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(Self-)Selection, Incentives and Resources – a Personnel Economics Perspective on Academia and Higher Education

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Abstract

In our paper, we view academia from a personnel economics perspective and analyze three important questions: (1) Who decides to become a researcher and what are the mechanisms of selection and self-selection that drive this process? (2) What makes researchers stay motivated and how can they be incentivized? (3) What other factors, aside from incentives, determine a researcher's productivity? In our selective review of the literature, we show how personnel economics has contributed and may further contribute to an enhanced understanding of the functioning of the academic system. First, however, we elaborate on a researcher's outcome dimensions, why these need to be measured by adequate output indicators and why differing inputs have to be taken into account. Here, too, personnel economics may contribute since it highlights the virtues and potential pitfalls associated with the identification of relevant outcome dimensions and potential measurement problems, and since it provides us with the necessary tools to assess productivity.

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1. Introduction

Viewing academia from a personnel economics perspective means focusing on its personnel, i.e., its human resources. Although many different groups of employees contribute to the functioning of the academic system, researchers arguably make up the group that is the most important. From a personnel economics perspective, the following questions concerning this important group of personnel arise:

(1) Who decides to become a researcher? What are the mechanisms of selection and self-selection that drive this process? What are the intended and potentially unintended side effects?
(2) What makes researchers stay motivated? How can they be incentivized? Do they need to be incentivized?
(3) What other factors – aside from incentives – determine a researcher's productivity? What can be done to enhance a researcher's productivity? What can be done in terms of training and development? What can be done on an organizational level?

In our selective review of the literature, we will investigate these three sets of questions and show how personnel economics has contributed and may further contribute to an enhanced understanding of the functioning of the academic system. However, we must first elaborate on the more fundamental question of what researchers in academia actually do, or to be more precise, what they should be doing. That is, we need to define their relevant outcome dimensions and how these might or should be measured by adequate output indicators. Furthermore, we must also take into account differing inputs in an attempt to measure productivity, and not simply outputs, before we can consider how to incentivize researchers (question set 2) or how to select the "best" researchers (question set 1) and how to adequately support them (question set 3). Here, too, personnel economics may contribute because it highlights the virtues and potential pitfalls associated with the identification of relevant outcome dimensions and potential measurement problems, and it provides us with the necessary tools to assess productivity.

Our paper is organized as follows. Section 2 addresses the relevant outcome dimensions in academia and the associated measurement problems with respect to the identification of output indicators. Section 3 describes the process from output to productivity measurement. Section 4 highlights the selection and self-selection processes into the academic system and hints at potentially unintended effects. Section 5 focuses on incentives in the academic system and how these have been affected by the new public management reforms. Again, a personnel economics perspective highlights the potential negative side effects associated with the reforms. Section 6 highlights other drivers of research performance and concentrates on human, social and organizational capital as important resources. Section 7 concludes the paper.

2. Defining the Relevant Outcomes in Academia and Searching for Adequate Output Indicators

As PULL (2009) has argued, researchers in universities basically produce three different outcomes: (i) they undertake research and publish their results, (ii) they teach and (iii) they serve their scientific community by, for example, taking posts as deans and reviewing the work of peers.[1] A university researcher's job can thus be characterized as what would typically be called "multi-tasking." From a personnel economics perspective, it is clear that *if* one wants to measure a researcher's outcome, (a) one has to measure it in every relevant dimension *and* (b) one has to measure it *adequately* to avoid producing adverse effects. This is true not only if incentives are tied to the output measurement but also if it is "only" measurement as such. SCHNEIDER (2007) convincingly shows for judges in the National Labor Relations Board in the US, measurement per se might itself have behavioral consequences.

