

The Trade-Offs of Teamwork Among STEM Doctoral Graduates

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Teamwork has increasingly become prevalent in professional fields such as academic science, perhaps partly because research shows that teams tend to produce superior work. Although research on teamwork has typically focused on its impact on work products, we complement that work by examining the degree to which teamwork influences salary, hours worked, and overall job satisfaction. Drawing on microdata collected through the National Science Foundation's Survey of Doctorate Recipients as well as the Survey of Earned Doctorates, we find that doctoral degree holders in science, technology, engineering, and mathematics (STEM) fields tend to earn substantially higher salaries and work more hours when they engage in teamwork. We also find no comparable difference in overall job satisfaction as a function of whether individuals work within teams. Additionally, we find evidence that age interacts significantly with teamwork, whereby older teamworkers tend to earn relatively more when participating in teams without appearing to work more hours; and we show that employment sector is important, whereby teamwork is relevant for salaries and hours worked in education and industry but not in government. Although our study is based on market outcomes and behavioral measures, our findings provide grounds for future research that examines the psychological mechanisms that are relevant to understanding why people join teams as well as the psychological consequences that people encounter through teamwork. More generally, this study provides a model for considering individual-level antecedents and outcomes associated with teamwork when degrees of discretion exist with respect to teaming.

Keywords: teamwork, incentives, salaries, income, STEM

The growing prevalence of teamwork among professional workers aligns positively with the emerging awareness that teams tend to produce better results across a wide array of settings. For example, there is strong evidence that teamwork among health care providers tends to yield superior patient outcomes (e.g., Baker, Day, & Salas, 2006; Baker, Gustafson, Beaubien, Salas, & Barach, 2005; Hughes et al., 2016; Salas, 2016; Salas & Frush, 2012; Wahr et al., 2013). Similarly, among academic researchers, Wuchty, Jones, and Uzzi (2007) showed that the products of scientific teams—

defined to be work produced by two or more collaborators—tended to generate better-than-average impact. Indeed, teamwork appears to generate higher quality research that benefits from the creativity that groups are more likely to consistently produce than solitary individuals (Uzzi, Mukherjee, Stringer, & Jones, 2013).

Although research examining the products and impacts of teamwork is sensible and valuable, the general question of how individuals navigate teaming in the workplace has not been closely explored. Especially for fields in which there

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exists discretion at either the individual or organizational level to pursue work within teams or not, there is complementary value to be gained by knowing whether people who participate in teamwork tend to be rewarded or penalized, or treated just like those who are not part of teams. Further, it would be especially helpful to know both the way that people feel as well as how they are compensated in relation to working within or outside of teams. In order to accomplish the goal of knowing more about teamwork in relation to individuals, an interdisciplinary approach that applies ideas from psychology and economics is sensible, as the former commonly considers variables such as job satisfaction, whereas the latter is more typically interested in examining compensation data.

In the current study, we apply an interdisciplinary approach to examine the individual-level career outcomes for PhD holders in the science, technology, engineering, and mathematics (STEM) fields. With the benefit of data sets from the National Center for Science and Engineering Statistics (NCSES), we examine the associations between participation in teamwork and individual-level salary, hours worked, and job satisfaction. Moreover, although prior studies examining the costs or benefits of teamwork among researchers are often based on relatively small samples of several hundred academics (e.g., Sarsons, 2017), we are able to consider the relevance of teamwork for a sample that includes tens of thousands of people who earned the PhD across STEM fields and who work both inside and outside of traditional academic settings. Through this approach, we are able to expand the scope of variables that researchers typically consider in relation to studying teamwork. More generally, our study offers a model for considering individual-

level impacts of teamwork among other groups of workers, outside of people who have earned PhDs in STEM fields, in which there exists some discretion with respect to engaging in teamwork.

Teamwork and the Career Paths of PhD Holders

Given the high value of skills possessed by people who earn the PhD (U.S. Census, 2012), there are direct and indirect reasons to learn more about the degree to which teamwork affects individual-level career outcomes. Directly, a better understanding of the varied reward structures faced by doctoral degree holders offers an opportunity to improve advising for graduate students, for example, about the relative costs and benefits—or trade-offs—that might be incurred by one approach or another. For example, Hanks and Kniffin (2014) addressed the question of whether people who complete interdisciplinary dissertations tended to be rewarded better in industry or other employment sectors, and—contrary to conventional wisdom—they found that industry does not offer greater compensation (in the year after earning the PhD, at least) for people whose dissertations spanned more than one disciplinary field. In analogous fashion, if one were to find that PhD holders in STEM are compensated differentially—or report differential job satisfaction scores—as a function of whether they work in teams, it would be helpful to individual PhD holders, PhD advisors, and the institutions that are training and employing people with PhDs.

