Research Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Research paper

Impact of research collaboration cosmopolitanism on job satisfaction

Jiwon Jung[a], Barry Bozeman[b], Monica Gaughan[c,*]

[a] Center for Organization Research and Design and School of Public Affairs, Arizona State University, MC3720, 411 N. Central Ave., Phoenix, AZ 85004-0687, United States

[b] Technology Policy and Public Management, Center for Organization Research and Design and School of Public Affairs, MC3720, 411 N. Central Ave., Arizona State University, Phoenix, AZ 85004-0687, United States

[c] School of Human Evolution and Social Change, PO Box 872402, Arizona State University, Tempe, AZ 85287-2402, United States

ARTICLE INFO

Keywords:
Scientific careers
Job satisfaction
Research collaboration
Scientific employment sectors

ABSTRACT

The concept of collaboration cosmopolitanism has referred to the institutional and geographic distance characteristics of academic researchers' collaboration patterns. We study the effect of collaboration cosmopolitanism on doctoral level research personnel working in different sectors–government, industry, and academia. The study examines the impact of collaboration cosmopolitanism on an important aspect of career success: job satisfaction. We employ the 2006 and 2010 Survey of Doctorate Recipients (SDR) collected by the US National Science Foundation to evaluate the cross-sectional and longitudinal effect of collaboration cosmopolitanism on job satisfaction. We are particularly interested in doctoral level researchers' job satisfaction related to sector of employment while controlling for demographic and work characteristics such as gender, minority status, salary, and work hours. Findings suggest that scientists working at a higher level of collaboration cosmopolitanism tend to report a higher level of job satisfaction. Furthermore, we find that academic scientists are more satisfied than those working in industry. This finding holds in the longitudinal model—industry scientists are less satisfied—but we find that over time, government scientists are more satisfied than academic scientists, and much more satisfied than industry scientists.

1. Introduction

We know that collaborative research is productive, both by perception and by measured gain (Abramo et al., 2009; Andrade et al., 2009; Bruneel et al., 2010; Hamann et al., 2011; Lee and Bozeman, 2005). Our interest is in the impacts of research collaboration, not only on science writ large but, especially, on the careers of STEM researchers. That is, our concern is much more personalistic than previous studies of collaboration's effects on productivity: what is the relationship of collaboration to job satisfaction? Our research focuses not on research collaboration experiences of all types but rather one specific aspect of collaboration, one we refer to as "collaboration cosmopolitanism" (Bozeman and Corley, 2004; Lee and Bozeman, 2005). The basic idea of collaboration cosmopolitanism is the extent to which researchers work with persons who are distant from them either institutionally or geographically. We shall later provide specific measurement details but for the present let us say that a very low degree of collaboration cosmopolitanism would be signified if all of one's collaborations are with people in the same laboratory. By contrast, the most cosmopolitan collaborators would be those who work with people in different laboratories, organizations, or nations than their own.

The central research question then is this: *To what extent, if any, do more cosmopolitan collaborators differ from less cosmopolitan collaborators with respect to job satisfaction?* We look at different nuances and variations of this question, focusing especially on differences according to sector of employment − academic, government and industry. Today, research is a generative process as collaborative teams attract more collaborators, thus accelerating the growth of research teams (Parker and Hackett, 2012). Furthermore, research takes place in a variety of settings not exclusive to universities (Roach and Sauermann, 2010), and scientists exhibit different preferences for the sector in which they wish to be employed (Agarwal and Ohyama, 2012; Fox and Stephan, 2001; Janger and Nowotny, 2016).

Collaboration across sector, disciplines, organizations, or countries becomes more prevalent in individuals' daily work life with the flow of globalization as well as the emphasis on interdisciplinary efforts seeking innovative solutions to the complex social problems such as health care or environmental issues (Van Rijnsoever and Hessels, 2011).

Research shows that those having higher degrees of job satisfaction have, among other positive benefits such as better productivity, better

* Corresponding author.
E-mail addresses: jiwon.jung@asu.edu (J. Jung), bbozeman@asu.edu (B. Bozeman), monica.gaughan@asu.edu (M. Gaughan).

http://dx.doi.org/10.1016/j.respol.2017.09.003
Received 28 December 2016; Received in revised form 2 September 2017; Accepted 5 September 2017

health outcomes, lower absenteeism, greater likelihood of remaining in the field of work (Spector, 1997; Cowin, 2002; Porter and Steers, 1973; Faragher et al., 2005). The more we learn about relationships between researchers' career attributes and their job satisfaction, the better our ability to identify incentives, policies and procedures with potential to enhance research careers and, ultimately, the capacity to produce research.

We examine the relationship between collaboration cosmopolitanism and job satisfaction among doctoral level scientists by sector in the United States labor market[1] − in this case government, industry or university − because a substantial number of studies have consistently shown the importance of sector context (Bullock et al., 2015; van Helden and Reichard, 2016; for an overview see Perry and Rainey, 1988). Not only do sectors tend to have different attractions but those attractions interact with the attributes of persons who choose to work in the respective sectors (Agarwal and Ohyama, 2012; Bullock et al., 2015). For example, it has been long known that persons working in government tend to place a higher priority on job security than do those choosing work in business (Lazear, 1990; Lewis and Frank, 2002). Perhaps more important for present purposes, sector context matters with respect to particular job requirements, including R & D (Bysted and Hansen, 2015). For example, academic researchers tend to have more autonomy than industry researchers and greater control of their research agendas (Box and Cotgrove, 1966; Heinze et al., 2009). This autonomy is relevant to the perceived benefits and costs of engaging in collaboration cosmopolitanism by individual researchers. Finally, studies have shown pronounced differences, by sector, in levels of job satisfaction (Kjeldsen and Hansen, 2016). In sum, though the importance of sector is in any given context an empirical question, there is much relevant research showing that expectations of variance by sector are both plausible and explicable in terms of existing theory and research.

Our paper is organized as follows. In the section immediately below, we examine the job satisfaction literature, focusing particularly on the rather modest body of work examining the job satisfaction of researchers and academic faculty, the central focus of this research. We then turn to the research collaboration literature, focusing especially on works related to collaboration cosmopolitanism. Based on this review, we present specific hypotheses about the effects of collaboration cosmopolitanism on job satisfaction in relation to the sector researchers work in. After describing our data and measures in detail we then present findings from our regression models. Finally, we discuss implications of the findings for both theory and policy.

2. Literature review

2.1. Job satisfaction among scientists

The research on job satisfaction is massive, indeed it is one of the most popular topics in organizational psychology and in management studies. While most studies of job satisfaction focus on persons working in business firms, usually at mid-management levels, the studies are so popular that by this time a number of different sectors, professions, and job settings have been examined including hospitals, nonprofit agencies, government welfare agencies, the military and there are even several studies of job satisfaction focusing on sports teams (e.g. Lillydahl and Singell, 1993; Olsen et al., 1995; Hagedorn, 1996, 2000; Hearn, 1999; Johnsrud and Rosser, 2002; Rosser, 2004; August and Waltman, 2004).[2] Unfortunately for our purposes, relatively few studies have explicitly examined research personnel. The findings from these studies are generally consistent − that job satisfaction predicts productivity, usually as mediated by various work climate variables (Keller, 1986; Keller et al., 1996; Jones, 1996; Chen et al., 2004). Having higher job satisfaction predicts lower absenteeism, greater work commitment, performance, and field and job retention (Koch and Steers, 1978; Locke, 1970; Tack and Patitu, 1992). However, scientists' job satisfaction is particularly noteworthy given the unique educational background, work environments, and work motivations, which create different levels of complexities and autonomy that would imply different incentives, policies, and procedures to enhance research careers and more essentially, potentials to generate novel research.

