Research Policy 50 (2021) 104366

Contents lists available at ScienceDirect

Research Policy

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

The Impact of False Investigators on Grant Funding

Eric A. Fong[a,*], Allen W. Wilhite[b]

[a] Department of Management, University of Alabama in Huntsville, 301 Sparkman Dr., Huntsville, AL 35899, USA
[b] Department of Economics, University of Alabama in Huntsville, 301 Sparkman Dr., Huntsville, AL 35899, USA

ARTICLE INFO

Keywords:
Research misconduct
False investigators
Research integrity
Misdirected grant funding
Reputation effect

ABSTRACT

False investigators are researchers who have been listed on grant proposals as part of a research team even though there is no expectation that they will contribute to the research effort. Their use seems to be widespread even though their inclusion raises legal and ethical questions. Using data collected from the top 200 universities listed on U.S. News and World Report (2015), this manuscript investigates whether the use of false investigators impacts the distribution of research money and if so, by how much? Our analysis suggests they do, grants with false investigators receive more money, and while the size of this return varies with grant size, we find an average increase of about 70%. We also investigate how this influence is manifested; whether the increased funding is because false investigators apply for more grants, or if the presence of a false investigator increases the amount of funding received per proposal. We close with a discussion of policy issues and questions about research funding that remain unanswered.

1. Introduction

The research misconduct literature mostly focuses on data falsification, fabrication, and misrepresentation (e.g., Fang et al., 2012; Fanelli et al., 2019), or on the misattribution in publications such as plagiarism (e.g., Martin 2013) and honorary authorship (Greenland and Fontanarosa 2012). Similarly, there is growing interest in the relationship between misconduct and grants; for example, Stern et al. (2014) use retracted articles, and the grants used to fund that research to calculate part of the cost of misconduct. Yet, even studies examining grants tend to look at what happens after a grant was funded, few examine the misconduct that may arise prior to grant funding. One exception is Fong and Wilhite (2017) who first document the practice of adding investigators to grant proposals even though those individuals are not expected to participate in the research in any meaningful fashion; they may include people added to proposals because of their reputation, their position as a lab director or administrator, for the sake of reciprocity, etc. They label these individuals false investigators and examine which academic disciplines and what ranks are more likely to participate in investigator falsification.

In this study, we examine the consequences of this investigator falsification; do researchers who include false investigators receive more funding than those who do not and, if so, how large is the difference? We also investigate how this additional funding is manifested; does the use of false investigators facilitate the submission of more grant proposals or does it impact the average size of grant awards per proposal.

There is an emerging interest in objectively measuring the impact of misconduct. For example, Michalek et al. (2010) identify investigation costs by measuring the resources used to identify misconduct and, as mentioned above, Stern et al. (2014) investigate grant dollars and retracted articles. By measuring the impact of the use of false investigators on grant funding, we also hope to add to that quantification literature. Of course, re-directed grant awards are not the only negative consequence of adding false investigators, their use may be illegal and their presence can create substantial friction in academic units as some faculty members receive credit and compensation for research that was not their work. The funding impact is only part of the problem.

2. Conceptual framework

According to Fong and Wilhite (2017), the phrase, false investigators, refers to individuals who are included on grant proposals as part of the research team, but for whom there is little expectation that they will contribute to the research effort in a meaningful way. Intuitively, a false investigator is someone included on a proposal who should not be; someone whose contribution does not fit the description of what should be funded by a granting agency. Examples would include department chairs, lab directors, and senior faculty who insist their

* Corresponding author.
E-mail address: eric.fong@uah.edu (E.A. Fong).

https://doi.org/10.1016/j.respol.2021.104366
Received 26 September 2020; Received in revised form 28 June 2021; Accepted 6 September 2021
Available online 12 September 2021

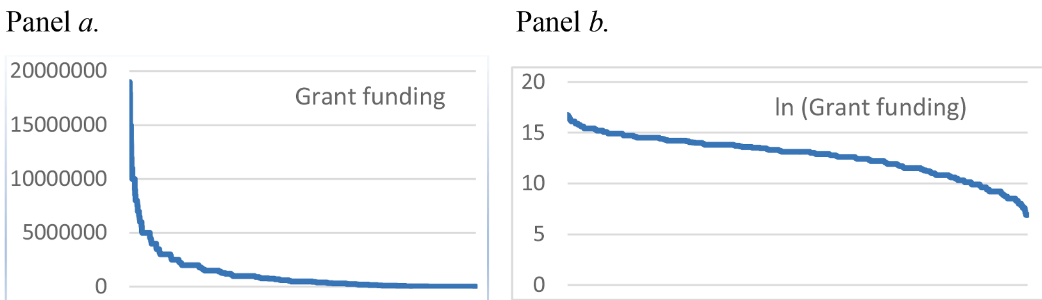

Fig. 1. Distribution of grant funding.

name be included on grants coming from within their sphere of influence regardless of their participation; colleagues included by another faculty member/friend to boost their performance review, vita, or promotion; researchers involved in reciprocating strategies (you put your name on my proposal and I'll put mine on yours); well-known scholars or scientists added to grant proposals hoping their reputation will trigger a positive review, and so forth. Intention is important, the decision to include a false investigator is made *knowingly*; these individuals are not expected to make a material contribution, but are included in the proposal as if they will. Consequently, this definition of false investigator would not include someone who inadvertently leaves a project before making a contribution or someone who simply underperforms.

Fong et al. (2020) argue that the inclusion of false investigators on research grants is a violation of multiple U.S. Federal statues, including the False Statements Act (18 U.S.C. §1001), the False Claims Act (31 U.S.C. §3729), and the statue against False, Fictitious, or Fraudulent Claims (18 U.S.C. §287).[1] In fact, their arguments suggest that culpability lies with not only grant applicants, but with any individual who signed off on the grant proposal and should have been aware of the falsity; therefore, universities may be guilty of misconduct as well as department chairs, deans, and administrators in offices of sponsored programs if they sign off on grant proposals prior to submission to U.S. Federal agencies.

The courts seem to agree. In a 2012 legal case against Cornell University Medical College, "key personnel" included in a grant application sent to the National Institute of Health did not participate in the research activities. In subsequent grant renewal applications these personnel continued to be listed even though it was known that they would not be participating.[2] Although these "false investigators" were not the thrust of the legal claims against Cornell, their inclusion on the grant renewals worked against Cornell in their bid to defend themselves against false claims.

The research proposed in this manuscript is a direct extension of Fong and Wilhite (2017) who first document the use of false investigators. Recognizing the rising competition for research money and the possibility that false investigators can influence awards, they looked for evidence that suggested a systematic and strategic use of false investigators given this incentive. Because grant funding is a limited resource and researchers compete for these limited dollars, they model grant competition as a zero-sum game; the success by one research team reduces the available funds for others. In this paper, we adopt that approach and recognize that the logic of strategic game-play and the power differences existing across academic disciplines and ranks, suggest that academic rank, gender, and discipline can all influence the use of false investigators. For example, academic rank can impact the willingness to accept a false investigator because scholars and scientists early in their university career and those without tenure may need more evidence of research success than someone with an established reputation. Similarly, female researchers, who are underrepresented in faculty leadership and administrative positions lack political power (Kovacs 2017; Ward and Eddy 2013) and may be more susceptible to pressure from senior researchers who want to be added to proposals. Consistent with a zero-sum game, the decisions of some researchers have an impact on others in the same research population. Consequentially, Wilhite et al. (2019) propose a snowball effect; as researchers in one research field embrace the use of false investigators then others' competing for the same research dollars face pressure to add false investigators to their proposals. They present confirmatory evidence of this prediction, finding significant cross-discipline differences in the use of false investigators.

Fong and Wilhite (2017) also ask respondents who had experienced the use of false investigators their rationale; why was a false investigator added to the proposal? Over 60% of the respondents said a person was added because their reputation would "increase the chances of funding." Others mention reciprocal agreements with the false investigator, several indicated that the additional personnel were lab directors or department chairs, some added mentors, others added researchers who had useful data, etc. Over all, their study focused on why false investigators are added to proposals, but it did not examine the financial consequences of their actions to see if adding false investigators impacts grant awards. Here, we explore those financial impacts; does the inclusion of false investigators lead to more grant money? We also break down the components of funding awards to see if the financial impact is due to individuals submitting more proposals, or if false investigators increase the size of the average award per application.

