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Participation in university-based research centers: Is it helping or hurting researchers?

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ABSTRACT

In general, affiliation with a university research center is considered to be an activity that can improve the research activities of scientists and academics. Yet there have only been a few studies examining whether research centers are positive institutional structures for individual researchers. Our research examines how affiliation with a research center in the United States can impact research productivity, collaboration, and careers of faculty members in the multidisciplinary field of learning sciences. This study utilizes data from a curriculum vitae (CV) analysis of 402 faculty members who are currently employed at research universities. The results indicate that, on average, the research productivity of faculty members affiliated with a research center is higher than non-center affiliated faculty members. The effects, however, disappear when controlling for factors such as years since Ph.D., gender, post-doctoral status, quality of publications, and quantity of other research outputs. Senior tenured faculty members appear to benefit greatly from affiliation with a research center, while center affiliation does not positively correlate with the productivity of junior faculty members.

1. Introduction

The emergence of university-based research centers is a relatively new phenomenon for institutions of higher education, but the trend is rapidly gaining momentum as federal agencies, such as the National Science Foundation (NSF) and National Institutes of Health (NIH), turn to these centers to solve complex interdisciplinary problems. There is no universal definition of a university research center. Our study adopts the definition that identifies a university research center as "*a formal organizational entity within a university that exists chiefly to serve a research mission, is set apart from the departmental organization, and includes researchers from more than one department*" (Bozeman and Boardman, 2003, p. 17).

University research centers hold a unique advantage as they serve as power houses for generating new knowledge that encompasses theories and application from disciplines that normally do not come together in traditional department-based academic settings (Boardman and Corley, 2008; Bozeman and Boardman, 2003; Stahler and Tash, 1994). Previous research has empirically measured a variety of career outcomes of faculty members within university centers. Some of these studies have shown that university research centers lead to positive outcomes for faculty members in the form of increased publication productivity (Bunton and Mallon, 2006; Corley and Gaughan, 2005; Ponomariov and Boardman, 2010), industry partnerships (Gaughan and Corley, 2010), collaboration and networking (Boardman and Corley, 2008; Bozeman and Corley, 2004; Gaughan and Ponomariov, 2008), and technology transfer (Bozeman and Boardman, 2003; Roger et al., 1999; Youtie et al., 2006).

Yet, other scholars suggest that university research centers can be a source of conflict between the values of academic departments and the interdisciplinary values that are often promoted in centers through commercial activities such as patenting (Kleinman and Vallas, 2001; Slaughter et al., 2002). Additionally, being affiliated with a research center results in competition among faculty for resources such as time, research support, and infrastructure (Boardman and Bozeman, 2007; Boardman and Ponomariov, 2007; Bozeman and Boardman, 2004; Stahler and Tash, 1994). Drawing on the results of existing research, our three research questions are as follows: does affiliation with a university-based research center in the United States aid or hinder publication productivity, collaboration patterns, and the career trajectory of faculty members? More specifically, how and to what extent does affiliation with a center affect the quality and quantity of research scholarship and collaborations? And how do these patterns vary by the career stage of faculty members?

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The funding of research centers is one of the major policy developments in the U.S. and increasingly in other countries, but the empirical knowledge about these centers is still comparatively modest. It is important to assess these questions given that much of the funding for academic research centers comes from publicly funded organizations such as NSF and NIH (Cozzens, 2000). In February 2011, the House of Representatives passed a bill, *HR1* that cut $1.6 billion from NIH and $359 million from the NSF 2011 budget. Based on the current financial situation, one might question whether funding agencies like NSF and NIH should continue funding university-based research centers. The results of this study provide some insights into this question.

While research centers in the sciences have gained prominence as houses for carrying out research and development, they remain a minor but important part of the university research system in the United States. However, most or all of the existing studies on research centers are focused on the fields of science, engineering, and medicine (Boardman and Corley, 2008; Bunton and Mallon, 2006; Corley and Gaughan, 2005; Gaughan and Bozeman, 2002; Gaughan and Corley, 2010; Gaughan and Ponomariov, 2008; Mallon and Bunton, 2005; Ponomariov and Boardman, 2010), despite the recent existence of centers targeting social science research. The participants in our study do not focus on a single discipline but have research interests in a variety of disciplines such as: psychology, education, computer science, and anthropology, among others, and identify their areas of research in a way that is similar to the disciplinary focus of researchers in the Science of Learning Centers (SLC)[2] funded by the National Science Foundation (NSF). The Science of Learning Centers program was established with the aim of furthering new ideas and expanding the science of learning from a truly multidisciplinary perspective (Sawyer, 2006). These NSF-funded centers are based in a university and can provide educators, administrators, policy makers, industry leaders, academics, and researchers with a new understanding of complex interdisciplinary issues.

Learning sciences is a newly founded discipline that differs from other pure sciences such as biological science, physical science, and mathematics by integrating multiple disciplines such as cognitive science, computer science, educational psychology, anthropology, and applied linguistics in an effort to understand and answer the complex global problems of the 21st century (Jacobson and Wilensky, 2006). As such learning scientists focus on the understanding of processes and outcomes of learning that occurs in real world settings. The discipline of learning sciences now has two peer-reviewed journals (*Journal of the Learning Sciences* and the *International Journal of Computer Support for Collaborative Learning*) solely dedicated to the advancement of education and learning in a multidisciplinary environment. In addition, there are six primary Science of Learning Centers funded by NSF for a total of $23 million in the fiscal year 2011 with an additional $17 million leveraged from sources other than NSF with a total of 1120 participants (total number of people who use the center facilities not just the persons supported directly by NSF).

Thus there are concerted efforts by NSF to fund science of learning centers to advance the "frontiers of all the sciences of learning through integrated research; to connect the research to specific scientific, technological, educational, and workforce challenges; to enable research communities to capitalize on new opportunities and discoveries; and to respond to new challenges" (NSF, 2012, p. 24). Additionally, there are several graduate programs in the US that specialize in the learning sciences. The authors use the learning sciences discipline as a case study for exploring how center affiliation either helps or hurts the careers of faculty members. In order to better understand these relationships the authors examine the curriculum vitae of 402 faculty members currently employed at research intensive or extensive universities.

