



# Influencing scientists' collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital<sup>☆</sup>

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## ABSTRACT

This paper analyzes the effect of university research centers on the productivity and collaboration patterns of university faculty. University research centers are an important subject for policy analysis insofar that they have become the predominant policy response to scientific and technical demands that have not been met by extant institutions, including academic departments, private firms, and government laboratories. Specifically, these centers aim to organize researchers from across the disciplines and sectors which, collectively as a research unit, possess the scientific and technical capacity relevant to scientific and technical goals of the sponsoring agencies. In this paper, we measure the productivity and collaboration patterns of university researchers affiliated with a relatively large-scale and “mature” university research center to discern the effects, if any, of the center mechanism on individual scientists and engineers. Based on an analysis of longitudinal bibliometric data, the results from this case study demonstrate affiliation with the center to be effective at enhancing overall productivity as well as at facilitating cross-discipline, cross-sector, and inter-institutional productivity and collaborations.

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## 1. Introduction

University research centers and comparable arrangements constitute a key mechanism for the strategic use of science and technology for solving problems (Stokols et al., 2008). Policy scholars' interest in university research centers began after the establishment in the 1980s of the large-scale (in terms of budget and length of funding cycle) centers programs sponsored by the National Science Foundation, most notably the Engineering Research Centers (ERC) program. The original program was authorized by the US Congress in 1985, with an initial budget of \$10 million (Bozeman and Boardman, 2004).<sup>1</sup> The creation of the ERC

program was an explicit policy response to the perceived economic competitiveness crisis with Japan (Suh, 1986) and was one of a number of mechanisms employed during those years to help bridge the divides between university research, education, and industrial innovation.<sup>2</sup> Today, the ERC program is still considered in such a strategic light, having recently been modified in response to current concerns over US competitiveness (Lal et al., 2007). Accordingly, assessments of university research centers and their effects,

biggest, costing more than \$50 million per year. Twenty-seven ERCs have graduated from the program, of which currently there are 16 who have become self-sustaining. There are 15 ERCs that are currently within their 10 year funding cycles. Depending on size and nature of research, ERCs may receive annual funding of up to \$4 million per year. The ERC program is considered a success by NSF, and recently (November 2008) 5 third generation ERCs were launched, with a budget of \$92 million for the next five years.

<sup>2</sup> Other policy mechanisms during the 1980s aimed at facilitating technology transfer to industry included Cooperative Research and Development Agreements wherein (per the Stevenson–Wylder Act) government laboratories and private companies could collaborate to commercialize technology developed with federal monies and the Bayh–Dole Act affording universities intellectual property control over their inventions (see Dai et al., 2001). Bozeman and Boardman (2003) and Corley et al. (2006) argue that the advent of “multipurpose, multidiscipline university research centers” (including NSF ERCs) constitutes a chief policy mechanism for facilitating technology transfer to industry.

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<sup>1</sup> Currently NSF allocates more than \$250 million (or about 6% of the NSF total budget) per year to different center programs, and the ERC program is among the

including but not limited to ERCs, have focused predominantly on the benefits afforded industry partners, including the conduct of applied and commercially relevant research (Gray et al., 2001) and access to upstream modes of knowledge and to students for hire upon graduation (Feller et al., 2002).

Few studies have addressed the publication patterns of center-affiliated university faculty. This is surprising for a number of reasons. First, the predominant mode of knowledge dissemination for university faculty is publishing, and aggregate statistics on scientific output generally are considered valuable for assessing the rate and quality of scientific production (van Raan, 1996), including for assessment of R&D organizations (Geisler, 1994).<sup>3</sup> Changes in the publication patterns of scientists, particularly ones triggered (whether deliberately or not) by new institutions, are of great interest to science policy makers (National Academy of Science, 2007; Stokols et al., 2008). Second, the primary operationalization of research collaboration in science and technology policy analysis and research evaluation is co-authorship (e.g., Katz and Martin, 1997). As university research centers are policy tools for fostering collaborative networks that create cross-disciplinary and cross-sector synergies to further a field of research and development (Boardman and Corley, 2008), one would expect bibliometric study of university research centers and their scientists, especially regarding center scientists' publications that are co-authored across institutional, disciplinary, and sectoral boundaries.