2.2. Job satisfaction of scientists across sector

Within the limited set of studies on research personnel, existing studies tend to focus on industry researchers and typically examine job satisfaction primarily as a predictor of research productivity and career development (Keller et al., 1996; Jones, 1996; Chen et al., 2004). Another set of job satisfaction studies, also a very small percentage of the whole, focuses exclusively on academic faculty (see Bentley et al., 2013; Bozeman and Gaughan, 2011; Lacy and Sheehan, 1997; Mamiseishvili and Rosser, 2010; Olsen et al., 1995; Sabharwal and Corley, 2009). For academics, research is central to satisfaction, especially the feeling that colleagues respect one's research work as well as the sense of supportive research and teaching community (Bentley et al., 2013; Bozeman and Gaughan, 2011; Lacy and Sheehan, 1997). The least satisfied academics are more likely to perceive that there are cumbersome administrative processes and little collegiality in decision-making in their institutions (Bentley et al., 2013).

Consistent with studies of job satisfaction among academics, pay is related to satisfaction − not absolute amounts but rather the feeling of being paid what one is worth (Bozeman and Gaughan, 2011), consistent with work in other occupational and sector domains (Kalleberg, 1977; Erez and Isen, 2002). Some studies of faculty suggest that academic researchers are high on intrinsic motivation for their work; by contrast, compared to those in other employment sectors, faculty may be less motivated by such extrinsic factors as pay, pension, benefits and geographic location (Janger and Nowotny, 2016; McKeachie, 1979; Blackburn and Lawrence, 1995; Roach and Sauermann, 2010). Academic researchers of color and women faculty members tend to have lower job satisfaction; this is attributed to encountering more barriers while advancing up the academic ladder and having access to fewer resources needed for their work (Hagedorn, 2000; Olsen et al., 1995; Sabharwal and Corley, 2009).

Given that job satisfaction is influenced by the complexities and the level of autonomy (Judge et al., 2001a,b) as well as the institutional setting (Hagedorn, 2000), examining the satisfaction of scientists in different sectors is a major objective of this paper. Our review showed that scientists working in the government sector are largely missing from the current literature of job satisfaction, a gap we fill with this research. We explore empirically the question of whether sector of employment affects job satisfaction of doctoral level scientists.

2.3. Research on collaboration and cosmopolitanism

The idea of collaboration cosmopolitanism draws loosely from much older conceptualizations of social cosmopolitan roles vs. social localism roles (Gouldner, 1957, 1958). Gouldner suggested that the contrasting roles provide much information about behavior and attitudes of workers. Later studies showed that measures related to Gouldner's cosmopolitanism/localism scales explained differences in performance (Abrahamson, 1965). The idea of research collaboration cosmopolitanism was first developed by Bozeman and Corley (2004) in their analysis of STEM collaborators' motives and strategies. Using questionnaire data and curricula vitae data from 1041 US academic

[1] Among employed scientists and engineers whose highest degree is a STEM discipline in the United States, 71.9% work in industry, 15.6% work in education, and 12.5% work in government (National Science Board, 2016).

[2] We do not review the more general job satisfaction literature. Several excellent and comprehensive literature reviews are available for those wishing more expansive and in-depth treatment (see Locke, 1976; Petty et al., 1984; Judge et al., 2001a,b; Erdogan et al., 2012; Chen et al., 2016).

scientists and engineers, they developed a collaboration cosmopolitanism scale based on amounts of research time working alone, working with one's immediate work group, with those in the same organization (or university) but not the same work group, with industry, with government laboratories and with persons in other nations. Results from the study show that the best predictor of position on the cosmopolitanism scale is number of grants and contracts received, which, in turn, relates to gender and minority status (Bozeman and Corley, 2004).

Using the same collaboration cosmopolitanism scale, Lee and Bozeman (2005) found that researchers engaged in collaborations with scholars outside of normal work groups, including other nations, tend to have a greater total number of collaborations than their peers and to be more productive in terms of publications. Other studies using collaboration cosmopolitanism variables include work on differences between men and women's collaboration patterns (Bozeman and Gaughan, 2011) and various studies of collaboration within university science centers or between university centers and industrial firms (Boardman and Corley, 2008; Ponomariov and Boardman, 2010; Gaughan and Corley, 2010).

The prevalence of cosmopolitanism in current research activities lends itself to the salience of examining collaboration cosmopolitanism. Bozeman and Youtie (2017) recently examined collaboration patterns for a set of 1064 respondents to a questionnaire, all of the respondents being academic researchers with faculty appointments, and find that the vast majority of respondents (80%) indicate that at least one of the collaborators on their most recent publication was from another university or another institution (usually a government laboratory or industry). A major limitation of the extant collaboration cosmopolitanism literature is its exclusive focus on academic scientists; an important contribution of this study is its inclusion of government and industry scientists.

Naturally, what would be most useful for our present purposes would be intersecting literature focusing on the impacts of research collaboration processes or outcomes on job satisfaction across sectors. As noted in the previous section, we have not been able to find any studies focusing directly on this intersection. However, there are studies focusing on satisfaction with research collaborations and related characteristics of research collaboration effectiveness. Most focus on satisfaction with particular research collaboration experiences, not the overall pattern of satisfaction from a career's worth or even a smaller set of research collaborations. In general, satisfaction with research collaboration tends to be related to such factors as trust, personal compatibility with team members, effective and productive specialization, and open and participative decision-making about collaborative activities and crediting (for an overview of findings on research collaboration effectiveness see Katz and Martin, 1997; Shrum et al., 2007; Bozeman et al., 2013; Bozeman et al., 2016). None of the studies reviewed focuses specifically on the impacts of research collaboration on job satisfaction, though some focus on its impacts on career outcomes, including tenure, promotion, and salary. The ability to study academic, industrial, and government scientists simultaneously allow us to understand how sector of employment itself affects job satisfaction with respect to the different collaboration pattern each scientist and engineer exerts.

2.4. Conceptual model and hypotheses

A good place to start is with this easy question: "Why would research collaboration processes and outcomes have any effect on job satisfaction?" Despite the fact that there is no research directly related to this question, it is easy enough to provide some intuitively appealing answers. One simple answer: it simply stands to reason that any activity that is absolutely integral to one's job will have at least some bearing on job satisfaction, whether that activity is the length of commute time, the relative ferocity of one's boss, the degree of red tape in processing reimbursements, or the smoothness of research collaborations. Given the amount of time and effort researchers spend in research collaboration, how would it be possible for collaboration outcomes and processes to be irrelevant to job satisfaction? For those adamantly opposed to intuitively appealing answers, we can also suggest that research collaboration is often a significant element of job satisfaction because we have elsewhere presented evidence that bad experiences with research collaboration (e.g. exploitation, unfair crediting practices, inability of collaborators to meet obligations, intellectual property disputes) often make people miserable, sometimes so much so that they actually leave academic research professions (see Bozeman and Youtie, 2017; Youtie and Bozeman, 2016). In short, despite the lack of research directly aimed at answering the question "how does research collaboration affect researcher's job satisfaction?" we have some confidence there is almost certainly an important relationship between the two.

As principal sources of job satisfaction, job characteristics require close examination in relation to sector and collaboration cosmopolitanism. Studies on job satisfaction have been done in each sector separately. However, as job characteristics, namely the level of autonomy, variety, and responsibility, are strongly related to job satisfaction (Koch and Steers, 1978), it is noteworthy to examine the sectoral differences in job satisfaction among research personnel as different job characteristics are shared differently in each sector. Employees may select into a specific sector which systematically differentiates the nature of workers working in a specific sector. For instance, researchers with a higher taste for science sort themselves into academia, while researchers who value easy access to resources and salary will sort themselves into research in industry (Roach and Sauermann, 2010; Agarwal and Ohyama, 2012). However, there are institutional characteristics embedded in different sectors that characterize the job environments affecting job satisfaction. For instance, Bender and Heywood (2006) have argued that the level of job satisfaction differs between academics and non-academics mainly due to the institution of tenure: academic researchers with tenure report greater satisfaction once the level of salary is held equal. Also, it is often the case that researchers in industry face greater pressure from short-term contracts and outcomes which generate a variety of tensions in the daily work of the researchers (Ylijoki, 2003). If one works in a sector where there is less research autonomy and perhaps less control of collaborator choice, then the effects of collaboration cosmopolitanism may be different and diminished. In short, working conditions such as working hours, promotional mechanism, salary, hierarchical structure, or workload differ quite significantly across sector, suggesting the following hypothesis, which directly tests a widespread assumption:

H1. Working in the academic sector has a positive effect on job satisfaction of scientists.