3. Methods

This study employs data from Fong and Wilhite's (2017) survey on misconduct which explored several misattribution activities including the use of false investigators. Unused data from that survey allows us to investigate the financial consequences. Surveys were distributed by email to 113,130 faculty members in the top 200 universities in the United States as identified by U.S. News and World Report (2015). Email addresses were hand-collected by visiting individual university web-sites and copying the publically posted contact emails of faculty members. Three to four weeks after the initial contact a reminder email was sent to the non-respondents. The initial sample consisted of 10,010 responses for a response rate of about 9.4%. Focusing on responses pertaining to false investigators and after accounting for missing data on grant funding dollars, the sample used here includes 5866 observations. As the analysis unfolds, there are minor differences in sample sizes across models because of variations in missing data in the control variables. The appendix provides an explanation of the data collection process, the survey questions, summary statistics of the responses as tests of response bias and the representativeness of the sample (appendix, Tables A1-A4).

To appropriately interpret the empirical results in the next section, it is important to understand how the data used here captures the concept

[1] 18 U.S.C. §1001 (2006); 31 U.S.C. §3729 (2009); 18 U.S.C. §287 (1986).

[2] *U.S. ex rel. Feldman v. van Gorp and Cornell University Medical College,* 697 F.3d 78 (2nd Cir. 2012).

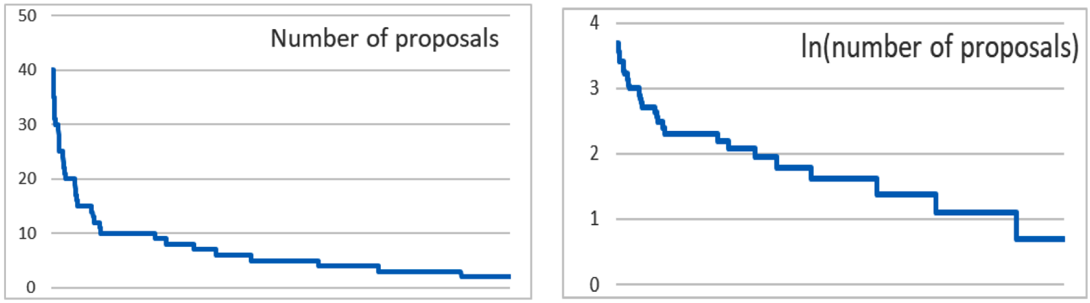

Fig. 2. Distribution of number of grant proposals.

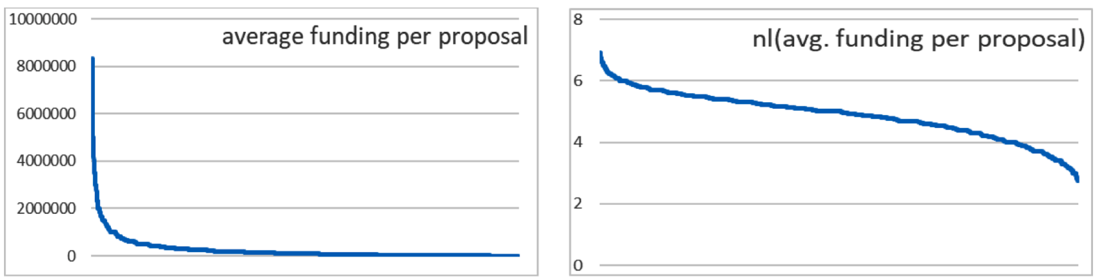

Fig. 3. Distribution of average funding per proposal.

of a false investigator. Fong and Wilhite's (2017) survey begins by asking about honorary authorship (authors added to manuscripts even though they had not contributed to the research). Following that section, the survey turns to research grants. After a few questions about grant activities, such as how many proposals have you submitted in the last five years, and how much money were you awarded, they asked: "*Have you ever felt obligated to add a scholar's name to a grant proposal even though you knew that individual would not make a significant contribution to the research effort?*" Their responses (y/n) identify the use of false investigators.

3.1. *Dependent variables*

3.1.1. *Grant funding*

To address whether the use of false investigators influences grant awards and if so, by how much, the first dependent variable is grant funding. In this study we use the natural log of total grant funding received in the five years prior to the survey. Aggregate awards are, in a practical sense, unlimited, and so we expect the distribution of awards to be distributed exponentially. Plotting grant awards confirms that expectation as shown in Fig. 1, panel *a*. The majority of our respondents report five-year totals of $1 million or less, but a handful of respondents claim over $1 billion in grant dollars over a five-year period. Taking the natural log of grant funding linearizes this distribution, as shown in panel *b*. This transformation corrects for the outsized impact that the very few, very large grants would have in our estimation.

3.1.2. *Number of grant proposals*

Respondents were also asked about the number of grant proposals they submitted in the five-year period prior to answering the survey and the second set of regressions focus on the impact of false investigators on this activity. As with awards, the number of grant applications are also exponentially distributed, many researchers submit a small number of grants while a few have submitted dozens. Again, a logarithmic transformation to linearize the data removes the outsized influence of these individuals (appendix, Fig. A1).

3.1.3. *Average funding per proposal*

In addition to measuring the impact of false investigators on aggregate five-year funding and on the total number of proposals submitted, we also want to investigate the impact on the size of grant proposals and the probability of being funded. However, specific data on these questions are not available so we turn to a composite measure, the average funding received per proposal. This value is calculated by dividing total grant funding by the number of proposals submitted over the same five-year period prior to the survey. If adding a false investigator increases the likelihood of success and/or the size of grant proposal, it could increase this value. As above, the distribution of average funding per proposal is linearized by using its natural log as our third dependent variable (appendix, Fig. A2).

3.2. *Independent variables*

3.2.1. *Adding false investigators*

Our focus is the impact of false investigators on these dependent variables. To identify their use, respondents were asked if they "ever felt obligated to add a scholar's name to a grant proposal even though you knew that individual would not make a significant contribution to the research effort?" Responses were coded as 1 = yes and 0 = no.

3.3. *Control variables*

Fong and Wilhite (2017) identified a variety of personal and professional attributes are expected to affect a researcher's use of false investigators and some of these same attributes are likely to impact grant funding. Thus, to isolate the impact of false investigators on grant funding, we control for these factors. First consider academic rank and position. We include four ranks; lecturer, assistant professor, associate professor, and the reference category, professor are measured as dummy variables, as well as three different faculty positions; research faculty, clinical faculty, and the reference category, academic faculty (also coded as dummy variables). As a measure of academic success we include each respondent's total publications over five-years. Oliveira et al. (2019) found that females received less grant funding from the NIH than males, thus we include the sex of the researcher as a control (1 = female and 0 = otherwise) to see if their result holds more universally.

There are several reasons to expect differences in the amount of grant funding across disciplines. For example, research in engineering,

Table 1
Impact of False Investigators on grant funding.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Added False Investigator	0.633* (0.253)	0.750** (0.198)	0.529† (0.289)
Lecturer	−0.953** (0.162)	−1.354** (0.162)	−1.716** (0.175)
Assistant Professor	−0.407** (0.074)	−0.647** (0.064)	−1.119** (0.069)
Associate Professor	−0.261** (0.073)	−0.338** (0.059)	−0.485** (0.058)
Clinical Faculty	−0.122 (0.203)	−0.541* (0.210)	−0.766** (0.225)
Research Faculty	0.202 (0.162)	0.0518 (0.135)	0.143 (0.130)
Total publications	0.026** (0.004)	0.026** (0.002)	0.031** (0.001)
Female	−0.110† (0.064)	−0.123* (0.054)	−0.041 (0.053)
Medicine	0.439** (0.120)	0.809** (0.108)	1.315** (0.112)
Nursing	−0.065 (0.140)	0.026 (0.131)	0.445** (0.136)
Accounting	−0.470* (0.205)	−1.193** (0.226)	−1.559** (0.254)
Finance	−0.229 (0.247)	−0.845** (0.270)	−0.847** (0.293)
Information Systems	0.236 (0.293)	0.276 (0.278)	0.603* (0.274)
Management	0.029 (0.141)	−0.180 (0.140)	−0.205 (0.150)
Marketing	−0.300 (0.202)	−0.600** (0.207)	−0.799** (0.228)
Political Science	−0.260† (0.143)	−0.609** (0.145)	−0.719** (0.159)
Psychology	0.287* (0.132)	0.484** (0.119)	0.773** (0.120)
Sociology	0.294* (0.146)	0.248† (0.136)	0.256† (0.143)
Biology	0.934** (0.134)	1.364** (0.113)	1.542** (0.117)
Chemistry	0.428** (0.161)	1.070** (0.130)	1.126** (0.133)
Computer Science	0.714** (0.225)	1.030** (0.167)	1.412** (0.156)
Ecology	0.788** (0.211)	1.273** (0.154)	1.532** (0.146)
Engineering	0.972** (0.183)	1.356** (0.130)	1.712** (0.124)
Mathematics	0.377* (0.192)	0.301 (0.182)	0.443* (0.187)
Physics	0.561** (0.186)	1.083** (0.142)	1.172** (0.141)
Constant	10.236** (0.110)	11.103** (0.100)	11.617** (0.109)
χ^2	407.5	1449.9	2834.9
N	2151	4072	5866

