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RESEARCH MANAGEMENT AND PERFORMANCE-BASED FUNDING IN HIGHER EDUCATION

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Abstract

This study examines the relationship between research input and output in higher education institutions, and the impact of adopting a performance-based funding system on their research activities. Exploring research activities carried out by Australian universities from 1995 to 2010, we find that funding was a key factor in generating research output, particularly in the form of journal articles. Among various sources of

research income, merit-based funding stimulated all kinds of publications. Nonetheless, research funds secured from private, industry sources thwarted research publications. These findings were more pronounced in well-established, elite universities than their less-esteemed counterparts. We also find that human resources exhibited positive effects on publications, especially for the small, regional universities. The analysis further reveals that academic staff played a role in journal article publications. Lastly, the adoption of a performance-based funding system appeared to boost research output and the effects were seemingly comparable across types of universities.

Keywords: research management, performance-based funding, quantitative research, accountability, public policy

Introduction

Universities play a vital role in the generation and transmission of new discoveries and knowledge. It is not surprising that governments have long supported these institutions, public and private alike. Nevertheless, an ever-increasing number of social programs and responsibilities have restricted public funding and threatened the continuity of support for university research and development (henceforth R&D). It has become increasingly crucial for governments to design and implement cost-effective policies, so as to improve accountability of these higher education providers and increase their teaching and research output.

Furthermore, the pressure facing universities in recent years to compete with fellow institutions, both at home and abroad, in attracting prospective students, recruiting and retaining competent scholars, and maintaining distinguished academic reputation has prompted a heated discussion in academia and brought about an increased effort by many universities around the world to enhance their own profiles. Such an effort is often aimed at improvement and excellence in research because research performance is commonly the most important component of any university ranking.

Externally, the pressing need to better manage public funds, enhance accountability, and improve research efficiency in higher education has led a rising number of countries not only to implement a research evaluation system but also to shift the scheme of sponsoring university R&D from the conventional system that remunerates institutional size and teaching duty to one that focuses on research performance (Hicks, 2012; Iorwerth, 2005). Such a funding system compares and ranks universities and rewards those demonstrating a higher level of research output or exhibiting an upswing in such a measure (Wu et al., 2012; Abramo et al., 2013; Wang et al. 2013, and Abramo & D'Angelo, 2015). This funding mechanism inevitably results in competition among universities. It is believed that research productivity, as measured by discoveries and new knowledge per dollar spent to fund university research, would increase as a consequence of competition (Feller. 2002; Watermeyer, 2014).

Unfortunately, such a policy and the rationale behind it have not been guided by much empirical, quantitative evidence. Although some prior studies, such as Geuna and Martin (2003), Liefner (2003), Hearn et al. (2006), and

Auranena and Nieminen (2010), have examined research evaluation in higher education, most of these studies either undertake a descriptive, theoretical investigation into research assessment mechanism or carry out a qualitative comparison of performance-based research funding systems around the world. Surprisingly, empirical and quantitative studies on this issue remain so sparse, as more countries have introduced or are considering adopting a performance-based research funding system.

More importantly, we have yet to develop a good understanding of how university research input and output are related. Previous studies, in general, explore one type of input—research income—and even more so, often examine the lump-sum amount or a specific income source, in isolation of other research funding channels and input factors. For example, Adams and Griliches (2000) and Payne and Siow (2003) focus on how federal funding affects publications and citations, while Hottenrott and Thorwarth (2011) examine the impact of industry funding. Little effort has been paid to a comparison of different input factors, so as to identify those most crucial to the generation of research output (Foltz et al., 2012).

Our study bridges the gap in the literature and sheds light on the effects of adopting a performance-based research funding system. In particular, we seek to answer the following questions. Whether and to what extent does an increase in research funding lead to an increase in research output? Among various kinds of research funding, which one is the most conducive to the generation of research output? Do the effects of increased funding, if any, vary across universities? What are the characteristics of a university that possibly explain such a variation? Do increases in other research input factors, such as academic personnel, raise research output? Finally, whether does a switch to a performance-based research funding system bring more research output?

We have chosen to study these issues by investigating Australia's higher education sector during the period from 1995 to 2010. There were then a total of 38 universities., As Aghion et al. (2010) show that university autonomy plays an important role in university research process, we are fortunate to have a majority of public universities, which are relatively homogeneous in administrating academic affairs and have much less autonomy in mobilizing funds. Moreover, the Australian Government adopted a performance-based research funding system in the mid-1990s and early 2000s. The timing of the adoption and the intrinsic nature of Australia's higher education sector together provide us a rare opportunity of a quasi- experiment to explore the effects of the new funding system.