The question of a possible relationship between collaboration cosmopolitanism and job satisfaction is not at all straightforward and possible causal relations are not intuitively evident. It is not clear that cosmopolitan research collaborators necessarily have higher job satisfaction inasmuch as they are more likely to be harried, to have greater work management demands and, to sustain higher transactions costs for their collaborative work. Despite the analytic and explanatory challenges presented in understanding the relationship between cosmopolitan research collaboration and job satisfaction, we expect that more cosmopolitan researchers have greater access to the broad resources needed for their work, and are generally more satisfied with their job. Broader and different types of social resources and networks provide access to intellectual and financial resources and information which are found to influence both objective and subjective career success (Seibert et al., 2001). Such wider networks and social resources are most likely to be accompanied by higher degree of collaboration cosmopolitanism can, therefore, positively influence job satisfaction. To examine the independent effects of collaboration cosmopolitanism on job satisfaction, we suggest the following.

H2. Researchers who have higher degrees of collaboration cosmopolitanism will tend to have higher degrees of job satisfaction.

In particular, we expect that different job characteristics across sector in terms of the level of autonomy, variety, and responsibility partly explains the relationship between collaboration cosmopolitanism and job satisfaction. Academic researchers are more likely to have autonomy in choosing with whom they would like to collaborate than those working in either industry or the government sector, and may experience fewer work management demands or perceive lower transactions costs for their collaborative work. Therefore, we suggest that:

H3. Academic workers are likely to have a greater positive effect on their job satisfaction from collaboration cosmopolitanism than those working in industry or in government sector.

2.5. Control variables

The expectations about causal impacts of work characteristics and demographic characteristics are well grounded in the literature on job satisfaction. Studies focusing on physicians find lower job satisfaction as a result of longer work hours, a common indicator of high workload (Sibbald et al., 2003; Keeton et al., 2007). Longer hours of work are strongly associated with the level of job stress reducing job satisfaction as well as job commitment (Kirkcaldy et al., 1997). Both absolute and comparative wage income have significant positive effects on the job satisfaction of men and women, but the effect is stronger for men (Sloane and Williams, 2000). Prior studies have also shown that younger employees are generally more satisfied with their job, but once tenure in the job or the years worked on the job is considered, those with longer tenure reported higher job satisfaction (Bender and Heywood, 2006; Sibbald et al., 2003).

Although the relationship between gender, family, and job satisfaction have yielded mixed results, it is important to control for demographic characteristics (Sabharwal and Corley, 2009; Tack and Patitu 1992; Olsen et. al 1995). Furthermore, ethnic minority doctors and those serving urban and deprived populations experience lower job satisfaction (Sibbald et al., 2003). An important construct to include given our interest in the US scientific labor force and its collaborative behavior is foreign-born status (Sabharwal, 2011).

3. Data and methods

3.1. Sample

We employ the 2006 and 2010 waves of the Survey of Doctorate Recipients (SDR), which is part of the Scientists and Engineers Statistical Data (SESTAT) collected by the US National Science Foundation. The SDR is a longitudinal biennial survey conducted since 1973 that provides demographic, employment, and educational characteristics of individuals with a doctoral degree from a U.S. academic institution. The survey follows a sample of individuals throughout their careers from the year of their degree award until age 76. SDR uses a closed-sample panel design with a sample of new doctoral graduates added in each biennial survey cycle. The 2006 and 2010 SDR samples include a total of 39,740 doctoral recipients with 30,817 surveyed in 2006 and 31,462 in 2010. A total of 22,539 individuals were surveyed the 2006 and 2010 surveys. The 2006 data include measures used to construct the collaboration cosmopolitanism scale, while the 2010 data includes a comprehensive measure of job satisfaction. The resulting panel data are used to examine the lasting effects of collaboration cosmopolitanism on job satisfaction four years later.

We focus our empirical analysis on scientists and engineers who are employed in academic institutions, government, or private industry. The SDR measures related to job activities are broad (14 categories), and only two of them are related to basic or applied work; our interest is not on categorizing scientists into basic or applied work, but rather assessing how the institutions for which scientists work in a variety of ways may affect job satisfaction. With the academic group our study is confined to those holding an academic position as teaching faculty, adjunct faculty, postdoctoral researchers, and research faculty, but not teaching or research assistants; we exclude respondents who hold academic administrative positions. Accordingly, the subsample size for this study is 19,197 for the 2006 SDR survey.

Table 1
Means and standard deviations of independent variables and controls in SDR 2006.

Variable	Weighted mean (Standard deviation)
Demographic Characteristics	
Female	0.27(0.45)
Minority	0.07 (0.26)
Age	47.20 (10.75)
Married	0.80 (0.40)
Foreign-born	0.28 (0.45)
Children in the household [all ages]	0.51 (0.50)
Currently Living in the United States	0.999(0.04)
Sector	
Academic institution	0.47 (0.50)
Government	0.10 (0.30)
Private business	0.43 (0.49)
Disciplinary affiliation	
Computer and mathematics	0.10 (0.30)
Biological, agricultural, and other life science	0.23 (0.42)
Physical and related science	0.14 (0.35)
Engineering	0.16 (0.36)
Social and related science	0.17 (0.37)
S & E related fields	0.10 (0.29)
Non S & E related fields	0.11 (0.32)
Career-related variables	
Years worked in current job	9.05 (9.06)
Number of hours worked per week	47.24 (11.64)
Collaboration activities	
International collaboration	0.35 (0.48)
Cosmopolitan collaboration	5.61 (3.17)

The study excludes academic administrators because research shows that compared to faculty (Milem et al., 2000) they tend to focus very little time on research, especially above the first-line management department chair positions (Favero, 2006). We do not exclude those who work in research centers or labs and have some research-related administrative tasks and, of course, principal investigators have administrative duties and we do not exclude them. By contrast, research shows that it is not uncommon for government managers to keep a hand in research (Bignon and Szajnfarber, 2015) and the career ladders (Allen and Katz, 1986) in the private sector are not as distinctly different as in the past (Bobadilla and Gilbert, 2017); moreover, many smaller firms simply do not have the option of removing human resources from R & D to focus exclusively on administration (Petroni et al., 2012; Michael, 2012).

We present weighted descriptive statistics to characterize the population in Table 1. Nearly one-third of respondents (27%) are women, which reflects the weaker representation of women in STEM disciplines. Although 13.5% of the sample are members of underrepresented minority groups,[3] the population representation of underrepresented minorities is seven percent. Eighty-eight percent of the sample are U.S. citizens, which makes sense given liberal US immigration policies and the requirement that participants earn their doctoral degree from a US university. Twenty-eight percent are foreign-born– either holding foreign citizenship or having become a U.S. citizen by naturalization.

[3] In the United States, underrepresented minorities include Hispanics of any race, African-Americans, Native Americans, and Pacific Islanders.

Table 2
Weighted means and standard deviations of 2006 and 2010 dependent variables.