Perhaps one reason there has been so little study of the publishing patterns of university research centers and their scientists is that the manner in which centers may affect individual publishing activities is not sufficiently clear. On one hand, many researchers choose to affiliate with centers to increase their publishing productivity (among other motivations, see Landry and Amara, 1998). In affiliating with a center, researchers may augment their "scientific and technical human capital" (Bozeman et al., 2001) and, with it, their respective abilities to conduct research of different types and publish the results. On the other hand, many centers are focused on modes of knowledge production that may not be as conducive to publishing as to other forms of dissemination, such as informal knowledge exchange (Ponomariov and Boardman, 2008) and patenting (Dietz and Bozeman, 2005). Moreover, the problem of "additionality" (Georghiou and Roessner, 2000) is omnipresent in the evaluation of policy mechanisms like university research centers. An essential but thorny evaluation question is precisely the extent to which changes in publication patterns may be attributed to the operations of university research centers, versus alternative explanations.

The purpose of this paper is to assess the effect of affiliating with a "mature" university research center – the Mid-America Earthquake (MAE) Center, an ERC established in 1997 and headquartered at the University of Illinois at Urbana-Champaign – on the publication patterns of the faculty affiliated with this center. The MAE Center provides an excellent opportunity for bibliometric analysis given that it has reached successfully the conclusion of its funding cycle with the NSF (ten years, with a review and renewal at 5 years) and therefore has had the maximum time (at least under the auspices of the ERC program) to have an effect on the university faculty working there. Another reason the MAE Center provides a particularly good case for developing a better understanding of how the center mechanism may affect the publishing patterns of university faculty is that the MAE Center is part of what many consider in the

ERC program to be the flagship university research centers program in the US and abroad.<sup>4</sup>

Thus, as a singular case study, the MAE Center is of significant "instrumental" value (Stake, 1995; Yin, 2003) insofar that the knowledge produced by an examination of how this center has altered the publication patterns and rates of its affiliated faculty can inform policy and management decision making for centers and centers programs more broadly. There are currently thousands of research centers on American campuses to date, and centers and centers programs have become the hallmark of national- and regional-level science and technology policies in most developed countries. While a single case like the MAE Center will not allow for broad conclusions regarding the general effects of the center mechanism, it can be instrumental in developing policies and management strategies for centers and centers programs insofar that so little is known about how centers alter the knowledge production patterns and rates of university faculty.

In this paper, we assess changes in the publishing of university faculty once they affiliate with the MAE Center, using longitudinal data from before and after the faculty joined the center (the analysis is based on scientists' complete publication histories). We combine bibliometric and survey data<sup>5</sup> to assess publishing patterns in a number of ways that speak directly to the primary goals of centers like the MAE Center and instrumentally to centers programs like the ERC program: cross-discipline, cross-sector, and inter-institutional research collaborations. We operationalize collaborations as publications authored conjointly by university faculty and other same-university researchers, researchers in industry, and at other universities as well as number of collaborators of different type.<sup>6</sup>

In addition to the collaboration goals of centers, we also use the MAE Center case to assess the effect of center affiliation on the productivity of university faculty. Therefore, the longitudinal analysis also includes overall yearly publication rates. This additional focus is important for addressing the extent to which center affiliation detracts from or enhances traditional academic behaviors and outputs, which has been an ongoing debate regarding not just university research centers with industry-related missions but also regarding other policies and institutions aimed at facilitating university–industry interactions (see Slaughter and Rhoades, 1996). While this case study is not general enough to resolve the debate, it constitutes one of the first direct empirical tests of the claim that centers detract from traditional modes of dissemination by university faculty.

The perspective that guides our analysis is the scientific and technical human capital perspective (Bozeman et al., 2001), which emphasizes individual-level research capacity and how it may be affected by professional linkages and network ties, including but not limited to linkages and ties made by way of affiliation with a university research center. Given the general purpose of government centers programs to facilitate collaboration (Boardman and Corley, 2008) and to develop research capacity that is different from that developed in traditional academic departments (Bozeman and Boardman, 2004; Ikenberry and Friedman, 1972), and given that we

<sup>4</sup> The ERC program is considered the advent of multidiscipline university–industry centers and has served as archetype for numerous subsequent centers programs in the US, South Korea, and Ireland (Bozeman and Boardman, 2004).

<sup>5</sup> From a survey administered to MAE faculty as a part of the external evaluation of the center in 2006.

<sup>6</sup> While this study is in the tradition of most prior study of research collaboration by focusing on co-authorship (Katz and Martin, 1997), other studies operationalize research collaboration using survey responses focused on self-reports of time allocation (Bozeman and Corley, 2004) insofar that not all collaboration, especially that between university and industry scientists, result in publications.

<sup>3</sup> While many centers employ researchers who are not employed on the tenure track in an academic department, it is a requirement of most NSF centers programs, including the ERC program that center researchers hold tenured or tenure track appointments in academic departments (Bozeman and Boardman, 2003).

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