innovations. Of course, this also involves the problem of recording and measuring such innovations (Nelson et al. 2014). In addition, the fact that research can result in corresponding external effects is neglected: free research and research funded by grants could be mutually beneficial.

Furthermore, it is a partial analysis. The governmental funding of the universities, which presumably comes from taxes, initially results in welfare losses for taxpayers, which are of course not taken into account in this model. In addition, the administration of the grant competition causes considerable costs, which, however, donate benefits elsewhere, since income is associated with it. A partial analysis of the grant competition must neglect both facts.

The model is based on the fact that only one grant is payed off. If the number of grants increases, it can be expected that the resources invested in applying for the grants will increase. Whether this then leads to a higher overall welfare initiated by the grant competition needs to be analyzed.

In the model, universities are viewed as anthropomorphic players, which they are not, of course, in reality. Rather, it can be assumed that the research performance of the departments differs considerably in each university (Abd Aziz et al. 2013). A grant competition will tend to divert resources from less research-intensive areas to more research-intensive areas and thus triggers a structural effect within the universities. The unpredictability of the research results and the non-existence of an innovation production function, i.e., the fact that the decisive characteristic of the innovation process are trial-and-error processes, has a considerable implication for the grant selection process.

At the moment, it seems that universities or departments that have already been successful in applying for grants are more likely to be successful in the grant competition in the future. On the one hand, this is due to the fact that the applications for grants are mutually evaluated by researchers on the basis of the peer review process, and researchers who have already been successful in acquiring grants tend to be hired as reviewers. In this way, at least informal networks emerge that favor a specific research direction that is already established. On the other hand, the institutions that allocate grants certainly have an interest that their financial resources are used for research purposes that promise at least a certain, albeit small, research output. This is more the case with traditional research approaches than with innovative ones, especially since the risk of failure is significantly greater with the latter. This creates a Matthew and a path-dependency effect (Kuhn 1962; Merton 1968). Future grants will not only be awarded to units that have already enjoyed frequent grants, but the same research areas will tend to be funded over and over again. The selection procedure for the grant competition should, however, be geared towards favoring a broad spectrum of applications and thus increasing the likelihood of innovations. This can be achieved, e.g., by establishing a two-stage decision procedure for grants. In the first stage, the application for grants is evaluated with regard to the formal requirements. These include, e.g., the availability of the necessary research expertise as well as the personnel and material resources. In the second stage, a lottery procedure is carried out. This means that every application that has passed the first stage has the same chance of success on the second stage. Another approach of allocation could be that every researcher who can prove the required scientific qualification is granted a one-off application for grants. Both instruments would significantly improve the possibility of unorthodox and innovative research approaches being funded by third parties.

6. Conclusions

The purpose of a grant competition is to increase the efficiency of free research and thus improve overall welfare. The presented model can be used to show the conditions under which such a grant competition leads to such an improvement. The decisive factors here are the extent of the increase in productivity of independent research triggered by the grant competition, the extent of administrative expenditure and the productivity of the research financed by the grant. A major problem of such a competition is the emergence of a Matthew effect and the path dependencies triggered by the grant competition, which negatively affect the "long-term" productivity of research. Admittedly, such a competition—if the selection process is designed sensibly—can result in a positive structural effect on the one hand in the university landscape and on the other hand within the universities themselves.

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