Dependent variable = ln(total funding over five years); Standard errors shown in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

Table 2
Impact of False Investigators on number of grant applications.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Added False Investigator	0.278* (0.128)	0.431** (0.092)	0.253* (0.119)
Lecturer	−0.051 (0.081)	−0.190* (0.074)	−0.263** (0.069)
Assistant Professor	0.263** (0.037)	0.243** (0.030)	0.179** (0.028)
Associate Professor	0.149** (0.037)	0.170** (0.027)	0.177** (0.024)
Clinical Faculty	−0.271** (0.102)	−0.327** (0.097)	−0.452** (0.087)
Research Faculty	−0.066 (0.082)	−0.105† (0.063)	−0.030 (0.054)
Total publications	0.016** (0.002)	0.013** (0.001)	0.013** (0.001)
Female	0.002 (0.032)	0.014 (0.025)	0.015 (0.021)
Medicine	0.082 (0.060)	0.121* (0.050)	0.215** (0.046)
Nursing	−0.074 (0.070)	−0.154* (0.061)	−0.095† (0.056)
Accounting	−0.121 (0.102)	−0.250* (0.104)	−0.319** (0.102)
Finance	−0.086 (0.123)	−0.178 (0.124)	−0.167 (0.115)
Information Systems	−0.288 (0.149)	−0.163 (0.129)	−0.074 (0.113)
Management	−0.153* (0.071)	−0.193** (0.064)	−0.212** (0.060)
Marketing	−0.237* (0.100)	−0.263** (0.095)	−0.330** (0.091)
Political Science	0.118† (0.071)	0.013 (0.067)	−0.029 (0.065)
Psychology	0.039 (0.066)	−0.004 (0.055)	0.025 (0.049)
Sociology	0.085 (0.074)	0.032 (0.063)	−0.002 (0.058)
Biology	0.455** (0.067)	0.492** (0.052)	0.477** (0.047)
Chemistry	0.311** (0.081)	0.453** (0.060)	0.442** (0.054)
Computer Science	0.318** (0.113)	0.320** (0.077)	0.461** (0.063)
Ecology	0.570** (0.106)	0.637** (0.071)	0.698** (0.060)
Engineering	0.584** (0.091)	0.711** (0.060)	0.866** (0.050)
Mathematics	0.036 (0.096)	−0.031 (0.084)	0.019 (0.076)
Physics	0.278** (0.094)	0.317** (0.065)	0.336** (0.057)
Constant	0.703** (0.055)	0.845** (0.046)	0.958** (0.044)
χ^2	389.0	1050.2	2040.7
N	2106	4011	6098

Dependent variable; ln(number of grant proposals). Standard errors shown in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

medicine, and science typically requires more expensive equipment, laboratory space, and supplies than research in the social sciences and business (Anderson et al., 2007) and more grant money is available to those laboratory science disciplines. In the 2017–2018 fiscal year, 83% of all NSF awards went to the sciences and engineering, 8% to social, behavioral and economic grants, and 7.6% to education and human resources (NSF 2018). Dummy variables identify these disciplines.

We expect different research environments and levels of institutional support to affect grant funding as well; for example, tier one research universities probably have more institutional resources to support grant activity and may have greater demands for grant funding than schools with a smaller focus on research. We want to account for this possibility, but to maintain the anonymity of the survey respondents, details on specific institutions were not collected. To accommodate this potential difference we use grant size as a proxy for institutional factors; that is, individuals competing for smaller grants may use false investigators to a different degree than individuals who pursue large and very large grants.[3] To account for this size difference we estimate each model using three categories of the data; researchers who received $250,000 or less in funding in the last five years (a group with roughly 2100

[3] For example, one respondent reporting over $300 million in awards writes, "I lead a large laboratory with 900+ individuals. This might be useful in interpreting my answers" (personal correspondence).

Table 3
Impact of false investigators on average funding per proposal.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Added False Investigator	0.375 (0.257)	0.321† (0.192)	0.338 (0.275)
Lecturer	−0.910** (0.162)	−1.171** (0.155)	−1.487** (0.164)
Assistant Professor	−0.668** (0.074)	−0.879** (0.061)	−1.309** (0.065)
Associate Professor	−0.410** (0.073)	−0.509** (0.057)	−0.677** (0.055)
Clinical Faculty	0.118 (0.204)	−0.246 (0.201)	−0.358 (0.212)
Research Faculty	0.217 (0.164)	0.137 (0.130)	0.130 (0.123)
Total publications	0.009* (0.004)	0.013** (0.002)	0.018** (0.001)
Female	−0.109 (0.064)	−0.140** (0.052)	−0.058 (0.049)
Medicine	0.371** (0.121)	0.714** (0.104)	1.108** (0.106)
Nursing	0.031 (0.141)	0.215† (0.126)	0.559** (0.128)
Accounting	−0.357† (0.204)	−0.945** (0.215)	−1.238** (0.238)
Finance	−0.153 (0.246)	−0.672** (0.257)	−0.661* (0.274)
Information Systems	0.431 (0.298)	0.412 (0.268)	0.671* (0.259)
Management	0.172 (0.141)	0.019 (0.134)	−0.004 (0.141)
Marketing	−0.073 (0.201)	−0.365* (0.198)	−0.524* (0.215)
Political Science	−0.369* (0.143)	−0.638** (0.139)	−0.673** (0.151)
Psychology	0.235† (0.132)	0.484** (0.114)	0.746** (0.113)
Sociology	0.253† (0.148)	0.269* (0.131)	0.301** (0.135)
Biology	0.468** (0.135)	0.875** (0.109)	1.071** (0.110)
Chemistry	0.109 (0.161)	0.622** (0.125)	0.684** (0.125)
Computer Science	0.392† (0.226)	0.716** (0.161)	0.938** (0.147)
Ecology	0.192 (0.212)	0.635** (0.147)	0.837** (0.137)
Engineering	0.380* (0.183)	0.646** (0.124)	0.830** (0.116)
Mathematics	0.336† (0.193)	0.339† (0.174)	0.446* (0.176)
Physics	0.277 (0.188)	0.781** (0.136)	0.844** (0.133)
Constant	9.539** (0.110)	10.261** (0.096)	10.655** (0.103)
χ^2	230.0	881.3	1888.8
N	2106	4011	5793

Dependent variable; ln(average funding per proposal); Standard errors lie below the estimated coefficients in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

observations), researchers who report $1 million or less (adding roughly 1900 observations), and then all grants including those with billions of awarded dollars in five years which adds the remaining responses.

3.4. Analytic technique

Measuring the impact of adding false investigators on the amount of grant money awarded is complicated by the simultaneous nature of grant awards and the incentive to add investigators. The amount of grant funding received by an individual is expected to be influenced by an individual researcher's personal and professional attributes, the academic discipline in which they reside, and the use or nonuse of false investigators. However, according to Fong and Wilhite (2017) the use of false investigators is affected by those same attributes; rank, personal and professional attributes, and discipline. Consequently, as an independent variable, false investigator fails the independence assumption. Technically, since variation in the use of false investigators can be attributed by changes in other variables, it may be correlated with the error term of the funding equation. For example, junior, untenured professors have greater pressure to perform, but less experience than their senior colleagues. Thus, academic rank can affect both the

Table 1.A
Response rates by discipline.