In recent years, teamwork among scientific researchers has been gaining significant attention. Notably, the Science of Team Science—or SciTS—is increasingly recognized as “a new interdisciplinary field” (Hall et al., 2012; Stokols, Hall, & Vogel, 2013, p. 4) that examines networks, collaborations, and all other partnerships among scientists as organizational puzzles that warrant closer attention and understanding (e.g., Croyle, 2008; Fiore, 2008, 2013; Stokols, Hall, Taylor, & Moser, 2008). SciTS conferences have been organized annually since 2010 (Falk-Krzesinski et al., 2010), attracting researchers from an array of disciplines as well as policymakers (e.g., from granting agencies). The conferences generally function as (a) a well-organized avenue for cultivating more analytic attention on the nature of teams among scientists, and (b) somewhat unique among academic meetings—a professional development opportunity for administrators whose responsibilities include oversight of translational research centers funded by the National Institutes of Health. In a broader context that is not specific to studying scientists, the growth of the SciTS field and related community of researchers is reflective of an overall growth in attention to workgroups and teams over the past two decades—as recently highlighted by Kozlowski, Chen, and Salas (2017).



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With respect to our current focus on teamwork, it is helpful to recognize that despite the evidence that teamwork tends to produce more impactful results for publications and patents (Uzzi et al., 2013), it is far from a guarantee that individual researchers will make a habit of joining teams. There are many potential reasons why a researcher might be averse to teamwork. In fact, those reasons include concerns, which the current study addresses, regarding whether or not they will be individually penalized for collaborating with others rather than producing work for which credit is assigned exclusively to them.

Both the direct and indirect reasons for learning more about the reward structures faced by PhD holders are clearly seen when one considers the conventional academic wisdom (reviewed by Klein et al., 2013) that scientists need to establish an individual reputation prior to collaborating with others. Although our study addresses questions about PhD holders, the conventional wisdom whereby people in some industries, at least, are pressured to prioritize individual reputation invites valuable juxtaposition with examples from other industries. For example, in light of McDaniel et al.'s (2013) finding that physicians can be at risk for being considered poor team players with other physicians with whom they share patient care, it is interesting to consider similarities and differences between physicians and PhD holders in STEM. To be clear, it is outside of the scope of our investigation to compare and contrast physicians and PhD holders; however, the concurrent consideration of examples such as those whereby the differentiation of one's services appears to be pressured or, at least, practiced is helpful for understanding how people—in a general way—navigate their individual place as part of a team.

Research Questions

Two research questions (RQs) served as the frame for our study. First, complementary to research showing that scientific team products tend to do better than articles authored by solitary researchers, we were interested in examining whether PhD holders in STEM fields tend to enjoy better work experiences. Specifically, even though outputs from teams tend to be of higher quality (Uzzi et al., 2013), it is not clear that those participating on teams are rewarded with higher salaries and/or with greater job satisfaction. In this sense, our primary question retains a focus on the full population of PhD holders in STEM with respect to understanding individual-level career outcomes that might vary as a function of teaming.

It is worth recognizing that a pattern of findings whereby individuals are rewarded for teamwork would help to explain the growth in teamwork that prior research (e.g., Jones, Wuchty, & Uzzi, 2008; Uzzi et al., 2013) has shown. Indeed, when one accepts that teamwork does tend to produce higher quality products, then there is a solid basis for expecting a reward premium to be associated with teaming. It is comparably imaginable, though, that the production of higher quality work through teams might be the result of other processes such as the requirement of more time on the job. It is for this kind of reason that our analysis of rewards is careful to integrate measures of salary, hours worked, and job satisfaction.

RQ1: Do individuals who work as part of teams experience individual-level career impacts?

Although the analysis of RQ1 requires us to control for individual and demographic characteristics, there exist reasons—building on RQ1—to expect that a number of those characteristics—such as gender, employment sector, and age or career stage—could interact with teamwork to produce differential career impacts. For example, with respect to gender, Bozeman and Gaughan (2011) found that women were more likely to participate in academic research teams, whereas Frehill and Zippel (2011) reported that women tended to participate in fewer international collaborations, and Zeng et al. (2016) showed that the overall number of collaborators as well as repeat collaborators tended to be lower for women. Although none of those studies directly examined individual-level career outcomes, their findings of gender-specific levels of engagement of teamwork suggest that gender might interact with teamwork to affect measures such as job satisfaction, hours worked, and salary.