Variable	Total	Women		Men
Job satisfaction				
General job satisfaction (2006)	3.46 (0.69)	3.41 (0.71)	***	3.48 (0.68)
General job satisfaction (2010)	3.37 (0.69)	3.34 (0.71)	**	3.39(0.68)
Opportunities for advancement (2010)	2.90 (0.87)	2.88 (0.90)	**	2.91 (0.86)
Level of job benefits (2010)	3.23 (0.79)	3.20 (0.83)	***	3.24(0.77)
Intellectual challenge (2010)	3.43 (0.79)	3.43 (0.75)		3.43 (0.73)
Degree of independence (2010)	3.54 (0.68)	3.55 (0.68)		3.54 (0.68)
Location of the workplace (2010)	3.37 (0.78)	3.37 (0.80)	*	3.37 (0.77)
Level of responsibility (2010)	3.39 (0.71)	3.40 (0.73)	***	3.38 (0.70)
Salary (2010)	3.04 (0.82)	2.96 (0.86)	***	3.08 (0.81)
Job security (2010)	3.20 (0.87)	3.13 (0.91)	***	3.23 (0.85)
Level of contribution to society (2010)	3.42 (0.69)	3.48 (0.67)	***	3.40 (0.69)
Sum of job satisfaction (2010)	20.53 (4.40)	20.37 (4.36)		20.57 (4.41)

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Nearly half (47%) work in educational institutions such as two or four-year colleges or universities, one-tenth in any level of government, and two-fifths in industry or the private business sector. It should be noted that government does not constitute a major employer of research scientists in the United States.

With respect to the disciplinary field of the respondent's primary work, 10% are computer and mathematical scientists, 14% are physical and related scientists, 23% are biological, agricultural, and other life scientists, 15% are engineers, 17% are social and related scientists, 8% are in other science and engineering (S & E) related fields,[4] and finally 11% are in non-S & E related fields. The biggest employer of engineers is business and industry while about 60% of biological, agricultural, and other life scientists are employed in educational institutions. Both in 2006 and 2010, men earned more on average than women. Men earned on average $97,015 while women earned $75,101 in 2006. In 2010, men earned on average $121,697 while women earned $97,384 on average. Also, people working in the business sector earn more on average ($108,757) than those in government ($91,573) or in educational institutions ($74,081), and a similar pattern can be observed in the 2010 SDR. As salary is not normally distributed, the analysis is based on the logged value.

3.2. Measurement

The variables so far described are fairly self-explanatory; in this section we describe how we developed our measures of job satisfaction and collaboration cosmopolitanism. Our primary independent construct of interest is collaboration activity. Respondents to the 2006 SDR were asked to indicate whether they collaborated with individuals in their immediate work group, within the organization, with another American organization, or internationally during the reference week of the survey. Table 1 shows that slightly over one-third of scientists had an international collaboration in the preceding year. Among those who said they have been involved in international collaboration, about 40% are in academia, half are in private business, and less than one in ten work in a government agency. In terms of communication methods, 98% of people who collaborate with people outside the country use phone or email to communicate, while about 62% indicated that their foreign collaborators travel to U.S. and 51% travel abroad for collaboration themselves. In terms of collaboration mechanisms surveyed in the 2006 SDR, men reported more than women that they participate in all kinds of collaborative activity.

[4] In the SDR, non-S & E fields are health fields, which in most systems are classified among science and engineering fields.

The collaboration cosmopolitanism variable is measured as a simple addition of different collaboration activities. That is, we assigned 0 to individuals who do not collaborate at all, 1 to those who collaborate with their immediate work group, 2 to those who work with others in their organization but not the immediate work group, 3 to those who work with other organizations in the United States, and 4 to those who collaborate with scientists in other countries. We add these variables for each individual to construct the collaboration cosmopolitanism scale. Scientists and engineers working in industry (mean = 6.13) have the highest collaboration cosmopolitanism scores, followed by those working in government (mean = 6.05) and then those in academia (mean = 5.08). Within academia, people in research universities have higher collaboration cosmopolitanism (mean = 5.55) than those in non-research universities (mean = 4.51); it should be noted that even among those in research universities, professors have lower collaboration cosmopolitanism than either industry or government scientists.

Our dependent variable, job satisfaction, is measured with a Likert scale from 1 to 4 in the 2006 administration, and then with a much broader scale in 2010. Bivariate statistics are presented in Table 2. Men, on average, are more satisfied with their primary work activities than women in both 2006 and 2010. Also, scientists working in academia are slightly more satisfied with their work in general than those in government or in business. More specific indicators of satisfaction were studied in the 2010 SDR such as job satisfaction with opportunities for advancement, the level of job benefits, intellectual challenge, degree of independence, location of the workplace, level of responsibility, salary, job security, and the level of contribution to society. We used confirmatory factor analysis to determine that these nine individual items of job satisfaction represent a unidimensional construct (Dolbier et al., 2005). The Cronbach's alpha score of the resulting summed scale is 0.80. Our approach to the composite measure of job satisfaction is consistent with Sabharwal's (2011) application to academics in the 2003 SDR data. We employ simple summation of these individual components to create a scale of job satisfaction. The summed score is centered at 0 with a range from 0 to 27 (mean = 20.53, s.d. = 4.36). The 2010 summary job satisfaction score is normally distributed.

4. Findings

4.1. Regression results

We begin by using ordered logit to examine job satisfaction in 2006; ordered logit is appropriate given the ordinal nature of this four-point Likert scale. We follow a nested modeling strategy, which allows us to examine the effects of blocks of constructs on job satisfaction; such a strategy facilitates examining mediating and moderating effects of the key independent constructs. Looking across models in Table 3, we find stability in the effects of demographic characteristics (Model 1). Men are more satisfied with their principal job relative to women. Furthermore, older researchers are more satisfied with their job as anticipated, although the size of the effect is minor. Foreign born researchers are less satisfied with their job. Married researchers are more satisfied with their job while having a dependent child at home regardless of the age of the child is negatively associated with the overall level of job satisfaction. Minority job satisfaction is not significantly different from that of non-minorities.

As hypothesized, there are sector and disciplinary effects on job satisfaction in 2006 (Models 2 and 3). Compared to academic researchers, those who work in the government sector or private sector are significantly less satisfied with their job in general. Social scientists, health scientists, and those working outside STEM are more satisfied with their principal job than the other STEM fields. Such disciplinary and sector effects persist in every model, which lends support to the idea that both sector and discipline have significant impacts on the level of job satisfaction. Work characteristics such as years worked in current job and the level of salary are consistently important predictors of job

Table 3
Weighted Ordered Logit on the Determinants of Overall Job Satisfaction in 2006.

	(1) Demographic	(2) Sector	(3) Discipline	(4) Work Characteristics	(5) International Collaborator	(6) Cosmopolitan Collaboration	(7) Sector*CC
Demographic characteristics							
Woman	−0.10**	−0.12***	-0.16***	-0.13***	-0.13***	-0.13***	-0.13***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Minority	0.05	0.04	0.01	0.02	0.02	0.01	0.02
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Age	0.02***	0.02***	0.02***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Foreign-born	−0.24***	−0.23***	-0.19***	-0.18***	-0.18***	-0.17***	-0.17***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Married	0.27***	0.28***	0.29***	0.29***	0.29***	0.29***	0.29***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Children in the household	−0.07*	−0.07*	-0.07*	-0.08*	-0.08*	-0.08*	-0.08*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Sector†							
Government		−0.16**	−0.16**	−0.15**	−0.15**	−0.17**	−0.49***
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.12)
Business		−0.16***	−0.17***	−0.15***	−0.16***	−0.18***	−0.04
		(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.07)
Disciplinary affiliation††							
Computer and mathematics			0.07	0.07	0.07	0.08	0.08
			(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Physical and related science			0.11*	0.11*	0.11*	0.11*	0.10*
			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Social and related science			0.24***	0.24***	0.25***	0.26***	0.26***
			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Engineering			−0.02	−0.02	−0.02	−0.02	−0.03
			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Other S & E related fields			0.23***	0.22***	0.22***	0.21***	0.21***
			(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Non S & E related fields			0.32***	0.32***	0.32***	0.31***	0.32***
			(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Work characteristics							
Years worked in current job				0.00*	0.00*	0.00	0.00
				(0.00)	(0.00)	(0.00)	(0.00)
Number of hours worked per week				0.00*	0.00*	0.00*	0.00*
				(0.00)	(0.00)	(0.00)	(0.00)
log(Salary)				0.05**	0.05**	0.04**	0.04**
				(0.02)	(0.02)	(0.02)	(0.02)
Collaboration activities							
International collaboration					0.09**		
					(0.03)		
Cosmopolitan collaboration						0.03***	0.03***
						(0.00)	(0.01)
Government*CC							0.05**
							(0.02)
Business*CC							−0.02*
							(0.01)
Constant cut1	−3.19***	−3.26***	−3.23***	−2.56***	−2.59***	−2.57***	−2.53***
	(0.10)	(0.10)	(0.10)	(0.20)	(0.20)	(0.20)	(0.20)
Constant cut2	−1.61***	−1.68***	−1.65***	−0.97***	−1.00***	−0.98***	−0.95***
	(0.08)	(0.08)	(0.09)	(0.20)	(0.20)	(0.20)	(0.20)
Constant cut3	0.64***	0.58***	0.61***	1.29***	1.26***	1.28***	1.32***
	(0.08)	(0.08)	(0.09)	(0.20)	(0.20)	(0.20)	(0.20)
Observations	19,197	19,197	19,197	19,197	19,197	19,197	19,197