The results of our empirical investigation show that research funding played an important role in generating research output, particularly journal articles. On average, a one percent increase in total research income brought about a 0.1074 percent increase in a measure of total research publications, and led to a 0.1753 percent increase in journal article publications. Among various sources of research income, competitive grants promoted all kinds of publications, while research income secured from industries and private sources reduced research publications. These findings were more pronounced in well-established, elite universities than those with a

shorter history. Human resources exhibited some positive effects. They were more visible on these new, small and regional universities than on their elite counterparts. Exploring human resources more deeply reveals that academic staff was key to journal article publications. Finally, the adoption of a performance-based funding system appeared to have boosted research output.

We organize the rest of the paper as follows. Section 2 outlines the conceptual framework that guides our empirical investigation. Particularly, we summarize different views towards the performance-based research funding system and the effects of such a system on research activities. Section 3 briefs on types of external research funding assessable to Australian universities. This section also provides an overview of the performance-based funding system implemented by the Australian Federal Government in the 1990s and early 2000s. Section 4 describes the data. Section 5 presents the empirical analysis and results. Finally, we conclude in section 6 with a discussion on policy implications.

Framework

Following studies on invention and technological progress such as the pioneer work of Pakes and Griliches (1980), Hausman, Hall, and Griliches (1984), and Sokoloff (1988) as well as recent studies on academic research such as Abbott and Doucouliagos (2004), we adopt the production function approach by abstracting a shorthand input-output expression from the more complex research process taking place in universities.

Research Output

To gauge research output of universities, we employ an explicit measure—the number of research publications. Such a measure, though unassuming, posits a few uncanny advantages. First, it is a more comprehensive assessment of research output than others, such as an account of the number of patents. Patents are designed to safeguard technological inventions, so the number of patent applications or grants by a university provides a picture of the creativity of its engineering and natural sciences faculties (Henderson et al., 1998; Mowery & Ziedonis, 2002; Lo, 2011). However, research output of other academic disciplines like humanities and social sciences is hardly patentable. In contrast, research publications such as journal articles, books and the like, are exploited by a much broader range of academic disciplines to disclose their R&D results and findings.

Second, the unit of measurement to gauge research publications is, to some extent, standardized, since a research publication conventionally takes on one of the four possible forms: book, chapter, journal article and conference article. Books, such a format of research results, are often considered as the most intensive research work of the four, followed by peer-reviewed journal articles and book chapters, and lastly conference papers. We can examine them individually as well as construct a weighted index and investigate such an index as an account of the total publications.

Last and most importantly, for countries that have instituted a university evaluation system and subsequently adopted a funding scheme rewarding research performance, an account of research publications is often the key criterion, and shall be more responsive and

more directly influenced by the adoption of such a funding system.

Research Input

Universities mobilize various resources to carry out research. These resources can be loosely categorized into three groups: research funds, human resources, and an aggregate economic environment conducive to research activities.

Universities largely secure research funds through three different channels: industry and private companies, government agencies, and public (non-commercial) research bodies such as research foundations. Different types of funding likely affect what and how university researchers study, and consequently their research publications. For example, industries and private companies are typically concerned with product innovation and commercialization of inventions. Funding derived from such institutions predictably gears towards research that is more applied in essence and more market-oriented. In contrast, government agencies and research foundations in general promote more basic research and emphasize new discoveries and invention.

A university, other than seeking research support from these three different and external channels to sponsor its researchers, likely provides research assistance and funding through its own annual revenue and budget. We would expect a direct relationship between university revenue and research activities, and thereby research publications.

Another input factor we also emphasize is human resources. We classify human resources that universities mobilize into two types. One is academic staff and the other is administrative and support personnel. We assess whether and to what extent each of these two types of human resources contributes to the generation of research output. It is also possible that the effects and relative importance of these two types of human resources vary across types of universities. For instance, academic staff may play a more important role in research for a newly established university than a well-organized and celebrated one, in order to jump start research activities and hence publications.

University research activities may also be affected by the environment that surrounds them, such as economic conditions in the national as well as at the regional level. Economic downturns likely have a negative impact on research, not only because all sorts of university funding dwindle but also because the general public tends to withdraw their support of academic research during recessions as it is often viewed as non-essential. In contrast, research activities may pick up again and increase sharply during upswings. University research activities are expected to track more or less closely with business cycles. A measure of economic performance, for instance, gross domestic product (henceforth, GDP), shall be included in the empirical analysis.