If it is measurement *per se* that matters, then, as PULL (2009) highlights, (a) measuring only one dimension of a researchers' outcome will inevitably attract the researcher's attention to this one outcome dimension and may lead to an unbalanced outcome portfolio. For example, if only the research outcome is measured by a corresponding output indicator, and teaching and service outcomes are not measured, then a researcher will focus on his or her research activities at the expense of teaching activities and services to the scientific community. This unintended side effect of measuring (and potentially even incentivizing) only one of several relevant outcome dimensions is a straightforward application of the well-known "equal compensation principle" in personnel economics (MILGROM/ROBERTS 1992, STADLER 2003). The argument going beyond the equal compensation principle is that even in a situation in which there are no explicit incentives tied to the output measurement, if the measurement is made public and may hence affect a researcher's reputation, then a one-dimensional measurement will potentially lead to an unintended concentration on the measured outcome dimension. Although the equal compensation principle and the above-derived generalized implication are only valid in a situation in which an employee's effort cost function is characterized by perfect substitutability in effort costs with respect to the different tasks to be fulfilled (i.e., where there are no complementarities between the different outcomes), SLIWKA (2010) has shown that in cases where there is no perfect substitutability in effort costs (as might be argued to be the case for researchers in academia; see below), there still needs to be "similar compensation" for the different outcome dimensions. That is, in the case of academia, there would also need to be similar public recognition for teaching and for services to the scientific community, and if there is not, outcome measures are inefficient at best or may cause negative side effects.

Furthermore, as PULL (2009) emphasizes, it is important to ensure that the different outcome dimensions are adequately measured with the help of appropriate output indicators (b). In spite of the many and substantial problems associated with the adequate measurement of *research* activities, it is still much easier to at least find proxies for the measurement of research than for the measurement of teaching outcomes or of services to the scientific community. A researcher's research can be measured by counting publications and adjusting for page lengths and/or for the number of coauthors in an attempt to assess the quantity dimension of research. One can also try to assess the quality dimension of research by counting citations or by assessing the quality of the journals in

[1] Further, researchers are expected to advise politicians and practitioners on the basis of their research and – depending on their field – also to engage in technology transfer.

which the researchers' papers have been published. Although the adequacy of the various proxies is a much-discussed topic (in the scientific community as a whole and in the day-to-day work of appointment committees), there is at least an idea of and a discussion about how research might be assessed. This situation is very different with respect to the assessment of teaching outcomes or of services to the scientific community.

With respect to *teaching*, PULL (2009) argues that evaluators would like to know whether and how a lecturer contributes to preparing a student for the different tasks (s)he might have to perform in later life, be they in business, academia, politics or society. A good teacher might even help a student determine the fields to which (s)he can contribute most. Obviously, this potential outcome of teaching can hardly be assessed. Asking the alumni will not really help: first, one would need to wait for a significant amount of time to be able to ask the relevant questions, and second, it will obviously not be possible to trace an alumnus's career success back to a single lecturer or even a single course. One might be able to learn something about the comparative success of different study programs at different institutions (assuming that teaching is a team production). However, even then, one would have to account for (and econometrically control for) different starting conditions, such as different student populations, regionally different labor market conditions and different financial resources and constraints. Provided one actually managed to measure team teaching performance, one would still not be in a position to assess an individual lecturer's contribution to this teaching performance. In fact, measuring (and potentially then also incentivizing) teaching performance on a team level might result in the well-known free-rider problem highlighted in the personnel economics literature. Using student evaluations as another potential indicator of teaching quality is, unfortunately, no alternative because it has been shown that these evaluations are highly influenced by the lecturer's (physical) attractiveness and by whether the content of the course is judged to be difficult or easy to understand (see, e.g., FELTON/MITCHELL/STINSON 2004). In an attempt to achieve better grades in student evaluations, a lecturer might hence be tempted to lower the course requirements by, e.g., only teaching very simple models. Alternatives such as standardizing course contents and introducing central exams (as has been propagated for schools, see, e.g., WOESSMANN 2005) are not available, given the constitutionally granted freedom of teaching and research. In other words, it is virtually impossible to adequately measure teaching quality, and hence, university professors should not be incentivized in this respect. Not being able to adequately measure teaching outcomes implies abstaining from measuring research outcomes – unless there are non-negligible complementarities between research and teaching. If HUMBOLDT was right (and empirical analyses by BACKES-GELLNER/ZANDER 1989 show this to be the case for advanced teaching; see below), then measuring research outcomes only would not necessarily lead to bad teaching (at least not at the graduate level) but would result in a researcher's focus of attention shifting to research at the expense of teaching undergraduates and at the expense of serving the academic community.