Robust standard errors in parentheses.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.
Comparison group: † Academic institutions. †† Biological, agricultural, and other life science.

satisfaction in every model. More experienced researchers have a higher degree of job satisfaction and those with higher salary are more satisfied (Model 4).

We evaluate alternative specifications of collaboration cosmopolitanism in Models 5–7. First, we estimate the effect of any international collaboration on job satisfaction, finding that it has a positive impact on general job satisfaction (Model 5). Next, we use our more comprehensive measure of the collaboration cosmopolitanism, which also supports the hypothesis that collaboration cosmopolitanism has a positive effect on job satisfaction (Model 6). In Model 7, we test the interaction between collaboration cosmopolitanism and sector. First, we find that collaboration cosmopolitanism continues to have a direct positive effect on job satisfaction. However, there are interesting interactive effects. The negative direct effect of business sector is completely mediated, illuminating that more cosmopolitan business scientists are less satisfied. By contrast, the interaction shows that government scientists are even less satisfied than in the other models, but there is some moderation of this negative effect for government scientists who are more cosmopolitan.

Despite the interesting and significant findings, there are some limitations of the analyses in Table 3. First, it is a cross-sectional analysis and therefore difficult to provide solid evidence that a higher

degree of collaboration cosmopolitanism causes a higher level of job satisfaction. Furthermore, the survey in 2006 has limited measurement of job satisfaction − a single item of overall job satisfaction measured with a 1–4 Likert scale. To better examine the effect of collaboration cosmopolitanism, therefore, the lagged model for 2010 job satisfaction is considered. In these models, past job satisfaction can be controlled, strengthening the specification of the model. Job satisfaction is measured with a comprehensive scale in 2010 providing more nuance and specification for job satisfaction. Finally, the 2010 job satisfaction scale is normally distributed, making OLS regression an appropriate econometric choice for estimation.[5]

Table 4 presents models estimating effects on job satisfaction in 2010. Demographic effects on job satisfaction are consistent with those found in 2006 with the exception of being female, which is no longer a predictor of job satisfaction (Model 1). In the simple sector model, we find that working in the private sector has a strong negative effect on job satisfaction, consistent with the hypothesis. We find, however, that government scientists are as satisfied as academic scientists (Model 2). Social scientists and those not working in STEM fields are more satisfied than those in STEM disciplines; those in computer science, mathematics, and physical science, and engineering fields are particularly dissatisfied (Model 3). Model 4 includes work characteristics, including overall job satisfaction in 2006. These constructs fully mediate the effect of age on job satisfaction. More important, prior job satisfaction has a strong positive effect on 2010 job satisfaction. Work characteristics also unmask a suppressor effect on government scientist job satisfaction: Their inclusion leads to a positive (relative to academic scientists) effect on government scientist job satisfaction.

We present the alternative collaboration cosmopolitanism specifications in Models 5–7. The simple measure of international collaboration does not have an effect on this more comprehensive measure of job satisfaction (Model 5). By contrast, the collaboration cosmopolitanism measure is positively associated with the level of job satisfaction, consistent with Hypothesis 2 (Models 6 and 7). We find that the negative effect of being a business scientist is fully mediated by the interaction term (Model 7): Industry scientists with high collaboration cosmopolitanism are less satisfied than other scientists. Taken together, the degree of collaboration cosmopolitanism has both cross-sectional and lagged effects on overall job satisfaction while controlling for other independent variables.

4.2. Implications of empirical findings

The central research question for the paper is “what is the relationship, if any, of collaboration cosmopolitanism to researchers’ job satisfaction?” Controlling for demographics and work characteristics, known to be key influences on the degree of job satisfaction, we demonstrate that collaboration cosmopolitanism is positively associated with researchers’ job satisfaction. Therefore, our primary hypothesis of interest (H2) is supported.

As hypothesized, sector matters, but so does model specification. In the cross-sectional model, academics are more satisfied than those in other sectors, consistent with hypothesis 1. In the longitudinal model, government employees are significantly more satisfied than academics, and private sector employees are significantly less satisfied than academics. More interestingly, researchers working in government are more likely to enjoy positive effects of collaboration cosmopolitanism on job satisfaction than academic researchers, which does not fully support hypothesis 3. On the other hand, working in industry negatively moderates the relationship between collaboration cosmopolitanism on job satisfaction suggesting the potential negative externalities experienced by broader collaboration across regions and institutions.

Given the empirical results, we can conclude that work characteristics such as work hours, years worked on the job, and salary have direct, positive, and statistically significant effects on job satisfaction. There are direct demographic effects on job satisfaction with men, US-born, married, and younger researchers being more likely to have a higher degree of job satisfaction. Lower job satisfaction among women researchers is consistent with results of past literature (Olsen et al., 1995; Scandura and Lankau, 1997). Foreign born and younger researchers have lower job satisfaction as different cultural background or lack of experience and expertise may establish a barrier to feeling comfortable or confident on their job or workplace environment, a finding which is also aligned with previous work (Sabharwal, 2011).

5. Conclusion

The central conclusion of this paper is straightforward, that doctoral researchers who are engaged in a higher degree of collaboration cosmopolitanism have higher levels of job satisfaction, but this finding holds for academics and government scientists only. On average, academic and government researchers involved in broader collaboration patterns outside of their geographical and institutional boundaries have greater job satisfaction than their counterparts working in industry. While there is the presumption that academic jobs are superior alternatives for those holding the doctorate, an important contribution of this paper is the empirical demonstration of that dynamic. Furthermore, government sector researchers who have had greater cosmopolitan experience in their research activities are found to have greater job satisfaction controlling for other work characteristics including past job satisfaction. On the other hand, such experiences for industry sector researchers negatively influence at the time of collaboration as well as afterwards, implying the importance of cautious design in promoting collaboration activities particularly for industry research personnel. Prevalence and greater advocacy of collaboration do not mean that it has greater benefit for everyone.

The main weakness of the analysis is that there is no information on the researchers’ collaboration pattern in 2010 such that it is impossible to test a full version of the longitudinal model in order to see how the collaboration pattern as well as the level of job satisfaction have changed and influenced one another. Due to a lack of additional waves of data, therefore, the estimation of the lagged model needs to be interpreted with caution. Another shortcoming of the results is that it is difficult to identify which scientific activities the researchers have collaborated on. Although the focus of the paper is on doctoral degree holders, it is difficult to conclude that collaboration is only aimed principally at scientific work. Despite the weaknesses, the analysis is noteworthy in examining the factors predicting job satisfaction among doctorate holders, and, more importantly, not limited to academic faculty. The concept of collaboration cosmopolitanism has been focused on academic faculty while the significance of cosmopolitanism, for instance, on productivity (Lee and Bozeman, 2005) and in generating systemic STEM capacity (Melkers and Kiopa, 2010), may not be limited to academia. Developing a collaboration cosmopolitanism scale and examining the cross-sectional and longitudinal effect on job satisfaction across sector and discipline, therefore, are noteworthy.