Discipline	Response Rate	Rank
Medicine	8.7	9
Nursing	11.6	6
Accounting	5.6	17
Economics	12.1	4
Finance	6.6	16
IS	6.8	13
Management	6.6	15
Marketing	11.3	7
Political Science	8.5	11
Psychology	12.0	5
Sociology	16.8	1
Bio	12.9	3
Chemistry	16.7	2
Computer Science	6.7	14
Ecology	8.6	10
Engineering	6.9	12
Mathematics	5.6	18
Physics	8.8	8
Overall	9.4	

Table 2.A
Population versus sample demographics.

	% Male	% Professor	% Associate Professor	% Assistant Professor
Medicine	66.1%/ 64.2%	27.1%/ 35.8%	20.1%/21.2%	33.5%/20.5%
Nursing	6.4%/ 7.7%	14.4%/ 19.1%	17.2%/23.3%	31.7%/28.9%
Accounting	66.9%/ 71.7%	17.3%/ 28.8%	16.8%/28.8%	19.7%/25.6%
Finance	80.0%/ 83.6%	31.6%/ 46.7%	22.2%/18.5%	23.1%/20.0%
Information Systems	73.5%/ 75.6%	17.3%/ 34.0%	20.6%/30.1%	12.7%/20.2%
Marketing	69.1%/ 67.4%	27.6%/ 40.0%	23.6%/32.8%	21.5%/19.4%
Political Science	69.6%/ 69.6%	29.7%/ 37.3%	23.5%/24.9%	20.2%/18.1%
Psychology	52.7%/ 53.3%	33.2%/ 38.9%	25.7%/23.4%	22.2%/16.5%
Sociology	50.6%/ 53.7%	27.9%/ 42.6%	30.5%/25.6%	21.2%/17.9%
Biology	64.8%/ 69.3%	29.2%/ 39.1%	15.7%/24.4%	11.4%/14.3%
Chemistry	76.2%/ 77.5%	35.7%/ 45.4%	19.3%/25.3%	19.3%/13.4%
Computer Science	81.4%/ 83.7%	33.5%/ 47.7%	26.5%/28.9%	15.2%/10.5%
Ecology	70.6%/ 70.6%	28.2%/ 40.3%	16.5%/16.8%	12.6%/11.0%
Engineering	87.7%/ 83.6%	41.2%/ 50.7%	18.6%/20.7%	15.3%/10.1%
Mathematics	74.7%/ 81.9%	31.5%/ 45.3%	18.4%/27.6%	15.9%/10.7%
Physics	88.0%/ 89.3%	37.5%/ 53.9%	14.4%/15.3%	12.5%/7.0%

The first number in each cell is the percentage of the population that falls into that category and the second number is the percentage of the responses in that category.

Table 3.A
Spearman rank correlation coefficients: Rank correlation between response rates by discipline and the ranked, estimated coefficients of disciplines in Tables 1-3, A5.

Dependent Variables	<= $250,000	<= $1 million	All grants
Grant money received (Table 1)	0.219	0.306	0.269
Number of grants submitted (Table 2)	0.304	0.357	0.261
Average award per submission (Table 3)	0.057	0.281	0.151
Adding false investigators (Table A5)	−0.001	−0.040	0.036

We cannot reject the hypothesis of no significant rank correlation for any of the models using either the 0.05 or 0.01 alpha level.

Table 4.A
Summary statistics.

Variable	N	mean	Std. Dev.
Total grant funding (5 years)	6283	1976,955	19,600,000
Total number of proposals (5 years)	6280	6.565	7.388
Average funding per proposal (5 years)	6202	413,479.3	6845,739
Added false investigator	6260	0.235	0.424
Lecturer	6866	0.025	0.157
Assistant Professor	6866	0.206	0.404
Associate Professor	6866	0.282	0.450
Clinical Professor	6866	0.015	0.122
Research Professor	6866	0.031	0.174
Total publication (5 years)	6283	15.46	16.35
Female	6138	0.343	0.475
Medicine	6098	0.221	0.415
Nursing	6098	0.071	0.257
Accounting	6099	0.009	0.093
Finance	6099	0.006	0.078
Information Systems	6099	0.007	0.084
Management	6099	0.036	0.185
Marketing	6099	0.011	0.105
Political Science	6099	0.032	0.175
Psychology	6099	0.094	0.292
Sociology	6099	0.042	0.202
Biology	6099	0.138	0.345
Chemistry	6099	0.060	0.237
Computer Science	6099	0.032	0.177
Ecology	6099	0.043	0.204
Engineering	6099	0.083	0.276
Mathematics	6099	0.019	0.135
Physics	6099	0.049	0.215
Aware of Honorary Authors	6253	0.915	0.279
Added an Honorary Author	6250	0.370	0.483

temptation to add false investigators and the likelihood of receiving funding. Academic disciplines are similarly situated.

The solution to this independence violation is to use an instrumental variables model; in this manuscript, we use two-stage least squares (2sls). Intuitively, a first-stage estimates an equation in which the use of false investigators is the dependent variable. The second stage uses the estimated false investigators data which are now, by construction, independent of the other independent variables. However, to estimate a system of equations using 2sls, the system must be identified and that requires the presence of an additional explanatory variables (called instrumental variables) in the first-stage equation that influence the likelihood of adding false investigators but do not affect the amount of grant funding received, or how it is received, except through their impact on the use of false investigators. To identify the model, we return to Fong and Wilhite's (2017) survey and use responses that address the respondent's knowledge of and use of honorary authors. The intuition behind using responses to honorary authorship questions as our instrumental variables to identify the system is that individuals who are willing to bend ethical issues by adding extra names on a publication (honorary authors) are more likely to behave anti-ethically during the grant proposal process (adding false investigators). However, there is no reason to expect individuals who have added honorary authors to manuscripts to win more grant money—unless it influences their willingness to add false investigators. Using honorary authorship and its frequency, we utilize 2sls to give us our primary result (Angrist and Pischke 2009), measuring the impact of false investigators on grant funding, absent the complicating simultaneity.

Table 5.A
Determinants of false investigators; total grant funding model.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Lecturer	0.070	0.086*	0.101*
	(0.049)	(0.043)	(0.042)
Assistant Professor	0.046*	0.075**	0.099**
	(0.022)	(0.016)	(0.015)
Associate Professor	0.069**	0.074**	0.081**
	(0.021)	(0.015)	(0.013)
Clinical Faculty	−0.098	−0.119*	−0.129*
	(0.061)	(0.055)	(0.054)
Research Faculty	0.072	0.111**	0.106**
	(0.049)	(0.035)	(0.031)
Total publications	0.000	0.006	0.0004
	(0.001)	(0.001)	(0.0004)
Female	0.032†	0.036*	0.043**
	(0.019)	(0.014)	(0.012)
Medicine	0.090*	0.091**	0.102**
	(0.036)	(0.028)	(0.026)
Nursing	0.128**	0.120**	0.108**
	(0.041)	(0.034)	(0.032)
Accounting	−0.011	−0.028	−0.053
	(0.062)	(0.060)	(0.062)
Finance	−0.020	−0.033	−0.049
	(0.075)	(0.072)	(0.071)
Information Systems	0.006	−0.045	−0.044
	(0.089)	(0.074)	(0.067)
Management	−0.014	−0.019	−0.019
	(0.043)	(0.037)	(0.037)
Marketing	−0.041	0.051	−0.056
	(0.062)	(0.055)	(0.055)
Political Science	−0.060	−0.081*	−0.105**
	(0.043)	(0.038)	(0.038)
Psychology	−0.016	−0.017	−0.007
	(0.040)	(0.032)	(0.029)
Sociology	−0.078†	−0.046	−0.036
	(0.044)	(0.036)	(0.035)
Biology	−0.048	−0.098**	−0.106**
	(0.041)	(0.030)	(0.028)
Chemistry	−0.013	−0.063†	−0.079*
	(0.049)	(0.034)	(0.032)
Computer Science	−0.065	−0.032	−0.022
	(0.069)	(0.044)	(0.038)
Ecology	−0.140*	−0.108	−0.071*
	(0.064)	(0.041)**	(0.035)
Engineering	0.107†	0.045	0.028
	(0.055)	(0.034)	(0.030)
Mathematics	−0.122*	−0.097*	−0.081†
	(0.058)	(0.048)	(0.045)
Physics	−0.082	−0.102**	−0.102**
	(0.057)	(0.038)	(0.034)
Aware of honorary authorship	0.070**	0.081**	0.122**
	(0.027)	(0.021)	(0.019)
Times added honorary author	0.060**	0.055**	0.019**
	(0.005)	(0.003)	(0.002)
Constant	0.052	0.043	0.039
	(0.039)	(0.032)	(0.030)
	$N = 2151$	$N = 4072$	$N = 5866$
	$F = 12.11$	$F = 26.36$	$F = 23.7$

Standard errors lie below the estimated coefficients in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

4. Results

Table 1 presents the results measuring the impact of adding false

Table 6.A
Determinants of false investigators; number of proposals model.