Concerning the measurement of *services to the scientific community*, the situation at first would seem rather unproblematic, given that it is easy to assess, for example, whether and for how long a researcher has held a post as a dean or vice-president, whether and for how long a researcher has served on the editorial board of a scientific journal or whether and how often a researcher has organized a scientific conference (see PULL 2009). However, how much (s)he actually worked in the respective job, how much effort and time (s)he put in and whether (s)he succeeded and actually advanced the respective institution or community are, as PULL (2009) highlights, completely different questions

that are much harder to answer. Furthermore, it is also not clear how different posts are to be weighted: is a dean's job twice as important and/or twice as time-consuming as a student dean's job? What weight should be attached to the annual organization of an international scientific conference with 100 participants? What weight should be attached to chairing the advisory board of a research institute? What weight should be attached to serving the scientific community by being an editor or a referee for a scientific journal?[2] In all of these realms, we observe significant, and typically unpaid, investments in the public good. Can we assess the values of these investments? Can we assess them on the cost or input side (in terms of, for example, how much of a researcher's own research is foregone while refereeing other researchers' papers)? Can we assess them on the outcome side? Are evaluation and appointment committees ready to honor these investments? If so, what value should be attached to these investments? As highlighted by PULL (2009), we are far from being able to answer these questions, but the personnel economics perspective helps us to ask the right questions. For those services to the scientific community that are research-related (e.g., editing a scientific journal or refereeing papers), we might hope for complementarities (see above), but in those cases in which the services are not research-related (e.g., being a student dean), simply hoping for the jobs to be done and also for good jobs to be done might not be enough.

As PULL (2009) highlights, there currently is intense discussion on how to adequately measure one outcome dimension: research. Although it is not wrong to search for adequate output indicators for research as one highly relevant outcome dimension in academia, it is important to keep in mind that there are other outcomes as well and that there is more to the job of a university professor than doing good and visible research.

3. From Output Indicators to Productivity: Accounting for Differing Inputs by Estimating Frontier Production Functions and Applying DEA

From a personnel economics perspective and from a public policy perspective, it is meaningless to assess output indicators irrespective of input. According to basic economic theory, one instead must ask who produces the greatest output given a certain amount of input, or who produces a given amount of output with the least amount of input. Research rankings, for instance, that compare the publication output of individual researchers are meaningless if one does not at least take into account a researcher's most fundamental resource: his or her career age as a proxy for the time (s)he has had to undertake the research and publish the results. Obviously, a 65-year-old researcher has had much more time to undertake research and publish the findings than a researcher who is 20 years younger. Still, we are confronted with highly visible and influential rankings of individual researchers according to their absolute research output (number of publications in highly ranked journals, number of citations, etc.) without the (career) ages of the researchers being taken into account. In much the same vein, there are rankings that compare research output at the university department level without the number of researchers, as one basic input of research production, being controlled for, let alone financial or other resources. That is, what we actually measure in these – again, highly influential – rankings are size effects, but still we speak of assessing the comparative "research strength" of departments.

[2] For attempts to assess the opportunity costs of teaching and services, see, e.g., TAYLOR/FENDER/BURKE (2006) and AGUINIS et al. (2010).

However, an individual's resources for research can at best be *proxied* by a researcher's career age, and a department's resources can at best be *proxied* by the number of researchers. A "market evaluation" of inputs and outputs alike would be preferable. If we had market values for inputs and outputs, we could calculate a parameter such as "return on investment" or "return on equity." However, this type of calculation is not easy to achieve in non-profit organizations, such as universities, where there are no reliable market evaluations. There are two tools in personnel and organization economics that have been used and further developed over the last 20 years to overcome the problem of missing market prizes: frontier production functions and data envelopment analyses (DEA), both of which BACKES-GELLNER (1989) and BACKES-GELLNER/ZANDER (1989) used in a very early stage in the mid-1980s. It has taken quite some time for these instruments, and particularly DEA, to become more widely used, but they have become quite popular in the last few years in university research, particularly DEA (e.g., OLIVARES 2012, SCHENKER-WICKI/OLIVARES 2009, UNGER/PULL/BACKES-GELLNER 2010, WARNING 2007).