Another limitation of the present study is the less than ideal operationalization of scientific field and discipline. As is the case with any study relying on secondary, institutional data, the researchers have no ability to change decisions made by others for their own purposes. However, we can at least recognize the several reasons why we feel a more fine-grained set of discipline measures would be preferable. First, we know, even from the crude measures of discipline available in the data base and the statistical results we report, that discipline relates to

[5] For a robustness check, we also ran an ordered logit model: The direction of the effect is the same as the weighted OLS regression analysis. However, the results from the OLS model should be considered with caution as it can be biased in the presence of a lagged dependent variable without a lagged independent variable. With only two points available to us, OLS estimation may consistently underestimate the effect of collaboration cosmopolitanism.

Table 4
Weighted Multiple Regression on the Determinants of Sum of Categorized Job Satisfaction in 2010.

	(1) Demographic	(2) Sector	(3) Discipline	(4) Work Characteristics	(5) International Collaborator	(6) Cosmopolitan Collaboration	(7) Sector*CC
Demographic characteristics							
Woman	−0.01	−0.10	−0.21*	0.02	0.03	0.03	0.02
	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)
Minority	0.30*	0.21	0.15	0.25	0.25	0.24	0.25
	(0.14)	(0.14)	(0.14)	(0.13)	(0.13)	(0.13)	(0.13)
Age	0.04***	0.04***	0.04***	0.01	0.01	0.01	0.01
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Foreign-born	−1.34***	−1.25***	−1.18***	−1.03***	−1.03***	−1.01***	−1.02***
	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)
Married	0.69***	0.71***	0.73***	0.49***	0.49***	0.49***	0.50***
	(0.12)	(0.12)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
Children in the household	−0.14	−0.11	−0.13	−0.12	−0.12	−0.13	−0.13
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Sector†							
Government		0.18	0.21	0.29*	0.29*	0.26*	0.12
		(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.29)
Business		−0.80***	−0.78***	−0.63***	−0.64***	−0.67***	−0.11
		(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.18)
Disciplinary affiliation††							
Computer and mathematics			−0.16	−0.33*	−0.33*	−0.31*	−0.32*
			(0.16)	(0.15)	(0.15)	(0.15)	(0.15)
Physical and related science			−0.22	−0.42***	−0.42***	−0.41***	−0.43***
			(0.14)	(0.13)	(0.13)	(0.12)	(0.12)
Social and related science			0.32*	0.10	0.11	0.14	0.14
			(0.13)	(0.12)	(0.12)	(0.12)	(0.12)
Engineering			−0.21	−0.38**	−0.38**	−0.37**	−0.39**
			(0.14)	(0.13)	(0.13)	(0.13)	(0.13)
Other S & E related fields			0.27	0.02	0.02	0.01	0.02
			(0.16)	(0.15)	(0.15)	(0.15)	(0.15)
Non S & E related fields			0.47**	0.21	0.20	0.19	0.23
			(0.17)	(0.16)	(0.16)	(0.16)	(0.16)
Work characteristics							
Years worked in current job				0.00	0.00	−0.00	0.00
				(0.00)	(0.00)	(0.00)	(0.00)
Number of hours worked per week				0.05***	0.05***	0.05***	0.05***
				(0.01)	(0.01)	(0.01)	(0.01)
log(Salary) (2010)				0.68***	0.67***	0.66***	0.67***
				(0.07)	(0.07)	(0.07)	(0.07)
Past job satisfaction				2.05***	2.05***	2.04***	2.04***
				(0.07)	(0.07)	(0.07)	(0.07)
Collaboration activities							
International collaboration					0.13		
					(0.08)		
Cosmopolitan collaboration						0.04***	0.08***
						(0.01)	(0.02)
Government*CC							0.02
							(0.04)
Business*CC							−0.10***
							(0.03)
Constant	18.80***	19.12***	19.22***	5.37***	5.45***	5.47***	5.22***
	(0.23)	(0.23)	(0.24)	(0.88)	(0.89)	(0.88)	(0.88)
Observations	11,379	11,379	11,379	11,379	11,379	11,379	11,379
R-squared	0.04	0.05	0.05	0.18	0.18	0.18	0.18

both collaboration cosmopolitanism and job satisfaction. We also know from previous studies, ones using a more articulated set of field and discipline measures, that there is systematic variation in the relationships of discipline to job satisfaction (e.g. Gmelch et al., 2005; Bentley et al., 2013; Bhat and Person, 2016). It is to some degree solace to know that the findings of these studies tend to confirm, usually with more precision, the distinctive relationships of engineering fields and social sciences, the first having lesser job satisfaction than average and the latter higher. Likewise, others have found considerable differences within the social sciences, especially the contrasting work patterns and collaboration patterns between economics and other disciplines such as sociology and political sciences that tend to be more focused on field studies and more often inductive in approach to analysis than deductive. In short, more work, and more precise work is needed on discipline and field and, thus, our findings must be treated with caution. Finally, we do not model directly the selection effects of doctoral degree holders choosing employers, or employers choosing scientific employees. Other research has shown the sorting process—at least between academia and industry—leads to those with a greater "taste for science" choosing academic careers (Agarwal and Ohyama, 2012; Roach and Sauermann, 2010). It would be interesting and desirable to evaluate how such a "taste for science" affects job satisfaction, but such an empirical analysis falls outside the scope of our purpose.

Given the findings from the analyses, there are other important questions not addressed in this study. For instance, the impact of collaboration cosmopolitanism on career outcomes other than job satisfaction needs to be examined to see the broader significance of it. Examples of such other career outcomes include the level of salary, promotion or advancement opportunities. As we have shown that the effect of collaboration cosmopolitanism on job satisfaction can vary

across sector and discipline, it would also be worthwhile to examine its effect for different educational groups like bachelor or master's degree holders. Therefore, examining the effects of collaboration cosmopolitanism and job satisfaction on other career outcomes for different groups would provide a more comprehensive understanding of the effect.

The study holds some implications for policy, not only public policy but also business policy. In our view, one of the most interesting, and possibly disturbing, findings is that collaboration cosmopolitanism has no positive impact on industry researchers' job satisfaction, in sharp contrast to university and government researchers. A benign view of this finding is that industry rewards tend to be somewhat more focused on rewards linked to the firm rather than the profession and, related, that industrial employees tend to have greater interest in pecuniary rewards than do researchers in government or universities. In other words, it may well be the case that the social capital and professional esteem accruing from cosmopolitan collaboration may hold less allure for those working in business. A more troubling possibility, one that goes beyond our current data, is that business researchers find that the development of extensive and distant (non-firm) collaboration networks is frustrating and not encouraged, or even actively discouraged, by administrative superiors. We must take into account that the organizational size of the industry researchers' firm is on average much smaller than universities and government agencies and, thus, any discouragement of non-firm collaborative activity may simply be viewed as having too high an opportunity cost for those in firms. In any case, for most scientists, collaboration tends to be an extremely positive and rewarding activity (both psychologically and in terms of productivity). If industrial researchers are not deriving satisfaction from broad-based collaboration, then it is perhaps worthy of the attention of human resources managers and administrative superiors.