	Grant funding<= $250,000	Grant funding <= $1000,000	All grants
Lecturer	0.073	0.088*	0.089*
	(0.049)	(0.043)	(0.039)
Assistant Professor	0.047*	0.077**	0.096**
	(0.022)	(0.016)	(0.014)
Associate Professor	0.069**	0.076**	0.075**
	(0.022)	(0.015)	(0.012)
Clinical Faculty	−0.093	−0.116*	−0.127*
	(0.062)	(0.056)	(0.050)
Research Faculty	0.077	0.115**	0.108**
	(0.050)	(0.036)	(0.030)
Total publications	0.001	0.001	0.0003
	(0.001)	(0.001)	(0.0003)
Female	0.028	0.034*	0.041**
	(0.020)	(0.0184)	(0.012)
Medicine	0.090*	0.093**	0.115**
	(0.036)	(0.028)	(0.025)
Nursing	0.128**	0.122**	0.127**
	(0.042)	(0.034)	(0.031)
Accounting	−0.013	−0.027	−0.017
	(0.063)	(0.060)	(0.059)
Finance	−0.022	−0.031	−0.062
	(0.076)	(0.072)	(0.067)
Information Systems	0.010	−0.040	−0.017
	(0.092)	(0.075)	(0.066)
Management	−0.013	−0.014	−0.010
	(0.044)	(0.038)	(0.035)
Marketing	−0.043	−0.060	−0.071
	(0.062)	(0.055)	(0.053)
Political Science	−0.060	−0.083*	−0.101**
	(0.044)	(0.039)	(0.037)
Psychology	−0.014	−0.011	0.004
	(0.041)	(0.032)	(0.028)
Sociology	−0.074	−0.040	−0.013
	(0.045)	(0.037)	(0.034)
Biology	−0.052	−0.099**	−0.099**
	(0.042)	(0.030)	(0.027)
Chemistry	−0.014	−0.061†	−0.068*
	(0.050)	(0.035)	(0.031)
Computer Science	−0.066	−0.028	−0.007
	(0.070)	(0.045)	(0.037)
Ecology	−0.141*	−0.105*	−0.057†
	(0.064)	(0.041)	(0.035)
Engineering	0.104†	0.047	0.033
	(0.056)	(0.035)	(0.029)
Mathematics	−0.124*	−0.095*	−0.056
	(0.059)	(0.048)	(0.044)
Physics	−0.081	−0.098*	−0.094**
	(0.058)	(0.038)	(0.033)
Aware of honorary authorship	0.071**	0.081**	0.124**
	(0.027)	(0.022)	(0.019)
Times added honorary author	0.059**	0.054**	0.019**
	(0.005)	(0.003)	(0.002)
Constant	0.053	0.042	0.029
	(0.040)	(0.032)	(0.029)
	$N = 2106$	$N = 4011$	$N = 6098$
	$F = 11.61$	$F = 25.82$	$F = 24.69$

Dependent variable: ln(number of proposals submitted); Standard errors lie below the estimated coefficients in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

investigators on total grant funding over five years. On average, researchers who engage in the practice of including false investigators receive more grant money than those who do not. Estimates for smaller grants (awards of $250,000 or less) appear in column 1. The impact of false investigators is positive (an estimated coefficient of 0.633; $p < .05$). The estimates in column 2 include grants summing up to $1 million and the impact is larger (0.75; $p < .01$) and when all grants are included (column 3) the impact declines in size and significance (0.529; $p < .10$). It is clear, including false investigators impacts total grant dollars over a

Table 7.A
Determinants of false investigators in average award per proposal model.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Lecturer	0.073	0.088*	0.103*
	(0.049)	(0.043)	(0.042)
Assistant Professor	0.047*	0.077**	0.102**
	(0.022)	(0.016)	(0.015)
Associate Professor	0.069**	0.076**	0.083**
	(0.022)	(0.015)	(0.013)
Clinical Faculty	−0.093	−0.116*	−0.127*
	(0.062)	(0.056)	(0.054)
Research Faculty	0.077	0.115**	0.110**
	(0.050)	(0.036)	(0.031)
Total publications	0.0001	0.001	0.0003
	(0.001)	(0.001)	(0.0003)
Female	0.028	0.034*	0.040**
	(0.020)	(0.014)	(0.012)
Medicine	0.090*	0.093**	0.103**
	(0.036)	(0.028)	(0.026)
Nursing	0.128**	0.122**	0.111**
	(0.042)	(0.034)	(0.032)
Accounting	−0.013	−0.027	−0.053
	(0.063)	(0.060)	(0.062)
Finance	−0.022	−0.031	−0.048
	(0.076)	(0.072)	(0.071)
Information Systems	0.010	−0.040	−0.040
	(0.092)	(0.075)	(0.067)
Management	−0.013	−0.014	−0.015
	(0.044)	(0.038)	(0.037)
Marketing	−0.043	−0.060	−0.066
	(0.062)	(0.055)	(0.056)
Political Science	−0.060	−0.083*	−0.108**
	(0.044)	(0.039)	(0.038)
Psychology	−0.014	−0.011	−0.004
	(0.041)	(0.032)	(0.029)
Sociology	−0.074	−0.040	−0.030
	(0.045)	(0.037)	(0.035)
Biology	−0.052	−0.099**	−0.107**
	(0.042)	(0.030)	(0.028)
Chemistry	−0.014	−0.061†	−0.080*
	(0.050)	(0.035)	(0.032)
Computer Science	−0.066	−0.028	−0.019
	(0.070)	(0.045)	(0.038)
Ecology	−0.141*	−0.105*	−0.069†
	(0.064)	(0.041)	(0.035)
Engineering	0.104†	0.047	0.029
	(0.056)	(0.035)	(0.030)
Mathematics	−0.124*	−0.095*	−0.080†
	(0.059)	(0.048)	(0.045)
Physics	−0.081	−0.098**	−0.099**
	(0.058)	(0.038)	(0.034)
Aware of honorary authorship	0.071**	0.081**	0.121**
	(0.027)	(0.022)	(0.019)
Times added honorary author	0.059**	0.054**	0.019**
	(0.005)	(0.003)	(0.002)
Constant	0.053	0.042	0.039
	(0.040)	(0.032)	(0.030)
	$N = 2106$	$N = 4011$	$N = 5793$
	$F = 11.61$	$F = 25.82$	$F = 23.47$

Dependent variable: ln(average funding per proposal); Standard errors lie below the estimated coefficients in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

five-year period.

For interpretation, the estimated coefficients of dummy variables in semilogarithmic regressions are transformed into percentage changes using the formula, 100 (e^{a}-1) where a is the estimated coefficient of interest (Halvorsen and Palmquist 1980). This transformation shows that for researchers who received $250,000 or less in grant funds over five years, their participation in adding a false investigator increases their funding by 88%, on average. The impact is larger when considering all grants up to $1 million dollars; an impact of about 110%, which

Table 8.A
Mediation of the false investigator impact by the number of grant applications.