While there is no unified theory that explains research productivity, collaboration, and faculty careers, the scientific and technical human capital theory has recently been widely used to explain these concepts in academic settings (Bozeman et al., 2001). The basic meaning of "scientific and technical human capital," or S&T human capital, can be defined as "the sum total of scientific, technical, and social knowledge and skills embodied in a particular individual" (Bozeman and Corley, 2004, p. 601). According to this theory—affiliation within a center has the potential to change a researcher's patterns of collaboration, professional relationships, and effectiveness long after the project is over. We thus expect that affiliation with a research center can have long lasting impact on the productivity and collaboration patters of faculty members.

The study is structured in the following manner. First, a detailed literature review is provided and is categorized into three main areas: (1) Center affiliation as it relates to the quantity and quality of research productivity produced by faculty members, (2) Center affiliation as it relates to the collaboration patterns of scholarship, and (3) Center affiliation as it relates to faculty research productivity at various stages in their careers. Second, several hypotheses are developed from the literature. Third, an explanation of the data used and methodology is provided. Fourth, the results are reported. Last, a discussion on the findings and implications is presented.

2. Literature review

As previously mentioned, the increasingly complex nature of scientific problems often requires research solutions that span disciplinary and institutional boundaries; to address this requirement university-based research centers are becoming more common (Boardman and Bozeman, 2007). University-based research centers and institutes were created in response to not only the changing needs and structures of the university, but also with a desire to bring researchers from diverse backgrounds and ideologies to come together in an effort to solve complex scientific and social problems that cross disciplinary boundaries (Boardman and Corley, 2008; Bozeman and Boardman, 2003; Ikenberry and Friedman, 1972; Stahler and Tash, 1994). Research centers allow faculty members to further develop their research agendas within the university structure (Ikenberry and Friedman, 1972). Research centers can attract faculty to join by way of offering extra space, resources, and additional funding opportunities (Mallon, 2006). Additionally, centers can help universities attract quality graduate students and improve overall graduate education (Ikenberry and Friedman, 1972; Steffensen et al., 2000) while also facilitating interdisciplinary research and collaboration between experts from different disciplines (Boardman and Corley, 2008; Bozeman and Boardman, 2003; Stahler and Tash, 1994). Often research centers are viewed as a platform for faculty members to focus more on their research agendas and gain resources that are not available through their academic departments (Gaughan and Bozeman, 2002; Bunton and Mallon, 2006).

Youtie et al. (2006) provide a thorough description of university research centers (URC) and their functions within the academic and scientific community. University research centers help promote research which aids in the accumulation of scientific knowledge along with providing opportunities for mentoring and increased publication productivity (Wen and Kobayashi, 2001; Youtie et al.,

[2] NSF defines Science of Learning Centers as being "built around a unifying research focus and incorporate a diverse, multidisciplinary environment involving appropriate partnerships with academia, industry, all levels of education, and other public and private entities." For more details see: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5567.

2006). University research centers can differ in their organizational structures and their hierarchy within the university. While some research centers are housed within an academic department and adhere to the administration of the department, other centers function as separate entities in the university and are governed by an external dean or other authority (Stahler and Tash, 1994). Since all of the study respondents affiliated with a research center are tenured and tenure track faculty members, the model described by Youtie et al. (2006) is most applicable to our research. Faculty members affiliated with a university research center are subject to the same academic norms of tenure and promotion like faculty members not affiliated with a center; it is thus important to investigate their research productivity, collaboration patterns and career trajectories.

2.1. Center affiliation and faculty productivity

Our first research question examines how center[3] affiliation affects the quantity and quality of research productivity of faculty members. Previous research on the relationship between faculty productivity and center-affiliation has yielded mixed results. For example, Gaughan and Bozeman (2002) found that center affiliation positively impacts the ability of a faculty member to get an industry grant, but it does not improve their overall productivity. However, the explanatory power of the model used to predict annual productivity was small and excluded some potentially important explanatory variables such as faculty rank, tenure status, employer type, teaching and administrative responsibilities—variables of importance in studies of faculty productivity (Bellas and Toutkoushian, 1999; Fox, 1983; Corley and Gaughan, 2005; Gaughan and Corley, 2010; Marsh and Hattie, 2002; Ramsden, 1994; Stack, 2004; Wanner et al., 1981). Corley and Gaughan (2005) reported center affiliated faculty members have a greater likelihood to be involved in industry research than departmental faculty not affiliated with such a center—the differences were more pronounced for male than female faculty members. However, their study did not measure the publication productivity of center and non-center affiliated faculty members.

Scholarly productivity of university faculty members is commonly measured by the number and rate of publications produced throughout the career. Productivity is a major criterion for tenure evaluation, pushing university faculty members to produce significant number of quality publications. With the requirement to produce an array of scholarly publications, faculty members must pursue an efficient path toward productivity within the early years of their careers. Among the benefits of affiliation with a research center is the opportunity to work with faculty members of other departments (Hetzner et al., 1989). Traditional academic departments do not always have the expertise needed to complete a certain research project or agenda, making it somewhat necessary to work with researchers in other fields (Ikenberry and Friedman, 1972). The interdisciplinarity of such research centers provides opportunities to collaborate with faculty members in different and diverse disciplines, therefore impacting the activities of an individual/department/school. Additionally, research has shown that affiliation with a university center helps with expanding the social network of academics, provides greater opportunities for research, and possibly reduce teaching loads thus furthering their research productivity (Bunton and Mallon, 2006; Corley and Gaughan, 2005; Dietz and Bozeman, 2005; Mallon, 2006; Steffensen et al., 2000). On the contrary, a recent study by Gaughan and Ponomariov (2008) on PhDs and MDs with research interests in the areas of fertility research and reproductive health found that affiliation with a center negatively impacted a researchers' abilities to receive grant funding—the results however, varied by type of funding received, with increased rate of funding observed for past NIH awardees.

Mallon (2006) noted that faculty members affiliated with a center often have smaller class loads leaving more time to devote to their research. Since teaching and research are inversely related to scholarly productivity (Centra, 1983; Fox, 1992; Marsh and Hattie, 2002; Menges and Exum, 1983), spending less time on teaching could increase the research productivity of faculty members. Despite the importance of Mallon's (2006) study, he only interviewed center-affiliated faculty members and did not compare productivity rates of faculty members not affiliated with a center. University-based centers can provide a forum for faculty members from different departments and academic fields to combine talents and strengths to produce quality research. Thus, these faculty members are likely to not only have higher number of publications, but also more grants (Bozeman and Corley, 2004; Bunton and Mallon, 2006). Given that previous studies have concluded that the productivity of scientists and engineers affiliated with a research center is higher than non-center affiliated faculty members (Bunton and Mallon, 2006; Corley and Gaughan, 2005; Dietz and Bozeman, 2005; Gaughan and Bozeman, 2002; Mallon, 2006; Ponomariov and Boardman, 2010), the authors hypothesize that for the learning sciences field the research productivity of faculty members affiliated with a center will be higher than faculty members who are not affiliated with a center (Hypothesis 1).