The implications for public policy are perhaps more straightforward. Especially if one agrees with the prevailing wisdom that collaboration has positive productivity impacts, then government and university policies that encourage collaboration cosmopolitanism are worthwhile and may warrant more attention than they now receive. To be sure, they already receive attention. For many years, academic researchers have availed themselves of such policies as Fulbright Awards which, among other benefits, tend to increase the reach of collaboration networks. By most accounts, these activities have proved quite successful in advancing careers and knowledge. To a large extent, however, university researchers forge their own path with respect of collaborators and tend to collaborate with those in their own university or in their own sector (see Bozeman and Corley, 2004 on this topic). This may be just fine for experienced senior researchers, ones who are in demand from prospective collaborators. However, it seems quite likely that early career policies to support the rapid formation of richer and more extensive collaboration networks among junior faculty, and perhaps even postdocs and graduate students, would be well redeemed in terms of both the quality of careers and also their productivity.

Acknowledgements

An earlier version of this paper was presented at the 2016 meeting of the 21st International Conference on Science and Technology Indicators in Valencia, Spain, September 14–16, 2016. The research is supported by the National Science Foundation (grant #NSCE-1537879; B. Bozeman, PI and M. Gaughan, co-PI), *Cosmopolitan collaboration among STEM women and minorities.*

References

Abrahamson, M., 1965. Cosmopolitanism, dependence-identification, and geographical mobility. Adm. Sci. Q. 10 (1), 98–106.
Abramo, G., D'Angelo, C.A., Di Costa, F., 2009. Research collaboration and productivity: is there correlation? Higher Educ. 57 (2), 155–171.
Agarwal, R., Ohyama, A., 2012. Industry or academia, basic or applied? Career choices and earnings trajectories of scientists. Manage. Sci. 59 (4), 950–970.
Allen, T.J., Katz, R., 1986. The dual ladder: motivational solution or managerial delusion? R & D Manag. 16 (2), 185–197.
Andrade, H.B., de Los, Reyes, Lopez, E., Martín, T.B., 2009. Dimensions of scientific collaboration and its contribution to the academic research groups' scientific quality. Res. Evaluat. 18 (4), 301–311.
August, L., Waltman, J., 2004. Culture, climate, and contribution career satisfaction among female faculty. Res. Higher Educ. 45 (2), 177–192.
Bender, K., Heywood, J., 2006. Job satisfaction of the highly educated: the role of gender, academic tenure, and earnings. Scott. J. Polit. Econ. 53 (2), 253–279.
Bentley, P.J., Coates, H., Dobson, I.R., Goedegebuure, L., Meek, V.L., 2013. Academic job satisfaction from an international comparative perspective: factors associated with satisfaction across 12 countries. In: Bentley, P.J., Coates, H., Dobson, I.R., Goedegebuure, L., Meek, V.L. (Eds.), Job Satisfaction Around the Academic World. Springer, pp. 239–262.
Bhat, V., Person, A., 2016. Differences in the factors influencing job satisfaction among scientists and engineers. Int. J. Appl. Manag. Sci. Eng. 3 (1), 1–10.
Bignon, I., Szajnfarber, Z., 2015. Technical professionals' identities in the R & D context: beyond the scientist versus engineer dichotomy. IEEE Trans. Eng. Manag. 62 (4), 517–528.
Blackburn, R., Lawrence, J., 1995. Faculty at Work: Motivation, Expectation Satisfaction. Johns Hopkins University Press, Baltimore, MD.
Boardman, P., Corley, E., 2008. University research centers and the composition of research collaborations. Res. Policy 37 (5), 900–913.
Bobadilla, N., Gilbert, P., 2017. Managing scientific and technical experts in R & D: beyond tensions, conflicting logics and orders of worth. R & D Manag. 47 (2), 223–235.
Box, S., Cotgrove, S., 1966. Scientific identity, occupational selection, and role strain. Brit. J. Sociol. 17 (1), 20–28.
Bozeman, B., Corley, E., 2004. Scientists' collaboration strategies: implications for scientific and technical human capital. Res. Policy 33 (4), 599–616.
Bozeman, B., Gaughan, M., 2011. Job satisfaction among university faculty: individual, work, and institutional determinants. J. Higher Educ. 82 (2), 154–186.
Bozeman, B., Youtie, J., 2017. Strength in Numbers: Research Collaboration Effectiveness. Princeton University Press.
Bozeman, B., Fay, D., Slade, C., 2013. Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. J. Technol. Transfer 38 (1), 1–67.
Bozeman, B., Gaughan, M., Youtie, J., Slade, C., Rimes, H., 2016. Research collaboration experiences, good and bad: dispatches from the front lines. Sci. Public Policy 43 (2), 226–244.
Bruneel, J., d'Este, P., Salter, A., 2010. Investigating the factors that diminish the barriers to university–industry collaboration. Res. Policy 39 (7), 858–868.
Bullock, J.B., Stritch, J.M., Rainey, H.G., 2015. International comparison of public and private employees' work motives, attitudes, and perceived rewards. Public Admin. Rev. 75 (3), 479–489.
Bysted, R., Hansen, J.R., 2015. Comparing public and private sector employees' innovative behaviour: understanding the role of job and organizational characteristics, job types, and subsectors. Public Manag. Rev. 17 (5), 698–717.
Chen, T., Chang, P., Yeh, C., 2004. A study of career needs, career development programs, job satisfaction and the turnover intentions of R & D personnel. Career Dev. Int. 9 (4), 424–437.
Chen, P., Sparrow, P., Cooper, C., 2016. The relationship between person-organization fit and job satisfaction. J. Manag. Psychol. 31 (5), 946–959.
Cowin, L., 2002. The effects of nurses' job satisfaction on retention: an Australian perspective. J. Nurs. Admin. 32 (5), 283–291.
Dolbier, C.L., Webster, J.A., McCalister, K.T., Mallon, M.W., Steinhardt, M.A., 2005. Reliability and validity of a single-item measure of job satisfaction. Am. J. Health Promot. 19 (3), 194–198.
Erdogan, B., Bauer, T., Truxillo, D., Mansfield, L., 2012. Whistle while you work a review of the life satisfaction literature. J. Manag. 38 (4), 1038–1083.
Erez, A., Isen, A., 2002. The influence of positive affect on the components of expectancy motivation. J. Appl. Psychol. 87 (6), 1055–1067.
Faragher, E., Cass, M., Cooper, C., 2005. The relationship between job satisfaction and health: a meta-analysis. Occup. Environ. Med. 62 (2), 105–112.
Favero, M.D., 2006. An examination of the relationship between academic discipline and cognitive complexity in academic deans' administrative behavior. Res. Higher Educ. 47 (3), 281–315.
Fox, M., Stephan, P., 2001. Careers of young scientists: preferences, prospects and realities by gender and field. Soc. Stud. Sci. 31 (1), 109–122.
Gaughan, M., Corley, E., 2010. Science faculty at US research universities: the impacts of university research center-affiliation and gender on industrial activities. Technovation 30 (3), 215–222.
Gmelch, W., Wilke, P., Lovrich, N., 2005. Dimensions of stress among university faculty. Res. Higher Educ. 24 (3), 266–286.
Gouldner, A., 1957. Cosmopolitans and locals: toward an analysis of latent social roles. I. Adm. Sci. Q. 2 (3), 281–306.
Gouldner, A., 1958. Cosmopolitans and locals: toward an analysis of latent social roles. II. Adm. Sci. Q. 2 (4), 444–480.
Hagedorn, L., 1996. Wage equity and female faculty job satisfaction: the role of wage differentials in a job satisfaction causal model. Res. Higher Educ. 37 (5), 569–598.
Hagedorn, L., 2000. Conceptualizing faculty job satisfaction: components, theories, and outcomes. New Direct. Inst. Res. 105, 5–20.
Hamann, R., Giamporcaro, S., Johnston, D., Yachkaschi, S., 2011. The role of business and cross-sector collaboration in addressing the 'wicked problem'of food insecurity. Dev. Southern Afr. 28 (4), 579–594.
Hearn, J., 1999. Pay and performance in the university: an examination of faculty