	Grant funding <= $250,000	Grant funding <= $1000,000	All grants
Added False Investigator	0.621* (0.250)	0.611** (0.198)	0.469† (0.284)
Number of applications	0.068** (0.009)	0.046** (0.004)	0.054** (0.003)
Lecturer	−0.94** (0.159)	−1.325** (0.159)	−1.681** (0.170)
Assistant Professor	−0.503** (0.072)	−0.735** (0.062)	−1.222** (0.066)
Associate Professor	−0.318** (0.072)	−0.396** (0.058)	−0.571** (0.056)
Clinical Faculty	−0.053 (0.200)	−0.497* (0.206)	−0.682** (0.219)
Research Faculty	0.234 (0.160)	0.094 (0.133)	0.172 (0.127)
Total publications	0.020** (0.004)	0.023** (0.002)	0.025** (0.001)
Female	−0.118† (0.063)	−0.131 (0.053)	−0.042 (0.051)
Medicine	0.399** (0.118)	0.788** (0 0.106)	1.257** (0.109)
Nursing	−0.042 (0.138)	0.083 (0.129)	0.494** (0.133)
Accounting	−0.436* (0.202)	−1.145** (0.221)	−1.472** (0.248)
Finance	−0.235 (0.243)	−0.829** (0.265)	−0.813** (0.285)
Information Systems	0.305 (0.289)	0.318 (0.272)	0.651* (0.267)
Management	0.070 (0.139)	−0.136 (0.137)	−0.148 (0.146)
Marketing	−0.249 (0.199)	−0.554** (0.203)	−0.721** (0.222)
Political Science	−0.282* (0.141)	−0.609** (0.142)	−0.688** (0.155)
Psychology	0.283* (0.130)	0.500** (0.117)	0.804** (0.117)
Sociology	0.299* (0.144)	0.252* (0.134)	0.279* (0.140)
Biology	0.759** (0.135)	1.213** (0.113)	1.387** (0.115)
Chemistry	0.337* (0.159)	0.953** (0.128)	0.989** (0.131)
Computer Science	0.635** (0.224)	0.969** (0.165)	1.282** (0.152)
Ecology	0.622** (0.211)	1.112** (0.152)	1.292** (0.144)
Engineering	0.750** (0.181)	1.134** (0.128)	1.328** (0.122)
Mathematics	0.363† (0.190)	0.297† (0.178)	0.436* (0.182)
Physics	0.480** (0.184)	0.995** (0.140)	1.086** (0.138)
Constant	0.621** (0.250)	11.020** (0.098)	11.486** (0.105)
χ^2	501.38	1657.4	3315.7
N	2150	4071	5863

Dependent variable = ln(total funding over five years); Standard errors shown in parentheses.
** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
† indicates significance at the 0.10 level.

doubles their five-year total. When all grants are included in the analysis, the effect declines to a 69% increase, but that impact is sufficiently erratic that it is only weakly significant ($p < .10$). Perhaps researchers seeking multi-million-dollar grants rely less on false investigators because large research operations already include high name-recognition scholars and scientists as actual contributors.

Table A5, A6, and A7 in the appendix report the results of the 1st stage equations, the determinants of the use of false investigators, and these results mirror the findings of Fong and Wilhite (2017). In addition, those tables show that the instrumental variables, "aware of honorary authorship" and "times added honorary author" perform well; they are statistically significant and post-estimation tests find them to be suitable instruments.

Table 2 displays the results measuring the impact of false investigators on the number of grants submitted and again researchers who admit to involvement with false investigators apply for significantly more grants than individuals who do not. This result was significant in all three groups of respondents and, as before, the largest impact was in the group that included all grants up to $1 million. Transforming the estimated coefficients into percentage changes, the number of proposals submitted by individuals who use false investigators increased by 28% overall, by 53% for the $1 million dollar or less group, and by 32% for the $250,000 or less group. Tables 1 & 2 together suggest that researchers using false investigators submit more proposals and receive more funding that those who don't. This parallel increase in numbers and dollars is consistent with the conclusions of von Hippel and von Hippel (2015) who report the general finding that researchers who submit more proposals, for any reason, receive more funding.

Taken together, Tables 1 and 2 raise the question of mediation; to what extent is the increase in funding found in Table 1 driven by the increased number of applications found in Table 2? To measure this level of mediation, we re-estimate the model reported on in Table 1 while including the number of grant applications submitted as an additional explanatory variable. The results suggest that there is only partial mediation and that the degree of mediation depends on the amount of grant funding received over 5-years. In the first sample in which researchers receive $250,000 or less, total funding attributed to false investigators falls from 88% to 86% when accounting for the mediation impact of the number of grant applications. In the middle group (researchers receiving $1 million or less), mediation was larger and the impact of adding false investigators fell from 110% to 84%. Using all observations, the impact of false investigators on total funding fell from 69% to 59%. Table A8 in the appendix presents the full set of estimated coefficients from the mediation investigation.

Because the impact of false investigators on aggregate grant funding is not explained by the increase in the number of applications, we look for other effects. Table 3 displays the estimated impact of false investigators on the average funding per proposal and in all three sets of regressions, the coefficient on false investigators was insignificant, that is, we find no consistent or persistent evidence that the use of false investigators influences average funding per proposal in small, medium or large grants. The dependent variable in this Table 3 is a ratio of two quantities and there may be offsetting relationships which lead to the inconclusive result. For example, after winning an award, especially a large award, at least some of the research team's efforts will turn to conducting the research itself, reducing the level of effort given to securing additional funding. Another reason to be cautious is that these results seem to contradict responses given elsewhere in this survey. Specifically, individuals who participated in grants with false investigators were asked to give the rationale for that inclusion and over 60% of those who responded said the primary reason they added a false investigator was, "that this individual's reputation increases the chance of a positive review." Those responses led us to expect a positive impact in Table 3 but none was found. Perhaps researchers' perceptions that reputation plays a large role are overblown. Or, perhaps reputation plays a role and the composite measure doesn't adequately reflect that its influence. Further study can help us understand those seemingly disparate outcomes.

5. Discussion

It is difficult to characterize these results as suggesting anything other than the use of false investigators leads to resource misallocation and research misattribution; money is wasted and individuals get credit where none is due. Respondents who said they participated in proposals that included false investigators were clear, the added individuals "would not make a significant contribution to the research effort." Thus, their removal and the redistribution of the false investigator funding would more efficiently allocate research resources and reduce the misattribution of results. However, the academy-wide benefits of eliminating false investigators involve sacrifice by the research teams who currently benefit from adding false investigators, they will receive less research funding, and consequently that sacrifice is unlikely to be embraced voluntarily.

Fong and Wilhite (2017) included an open-ended question at the end of their survey that reads, "Any comments or examples you wish to share will be appreciated." Many respondents described the use of false investigators as being rampant at their institution and an integral part of the funding process. A few examples illustrate:

-"I think having a 'senior' on the grant is almost an expectation even if that individual does not contribute to the conceptualization of the project."
-"I always thought this practice was "old school" but it is alive and well at my institution, causing much anxiety and distress."
-"Grant reviewers demand addition of so called "experts" and specifically score on qualification of "investigators".

Additionally, comments suggest that many scholars and scientists view the use of false investigators as being innately unfair, writing:

-"I was pressured to do this (and did it once) .... It was 2002, but it still burns me. I resent it terribly."
-"I often wonder if individuals with political skills but not having sufficient research skills are doing better and moving up."
-"I put someone's name on my grant because they expected this, have many friends on review committees, and can be very vindictive. Also they wanted the additional funding. Not right, but I was very concerned."

These comments and the results presented above show that there is still much to uncover in the grant proposal and award process. When false investigators are added to grant proposals, are the other, "legitimate" investigators victims, are they co-conspirators, or are they a bit of both?

Grants have long played a central role in academia where the ability to acquire funding can affect hiring, tenure, promotion, and merit raises (Ruben 2017; Abbott et al., 2010). With public funding of education stagnant or declining, universities increasingly depend on research grants to support academic programs and to expand campus resources in general (Howard and Laird 2013). These factors have fostered growing competition for research funding (Anderson et al., 2007; Roebber and Schultz 2011; von Hippel and von Hippel 2015) and, according to Edwards and Roy (2017), this competition creates incentives to skirt ethical norms. These pressures can make it difficult to stop the use of false investigators because the awards are misaligned from a research integrity viewpoint. Those willing to commit misconduct lay claim to more funding dollars, which impacts promotion and tenure and future research at that institution. This is not only resource misallocation, but it puts significant pressure on those who want to uphold integrity given they, in some instances, record half as much funding.