Further, while most studies use total number of articles published as a measure of productivity (Fox and Faver, 1985; Massy and Wilger, 1995; Sabharwal and Corley, 2008; Xie and Shauman, 1998), this indicator is only a measure of quantity not quality. Using an additional measure of quality (such as journal impact factors[4]) can provide a more holistic assessment of productivity. Studies have shown that the quality of work is higher in collaborative papers (Presser, 1980; Smart and Bayer, 1986). Studies linking center affiliation with quality of publications are sparse; however, since affiliation with a research center generally results in collaborative work, the authors hypothesize that faculty members in learning science disciplines affiliated with a research center will tend to publish in higher impact journals than their non-center affiliated peers (Hypothesis 2).

2.2. Center affiliation and collaboration

Our second research question examines how affiliation with a center affects the collaboration or co-authorship rates of individual faculty members. Collaboration in a formal setting is the joint effort of two or more researchers in producing research. Collaboration occurs in many different ways across university institutions; it can develop within academic departments, between academic departments, across different institutions, and across country boundaries. Since 1980, collaboration between researchers in the natural and social sciences has increased by approximately 25% and 30%, respectively (Larivière et al., 2006). In cases where collaboration is required for the sharing of resources and the advancement of a field (Katz and Martin, 1997), center affiliation can often support these activities. University-based research centers were originally established to improve collaboration among faculty members in interdisciplinary settings (Boardman and Corley, 2008; Gaughan and Bozeman, 2002), though few studies have examined collaboration rates for center and non-center affiliated peers—with the exception of Gaughan and Ponomariov (2008) who limited their

[3] The word center/research center in this study is used synonymously with university based research center.

[4] Measures the frequency with which an average article published in a given journal has been cited in a particular year.

sample and findings to the researchers in the field of reproductive health. Gaughan and Ponomariov (2008) found increased co-authorship as a result of affiliation with a multidisciplinary research center, although no impact was observed on the publication productivity of faculty members affiliated with a center.

Mallon (2006) noted that center affiliation promotes collaboration through access to diverse faculty and more research-based activities. Collaboration in general has been shown to improve productivity (Gordon, 1980; Kyvik and Teigen, 1996; Landry et al., 1996; Lee and Bozeman, 2005; Melin, 2000; Ponomariov and Boardman, 2010) thus, providing faculty members affiliated with a research center an opportunity to work and produce scholarly work together. Based on a questionnaire of scientists and engineers, Bozeman and Corley (2004) found that increased grant funding is correlated with increased collaboration rates. Center affiliated faculty members are 88% less likely to work alone when compared with faculty members that are not affiliated with a research center (Boardman and Corley, 2008). Based on past documented research, the authors hypothesize that faculty members in learning science disciplines with a center affiliation will have higher collaboration rates than faculty members without a center affiliation (Hypothesis 3).

2.3. Center affiliation and faculty rank

Our third research question explores the professional characteristics of center affiliated faculty members. What type (i.e. junior faculty vs. senior faculty, women vs. men) of faculty members are most likely to be associated with a research center and how do these factors relate to their productivity? As previously mentioned, research centers can provide opportunities for collaboration, increased productivity, and interdisciplinary work (Boardman and Corley, 2008; Bozeman and Boardman, 2003; Bozeman and Corley, 2004; Bunton and Mallon, 2006; Corley and Gaughan, 2005; Gaughan and Ponomariov, 2008; Ponomariov and Boardman, 2010; Stahler and Tash, 1994). Yet, the interdisciplinary nature of most research centers can pose some challenges for center researchers. For example, the opportunities that come about because of center affiliation do not necessarily have the same impact on faculty members at different career stages. Lee and Bozeman (2005) found that faculty members in later stages of their careers in science and engineering disciplines collaborated more than junior faculty members, which is a result of the scientific and technical human capital accrued by senior faculty members over several years in academia.

Faculty members affiliated with a research center are more likely to do interdisciplinary work, and since such work often requires more time, effort, and expertise it is highly likely that center-affiliated faculty members will be tenured and more senior (Carayol and Thi, 2005). On the other hand, previous research has shown that junior faculty members affiliated with a center do not experience an increase in productivity publication rates compared to non-center affiliated junior faculty; at the same time, it appears that center affiliation does not decrease their productivity rates below their peers (Bunton and Mallon, 2006). Junior faculty members might spend too much time with center related work, thus alienating themselves from departmental activities and their fellow staff (Boardman and Bozeman, 2007; Boardman and Ponomariov, 2007; Bozeman and Boardman, 2004; Mallon, 2006). On the contrary, a few studies have reported that junior faculty members and female faculty members affiliated with a center have higher publication productivity than their un-affiliated colleagues (Corley and Gaughan, 2005; Lin and Bozeman, 2006; Ponomariov and Boardman, 2010). The difference in results can partly be attributed to the sample under study—Bunton and Mallon's (2006) study focused on researchers in internal medicine. Corley and Gaughan's (2005) sample consisted of researchers working at Energy Research Centers and Corley et al. (2003) used data from interdisciplinary science centers funded by the NSF. Similarly, Lin and Bozeman (2006) analyzed CVs and survey responses of faculty members affiliated with the Department of Energy and NSF. While Ponomariov and Boardman (2010) did a case study on an ERC—Mid-America Earthquake (MAE) Center with close to three-fourth of the faculty from civil engineering and geophysical sciences. None of the previous studies focused on social sciences. Most of previous studies have focused on science and engineering disciplines, which may show very different behavior and outcomes than the social science disciplines under study in this paper. Therefore, based on previous research, the authors expect that senior level faculty members in learning science disciplines will be more likely to be affiliated with a research center than junior faculty (Hypothesis 4). In addition, the authors hypothesize that center-affiliation will be positively correlated with productivity for senior faculty members in the learning science disciplines (Hypothesis 5). Of course, the mixed nature of the results on center affiliation might be the product of comparing different kinds of research centers and different disciplines. While assumptions about the differences in centers by discipline could potentially explain why some junior faculty members benefit more from center affiliation than others, the authors are not aware of any existing data that could quantitatively explain how different the centers are in reality. A summary of the hypotheses tested in this study are stated below (with all hypothesis being applied to the multidisciplinary research area of the learning sciences):

H1. Center-affiliated faculty members will have higher levels of research productivity than non-center affiliated faculty members.