More recently and intensively, Sarsons (2017) reported that women who participated in teamwork—as measured by coauthored versus solo-authored academic articles—tended to face a penalty in the field of economics when compared with men who do likewise. Specifically, based on the analysis of a sample of 552 curriculum vitae of academic

economists, Sarsons found that tenure decisions were negatively affected for women who coauthored, whereas men who coauthored were not penalized. In a parallel study of sociology, Sarsons found no interaction effect between gender and teamwork, and inferred that the discipline-specific convention whereby economists list coauthors alphabetically rather than by relative contribution (as sociologists do) resulted in less credit for coauthorship for women in economics. Our research was not able to examine the specific patterns highlighted by Sarsons; however, our analysis does allow us to see whether women who are part of teams are penalized or rewarded differentially from men who are part of teams.

Regarding employment sectors, prior research has shown that it can have a large impact on individual-level rewards among PhD holders in STEM. For example, Hanks and Kniffin (2014) showed that—with respect to measurements of income in the first year after earning the PhD, at least—there exists a high salary premium for PhD holders who work in industry versus education (including academia) or government. It is an open question, though, whether or not the nature and potential individual-level career effects of teamwork vary across these employment sectors.

Regarding a person's age or career stage, there is reason to expect that one or both variables might also importantly interact with teaming in relation to individual-level career outcomes. For example, in a recent study of contributorship statements that increasingly accompany articles and specify the roles that each author served for a given article, Larivière et al. (2016) found evidence that senior members of coauthorship teams tended to be significantly less likely to be part of time-intensive aspects of a project such as data analysis. This finding is consistent with recognition of the “Matthew effect” (Merton, 1968), whereby people who are recognized as senior and authoritative tend to reap rewards disproportionately when compared with people who are more junior in their field.

To illustrate the depth to which potentially important interactions can be considered through RQ2, we can integrate our consideration of gender, employment sector, and age or career stage to note that—with the benefit of a large sample—it is possible to consider two-, three-, and four-way interactions, such as whether or not there exist differences in teamwork-related outcomes for women and, independently, for relatively young or old men working in specific employment sectors. Indeed, in light of work such as Sarsons (2017), there is a strong reason to examine such multiway interactions. More broadly, though, RQ2 is presented in a way to recognize that there exists a wide array of individual variables that might importantly interact with teamwork to affect individual-level career outcomes, even though the present study will retain a focus on gender, employment sector, and age or career stage.

RQ2: Do individual characteristics interact with teamwork to affect individual-level career outcomes?

Method

Data

The Survey of Doctorate Recipients (SDR) is administered periodically by the NCSES, a unit within the National Science Foundation (NSF), and offers the potential to conduct longitudinal research among people who have earned the PhD in STEM fields (Chang & Foley, 2017). The SDR sample is drawn from participants in the annual Survey of Earned Doctorates (SED), which typically gains a participation rate that is higher than 90% of all individuals being awarded a research PhD in the United States in any given academic year (Fiegener, 2011). In our case, we matched individual-level responses for the 2006, 2008, 2010, and 2013 waves of the SDR data files with the corresponding SED data. Because the SDR resamples respondents in each cycle and recruits newer PhD recipients as well in each wave, we use sampling weights in our analyses of the 2006 SDR respondents; however, because our analyses of subsequent waves focus on the subset of those who were in the 2006 SDR, and omit those in later waves who were not part of the 2006 SDR, the weights are not used in our analyses of subsequent years because their relevance applies to the full cross-sectional use of a given wave's sample.

Variables

Teamwork. As demonstrated in Figure 1, the 2006 SDR asked respondents to indicate various ways in which they do (or do not) participate in teamwork. The set of questions are, to date, unique to the 2006 version of the SDR and have not yet been asked again in a subsequent survey. The four specific measures, along with the brief labels that we will use throughout our analyses, are specified here:

1. An *on-site team* is one in which respondents “work with an immediate work group or team”;
2. A *team in-organization* is one in which respondents “work with others in the same organization (company, university, agency, etc.), but not the same group or team”;
3. A *team in other U.S. organizations* is one in which respondents “work with individuals in other organizations in the U.S.”; and,
4. An *international team* is one in which respondents “work with individuals located in other countries.”