Let us first explain very briefly how efficiency is measured in this context and what it means. For the sake of simplicity, let us take a simple example with two inputs and one output. We have a number of departments, and we observe different combinations of input 1 (e.g., the number of researchers in full-time-equivalents) and input 2 (e.g., the financial resources available) being used to produce one unit of output (e.g., the number of articles in A-Journals). Using linear programming techniques, we can estimate a so-called *frontier production function* representing all minimal possible combinations of inputs 1 and 2 that produce one unit of output. Relative efficiency is then calculated as the relative distance of a given input combination to the production frontier, i.e., the best possible input combination. The efficiency standard is thus defined by the best-practicing organizations in the sample and not by some theoretical or hypothetical concept.

Data envelopment analysis basically performs the same function, but it can also be used in the case of multiple outputs (e.g., publication output *and* graduation rates) – again, even in the absence of market prices. DEA uses similar algorithms to estimate a "frontier" production function (a function that envelops the data) and simultaneously determines organization-specific weights for the multiple outputs. The appealing aspect of this simultaneous weighting procedure is that the weights are set in such a way that every organization is seen through the most favorable lens possible. For example, if there is a university or a department that is strong in research, the respective university or department is assigned a large weight for research and is only compared with similar universities. A university or department that is good in teaching undergraduates, in contrast, is assigned a large weight for its undergraduate output variable and is compared only with the most similar universities or departments.

What are the results of these types of analyses? BACKES-GELLNER (1989) finds a substantial variation in research efficiency among German economics and business economics departments. Approximately one quarter of the departments are at or very close to the efficient production function (90–100%). There is a strong middle field with efficiency degrees of between 50 and 90%, but there is also a non-negligible lower end with efficiency degrees as low as "10% or less." Of course, those at the lower end in particular argue that research is only part of the story: "if one would only take teaching into account, it would look quite different because this is what we are strong at." In a further analysis, BACKES-GELLNER/ZANDER (1989) use DEA to consider multiple outputs. In addition to publications, they use the number of diplomas and the number of doctoral degrees granted by a department as two types of teaching indicators. However, the picture

does not change dramatically. There are a few more departments on the efficient frontier, but there is still a range of inefficient departments. Thus, carefully accounting for outputs in relation to inputs is very important.

4. Selection and Self-Selection: Intended and Unintended Effects

When "personnel" is an organization's most crucial asset, the question of selection and self-selection becomes a central one. Selection and self-selection processes are important sources of productivity because such (self-)selection processes determine the productivity potential (cognitive and non-cognitive skills) of those individuals who pursue academic careers. The questions that arise are to what selection do university systems lead and what factors influence the (self-)selection process?

BACKES-GELLNER/SCHLINGHOFF (2002), for example, found empirically that in Germany, academics with higher research productivity and from a more prestigious university are more likely to be appointed to chairs and to be granted tenure. Whereas the former hints at a successful positive (self-)selection, the latter might be the result of positive (self-)selection at an earlier career stage – at which only the most talented junior researchers are accepted at the most prestigious universities – or a human capital effect whereby those who graduate from prestigious universities acquire more human capital in their early careers (see below).

In much the same vein, CHLOSTA et al. (2010) empirically analyzed who leaves the academic system after having been on the academic track for some time. Using an original data set on junior researchers who originally intended to stay in academia, the authors found a young academic's decision to leave the university system to be influenced by the following factors: the less successful the young researchers were in publishing their results, the less they enjoyed what they were doing, and the higher their time preference (measured by the number of children) was, the higher the probability was that they left academia. That is, if one wants the high performers to stay in academia, one should ensure that they have opportunities to work on research questions in which they are interested (potentially increasing their intrinsic motivation and reducing their effort costs) and that they are paid in a way that enables them to earn a decent living and care for their families.

Finally, in their recent analysis of the effects of childbearing in academia, JOECKS/PULL/BACKES-GELLNER (2013) found evidence of self-selection playing a significant role. Despite the fact that raising children is time-consuming (i.e., reduces the availbable time for research), the authors report the somewhat counterintuitive result that female researchers with children in business and economics are *more* productive than female researchers without children. Hence, female researchers with children either manage to overcompensate for the negative resource effect associated with raising children by working even harder (positive incentive effect), or alternatively, only the most productive female researchers decide to pursue careers in academia and have children at the same time (positive self-selection effect). The first descriptive evidence on the timing of parenthood hints at the latter being the case: only the most productive female researchers dare to have children *and* go for academic careers.