H2. Faculty members affiliated with a research center will publish in higher impact journals than their non-center affiliated peers.

H3. Faculty members affiliated with a research center will have higher collaboration rates than faculty members without center affiliations.

H4. Senior faculty members are more likely to be affiliated with a research center than junior faculty members.

H5. Senior faculty members that are affiliated with a research center will have higher productivity rates than junior level faculty members with similar affiliations.

3. Data and methods

The data for this study were collected from the curriculum vitae of 402 faculty members within the field of the learning sciences that include psychology, educational psychology, clinical psychology, biology, communications, and management. curriculum vitae (CV) analysis utilizes the vitae of researchers to collect data and variables about career trajectories, publication rates, impact factors, and collaboration rates, among other things (Dietz et al., 2000). In recent years CV analysis has been used to measure several aspects of scientific and technical human capital that embody productivity levels, career patterns, networks, and collaboration among scientists and engineers (Bozeman and Corley, 2004; Canibano and Bozeman, 2009; Corley, 2005; Corley et al., 2003; Dietz and Bozeman, 2005; Dietz, 2004; Dietz et al., 2000; Gaughan, 2009; Gaughan and Robin, 2004). This approach is different from the traditional models of productivity wherein only publications are taken into account. An analysis of a full CV captures almost the entire gamut of a researcher's life course.

Dietz et al. (2000) presented several advantages of using CVs as a data collection tool to evaluate careers of scientists and engineers. For example, the longitudinal nature of the data holds significant advantage over similar studies of collaboration that utilize

cross-sectional data with the inability to measure change. Other advantages of using the CV as a data source are the ease of collection (via e-mail requests or by using website searches) and compatibility with citation data from various indices like ISI Web of Science. Morzinski and Schubot (2000) describe the CV as a non-invasive source of data collection, as it is non-threatening to the individuals who are generally required to fill out lengthy questionnaires. Furthermore, CV data are standardized enough to make it possible to aggregate with those of other researchers. Using CVs also help with the "distinct authorship" problem, an important variable in examining collaboration patterns (Larivière et al., 2006; Newman, 2001).

However, using CV as a data source is not devoid of limitations. One of the challenges is the lack of standard formatting for CVs. Not all individuals present the information in the same order (or the same level of detail) leading to formatting issues. Missing data, varying CV lengths, inadequate information on variables like job, grants, publications, and patents make it difficult for coding, ultimately making the coding and data collection process more tedious and labor intensive (Dietz, 2004). Despite some of the difficulties of using the CV as a tool for research evaluation, the results of the analysis can be quite powerful. First, for most faculty members the CV is a dynamic document that they change regularly to reflect any career changes. Second, there is some degree of standardization across CVs. One can expect the CV to give information about major career changes and most significant outputs and activities, including grants, publications and patents. Our data collection method controls for many of the above issues by using variables that the authors coded from the curriculum vitae of researchers.

Respondents for this study were sampled from the Community of Science (COS), which is a comprehensive database for interdisciplinary scientific research. One caveat associated with using the COS database is that researchers self-select into the system. At the time of data collection, however, this was one of the only ways to capture scholars across different fields with similar research interests. The authors identified a group of researchers as being part of the learning sciences field based on their use of key words in COS. Therefore, the respondents that are in our sample used 15 keywords identified as "learning sciences" keywords by the lead researchers at an NSF-funded Science of Learning Center (specifically the LIFE—Learning in Informal and Formal Environments—Center).

LIFE is one of the Science of Learning centers established and funded by the NSF. While we did not want to limit our study to a few LIFE researchers, we chose to find a comparison group that mimicked the research interests of LIFE faculty members. Thus we developed a comparison group by using the Community of Science (COS) database to identify scholars who conducted research similar to the research being undertaken by the LIFE Center scientists. We asked the LIFE Center researchers (via a web-based questionnaire) to identify the COS keywords that describe "research conducted in their field of expertise." Therefore the research interests of our sample match the research interests the lead researchers within this center. Our search of COS scholars was conducted in June 2007 and the full search yielded 5656 COS learning science researchers. The keywords used for sampling are listed in Table 1.

Next, the authors filtered out all scientists who were not employed at a Carnegie intensive or extensive[5] university to account for the potential differences in research requirements. After completing this filtering activity (and removing duplicate records) the 5656 scholars were reduced to 2885. Then the authors took a random sample of 1446 of these names because (based on previous CV analysis research) the authors expected a response rate of around 35% for respondents. Out of the 1446 people contacted initially, 178 contacts yielded non-functioning email addresses, which reduced the sample to 1268. For all non-respondents, the authors sent a first follow-up reminder exactly one week after the initial contact was made in November 2007. A week after the first reminder was delivered the authors sent a second and final reminder to the non-respondents, resulting in a response rate of 39% ($N = 493$). The data were further cleaned to remove any non-tenure track faculty members[6] and to remove incomplete CVs from the sample. After the data cleaning process was complete the final sample size was 402.

Table 1
Keywords used by faculty listed in community of science database for sampling.

COS keyword	# LIFE center researchers choosing as important	Number of researchers in COS database
Education or instructional programs		
Mathematics education	5	441
Educational modes or psychology or theory		
Academic achievement	5	137
Classroom instruction	5	209
Computer aided instruction	6	354
Educational reform	5	152
Educational research	6	519
Instructional materials and practices	5	155
Instruction technology	6	908
Psychology		
Cognitive development or processes	6	504
Cognitive psychology	8	344
Cognitive science	8	377
Developmental psychology	7	353
Educational psychology	5	526
Experimental psychology	6	152
Human learning and memory	6	525

Note: Data collected from COS database in June 2007.

The CVs were coded in Microsoft Access. The relational database was user-friendly and had an interface that enabled reliable coding. Our choice of using Access over any other format for coding the CVs was mainly dictated by its capability to handle the relational data found in CVs (which is much harder to record into traditional "flat" spreadsheet data sets). The three members of the coding team coded a test set of 10 common CVs. The CVs were purposively selected to represent a range of faculty ranks (i.e., Post-doc, Assistant Professor, Associate Professor, and Full Professor). In the first round of inter-coder reliability tests the overall measure of reliability was 81.3%. Then, the coding protocol was revised and the coders completed another round of training. For the second round of reliability tests, the overall measure of inter-coder reliability was 97.1%. Given this high level of reliability, the team completed the training phase of the coding project and began the actual data coding for the full sample of CVs. Information on the research productivity (number of peer reviewed journal articles, books, book

[5] The Carnegie Classification classifies universities based on the type of degree programs offered, amount of federal monies received, emphasis on teaching and or research. The categories "Doctoral/Research Universities—Extensive" and "Doctoral/Research Universities—Intensive" reflect a division within doctorate-granting universities that is heavily focused on research. Beginning with the 2005 update of the Basic Classification (the traditional classification framework), all doctorate-granting universities are now classified into three categories: RU/VH, Research Universities (very high research activity); RU/H, Research Universities (high research activity); and DRU, Doctoral/Research Universities.