Individual-level career measures. Salary was self-reported in actual dollars for the year in which the survey

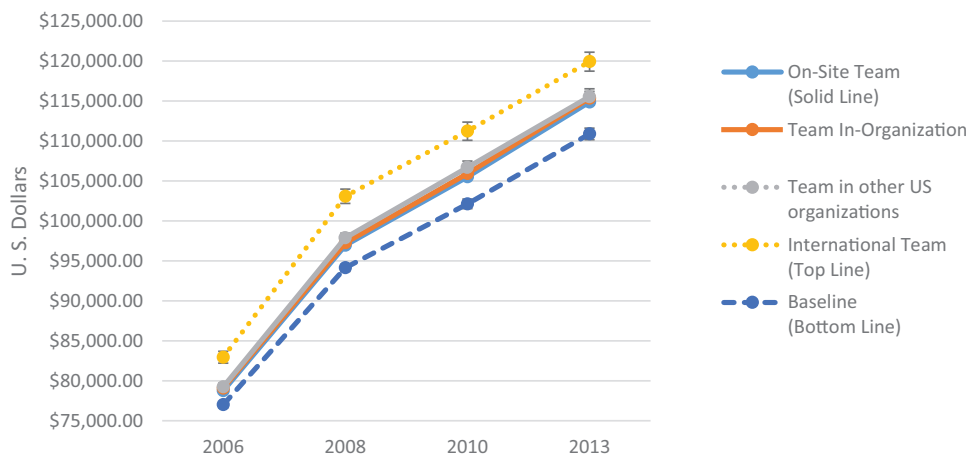


Figure 1. Model-predicted salary levels are persistently higher for teamworkers based on data from the 2006, 2008, 2010, and 2013 Survey of Doctorate Recipients and matched Survey of Earned Doctorates responses. Salary levels are not adjusted for inflation across years; consequently, it is the relative difference among the lines that is the focus of the figure. See the online article for the color version of this figure.

was administered. Specifically, the SDR asks (for a specific week of the year that varies across the SDR waves), “What was your *basic annual salary* on your principal job, before deductions?”

Job satisfaction is measured by asking respondents, “How would you rate your overall satisfaction with [your] principal job” and providing the following rating-options: 1 = *very satisfied*, 2 = *somewhat satisfied*, 3 = *somewhat dissatisfied*, and 4 = *very dissatisfied*.

Questions related to hours worked are asked as open-ended questions, such as, “During a typical week on your principal job, how many hours did you work?” Given the possibility of response bias for hours worked (e.g., Reid, 2015), one of the robustness checks that we completed for our analyses relies on replacing hours worked with responses to the question “How many people did you supervise *directly*?” (original emphasis) as a proxy measure of job demands.

More generally, SDR respondents indicate the sector (industry, education, or government) in which they were working in a given survey year, which we translated into dummy variables for each survey wave. To identify another variable that we drew upon for robustness checks in our analyses, the SDR also includes a finer-grained question about whether the respondent’s job changed since the time of the previous SDR survey.

Demographic and individual differences. Gender, ethnicity, age, citizenship, and years since earning the PhD are among the key demographic variables available in our data. Regarding ethnicity, our analyses consistently use a dummy variable that is based on the most common categorization (White) reported by the surveys.

Similarly, disciplinary groupings are based on how respondents classified the primary field to which their disser-

tation contributed. Consistent with prior analyses of the SED (e.g., Hanks & Kniffin, 2014), those fields are conventionally grouped into the following 12 main categories, which are used in our analyses: (a) agricultural and life sciences, (b) biological sciences, (c) health sciences, (d) engineering, (e) computer and mathematics, (f) physical sciences, (g) social sciences, (h) humanities, (i) education, (j) business, (k) communication, and (l) other (e.g., library science).

Analyses. For the analyses reported in this section, we utilized three different analytical methods based on our data structure using Stata 14.2 for Windows (64 bit) with the command lines that generated our results accessible online at (<https://doi.org/10.6077/J5CISER2799>). First, for our primary analyses of the 2006 wave of the SDR, we employed ordinary least-squares regression models with robust standard errors, and we incorporated the survey weights to account for the sampling design. In each model related to RQ1, we included a set of demographic variables—gender, employment sector, age, ethnicity, and the person’s disciplinary background when they earned the PhD and completed the SED—to control for individual-level variation; and, for calculations related to RQ2, we added interaction terms. Second, in order to assess the robustness of patterns that we found in the 2006 sample, we then estimated models separately for the 2008, 2010, and 2013 survey waves by focusing on the subset of those waves’ respondents who were part of the 2006 SDR sample. For each wave, we estimated average values for the main outcome variables (salary, hours worked, and job satisfaction) and note the increasingly smaller sample size in each wave as 2006 respondents gradually become nonresponders. Third, in a final robustness check, we leveraged the repeated-measures characteristic of the data and constructed a balanced panel