Possible Effects of Adopting a Performance-Based Funding System

A performance-based research funding system evaluates universities and rewards research performance. In the favorable view, a university and its researchers under such a funding system would intensify their research efforts in hope to increase research output. This

funding system thus enhance the incentive to carry out R&D. In addition, such a system distributes funds according to research output performance and inevitably creates a competitive environment among universities. Such a competitive nature is believed to make research activities undertaken in universities more effectively and efficiently as it promotes better research management and encourages completion, publication and dissemination of research results. In other words, research productivity would rise. If this perspective holds true, we would expect an increase in research output to occur around the time when the adoption of a performance-based research funding system takes place.

Unfortunately, performance-based funding systems and the conventionally favorable view towards them have been greeted with some skepticism. A recent study by Nisar (2015) summarizes some possible reasons that performance based funding has little impact. First, a too small portion of funding is distributed through such a system. Second, idiosyncratic characteristics of universities may play a role. Finally, the unavoidable principal agent problem between policymakers and university administrators can diminish the effects of such a funding scheme. In addition, some scholars believe that such systems may cause universities and their researchers to undertake "safer" research rather than to carry out riskier but potentially revolutionary studies. Moreover, novice researchers and newly established universities may be put into a huge disadvantage because performance-based systems reward past performance and thereby can stifle new entry into research. Intuitively, there may be less research activities carried out in newly founded institutions after implementing a performance-based funding system (Iorwerth, 2005; Butler, 2010).

External Research Funding And The Performance-Based Funding System In Australia

External Research Funding

Australia's universities and their researchers may acquire external funding to carry out R&D. The sources of these external funds are customarily grouped into four categories. The first and foremost is the Australian Competitive Grants. These grants are provided by the Australian Federal Government. Based on merit and performance, funds are distributed to higher education institutions in the form of block grants, rather than to individual researchers. The main grant awarding agencies include the Australian Research Council, the National Health and Medical Research Council, and the Department of Industry.

The second group—other public sector research income—consists of funding from other government sources, for example, Australian state and local governments, as well as entities fully or partly owned or funded by various levels of Australian governments. The third category—industry and other research income—includes funding from non-Australian government agencies. Contract research with Australian and international businesses, and research grants secured from foundations and donations predominantly make up this category. The last category is concerned with research income provided by the Cooperative Research Centers. The Cooperative Research Centers program was created in 1990 by the Australian Government to encourage research collaboration and

information sharing between private and public sectors. Such centers promote technology transfer and licensing as well as commercialization of technological innovation, so as to maximize the benefits of R&D conducted in higher education institutions.

The importance of each funding category varies across universities. It also changes over time. For example, in 1995 the University of Sydney secured about a total of 60.4 million Australian dollars of research income. Approximately, 58 percent of this amount, 35 million, came from the Australian Competitive Grants. Roughly 31 percent (19 million) was provided by industries and other research sources. Other public channels accounted for only seven percent. The Cooperative Research Centers program constituted the least, less than four percent. In the following two decades, the university's research income grew substantially. Research income of the university swelled to about 297 million in 2010. The Australian Competitive Grants remained to be the main source, but its importance had gone down considerably, dropping to 52.5 percent. The share of research income through the Cooperative Research Centers program also reduced to merely 1.2 percent. In contrast, funding from other public sectors, such as state and local governments, grew tenfold to a little more than 41 million and accounted for about 14 percent. Industry and other research income also increased in both absolute and relative levels to 96 million and about 32 percent.

Performance-Based Research Funding System in Australia

The Australian Government has supported its higher education providers based on two dimensions of these institutions: teaching and research. Annual funding for teaching and learning is largely distributed according to student enrollments. On the other hand, a performance-based research funding scheme, the so-called "Research Quantum" system, was first created in 1996 to allocate support for research and research training. Such a system received modification and strengthened in 2002. Funds distributed through the Research Quantum system were in the form of block grants. Participating universities had considerable discretion to administrate these grants so as to support research activities.

The core feature of the Research Quantum system was a composite index, which comprised measures of both research input and research output of these institutions. Such an index provided a simple figure that was believed to unveil the level of each and every university's research performance. To construct the index, research input was gauged through the four types of research income (discussed in section 3.1) the university successfully secured in the previous year. Research output was evaluated through two indicators: the quantity of scholarly publications and the number of post-graduate degrees completed. Despite that the index took both input and output perspectives of research activities into account and that the weight of each component varied from time to time, the volume of scholarly publications remained the central component of the Quantum system (Garrett-Jones et al., 2000).

Because the Research Quantum system in Australia was further strengthened in 2002 and it had changed little in its core features until 2010, par-

ticularly the composite index and its composition, the implementation provides us a rare and unique opportunity to investigate effects of such a system on research activities. The findings shall offer some insights into future development and modification of such a research support system.