[6] Faculty members listed as lectures and instructors are excluded. Only faculty members who identified as Assistant or Associate or Full professors were included in the sample.

Table 2
Summary data for faculty in our sample.

Characteristic	$N = 402$	Percentage in the sample
Gender		
Male	243	60.4
Completed a post-doctoral fellowship	85	21.1
Faculty rank		
Assistant Professor	54	13.6
Associate Professor	129	32.5
Full Professor	214	53.9
Center variables		
Faculty affiliated with a research center	145	36.1
Role in center		
Principal investigator or co-principal investigator	28	19.6
Researcher	29	20.3
Affiliated faculty	11	7.7
Director or co-director	61	42.7
Other	14	9.8

chapters, conference presentations, and grants) was coded for a 9-year period from 1999 to 2008 (operationalization of variables is further detailed in the notes section). Further, respondents who identified as being affiliated with only a university-based research center are included in this study.[7] Faculty members on average report 4.9 years as center affiliation.

4. Results

Overall, more than one-third (36.1%) of the respondents in the sample are affiliated with a research center. Approximately two-third of the faculty members are males and 21% completed a postdoctoral fellowship. More than half the faculty members in the sample are full professors (54%) while the remaining are either associate or assistant professors. Detailed results are presented in Table 2.

4.1. Center affiliation and research productivity

Our first hypothesis was that center-affiliated faculty members in the learning science disciplines would be more productive than non-center affiliated faculty members. As demonstrated in Table 3, this hypothesis was confirmed with center-affiliated faculty members being significantly more productive in measures of articles, books, book chapters, and grants per year. The results presented in Table 3 shows both annual research productivity[8] (controls for the year an individual faculty member receives their doctoral degree) and average productivity over the 9-year period. On average, faculty members affiliated with a research center published 2.42 articles annually, compared with 1.84 articles for faculty members not affiliated with a research center. However, over a 9-year period (1999–2008), faculty members affiliated with a center on average published 7 articles more than non-center affiliated faculty members. In addition, center-affiliated faculty members in learning science disciplines during the 9-year period produce, on average, about two times more books than their non-center counterparts. The trend continues for book chapters and the number of grants received per person also averaged higher for center-affiliated faculty members.

The results also confirmed findings by previous studies (Bunton and Mallon, 2006; Corley and Gaughan, 2005; Mallon, 2006; Ponomariov and Boardman, 2010) which show center-affiliated faculty members having higher levels of research productivity than non-affiliated faculty members. Since the number of articles is more of a quantity measure than a quality measure, the authors further examined the average impact factor of journals faculty members targeted for their published work. The findings do not support our second hypothesis, which stated that faculty members associated with a research center would publish in higher impact journals than their non-affiliated peers. No significant statistical differences are found in the quality of outlets that center and non-affiliated faculty members choose to publish their research.

4.2. Center affiliation and collaboration

Our third hypothesis was that collaboration rates would be higher for learning science discipline faculty members affiliated with a research center than for faculty members without center affiliations. Several measures of collaboration were computed for various research products (articles, books, book chapters and conferences). Overall, the results in Table 4 partially support Hypothesis 3. The collaboration rate which is calculated as a ratio of the total number of co-authored publications between 1999 and 2008 and total number of publications during the same time period is not significantly different for faculty members affiliated with a research center than non-center affiliated faculty members for all types of research outputs.

Center affiliated researchers on average had more authors on their publications than the non-center affiliated group. For example, for articles, book chapters, and conferences, respectively, the center affiliated faculty members had an average of 3.50, 2.44, and 2.89 authors per publication while the non-center affiliated group had the values of 2.92, 2.06, and 2.52. These findings are important given that one of the major goals of research centers is bringing faculty members together to share ideas and collaborate. The number of sole-authored articles, books, book chapters, and conferences did not differ by center affiliation. Additionally, the author order for faculty members affiliated with a research center is significantly higher for articles and conferences—a further indication of higher number of co-authors and increased collaboration. Overall, the authors conclude that center affiliated faculty members in learning science disciplines collaborate with more people than faculty not affiliated with a center for all types of publications, but books. It may be that researchers are working together but publishing sole authored books. The findings resonate with past research that shows positive relationship between collaboration and center affiliation (Boardman and Corley, 2008; Gaughan and Bozeman, 2002; Gaughan and Ponomariov, 2008).

4.3. Center affiliation and faculty rank

Our third research question addressed how careers of center-affiliated faculty members in learning science disciplines differ from non-center affiliated faculty members. Past research has not formally addressed this question. Results presented in Table 5 suggest that center-affiliated faculty members have a higher likelihood of having a post-doctoral degree.[9] This finding is not surprising—a research center is a typical place to hold a post-doc as centers

[7] We believe that the CV is the most thorough document that maps a faculty members' career. Since the CVs we collected were most current, we believe that faculty would indicate if they were affiliated with a center. Thorough scouring of CV helped differentiate between center affiliates and non-affiliates. In addition, we randomly verified the information by visiting faculty members' websites.

[8] For those with Ph.D. degree granted in or before 1999, annual productivity = (total number of products between 2008 and 1999)/9 years. For those with highest degree granted after 1999, annual number of articles = (total articles between 2008 and 1999)/(2008-year of Ph.D. degree).

[9] While the data were filtered to limit to faculty members in tenure track or tenured positions, the finding is merely suggestive of the percentage of researchers who held a post-doctoral position at some point in their careers.

Table 3
Research productivity for center and non-center affiliated faculty (1999–2008).

