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Funding model and creativity in science: Competitive versus block funding and status contingency effects

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ABSTRACT

In many countries the scientific funding system is shifting from an internal block funding model toward a competitive project funding model. However, there is growing concern that the competitive project funding system favors relatively safe, conventional projects at the expense of risky, novel research. It is important to assess different funding models in order to design better funding systems for science. This paper empirically tests for differences in the novelty of funded outputs between internal block funding and competitive project funding, in the setting of Japan, where both funding models play a significant role. Combining survey data from a large sample of research projects in Japan and bibliometric information about the publications produced from these projects, we find that projects funded by competitive funds on average have higher novelty compared to those funded by internal block funds. However, such positive effects only hold for researchers with high status, such as senior and male researchers. In contrast, compared to internal block funding, competitive project funding has a negative relation to novelty for low status scientists (especially junior and female researchers). The findings suggest that the competitive project selection procedure is less receptive to novel ideas from researchers with low academic status and therefore discourages their novel research. These findings can serve as a warning about potential biases in competitive funding allocation procedures and suggest the importance of secure stable funding for allowing researchers with low status to pursue their novel ideas.

1. Introduction

While public science systems in Europe, Japan and North America have traditionally extended significant autonomy to researchers to set research priorities and (especially in Europe and Japan) imposed relatively weak evaluation criteria on that research, the New Public Management (NPM) and related movements have begun a shift in the governance of public science (Welpe et al., 2015; Whitley and Gläser, 2007). This New Public Management perspective emphasizes competitive allocation of resources and consequential evaluation of outputs (Hicks, 2012; Lewis, 2015; Whitley and Gläser, 2007). While there is significant variation in the shares of block versus competitive funding across countries, there has been a growing movement toward increasingly active governance of public research, and, in particular a debate about shifting from block to competitive allocation of funding (Geuna, 2001; Lewis, 2015; Whitley and Gläser, 2007).

This debate on block versus project-based funding of science echoes a broader debate in public administration regarding the governance perspective and the New Public Management (Page, 2005). For example, with the emergence of new administrative forms pursuing efficiency, market mechanisms have been applied to public hospital management and an organizational transformation of universities that had traditionally been considered to lack performance-based incentives (De Boer et al., 2007; Ramesh, 2008). A key focus in this debate is how best to ensure that public funds allocated to non-government entities are effectively achieving agency goals, with an increasing emphasis on performance measurement and outputs rather than inputs (Lewis, 2015). This governance perspective emphasizes the need to manage and steer the university research system toward national goals of efficiency, productivity and applicability (Lewis, 2015).

There have been increasing concerns among science policy researchers about how best to provide incentives for both productive and ground-breaking science (Bollen et al., 2013; Hicks, 2012; Ioannidis, 2011), as well as concerns about how best to document the returns to public funding (Lane et al., 2015). One dimension of this debate is whether the funding system should emphasize broad block funding for

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research (the German model) or whether funding should be allocated on the basis of project-level competitive grant proposals (the US model) (Capano, 2011; Geuna, 2001; Stephan, 2010). There is also a third model, with university-level competition for differential levels of block funding (the UK model) (Lewis, 2015). In addition, of course, in each country, there are variations in the mix of funding for particular projects or fields. Since around the 1980s, Europe has been moving from a block funding system to a more competitive funding system and increased industry-based funding, expecting, like in other cases of New Public Management, efficiency gains from more market-like incentives (Auranen and Nieminen, 2010; Geuna, 1999, 2001; Stephan, 2010). At the same time, there is growing concern in the US that its current funding system fails to encourage novel research: concerns that funding agencies are increasingly risk-averse, and their competitive selection procedures favor relatively safe projects at the expense of novel and risky research (Alberts, 2010; Petsko, 2012; Stephan et al., 2017). For the rest of the world, it is also uncertain whether a change to a greater emphasis on competitive funding would improve scientific performance (Lewis, 2015; Whitley and Gläser, 2007), and what would be a good metric by which to judge any effects (Geuna and Martin, 2003). Such a transition may also underestimate the cost of implementing a peer-reviewed, centrally monitored evaluation and allocation system (Bollen et al., 2013; Ioannidis, 2011). Geuna (1999, 2001) discusses some evidence that the change to the quasi-market incentive system pushes universities to do more routine contract research for industry, rather than contributing to long-term innovation, and causes inequality of funding, with substitution to large from small and medium-sized departments. Comparing country-level publication productivities, Auranen and Nieminen (2010) find no clear connection between the competitiveness of national funding systems and the efficiency of university research. Therefore, the potential effects of a change in the funding system on research performance are not straightforward.