Data

We collected information on annual research income and publication statistics of Australian universities for all the years from 1995 to 2010 from the Higher Education Research Data Collection, published online by the Australian Department of Education. University personnel and staff data were gathered from the Higher Education Staff Data Collection, also provided by the Australian Department of Education. We also retrieved annual university revenue figures from various Australian government publications and online sources.

Australian macroeconomic data, such as GDP and consumer price index (CPI), were too collected. The GDP information is published on a quarterly basis, so it is necessary to transform the series into annual figures in order to be in line with research and other data. The CPI statistics are also reported quarterly. For the sake of convenience, we opted to select the fourth quarter's CPI figure in each calendar year. More importantly, the CPI data, we gathered, are of each individual city (for example, Sydney, Melbourne and Perth) and of the entire country, Australia, as a whole. Such regional CPI information allows us to more accurately gauge the real change in the revenues and research incomes of each and every individual university because inflation varies across places.

Empirical Analysis

We adopt the typical production function approach, often employed by scholars studying R&D, patenting and intellectual property rights, such as Hall, Griliches, and Hausman (1986), Lerner and Wulf (2007), and Lo and Sutthiphisal (2009). Such an approach abstracts a short form of the relationship between research input and output. We use university-year as the unit of observations and categorically employ a fixed effects model because each and every university inevitably has some unobservable idiosyncratic characteristics, which play a role in how these universities carry out research and other functions.

Results

After data analysis, the results are summarized as follows:

1. Human resources were an important factor in generating journal articles, as the coefficient on the total full-time-equivalent staff is statistically significant. The estimate on GDP shows that a booming economy boosted book chapters and conference papers, but not academic journal articles. During an economic boom, more conferences are held and more academics attend these conferences.

2. Secrecy is an effective mean to protect intellectual property rights and can secure market power better (Levin et al., 1987; Cohen et al., 2000). Consequently, research projects sponsored by commercial enterprises are less likely to result in academic publications (Chang et al., 2016). The results on university revenues confirm again that a uni-

versity's own revenue had a positive and close relationship with research papers (e.g., book chapters, journal articles, and conference papers), but failed to stimulate the generation of research books.

3. Support staff is crucial in not only managing these meetings but also keeping an eye on the details of the tedious publishing process. On the other hand, academic staff played an encouraging role in the creation of journal articles.

4. If the Research Quantum system had stimulated research activities and thereby research output, an upsurge or acceleration in publications would appear around the time when such a performance-based funding system came into force. The time trend of the total weighted publications made by all the universities.

Conclusion

In this paper, we aim to improve our understanding of the relationship between research input and research output in higher education providers. We seek to identify which type of research income provides a strong incentive to carry out research activities and thereby produce published output, as well as to pinpoint whether and what kind of human capital is crucial in such a process. We also explore the difference in research behavior across universities and examine whether the adoption of a performance-based research funding system has an impact on these institutions' research practice.

The empirical evidence, by examining Australian universities, shows that an increase in research funding brought about an increase in research output. Among various types of research funding, the merit-based competitive grants were the most effective in boosting up publications. Among various types of publications, academic journal articles were the most responsive to the increased research funding. Our regression analysis also indicates that elite universities were more responsive to the incentive provided by the competitive grants than their less-esteemed counterparts. For these less-esteemed universities, academic staff was key to the generation of journal articles. Finally, a switch to a research funding system focused on past publication records led to a rise in publications.

The findings yield some important implications. First, to generate more visible or measurable research output, policymakers could allocate public funds to support research via a competitive funding system. The majority of the funding, if efficiency and accountability are the main concern, should be distributed towards prestigious research- oriented universities, as they are more responsive and effective in transforming research funds into published output. Unfortunately, diversity, equality, and accessibility in education and research are of similar importance, if not more. How policymakers balance these two conflicting goals—improving efficiency in utilizing public funds while maintaining diversity and accessibility in the higher education sector—poses a new challenge (Woelert, 2015). Furthermore, the evidence shows that the adoption of a performance-based research funding system had raised the amount of published output. The two different types of universities—the prestigious and the less-culturally valued—exhibited similar responses (comparable increases in pub-

lished output) to such a policy change. It is, however, unclear whether the quality of research or the importance of the conducted research work was also enhanced. As one of the concerns about implementing a performance-based funding system is that it may lead to "safer," and "less revolutionary" research, an investigation into the quality of carried-out research and thereby publications is worth pursuing and shall yield a fruitful direction in future studies.

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