The practice of adding false investigators to grant proposals mirrors the practice of adding honorary authors to research publications. Studies of honorary and gift authorships have identified some of the subtleties of the practice demonstrating that it isn't always clear who is a victim and who is a culprit. There are times when senior faculty members or individuals in authority positions prey on younger faculty and force their names on to papers. However, Biagioli (2019) notes that gift authorship can be given to famous individuals without even their knowledge in an attempt to make the manuscript seem more important. That rationale, the impact of fame, was also found in Fong and Wilhite's (2017) study where 60% of the respondents who had experience with false investigators said they hoped that the added individual's reputation would lead to a positive review. Clearly, in these cases researchers are culpable; they purposively deceive grant reviewers to improve their grants' chances. Other respondents participate in reciprocal agreements (I include you and you include me); they too are conspirators. In other cases, respondents felt pressured to include false investigators that were in a position of power and could affect their career, such as a lab director, senior faculty member, or department chair. These individuals may more readily be considered to be victims, however, they too benefit from the practice. A small subset of respondents (less than 1%) stated that they included a false investigator because, "they had data I needed." Granting agencies generally allow funding to be spent on purchasing existing data, but a swap, data for co-investigator status, misleads reviewers and misattributes credit. Walsh, Cho, and Cohen (2005) found that some researchers ask for co-authorship in exchange for the right to use patented materials; this may also impact grants.

Because we are only beginning to unravel the impact of false investigators on research funding, it is premature to design policies that would broadly reduce the use of false investigators without being counterproductive. But first steps are possible. To start we strongly encourage the Office of Research Integrity to officially identify the use of false investigators as research misconduct. Current standards focus on the misrepresentation of data, claims, or evidence, and condemn plagiarism. Adding non-participants as gift authors or false investigators is not identified as misconduct even though it is widely considered to be unethical. Additional unethical activities such as the use of honorary authors in manuscripts and editors coercing citations are also omitted from the current definition. This needs to be updated. Second, universities and research institutions should take action and they can begin by clearly indicating that the addition of non-participating individuals to grant proposals or to manuscripts submitted for publication is misconduct. Clearer guidelines are a necessary precursor to policy.

Even though the issues are complex, we find strong evidence that grant funding is influenced by the addition of false investigators and certainly some portion of that reallocation is waste. Without some action it seems likely that the use of false investigators will increase. Research funding is of growing importance to scholars, scientists, and research institutions. If the addition of false investigators is perceived to give an edge to those proposals, their use is expected to grow as well. We have seen other types of academic cheating spread, especially when those who play it straight are disadvantaged (Wilhite et al., 2019). The longer we delay in addressing these issues the more entrenched misconduct becomes.

Thus, we encourage other researchers to investigate the grant writing and review process. Some of the policy issues may be mitigated with a better understanding of the motives and the impact of research culture on the use of false investigators. It may be possible to minimize the advantage false investigators seem to lend to the grant competition without overly burdening the process or researchers who don't play that game.

We recognize that our study is not without limitations. First, future research should seek to disentangle our composite measure, average funding per proposal, to independently measure the impact of false investigators on the size of grant proposals and on the probability of being funded. Although our tests of mediation show that some of the increased funding received through the use of false investigators came through an increase in the number of submitted grant proposals, it accounted for only a small portion of the increased funding. In other words, we found only partial mediation so there is more going on and disentangling our composite measure may shed more light on the independent impacts of false investigators on the size of grant proposals and the probability of receiving grant awards.

Second, and of similar importance, is the need to gain a better understanding of the motives behind the use of false investigators; are team members victims or co-conspirators? Such knowledge allows us to distinguish between different cases of false investigators and to perhaps design policy that more effectively targets the most objectionable practices and motives. Third, we recognize that these data may understate the use of false investigators because this survey focused on researchers' perceptions of whether an individual would make a significant contribution to the research effort and asked if researchers felt "obligated" to add that person. Thus, someone who perceives such action as the norm or who wanted to add someone might respond, no, they had not felt obligated to add a false investigator. Such instances would not be identified as the addition of a false investigator in these data. Fourth, some of the data used in this study are the respondents' perception of things such as, whether an added individual is a false investigator or not and the inappropriateness of adding honorary authors to publications. Perceptions can be misguided and so it is prudent to be cautious. At the same time however, it can be argued that perceptions are sometimes the appropriate measure, for example, if a research team member thinks someone has been inappropriately added to a grant proposal then they are going to act and respond under that perception.

To address some of these issues it might be useful to investigate the impact of false investigators using data from the granting agency side; where information on the budget and personnel from actual grant applications reside and where there may be explanations for how the grant was used. Although we know that researchers willing to participate in the use of false investigators claim more grant dollars, we don't know how those dollars are allocated. If the addition of a false investigator increases the amount of funding received, do those additional funds go solely to the false investigator or are some funneled to other portions of the research project? If others receive a portion, to what extent does this encourage them to look the other way? The potential of additional research funding and a rising academic reputation are the rewards for participating in this zero-sum game, but there are many reasons scholars and scientists decide to play.

CRediT authorship contribution statement

Eric A. Fong: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Allen W. Wilhite:** Conceptualization, Investigation, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by a grant from the University of Alabama in Huntsville's (UAH) College of Business and a grant from the Office of Research Integrity through the United States Department of Health and Human Services [Grant number ORIIR130003]. Any opinions, findings, and conclusions of recommendations expressed in this material are those of the authors and do not necessarily reflect the views of UAH, ORI, or HHS.

Appendix

The number of proposals submitted over a five-year period and the average funding per proposal are both distributed exponentially, as shown in Figures A1 and A2. By ignoring that nonlinear shape, the estimates would over-weigh the few, very large numbers at the upper tail of the distribution. Using the logarithmic transformation corrects this bias.

Survey statistics and raw responses

Response rates. As noted in the methods, 113,130 surveys were initially sent, which yielded 10,010 responses for an overall response rate of about 9.4%. Response rates vary across disciplines as shown in Table 1.A.

All survey-driven studies need to address the question of representation, i.e., do the respondents accurately reflect the target population? Of particular concern is the possibility that a survey may spark greater interest among potential respondents if those individuals have experience with the question under study. In this project, the question is, are individuals who have been involved in research grants that include false investigators more likely or less likely to respond to the survey than potential respondents who have not had such experiences? And, if that is true, does that affect our estimates? Those questions cannot be definitively answered for any survey; however, we can look for evidence of such bias and temper our results and interpretation accordingly.

In this study, we look at several relationships that should reveal bias if a significant level of respondent bias exists. The first test is to compare recipient characteristics to respondent characteristics. In our study, we were able to identify the sex and the academic rank of most of the survey recipients. We also asked our respondents to provide their academic rank and sex. Table 2.A compares the percentage of those characteristics in the target population to the respondent population. For example, in the first cell 66.1% of the researchers in the medical field to whom a survey was sent were male. Of the respondents, 64.2% were male—a very close match. It is likewise in the other disciplines; in every case the male/female breakdown of the respondents was very close to the targeted population's gender mix. This is particularly noteworthy, because, as we will see later in the appendix, (Tables 8, 9, 10) that females are significantly more likely to have experience with false investigators being on grant proposals. Thus, if participation in grants with false investigators influences the response rate, we would expect to see a significant gender difference in their reporting percentages. There is not.

There is greater variation between the target population and respondents across the academic ranks, specifically, assistant professors tended to under respond (the percentage of assistant professors responding was less than their portion of the target population) and professors tended to over-respond (a higher percentage responding than their presence in the target population). However, some of that difference is due to the data collection protocol. As email addresses were being collected from university websites, the information on academic rank, and sex were also collected. At a later date the surveys were distributed. During this lag, some faculty were promoted and so the proportion of assistant professors receiving surveys is actually smaller, and the proportion of professors receiving surveys is larger, than the reported population numbers in Table 2.A. This is exacerbated if information on departmental websites are updated with a lag.