In their personnel economics analysis, JOECKS/PULL/BACKES-GELLNER (2013) hence show that naïve expectations might prove to be wrong: Whereas, naively, one would expect that female academics with children have lower research productivity as a result of childcare responsibilities, the empirical results show that female academics with childbearing responsibilities are more productive than comparable females without

children. Personnel economics theories help to explain this surprising result because they point to the importance of self-selection mechanisms. If, among female academics, only the high-performers (high-ability candidates) dare to go into academia and have children at the same time, their average productivity is higher than that of male academics because those females are drawn only from the upper part of the distribution, whereas male academics are also drawn from a large pool of "normally" talented candidates and not just the upper tail of the distribution.[3]

5. Incentives: Pay for Performance vs. Career Incentives

"Incentives are the essence of economics" – this often-cited quote by PENDERGAST (1999) hints at the importance of the topic, also for the economic analysis of academia and higher education. The provision of incentives is at the heart of a whole set of new public management reforms within and outside the academic system. The idea of these reforms is (and this is what a naïve economics perspective might support) the following: if we do not provide explicit monetary incentives for tenured professors, they will not exert enough effort when undertaking research because they do not have an incentive to do so. In this context, it is often argued that, particularly in the traditional German university system, there were no incentives to stay productive after tenure because income was not attached to individual performance.[4] A naïve conclusion that is occasionally drawn is that introducing performance pay in a professor's compensation package would solve the problem.

However, a sound personnel economics analysis questions this conclusion because it clearly indicates that a lack of incentives is neither the cause nor the cure for differences in research productivity. BACKES-GELLNER (1993), for example, studied comparative research productivity of US and German universities and showed that it is not the existence of pay-for-performance that distinguishes the best US research universities from the rest of the world but, rather, the differences in selection procedures, career patterns, teaching loads, academic culture, organizational strategies and, perhaps most importantly, differences in the available resources.

However, the fact that academic systems often do not rely on performance pay is not surprising given that personnel economics teaches us that in practice, incentives do not only come from pay-for-performance systems – as public opinion and political discussions sometimes seem to assume. Rather, incentives – even in private companies – are very often set by career incentives (set up as a "tournament" in which it is relative performance that counts, cf. BACKES-GELLNER/PULL 2008, 2013). As personnel economic analyses show for universities, tournament incentives are often better suited for incentive setting from a theoretical perspective, and they are also empirically more important (see SCHLINGHOFF/BACKES-GELLNER 2004 for Germany or COUPÉ/SMEETS/WARZYNSKI 2006 for an international comparison).

However, why should tournament incentives (i.e., incentive systems based on relative performance) be better suited for universities than performance pay based on absolute

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[3] Another explanation would be selection procedures that set higher performance thresholds for females with children because selection committees want to counterbalance the signal "childbearing" that is considered to be negative. If this is not assumed, self-selection must be an important explanation for a positive productivity differential for female academics with children.

[4] A simple plausibility check indicates that the naïve explanation does not hold. BACKES-GELLNER/SCHLINGHOFF (2010) and SCHLINGHOFF (2003), for example, compared productivity profiles before and after tenure in the US in comparison to Germany and found that – if at all – a huge productivity drop after tenure occurs in the US and not in Germany.

performance measures? First and foremost, relative performance is easier to measure for complex and multidimensional tasks such as those performed by university professors (see above), and second, relative performance measures cancel out the common risks inherent in the output production of all contestants (see the seminal paper by LAZEAR/ROSEN 1981). Furthermore, absolute performance pay is characterized by a whole set of problems that makes it less suitable in a university context. Personnel economics shows, for example, that absolute performance pay causes problems as soon as performance measures are subject to large variations (e.g., over time) and have a high external risk (MILGROM/ROBERTS 1991), which is, for example, the case in publication processes that in some cases take many years and have a substantial random component.[5] Therefore, it comes as no surprise that for centuries, the university systems in many countries in Europe and in the US have relied much more on tournament incentives then on pay for absolute performance.

Empirical analyses have shown that tournament incentives work. For example, BACKES-GELLNER/SCHLINGHOFF (2010) report that in the German as well as in the US university system, the career steps leading to the first tenured position are designed in a way that creates effective incentives for an individual's research productivity. After the first tenured position, there are systematic differences between the German and the US systems: whereas in the German system, additional appointments bring only small monetary and non-monetary gains in comparison to the gains at the tenure level, in the US system, even after tenure, there are still effective incentives until a full professorship is reached. However, BACKES-GELLNER/SCHLINGHOFF (2010) also report that after a full professorship is reached in the US system, incentives are very weak and cannot ensure a productivity level that is similar to the level before tenure or before promotion to full professor. Hence, the analyses indicate that incentives in the German and US systems function very similarly; they only last a little longer in the US than in Germany due to a second major career step not available in the German system.