Measures of research productivity	Mean for faculty affiliated with a research center	Mean for faculty *not* affiliated with a research center
Articles published annually[a,**]	2.42	1.84
Articles published from 1999 to 2008[***]	21.69	14.85
Impact factor for published articles	1.60	2.52
Books published annually[a,**]	.14	.08
Books published from 1999 to 2008	1.24	.70
Book chapters published annually[a,**]	.81	.56
Book chapters published from 1999 to 2008[***]	7.34	4.74
Conference presentations annually[a]	1.95	2.03
Conference presentations from 1999 to 2008	17.82	15.65
Grants awarded annually[a,**]	1.01	.76
Grants awarded from 1999 to 2008[***]	9.10	5.98

[a] For those with Ph.D. degree granted in or before 1999, annual productivity = (total number of products between 2008 and 1999)/9 years. For those with highest degree granted after 1999, annual number = (total products between 2008 and 1999)/(2008-year of Ph.D. degree).
[*] Mean differences using *t*-test for faculty affiliated and *not* affiliated with a center are significant at the 0.05 level.
[**] Mean differences using *t*-test for faculty affiliated and *not* affiliated with a center are significant at the 0.01 level.
[***] Mean differences using *t*-test for faculty affiliated and *not* affiliated with a center are significant at the 0.001 level.

Table 4
Collaboration rates for center and non-center affiliated faculty (1999–2008).

Measures of research collaboration	Mean for faculty affiliated with a research center	Mean for faculty *not* affiliated with a research center
Collaboration variables: articles		
Average number of authors[**]	3.50	2.92
Average author order[**]	2.20	1.87
Average number sole-authored	.20	.24
Collaboration rate[a]	0.37	0.41
Collaboration variables: books		
Average number of authors	2.47	2.17
Average author order	1.65	1.51
Average number sole-authored	.26	.31
Collaboration rate[a]	0.77	0.80
Collaboration variables: book chapters		
Average number of authors[*]	2.44	2.06
Average author order	1.54	1.42
Average number sole-authored	.35	.39
Collaboration rate[a]	0.65	0.61
Collaboration variables: conferences		
Average number of authors[*]	2.88	2.52
Average author order[*]	1.89	1.68
Average number sole-authored	.31	.33
Collaboration rate[a]	0.37	0.40

[a] Collaboration rates are calculated as (total number of co-authored publications between 1999 and 2008/total number of publications between 1999 and 2008).
[*] Mean differences across faculty affiliated and *not* affiliated with a center are significant at the 0.05 level.
[**] Mean differences across faculty affiliated and *not* affiliated with a center are significant at the 0.01 level.

also have the goal of training new researchers. Additional results suggest that the rate of participation of men and women in centers does not differ across gender. Given that a majority of the study participants are in fields of Psychology and Education where women are not underrepresented these results are not surprising. The results support findings of a study conducted by Corley and Gaughan (2005) who reported research centers to act as a leveling field for women faculty members.

A higher proportion of full-professors are affiliated with research centers than their peers. The results are reversed for associate and assistant professors—with a lower percentage of these faculty members affiliated with a research center. The findings confirmed our fourth hypothesis that senior faculty members in learning science disciplines would be more likely to be affiliated with a research center than junior faculty members. On average, center-affiliated faculty members received their first grant a year

Table 5
Career stage for center and non-center affiliated faculty (1999–2008).

Characteristics	Percentage faculty affiliated with a research center	Percentage faculty *not* affiliated with a research center
Gender		
Male	62.1	59.5
Female	37.9	40.5
Mean year of Assistant Professor job start year	1985	1989
Mean year of first grant awarded	2002	2003
Post-doc[**]	50.6	49.4
Faculty rank[**]		
Assistant Professor	7.0	17.3
Associate Professor	28.7	34.6
Full Professor	64.3	48.0

[**] Differences by center affiliation using Chi-square tests are significant at the 0.01 level.

Table 6
Research productivity and collaboration rates for center and non-center affiliated faculty by rank.

Research output	Assistant Professors		Associate Professors		Full Professors	
	Center affiliated	Non-center affiliated	Center affiliated	Non-center affiliated	Center affiliated	Non-center affiliated
Research productivity						
Number of articles (1999–2008)	13.00	10.82	17.54	13.56	24.60**	17.40
Annual number of articles[a]	1.69	2.04	2.12	1.33	2.71**	1.95
Impact factor of articles	2.37	2.68	2.15	1.91	1.68	1.68
Number of grants (1999–2008)	7.30	6.39	8.27	6.88	9.59***	5.24
Annual number of grants[a]	.83	1.23	.92	.78	1.06***	.58
Number of books (1999–2008)	.00	.11**	.83	.61	1.52**	.98
Annual number of books[a]	.00	.02**	.09	.07	.17*	.11
Number of book chapters (1999–2008)	2.40	2.20	4.88	4.10	8.98***	6.06
Annual number of book chapters[a]	.28	.9	.54	.47	.98**	.68
Number of conference papers (1999–2008)	11.00	13.25	17.88	14.60	18.41	17.0
Annual number of conference papers[a]	1.02	2.80***	2.01	1.78	2.0	1.91

[a] For those with Ph.D. degree granted in or before 1999, annual productivity = (total number of products between 2008 and 1999)/9 years. For those with highest degree granted after 1999, annual number of products = (total products between 2008 and 1999)/(2008-year of Ph.D. degree).
* Mean differences across faculty affiliated and *not* affiliated with a center are significant at the 0.10 level.
** Mean differences across faculty affiliated and *not* affiliated with a center are significant at the 0.05 level.
*** Mean differences across faculty affiliated and *not* affiliated with a center are significant at the 0.01 level.

earlier than non-center faculty members. The authors also examined the research productivity and collaboration at various career stages of faculty members; the results of which are presented in Table 6.

The authors examined five types of outputs: articles, grants, books, book chapters, and conference papers. The annual number of articles published by center-affiliated Assistant, Associate and Full Professors was 1.69, 2.12, and 2.17, respectively. For the non-center affiliated group, the Assistant, Associate, and Full Professors published 2.04, 1.33, and 1.95 articles, respectively. Even though the general trend demonstrates that the article productivity averages are higher for the center affiliated researchers (except assistant professors), the differences in article productivity was significant only for full-professors at the 0.01 level. Center affiliated full-professors have significantly higher likelihood of receiving grants annually and over the 9-year period than their non-center affiliated peers. On average, center affiliated full-professors had 9.59 grants from 1999 to 2008 compared with 5.24 for non-center affiliated peers. The differences were not significant for assistant and associate rank faculty members. The number of conference papers presented annually by assistant professors affiliated with a research center was significantly higher ($p < .001$) than their counterparts not affiliated with a center. Research centers are usually funded through research grants, with separate funds allocated for disseminating information at conferences and workshops, allowing junior faculty members affiliated with such centers to have access to travel funds.