More importantly, even if there were a systematic difference in the response rates there is no evidence it influences the results. Our results show significant discipline effects in the grant money awarded (Table 1), the use of false investigators (Table 5.A), the number of grants submitted (Table 2), and the average level of funding per proposal (Table 3). If any of those activities affect response rates in a significant fashion, then the response rates of the disciplines should vary with those disciplines differences. We can test that hypothesis using a Spearman rank correlation test. For example, if the use of false investigators encourages (or discourages) response rates then there should be a positive (or negative) correlation between the disciplines that most frequently use false investigators (Table 5.A) and discipline response rates (Table 1.A). We should expect similar correlations between discipline response rates and discipline estimates in other tables. After ranking all of the discipline estimated coefficients and their response rates, we calculate the Spearman rank correlation coefficients for each. Those coefficients appear in Table 3.A. None of the twelve correlations are statistically significant and this is a fairly sensitive test. Even if response rates were affected by the recipients' experiences (an effect for which we find little evidence) those cross discipline response rates do not seem to have influenced our estimates.

Survey questions and summary statistics:

1 In the last five years approximately how many grant proposals have you submitted for funding? (respondents entered a number)
2 Approximately how much grant money have you received in the last five years? Please write your estimated dollars in box; enter 0 if zero.

How strongly do you agree or disagree with the following statements?

1 Grant reviewers' evaluations of grant proposals are influenced by citations to journals with high impact factors.

Strongly Agree = 5; Agree = 4; Neutral = 3; Disagree; = 2; Strongly Disagree = 1.

1 When developing a grant proposal I tend to skew my citations toward high impact factor journals, even if those citations are of marginal import to my proposal.

Strongly Agree = 5; Agree = 4; Neutral = 3; Disagree; = 2; Strongly Disagree = 1.

1 Have you ever felt obligated to add a scholar's name to a grant proposal even though you knew that individual would not make a significant contribution to the research effort? (yes = 1; no = 0)
2 The main reason you added an individual to this grant proposal even though he (or she) was not expected to make a significant contribution was:

Director: was the Director of the lab or facility used in the research

Authority: occupies a position of authority and can influence my career.

Mentor: this is my mentor

Colleague: this is a colleague I wanted to help out

Reciprocity: I was included or expect to be included as a co-author on their work

Data: they had data I needed.

Reputation: their reputation increases the chances of receiving funding

Reviewers: adding author(s) was suggested by grant reviewers

Other (please specify)

Honorary Authorship:

Some scholars feel obligated to add individuals, often senior researchers, to the list of co-authors of their manuscripts even though the contributions of those individuals are minimal. This has been called Honorary Authorship. The first few questions address this practice.

1 Prior to this survey were you aware of this practice? (yes = 1; no = 0)
2 How many times have you felt obligated to add someone's name to a manuscript even though they did not contribute to the research? (respondents entered a number)

General Information:

1 What is your current rank?

Lecturer; Assistant Professor; Associate Professor; Professor; Research Faculty; Clinical Faculty

1 In what discipline do you do your primary research?
2 Gender: (female = 1; male = 0)
3 How publications or acceptances have you had in the last five years? (respondents enter a number)

Summary statistics for all variables included in regression analysis appear in Table 4.A.

To estimate the impact of false investigators on the amount of grant money received, the number of grants submitted, and the average funding per proposal, we used a two-stage model because the factors that affect grants also effects the decision to add false investigators. The independence problem this overlap creates is eliminated by estimated a first-stage equation in which false investigators is the dependent variable. The estimated coefficients from those models appear below in Tables 8, 9, and 10. In all cases the results closely align with the results in Fong and Wilhite (2017).

Table 8.A presents the results of the tests of mediation. By including the number of proposals submitted as an additional explanatory variable in model 1, its mediating impact on the use of false investigators impact emerges. The number of proposals is positive and significant, and the estimated impact of using false investigators does decline. However, that declination is only partial—for all observations the impact of false investigators falls from 69% to 59%. Clearly the change in funding attributed to the use of false investigators is caused by more than an uptick in the number of applications. Further study is needed to identify those impacts.

References

Abbott, A., Cyranoski, D., Jones, N., Maher, B., Schiermeier, Q., Van Noorden, R., 2010. Metrics: do metrics matter? Nature 465 (7300), 860–862.

Angrist, J., Pischke, J., 2009. Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press, Oxford, MA.

Anderson, M., Ronning, E., De Vries, R., Martinson, B., 2007. The perverse effects of competition on scientists' work and relationships. Sci. Eng. Ethics 13 (4), 437–461.

Biagioli, M., 2019. Plagiarizing names? Trends in Chem 1 (1), 3–5.

Edwards, M., Roy, S., 2017. Academic research in the 21st century: maintaining scientific integrity in a climate of perverse incentives and hypercompetition. Env. Eng. Sci. 34 (1), 51–61.

Fanelli, D., Costas, R., Fang, F., Casadevall, A., Bik, E., 2019. Testing hypotheses on risk factors for scientific misconduct via matched-controlled analysis of papers containing problematic image duplications. Sci. Eng. Ethics 25 (3), 771–789.

Fang, F., Steen, R., Casadevall, A., 2012. Misconduct accounts for the majority of retracted scientific publications. PNAS 109 (42), 17028–17033.

Fong, E., Wilhite, A., 2017. Authorship and citation manipulation in academic research. PLoS ONE 12 (12), e0187394.

Fong, E., Wilhite, A., Lee, Y., Hickman, C., 2020. The legal consequences of research misconduct: false investigators and grant proposals. J. Law, Med. and Ethics 48, 331–339.

Greenland, P., Fontanarosa, P., 2012. Ending honorary authorship. Science 337 (6098), 1019.

Halvorsen, R., Palmquist, R., 1980. The interpretation of dummy variable in semilogarithmic equations. American Econ. Rev. 70 (3), 474–475.

Howard, D., Laird, F., 2013. The new normal in funding university science. Iss. Science and Tech. 30 (1). https://issues.org/the-new-normal-in-funding-university-science/.

Kovacs, J., 2017. Honorary authorship and symbolic violence. *Med. Health Care and Philos* 20, 51–59.

Martin, B., 2013. Whither research integrity? Plagiarism, self-plagiarism and coercive citation in an age of research assessment. Res. Pol. 42 (5), 1005–1014.

Michalek, A.M., Hutson, A.D., Wicher, C.P., Trump, D.L., 2010. The cost and underappreciated consequences of research misconduct: a case study. PLoS Med 7 (8), e1000318.

NSF, 2018. Summary proposal and award information FY 2017-2018. Budget Inform. Sys. https://nsf.gov/awards/about.jsp.

Oliveira, D.F.M., Yifang, M., Woodruff, T.K., Uzzi, B., 2019. Comparison of national institute of health grant amounts to first-time male and female principal investigators. JAMA 321 (9), 898–900.

Roebber, P., Schultz, D., 2011. Peer review, program officers and science funding. PLoS ONE 6 (4), e18680.

Ruben, A., 2017. Another tenure-track scientist bites the dust. *Science* (July 19). https://www.sciencemag.org/careers/2017/07/another-tenure-track-scientist-bites-dust.

Stern, A.M., Casadevall, A., Steen, R.G., Fang, F.C., 2014. Financial costs and personal consequences of research misconduct resulting in retracted publications. eLife 3, e02956.

vonHippel, T., von Hippel, C., 2015. To apply or not apply: a survey analysis of grant writing costs and benefits. PLoS ONE 10 (3), e0118494.

Walsh, J.P., Cho, C, Cohen, 2005. Patents, material transfers and access to research inputs in biomedical research. In: *Final Report to the National Academy of Sciences' Committee Intellectual Property Rights in Genomic and Protein-Related Inventions*

(available at. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.531.1401&rep=rep1&type=pdf.
Ward, K., Eddy, P.L., 2013. Women and Academic Leadership: 'Leaning Out. Chron. of Higher Ed. (December 3).
Wilhite, A., Fong, E., Wilhite, S., 2019. The influence of editorial decisions and the academic network on self-citations and journal impact factors. Res. Pol. 48 (6), 1513–1522.