Moreover, many studies of the relationship between funding type and research performance have focused on productivity as the main measure of performance (Auranen and Nieminen, 2010; Boyack and Börner, 2003; Himanen et al., 2009). An important exception is Azoulay et al. (2011), who focus on differences in the novelty of published research between competitive funding (National Institutes of Health grants) and long-term funding (Howard Hughes Medical Institute fellowships). Thus, in addition to differences in funding systems, there is also the question of differences in metrics.

To bring more insights into this science policy debate, in this study we analyze the relation between different funding schemes and the novelty of scientific research in Japan. As a research case, the Japanese research funding system has the advantage of providing both significant individual-level (chair) block funding, based on the German model, as well as a substantial share of competitive project funding (e.g., grants-in-aid for research) based on the US model (Kneller, 2007; Shibayama, 2011). Japanese professors have access to both block funding and competitive project funding, allowing a within country comparison of the outputs of each kind of funding. This heterogeneity of funding sources makes this a fruitful site for examining these questions.

Furthermore, we focus on novelty in research output rather than productivity. While part of the debate on the effectiveness of funding schemes revolves around productivity versus novelty (cf. Geuna, 2001), novelty has received less attention in discussion of the effect of different funding schemes (Azoulay et al., 2011). Thus, while productivity or impact of research are important, these are distinct from novelty, which may have important value as an output of the science system in its own right (Azoulay et al., 2011; Lee et al., 2015; Wang et al., 2017).

We also go beyond prior work by focusing on how those in high and low status categories might be differentially affected by different funding schemes (Whitley and Gläser, 2007). This focus echoes the debates on whether different funding models in the NPM affect equity in the allocation of funding. In particular, we compare high and low status scientists (comparing on rank, gender and institution type) to see if there are systematic differences in the relative novelty of their projects by funding mechanism (cf. Hermanowicz, 2009; Hesse et al., 1993; Whitley and Gläser, 2007).

Based on a broad survey of scientists in Japan and using unobtrusive measures of the novelty of their scientific research outcomes, we first examine the relation between different funding types and novelty. We then examine whether these relations vary by the status of the scientist, with status seen as a proxy for lesser or greater vulnerability to conformity pressure. We find that, overall, competitively-funded papers have higher novelty than block-funded papers, consistent with those who argue that market-like competitive incentives will drive more effective allocation of government funding. However, among low status scientists (assistant professors, women, those outside the top seven universities), we find that novelty is relatively higher for block-funded projects, consistent with arguments that market-like mechanisms may exacerbate inequality and disadvantage vulnerable groups.

In the following sections, we develop the theories that drive our arguments on the relation between funding types and novelty and the contingent effects of vulnerability to conformity pressure. We then test our hypotheses using novel survey data about Japanese scientists and their project characteristics and research funding sources combined with a big data-based measure of novelty. We conclude with discussion of our results and the implications for policies regarding government funding of science.

2. Funding allocation models and novelty

Vannevar Bush argued in *Science: The Endless Frontier* that national science policy can be most effective if the national government funds basic scientific research and that research is executed (under contract) by universities (Bush, 1945). He further argued that research funding should be allocated based on investigator-initiated, peer-reviewed funding competitions. Empirically, Li and Agha (2015) find that the higher review scores in the National Institutes of Health (NIH) peer review, the better the research outcomes, i.e., more hit publications, more citations and more patents, suggesting that review panels are good at selecting the highest impact projects. Similarly, Park et al. (2015) compare projects funded by regular NIH budget with those additionally selected due to an unexpected increase in resources under the American Recovery and Reinvestment Act (ARRA) of 2009 and find that the former produces more publications and their publications are more cited.

While there has been interest by science agencies across the globe in adopting more competitive funding models based on the US experience (Lewis, 2015; Welpe et al., 2015; Whitley and Gläser, 2007), at the same time, there has been increasing concern that such funding mechanisms, with their emphases on feasibility and preliminary findings, may be biased toward incremental projects with high certainty over truly novel but riskier research (Alberts, 2010; Petsko, 2012; Stephan et al., 2017). Chubin and Hackett (1990) contend that quality control by peer-review drives science to conservatism, ignoring the possibility of serendipitous results or suppressing unorthodox ideas. Simonton (2003) notes that reviewers have low agreement on the quality of grant proposals, and their criteria have little predictive validity. Similarly, Kaplan et al. (2008) show that in highly competitive grant systems such as NIH in the US, the differences between fundable and not fundable scores are well below the threshold of reviewers' abilities to discern difference in project quality, suggesting substantial noise in the evaluation. Bornmann et al. (2010) compare funding decisions across four funding programs in Europe, including both life sciences and social sciences, and find that those who were chosen for funding tend to have higher scores, both ex ante and ex post, on various bibliometric indicators of productivity and impact (publications, *h* index, citations). However, when comparing those who were funded with those who were nearly funded, they find that those productive scientists who were rejected by the peer review system tended to have higher productivity