However, new public management reforms in recent decades have brought a shift toward more elements of absolute performance incentives, such as bonuses for a certain number or quality of publications or the like.[6] CHLOSTA/PULL (2010) theoretically analyzed the effects of selected components of the reform in Germany on the existing (career) incentives provided by the appointment system. In their analysis, CHLOSTA/PULL model the German appointment system in higher education as a tournament in which two types of contestants, professors and junior researchers, compete for a vacant chair

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[5] It is interesting to note that among all economists and business economists in Germany, the average number of publications in top journals was 0.1 at the beginning of the century, which means only every tenth year can a researcher expect to publish an article in a top journal, or more likely, only every tenth professor produces a top article per year (BACKES-GELLNER 2004). If we look at the publications of German researchers in top international journals, it becomes obvious how absurd the discussion in German universities often is (at least in our fields, where top international publications seem to be the criterion for every professor). Every 1,000th professor has an article published in a top international journal in any given year, or every thousand years on average, we can expect to get a paper published in a top international journal. (To take such a measure to evaluate the performance of all professors alike seems like rolling dice.)

[6] As KRÄKEL/HARBRING/IRLENBUSCH (2004) argue, these absolute performance payments might, however, also entail a tournament component on the department level, as the budget for the performance payments in a given department is fixed. This new and additional tournament might have adverse effects on the functioning of the career system because members of appointment committees might have an incentive to appoint less able colleagues. Although these additional adverse effects cannot, in general, be excluded, there is good reason not to overestimate their adverse selection effects (see BACKES-GELLNER 2004).

on the basis of their past performance. CHLOSTA/PULL rely on a simple tournament model based on LAZEAR/ROSEN (1981) and introduce J-curved effort cost functions in that base model structure, i.e., they assume that researchers might in principle also enjoy what they do. By further taking into account systematic differences between the two different types of contestants, junior researchers and professors, they are able to explain that even in the absence of variable payments, before the reform in 2001, professors did not automatically "slack off" after their first appointment to a chair (see e.g. SCHLINGHOFF 2003, RAUBER/URSPRUNG 2006 and WOLF/ROHN/MACHARZINA 2006).

Theoretically analyzing the potential effects of selected elements of the 2001 reform of the system of German higher education on the tournament incentives provided by the appointment system, CHLOSTA/PULL (2010) distinguish *three* different effects: a *prize effect* (resulting from a variation of tournament prize spans), an effort *cost effect* (created by the introduction of the position of the junior professor) and a *heterogeneity effect* (arising from an asymmetric variation in tournament prizes and effort cost function parameters through various reform elements, as well as from a variation in "handicaps" implicitly set by appointment committees). Concerning the net effect of the selected elements of the 2001 reform, it is *a priori* not clear whether the career incentives will increase or decrease as a result of the reform. As adverse effects on career incentives generally cannot be excluded, the burden for a successful reform rests on the intended positive incentive effects connected with the introduction of variable pay components – a reform element that is implemented only gradually and rather hesitantly.

Furthermore, one has to keep in mind that adding pay for performance as a further incentive (on top of the existing career incentives) increases the risk of "perverted" incentives leading to researchers manipulating and "gaming" the system, e.g., by duplicating publications or by plagiarism – both of which can be observed in some very recent cases in business and economics. Thus, absolute performance pay schemes, according to personnel economics analyses, are unlikely to be the best cure for alleged productivity problems in universities.

Overall, the empirical results suggest that different incentives cannot explain the large productivity differences between, for example, top US universities on the one hand and German universities on the other. Thus, although the omnipresence of incentives in theories and political discussions might suggest that potentially low research productivity is basically the result of a lack of incentives, personnel economics and classical business economics theories point to the importance of differences in production technology, in available resources such as financial capital and – since BECKER (1967) – human capital.