Overall, the findings suggest that full professors affiliated with a research center produce more number of journal articles, grants, books, and book chapters annually and over the 9-year period (1999–2008) when compared with full professors not affiliated with a research center. These findings provide support for our fifth hypothesis that senior faculty members affiliated with a center have higher productivity rates than junior faculty and faculty members not affiliated with a research center.

Research productivity is crucial to an academics' career; hence, we further explored the relationship between center affiliation and research productivity across various career stages—controlling for gender, years since Ph.D., role faculty members play in the center, total number of center affiliations, and collaboration. To do this the authors conducted a Poisson regression with the total number of journal articles published by faculty as the dependent variable. The authors conducted a Poisson regression because the key dependent variable—the total number of articles—is count data and is not normally distributed. Furthermore, the existence of zero counts (no publications) and the issue of heteroscedasticity makes it inappropriate to use the regular Ordinary Least Square (OLS) analysis (Cohen et al., 2003). And, the Poisson analysis has been used in previous studies on the effects of center affiliation on the productivity of faculty members (e.g. Ponomariov & Boardman, 2010)

Table 7
Poisson regression analysis with the number of published articles as the dependent variable.

Independent variable	Model 1: unstandardized coefficients
Constant	2.21
Center affiliation	−.202+
Number of center affiliations	.064**
Center role-PI or Co-PI	−.141**
Number of co-authored articles	.025***
Male	−.02
Years since Ph.D.	−.007***
If held a post-doctoral positions	.186***
Associate Professor	.231***
Full Professor	.285***
Center affiliation × Associate Professor (interaction)	.109
Center affiliation × Full Professor (interaction)	.292**
Likelihood ratio Chi square	3214.773***

+ $p < .1$.
** $p < .01$.
*** $p < .001$.

The Poisson regression model predicting the number of published articles was statistically significant with Chi-square likelihood ratio = 3214.773, df = 11, $p < .001$ Interestingly, even though center affiliated faculty members demonstrated on average higher research productivity when compared with non-center faculty members, these results do not hold up for the total number of journal articles when controlling for various factors. Affiliation with a research center does not lead to increased publications. As seen in Table 7, the Poisson coefficient is −.202, which represents the logs of the expected counts of the published journal articles. The exponent of this coefficient ($e^{-.202} = .82$) produces estimates in which the "rate" of publications changes proportionately as a function of the center affiliation. When compared with faculty members without any center affiliation, faculty members with center affiliation publish about 82% (compare the $e^{0\times(-.202)}$ with $e^{1\times(-.202)}$) of the total number of articles published by faculty members without any center affiliation ($p = .08$), holding constant other variables. To expand on this, if hypothetically non-center affiliated faculty members publish 10 articles in 9 years, faculty members with center affiliation on average publish only 8.2

($10 \times e^{-.202}$) articles during the same time period. However, we need to be cautious with generalization given the p value is higher than .05. This finding corresponds to a previous study by Gaughan and Ponomariov (2008) that center affiliation does not necessarily result in more publications. Another interesting finding is that there is an interaction effect between faculty rank and center affiliation. Among faculty members affiliated with a center, full professors on average publish 1.33 ($e^{.292}$) times more articles ($p < .001$), when compared with assistant professors. In other words, center affiliation enhances the productivity of full professors but does not necessarily enhance the productivity of untenured junior faculty members. Thus, this finding further supports Hypothesis 5 that senior faculty members affiliated with a center are more productive than junior untenured faculty members.

Experience, which is calculated as the difference between year of the survey and (2008) and the year an individual received their Ph.D. is significant. The results indicate that the relationship between the numbers of years after Ph.D. is not a strong predictor for productivity, with the multiplicative value at .99 ($e^{-.007} = .99$). Gender is not significantly related to the number of articles published. University-based research centers act as leveling grounds for female faculty members, which is encouraging and in concert with previous research (Corley, 2005; Corley and Gaughan, 2005). It is also not surprising that having a postdoctoral research degree can help increase productivity. It is interesting that serving as the principal investigator on grants in fact does not increase productivity. When compared with those not in principal investigator roles, researchers with PI roles publish 87% ($e^{-.141} = .87$) of the number of articles published by the researchers without the PI roles. The results also show that as the number of center affiliations increase by one, the total number of articles published on average increases 1.03 ($e^{.64} = 1.03$) times. This finding indicates that as researchers affiliate with more number of centers they widen their collaboration scope resulting in higher productivity.

Faculty members collaborating on research are likely to publish more articles. With one unit increase in co-authored publications between 1999 and 2008, the total number of published articles is 1.03 times more, in other words, collaboration results in higher article productivity. Although co-authorship is a limited measure of collaboration it is most widely used and studied (Bahr and Zemon, 2000; Corley and Sabharwal, 2010; Gaughan and Ponomariov, 2008; Glänzel and Schubert, 2005). With complex problems and limited resources available to faculty members (Stephan, 1996; Stephan and Levin, 1997) collaboration is on the rise in both sciences and social sciences. Given that the sample of this study comes from faculty members who self identify as doing interdisciplinary research, this finding is not surprising. While the findings corroborate with studies that have shown positive impact of collaboration on article productivity (Bordons et al., 1996; Lee and Bozeman, 2005; Gaughan and Ponomariov, 2008; Maske et al., 2003), it stands in contrast to some research that has shown reverse trends (Duque et al., 2005; McDowell and Smith, 1992).

5. Discussion and conclusion

This study explores how individual faculty members function within university-based centers and contribute to the production of new science and the development of new capacity in a multidisciplinary environment. This research is a case study, limited to learning sciences; one might argue that the findings of this study are not generalizable to all types of research centers. However, given that SLCs function in a multidisciplinary environment involving appropriate partnerships with academia, industry, and other public and private entities, the results can contribute to studying other types of university-based research centers.

Previous studies on this topic have solely focused on studying the impact research centers have on careers of researchers in STEM disciplines, but as problems are becoming more and more complex their solutions are no longer disciplinary in nature. Faculty and researchers from various disciplines are coming together in an effort to solve problems that impact the society at large. The current study contributes to the ongoing dialog on the impact research centers have on research productivity and careers of faculty members in the learning sciences which typically fall under the umbrella of social sciences. Additionally, this study goes beyond some previous studies that have focused on bibliometric analysis of publications records (Boardman and Ponomariov, 2007; Bunton and Mallon, 2006; Corley and Gaughan, 2005; Ponomariov et al., 2009).