salaries. Rev. Higher Educ. 22 (4), 391–410.
Heinze, T., Shapira, P., Rogers, J.D., Senker, J.M., 2009. Organizational and institutional influences on creativity in scientific research. Res. Policy 38 (4), 610–623.
Janger, J., Nowotny, K., 2016. Job choice in academia. Res. Policy 45 (8), 1672–1683.
Johnsrud, L., Rosser, V., 2002. Faculty members' morale and their intention to leave: a multilevel explanation. J. Higher Educ. 73 (4), 518–542.
Jones, O., 1996. Human resources, scientists, and internal reputation: the role of climate and job satisfaction. Hum. Relat. 49 (3), 269–294.
Judge, T.A., Parker, S., Colbert, A.E., Heller, D., Ilies, R., 2001a. Job satisfaction: a cross-cultural review. handbook of industrial. Work Organ. Psychol. 2, 25–52.
Judge, T., Thoresen, T., Bono, J., Patton, G., 2001b. The job satisfaction-job performance relationship: a qualitative and quantitative review. Psychol. Bull. 127 (3), 376–407.
Kalleberg, A., 1977. Work values and job rewards: a theory of job satisfaction. Am. Sociol. Rev. 42 (1), 124–143.
Katz, J., Martin, B., 1997. What is research collaboration? Res. Policy 26 (1), 1–18.
Keeton, K., Fenner, D., Johnson, T., Hayward, R., 2007. Predictors of physician career satisfaction, work-life balance, and burnout. Obstetr. Gynecol. 109 (4), 949–955.
Keller, R., Julian, S., Kedia, B., 1996. A multinational study of work climate, job satisfaction, and the productivity of R & D teams. IEEE Trans. Eng. Manage. 43 (1), 48–55.
Keller, R., 1986. Predictors of the performance of project groups in R & D organizations. Acad. Manage. J. 29 (4), 715–726.
Kirkcaldy, B., Trimpop, R., Cooper, C., 1997. Working hours, job stress, work satisfaction, and accident rates among medical practitioners and allied personnel. Int. J. Stress Manag. 4 (2), 79–87.
Kjeldsen, A.M., Hansen, J.R., 2016. Sector differences in the public service motivation–job satisfaction relationship exploring the role of organizational characteristics. Rev. Public Personnel Admin (0734371×16631605).
Koch, J., Steers, R., 1978. Job attachment, satisfaction, and turnover among public sector employees. J. Vocat. Behav. 12 (1), 119–128.
Lacy, F.J., Sheehan, B.A., 1997. Job satisfaction among academic staff: an international perspective. Higher Educ. 34 (3), 305–322.
Lazear, E.P., 1990. Job security provisions and employment. Q. J. Econ. 105 (3), 699–726.
Lee, S., Bozeman, B., 2005. The impact of research collaboration on scientific productivity. Soc. Stud. Sci. 35 (5), 673–702.
Lewis, G.B., Frank, S.A., 2002. Who wants to work for the government? Public Adm. Rev. 62 (4), 395–404.
Lillydahl, J., Singell, L., 1993. Job satisfaction, salaries and unions: the determination of university faculty compensation. Econ. Educ. Rev. 12 (3), 233–243.
Locke, E.A., 1970. Job satisfaction and job performance: a theoretical analysis. Organ. Behav. Hum. Perform. 5 (5), 484–500.
Locke, E.A., 1976. The nature and causes of job satisfaction. In: Dunette, M. (Ed.), Handbook of Industrial and Organizational Psychology. Consulting Psychologists Press, Palo Alto, CA.
Mamiseishvili, K., Rosser, V.J., 2010. International and citizen faculty in the United States: an examination of their productivity at research universities. Res. Higher Educ. 51 (1), 88.
McKeachie, W., 1979. Perspectives from psychology: financial incentives are ineffective for faculty. In: Lewis, D., Becker, W. (Eds.), Academic Rewards in Higher Education. Ballinger, Cambridge, MA, pp. 3–20.
Melkers, J., Kiopa, A., 2010. The social capital of global ties in science: the added value of international collaboration. Rev. Policy Res. 27 (4), 389–414.
Michael, S.C., 2012. Monitoring technical managers: theory, evidence, and prescriptions. J. High Technol. Manag. Res. 23 (1), 36–45.
Milem, J.F., Berger, J.B., Dey, E.L., 2000. Faculty time allocation: a study of change over twenty years. J. Higher Educ. 71 (4), 454–475.
National Science Board, 2016. Science and Engineering Indicators 2016. National Science Foundation (NSB-2016-1), Arlington, VA.
Olsen, D., Maple, S., Stage, F., 1995. Women and minority faculty job satisfaction: professional role interests, professional satisfactions, and institutional fit. J. Higher Educ. 66 (3), 267–291.
Parker, J., Hackett, E., 2012. Hot spots and hot moments in scientific collaborations and social movements. Am. Sociol. Rev. 77 (1), 21–44.
Perry, J.L., Rainey, H.G., 1988. The public-private distinction in organization theory: a critique and research strategy. Acad. Manage. Rev. 13 (2), 182–201.
Petroni, G., Venturini, K., Verbano, C., 2012. Open innovation and new issues in R & D organization and personnel management. Int. J. Hum. Resource Manag. 23 (1), 147–173.
Petty, M., McGee, G., Cavender, J., 1984. A meta-analysis of the relationships between individual job satisfaction and individual performance. Acad. Manag. Rev. 9 (4), 712–721.
Ponomariov, B., Boardman, P., 2010. Influencing scientists' collaboration and productivity patterns through new institutions: university research centers and scientific and technical human capital. Res. Policy 39 (5), 613–624.
Porter, L., Steers, R., 1973. Organizational, work, and personal factors in employee turnover and absenteeism. Psychol. Bull. 80 (2), 151–176.
Roach, M., Sauermann, H., 2010. A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry. Res. Policy 39 (3), 422–434.
Rosser, V., 2004. Faculty members' intentions to leave: a national study on their worklife and satisfaction. Res. Higher Educ. 45 (3), 285–309.
Sabharwal, M., Corley, E.A., 2009. Faculty job satisfaction across gender and discipline. Soc. Sci. J. 46 (3), 539–556.
Sabharwal, M., 2011. Job satisfaction patterns of scientists and engineers by status of birth. Res. Policy 40 (6), 853–863.
Scandura, T., Lankau, M., 1997. Relationships of gender, family responsibility and flexible work hours to organizational commitment and job satisfaction. J. Organ. Behav. 18 (4), 377–391.
Seibert, S.E., Kraimer, M.L., Liden, R.C., 2001. A social capital theory of career success. Acad. Manage. J. 44 (2), 219–237.
Shrum, W., Genuth, J., Chompalov, I., 2007. Structures of Scientific Collaboration. Cambridge, MA, MIT Press.
Sibbald, B., Bojke, C., Gravelle, H., 2003. National survey of job satisfaction and retirement intentions among general practitioners in England. Br. Med. J. 326 (7379), 22–25.
Sloane, P., Williams, H., 2000. Job satisfaction, comparison earnings, and gender. Labour 14 (3), 473–502.
Spector, P., 1997. Job Satisfaction: Application, Assessment, Causes, and Consequences. Sage Publications, Thousand Oaks, CA.
Tack, M.W., Patitu, C.L., 1992. Faculty Job Satisfaction: Women and Minorities in Peril. ERIC, The George Washington University, Washington D.C.
van Helden, J., Reichard, C., 2016. Commonalities and differences in public and private sector performance management practices: a literature review. Performance Measurement and Management Control: Contemporary Issues. Emerald Group Publishing Limited, pp. 309–351.
Van Rijnsoever, F.J., Hessels, L.K., 2011. Factors associated with disciplinary and interdisciplinary research collaboration. Res. Policy 40 (3), 463–472.
Ylijoki, O.H., 2003. Entangled in academic capitalism? A case-study on changing ideals and practices of university research. Higher Educ. 45 (3), 307–335.
Youtie, J., Bozeman, B., 2016. Dueling co-authors: how collaborators create and sometimes solve contributorship conflicts. Minerva 54 (4), 375–397.