6. Drivers of Productivity: Human, Social and Organizational Capital as Relevant Resources

If it is not only incentives, what is it that drives research performance? The literature on the determinants of research productivity has identified a whole set of variables that influence publication output, such as individual demographics, organizational variables and collaboration, many of which are clearly related to human, social and organizational capital.

Human and Social Capital

Human and social capital might be assessed by very different means. One first and obvious channel by which human and social capital might be transferred is through the *academic advisor*: as has been shown repeatedly, there is a direct relation between advisor

and student research productivity (see, e.g., LONG/MCGINNIS 1985, WILLIAMSON/CABLE 2003, HILMER/HILMER 2007, FIEDLER et al. 2008). Although from a theoretical perspective, it is not clear whether we should expect the relation between student and advisor research productivity to be generally positive (it might well be that very productive researchers find no time to adequately supervise their student researchers), the empirical findings in fact hint at a consistently positive relation between the two. As highlighted by BREUNINGER/PFERDMENGES/PULL (2012), this positive relation between student and advisor research productivity is likely to be the joint result of a set of diverse mechanisms: (a) advisors passing on their *human capital* to their students, (b) advisors introducing their students into the scientific community and hence endowing them with *social capital* and (c) the more productive advisors being able to attract the more able and more productive doctoral and postdoctoral students (*self-selection*). In their empirical analysis, BREUNINGER/PFERDMENGES/PULL (2012) found the positive relation between advisor and student research productivity to hold on a group level as well – i.e., for doctoral students in research training groups (*Graduiertenkollegs* financed by the German Research Foundation, DFG) and the respective group of principal investigators.

In addition to the academic advisor, there might be other mentors who play roles in providing human and, perhaps to an even greater extent, social capital. As MUSCHALLIK/PULL (2013) show with the help of an original data set of about 400 researchers in economics and business administration, participants in formal mentoring programs are more productive in terms of publication output than their non-participating counterparts (see BLAU et al. 2010 and GARDINER et al. 2007 for similar results). Accounting for a potential process of self-selection via matching techniques, MUSCHALLIK/PULL (2013) found this result to be robust. That is, formal mentoring programs seem to enhance mentee research productivity (arguably by enhancing mentees' human and social capital). Informal mentoring relationships, however, do not seem to affect mentees' publication performance.

Furthermore, human and social capital might also be enhanced via national or international mobility. Indeed, BREUNINGER (2013) finds that research stays abroad are associated with increased publication output (for a similar finding of the positive effect of stays abroad on appointment success, see SCHULZE/WARNING/WIERMANN 2008). According to BÄKER (2013), national changes of affiliation might also lead to an improvement in the publication record.[7] In both studies, potential (self-)selection effects are addressed via (propensity score) matching techniques.

Organizational Capital

Although the analysis of individual characteristics is important in a research context, simply measuring and comparing research productivity on an individual level is not sufficient from a business economist's or personnel economist's point of view because the productivity of an organization is more than the sum of individual productivities. Due to

[7] BÄKER et al. (2013) further analyzed whether and how academic mobility (national and international) relates to a researcher's appointment success. Specifically, they asked whether mobility serves as a (positive or negative) *signal* to appointment committees. In their empirical analysis of a data set of about 250researchers from business and economics, they measured appointment success by (a) the time required for the researcher to obtain tenure and (b) the reputation of the appointing institution. Applying Cox proportional hazard regressions and logit analyses, they found that researchers' international mobility—depending on the length of the stay abroad—reduces the time until the researcher gets tenure and increases the likelihood of getting tenure at a highly ranked institution. To the contrary, a researcher's previous change in affiliation (*national mobility*) is associated with a longer time to tenure, and it might also adversely affect his or her chances to get tenure at a top ranked institution.

complementarities and economies of scope, the most productive research organization is most likely one with a well-assembled team of people who practice a successful division of labor. Therefore, research productivity should be measured on an organizational level, such as departments, institutes, graduate schools or even universities (if differences in fields are controlled for), and explanations for differences in research productivity should also be sought on an organizational level.