The findings of this study suggest that faculty members affiliated with a research center are likely to produce more articles, books, book chapters, and grants annually when compared with faculty members not affiliated with a research center. However, the differences in article productivity disappear when controlling for various factors such as years since Ph.D., gender, post-doctoral status, quality of publications, and quantity of other research outputs. Does affiliation with a research center enhance research productivity/collaboration or do most productive faculty members affiliate themselves with research centers? Most research determines the former; however, it is very difficult to determine the latter as there are several factors that can impact individual faculty productivity—thus creating the classic problem with endogeneity.

Another limitation of this study is that it uses co-authorship as a measure of collaboration, though it is not a perfect measure it is shown to highly correlate with productivity (Corley and Sabharwal, 2010; Eaton et al., 1999; Fox and Mohapatra, 2007; Laband and Tollison, 2000), and is the easiest way of quantifying collaboration (Katz and Martin, 1997). Measuring collaboration is a complex phenomenon and thus several studies use co-authorship as a surrogate to measure collaboration (Fox and Mohapatra, 2007; Hafernik et al., 1997; Laband and Tollison, 2000).

Our research shows that tenured full faculty members benefit the most from affiliation with a research center, in terms of collaboration and productivity rates. These findings are in contrast to a recent study by Ponomariov and Boardman (2010) who reported higher publication productivity for junior faculty members affiliated with a research center—a result of resources and opportunities afforded to them in the form of new collaborations, additional funding stream, and a network of senior productive scholars. Faculty members often accept positions with research centers because they expect that the outcomes of the affiliation to be positive, including an increase in resources for research, enhanced research productivity, new interdisciplinary collaboration opportunities, and perhaps reductions in teaching loads and/or academic service loads in return for extra resources, social capital, and great career success. Our study finds that research centers are effective vehicles in fostering collaboration and productivity of senior faculty members in learning sciences but the impacts on junior faculty members are less positive. Although a detailed discussion about the history and existence of research centers is beyond the scope of this research, we argue that the impetus for creating these centers was primarily to promote and foster interdisciplinary collaborations and in the process create avenues for knowledge transfer, student training, networking, and mentoring of junior faculty to name a few. This certainly does not appear to be the case for junior faculty—they tend to be *less* productive than senior faculty members affiliated with a center. The finding is all the more telling in as much as the junior faculty at centers experience some form of "role strain" (Boardman and Bozeman, 2007). However, it should be noted that in the United States, faculty members on tenure track constitute a long probationary period, usually six years. This is not true in most other academic systems across the world. This is perhaps one of the

reasons why junior faculty members affiliated with a center differ in productivity from senior faculty members.

While the affiliation with centers is very complicated, replete with multiple motives from diverse parties, it is certainly the case that center directors only encourage the best junior faculty to join. This suggests that the human capital in centers may be great among junior faculty, even while their productivity is less. Despite lower productivity of junior faculty members affiliated with a center—these results should be interpreted with caution as they do not apply to all junior rank faculty members (this study is specific to learning science disciplines). There are several positive and long-term impacts that centers have on the careers of junior faculty members. For instance, the networks junior faculty members develop when affiliated with a center are invaluable as they start their careers. These networks often lead to future collaborations and research outcomes. Additionally, junior faculty members gain new insights into cutting edge research that happens within these centers. They also learn the mechanisms and administrative procedures involved in applying for funding to national and international agencies.

To ensure junior faculty members are not disadvantaged as a result of their association with a research center, center directors should try to encourage junior faculty members to focus on research outcomes of their center work and leave time-consuming center management tasks for senior colleagues. Due to lack of data on the percentages of time that faculty members invest in center administration versus center research, we cannot conclude that junior faculty members have lower productivity rates because of administrative tasks. Yet, it is true that administrative work takes time away from research activities. Junior faculty members might need to balance center-related commitments and individual research. This finding is very important given the negative impact affiliation with a research center can have on junior faculty members. To further flesh out the relationships between academic rank, productivity and center participation, future research should employ qualitative approaches like in-depth interviews or case studies to investigate the impact center affiliation has on junior faculty members. Specifically, how affiliation with a center impacts faculty research agendas, their subsequent grant seeking capacity, promotions and career mobility are some aspects future researchers can examine.

These results are important given that funding agencies such as the NSF and the NIH are investing in learning science research centers with the aim that such institutional structures foster interdisciplinary and multidisciplinary research and strengthen networks of researchers. Even though our data did not allow us to measure collaboration beyond scholarly publications, future studies could examine the network of academic collaboration as they result in transfer of skills and knowledge within and outside their networks (Ahuja, 2000; Katz and Martin, 1997). As faculty members continue to collaborate, affiliation with a research center will become increasingly important to further interactions and develop a knowledge base that spans disciplinary boundaries. With over 115 million USD awarded by the National Science Foundation thus far to Science of Learning Centers located across 12 states of the country, the stakes for promoting interdisciplinary research and creating newer forms of knowledge and learning has never been higher.

5.1. Notes

The variables used in this study are operationalized as follows:

a) *Center affiliation*: A key word search on 'center' and 'centre' was performed on each of the 402 CVs. Faculty members who provided information in their CV as being affiliated with a research center were assigned a 1. The name of the research center was recorded and additional checks were made to assure inclusion of only university-based research centers in the analyses. Centers not affiliated with a university were excluded. If a faculty member made no mention of any center affiliation in their CV a 0 was assigned.
b) *Number of center affiliations*: Total number of centers a faculty member was affiliated with.
c) *Center role*: Center role is classified as 1 = PI or Co-PI and 0 = others (researcher, affiliated faculty, director or co-director and other).
d) *Number of co-authored articles*: The total number of authors on each article was recorded. Number of articles on which more than one author was listed was recorded as co-authored.
e) *Gender*: 1 = Male and 0 = Female.
f) *Experience*: Years since Ph.D (2008-year PhD was attained).
g) If held a post-doctoral position a 1 was assigned, else = 0.
h) *Faculty Rank*: 1 = Assistant Professor, 2 = Associate Professor and 3 = Full Professor.
i) *Grants*: All grants that were funded between 1999 and 2008 were reorded.
j) Annual Article or Book or Conference presentation = For those with Ph.D. degree granted in or before 1999, annual productivity = (total number of products between 2008 and 1999)/9 years. For those with highest degree granted after 1999, annual number = (total products between 2008 and 1999)/(2008-year of Ph.D. degree).

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