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Funding, evaluation, and the performance of national research systems

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ABSTRACT

Understanding the quality of science systems requires international comparative studies, which are difficult because of the lack of comparable data especially about inputs in research. In this study, we deploy an approach based on change instead of on levels of inputs and outputs: an approach that to a large extent eliminates the problem of measurement differences between countries. We firstly show that there are large differences in efficiency between national science systems, defined as the increase in output (highly cited papers) per percentage increase in input (funding). We then discuss our findings using popular explanations of performance differences: differences in funding systems (performance related or not), differences in the level of competition, differences in the level of university autonomy, and differences in the level of academic freedom. Interestingly, the available data do not support these common explanations. What the data suggest is that efficient systems are characterized by a well-developed *ex post* evaluation system combined with considerably high institutional funding and relatively low university autonomy (meaning a high autonomy of professionals). On the other hand, the less efficient systems have a strong *ex ante* control, either through a high level of so-called competitive project funding, or through strong power of the university management. Another conclusion is that more and better data are needed.

1. Introduction

What are the characteristics of research systems that influence efficiency? That issue has a long tradition in the political economics of science: how to get most value for money, i.e. how to get the best possible results from the investments in research (Stephan, 2012). How these investments should be measured is a difficult issue, especially when the aim is international comparison (Luwel, 2004). Also, output of research is heterogeneous and one may take into account various dimensions of research activities (Bonaccorsi & Daraio, 2004, p.60). In this paper, we restrict the analysis to scholarly output, in terms of (field normalized) highly cited scientific publications, which are considered to represent the important contributions to the growth of knowledge. It should be noted that we do not discuss efficiency in producing e.g., societal relevant knowledge, or patents, or the number of papers in general. Apart from presenting some solution for *measuring the investments in science*, we will address the question *what factors determine the efficiency of research systems?*

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Our paper is first and foremost a critical discussion of the *existing theories* and *dominant ideas* in terms of the *evidence currently available,* evidence that is often used in science policy discussions. As we shall show, the available data contradict several of the popular (theoretical) claims, and lead to other intelligible findings. However, given the problematic nature of the available data, we do not claim that we have robust findings, but we do have an interesting research agenda: Additional research is needed, especially there is a need for more prudence in data collection.

The contributions of this paper are: (i) we show that most of the popular claims about what makes an efficient research system should not be believed too easily, as they lack support, even from the data they are based on; (ii) we argue that several of the core concepts in theorizing efficient research systems are more problematic than realized in contemporary discussions; and (iii) we suggest what alternative approaches may provide better explanations of efficiency differences. Last but not least, we argue (iv) that more and better data are needed to investigate how structural characteristics of science systems influence efficiency.

2. Explaining efficiency

Several properties of science systems are associated with the idea of efficiency (Sandström & Heyman, 2015). (i) The structure of *research funding* has been emphasized, and especially the growth of *competitive project funding* at the expense of institutional funding is generally seen as a stimulus for efficiency. (ii) Also the introduction of *national research evaluation systems* is expected to increase performance and efficiency of science systems, as is (iii) the turn to *New Public Management* (NPM) with its performance contracts and performance based institutional funding (Auranen & Nieminen, 2010). The latter is often based on indicators and 'funding formula' (Jonkers & Zacharewicz, 2015) which may be based on a national evaluation system. (iv) NPM should improve efficiency, accountability (Schubert, 2009), and responsiveness to changes in the environment, requiring more *autonomous* universities with powerful managers. Finally, the literature in science policy studies often emphasizes (v) the role of *academic freedom* (Heinze, 2008). We will briefly discuss the underlying theories below. To summarize, the following factors explain efficiency differences between science systems:

(a) The level of competition
  - Share of project funding
  - Performance based funding systems
  - National evaluation systems
(b) The level of university autonomy
  - Financial, organizational, staffing and academic autonomy
(c) Academic freedom

2.1. The role of competition and evaluation systems

Competiveness is generally defined in terms of the share of *basic university funds* (i.e. General University Funds GUF, Institutional Funds or Block Grants) in total research funding. The higher the share of such institutional funding and consequently the lower the share of project funding, the less competition would exist in a research system (Abramo, Cicero, & D'Angelo, 2012). However, increasingly also institutional funding is based on performance whereas in the past it was mainly input based (e.g., student numbers). Also other system pressures, such as excellence initiatives, NPM, and national research assessments are associated with the level of competition (Auranen & Nieminen, 2010).

An interesting attempt to build a dataset for seven European countries plus Australia was done by Auranen and Nieminen (2010), without justifying the selection of countries. In their analysis they proposed a two-dimensional typology of (i) input versus output oriented institutional funding,[1] and (ii) the share of external (project) funding in total university funding. The UK is in their view an example of a highly competitive system as it combines a high level of project funding with output-oriented institutional funding through the REF/RAE, and the former by the large share of money that goes through the various UK research councils and charities. On the other hand, countries like the Netherlands and Sweden were classified as poor performers with low efficiency, i.e. high cost per paper, in "a quite non-competitive environment". The latter claim is based on the observation that institutional funding is input oriented (student numbers, history and politics) although in Sweden the level of project funding is considerably high (Van Steen, 2012). Finland, Australia and Denmark were positioned in an in-between group. Germany and Norway were a bit closer to Sweden and the Netherlands.

The question why competition would lead to higher performing systems is addressed by Abramo et al. (2012), who formulated a theory concerning the expected effects of scholarly competition on the structure and performance of the academic system: Over time competitive arrangements are expected to redistribute high performing scholars between universities, i.e. the competitive process should lead to a concentration of funding to the best scholars in a few top universities. They argue that this will lead to (i) a higher performance variety between universities and at the same time to (ii) a lower

[1] This distinction was first proposed by Jongbloed & Vossensteyn (2001): the distinction whether public subsidies are based "[. . .] on input elements (i.e. indicators that refer to the resources used and/or the activities carried out by the higher education institutions) or output elements (i.e. indicators that refer to the institution's performance in terms of teaching and research)." (p. 128).