Because, as argued above, individual talents are important prerequisites for research productivity, the selection and socialization procedures implemented by a particular organization are important factors in the organization's research efficiency. In this context, empirical results show, for example, that academic socialization by means of working together to coauthor articles is one way to increase the overall productivity of a department. BACKES-GELLNER (1989) shows that the higher the share of publications published in co-authorship is, the higher research productivity is (i.e., the number of publications given a fixed number of researchers).[8] According to personnel economics, this finding can be explained by three effects: (a) via (early) co-authorships and (young) scholars being socialized toward giving publication production a high priority, (b) via peer pressure and mutual monitoring and (c) via more efficient production technologies, i.e., with coauthors effectively using advantages of specialization, complementarities and economies of scope.

Another source of increased productivity potential in an organization is the composition of the organization's employees. From a theoretical perspective, a more diverse workforce may mean additional sources of knowledge and creativity, which, in turn, might lead to additional or better research outcomes. At the same time, increased diversity goes together with more severe coordination and communication problems; thus, the optimal level of diversity is not the maximum level. Referring to the work by LAZEAR (1999), PULL/UNGER/BACKES-GELLNER (forthcoming) analyzed the effect of interdisciplinarity and internationality on the performance of research training groups. Using seemingly unrelated regressions, PULL/UNGER/BACKES-GELLNER found for the humanities and social sciences that heterogeneity has significant effects on performance, with study field heterogeneity enhancing scientific visibility (in terms of an enhanced publication output) and the internationality of the group being inversely hump-shaped related to the doctoral completion rate. In contrast, for the natural and life sciences, they only found a significant effect for the doctoral completion rate exhibiting a hump-shaped relationship with study field heterogeneity. What may work well in one disciplinary field may have the opposite effect in another. An increasing degree of interdisciplinarity in the humanities and social sciences positively affects research performance. At the same time, when the degree of interdisciplinarity in the natural and life sciences increases, positive effects on research performance can only be observed up to a certain point and not if interdisciplinarity is driven to the extreme. Therefore, it seems reasonable to conclude that in governing research groups, all types of external governance should be either precisely customized to the disciplinary field concerned or a menu of options should be offered that allows research teams to choose a structure that is most effective given the specificities of their disciplinary fields and specific research requirements.

In addition to the productivity potential of an organization associated with its individual researchers, i.e. its human capital, an organization's financial capital and other resources are also important drivers of research productivity. In this context, empirical results

[8] Because publications in joint authorships are divided by the number of authors before they enter the publication data base, this result is not simply a statistical artifact but, rather, reflects a true productivity increase.

reported by BACKES-GELLNER (1989, 1993), for example, show that the more students there are in a department, the higher the department's research efficiency is, which sounds somewhat counterintuitive if students are seen as a burden for research. However, the result becomes less questionable if it is interpreted in the context of personnel economics, which suggests considering students also as an input to the research production process. Why is this the case? First, a larger student pool allows for a better selection of young researchers. Second, departments with more students are typically granted more financial resources, which will be used for teaching but at the same time may be used for research-oriented teaching and research personnel, thereby increasing research resources. This logic is consistent with the findings by BACKES-GELLNER (1992) and BACKES-GELLNER/ZANDER (1989) that the effect of student numbers on research productivity also depends on how the curriculum is structured, i.e., on the relative number of undergraduate and graduate courses a department offers. The number of undergraduate courses is negatively correlated with research efficiency, but the number of graduate courses is positively correlated with research efficiency. Thus, teaching a larger number of undergraduates diverts time and effort away from research, whereas a larger number of graduate courses or teaching more graduates actually is an additional resource for or a byproduct of research. BACKES-GELLNER (1992) found similar patterns in US universities, albeit on a very different scale. In the US, the best universities have budgets per student that are much higher than the best German universities.

7. Conclusion: What are the Lessons to be Learned for Higher Education Policy?

Overall, empirical analyses from a personnel economics perspective show that research efficiency is influenced by a number of factors with similar effects across countries: (self-)selection procedures that ensure a pool of very talented researchers, socialization procedures that lead to researchers pursuing the same goals, financial resources and graduate students that complement individual research efforts. Hence, organizational strategies and resources do matter for research efficiency, even if, in the end, a research paper can only be written by one or more individuals. Selection and resource effects apparently matter as much as incentive effects. Tournament incentives seem to be well suited for research environments, but incentives are not all that matters. From a personnel economics perspective, the public discussion in recent decades that has mainly focused on incentives and pay for performance seems to have gone in the wrong direction. Resources, socialization, self-selection and selection procedures should receive more attention in the future.

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