for all four survey waves. We then used fixed-effect regression methods to estimate parameters in models similar to the cross-section models. The only difference in the panel data analysis was the individual-level time-invariant fixed effect that we were able to estimate for each respondent in the panel. The sample size for this panel was smaller than those in the other analyses because it tracked respondents over four consecutive waves of the survey and did not include, for example, people who responded to the 2006 SDR but only one or two of the subsequent SDR waves.

To help us digest the relatively wide parameter space reflected in the data, whereby we have four survey waves, three main outcome variables (salary, hours worked, and job satisfaction), and four measures of the main independent variable of interest—teamwork, and a number of additional variables of interest such as gender, employment sector, and age—we often focus our reporting on model-estimated means. Beyond allowing for succinctness, an extra benefit of this approach is that model-estimated means are more informative than beta coefficients, because they are unit specific (e.g., dollars, hours worked, or level of job satisfaction) and do not require cross-referencing with the full set of a given model's other beta values.

Results

Basic descriptive statistics for the individual-level career outcomes examined below show that unconditional salaries for the full sample were from a mean (*SE*) of \$90,243.91 (\$402.59) in 2006 to \$123,560.70 (1,295.02) in 2013. Job satisfaction was quite high ($M = 1.54$, $SE = .004$) in 2006 and similar ($M = 1.58$; $SE = .006$) in 2013; and mean hours worked was 45.84 ($SE = .08$) in 2006 and 45.59 ($SE = .11$) in 2013. Additionally, the number of people directly supervised by the respondents was 3.28 ($SE = .08$) in 2006 to 3.39 ($SE = .06$) in 2013. More basically, because we only considered responses in 2008, 2010, and 2013 from those who also participated in the survey in 2006, the number of respondents considered in our analyses ranges from 27,119 in 2006 to 14,603 in 2013. Regarding the percentage of respondents indicating teamwork, 76.4% reported being part of an on-site team, 73% were part of a team within their organization, 58.1% were part of a team with members of a different organization in the United States, and 30.3% were part of an international team when surveyed in 2006.

Focusing on RQ1, we found a general overall pattern whereby people who were part of teams tended to (a) earn higher salaries, (b) work more hours, and (c) show non-consistent difference in overall job satisfaction compared with those who were not part of teams. Table 1 shows the results of an illustrative model for salary earned in 2006 based on responses to the 2006 SDR, with teamwork operationalized as being part of an on-site team. As we describe and report in the following paragraphs, our calcula-

Table 1
On-Site Team Membership is Positively and Significantly Associated With 2006 Salaries (US Dollars)

Regression variables	<i>B</i>	<i>SE</i>
On-site team membership	8,610.03**	1,054.02
Woman	-8,959.87**	865.56
White	2,426.42**	921.03
Age	867.42**	58.95
Disciplinary grouping		
Biological sciences	9,752.56**	1,896.79
Health sciences	14,182.02**	2,476.43
Engineering	20,433.30**	1,891.06
Computer and mathematics	21,204.37**	2,056.81
Physical sciences	11,299.62**	1,739.23
Social sciences	10,858.01**	1,804.82
Humanities	1,598.56	2,455.16
Education	5,441.80	3,753.11
Business	17,126.10	9,516.37
Communication	16,845.71**	2,912.59
Other	16,345.71	10,743.43
Industry sector employment	13,940.78**	1,470.53
Education sector employment	-17,243.83**	1,406.85
Hours worked	833.05**	43.56
Constant	-12,459.65**	3,761.26

Note. Reference standards/values (i.e., the comparison groups) for Disciplinary background is Agricultural and Life Sciences; and, for Employment sector, is Government.

** $p < .01$.

tions of the same basic model for each of the four teamwork variables as well as all three outcome variables (salary, hours worked, and job satisfaction) produced results that matched the overall pattern of higher salary, more hours worked, and non-consistent difference in job satisfaction for PhD holders in STEM who participated—compared with those who did not participate—in various kinds of teamwork.

Our analyses were not able to disentangle whether teamworkers were paid at a different salary rate than others, but it is reasonable to expect that at least part of the reason for the higher salaries is the additional hours that appear to be required for teamwork-associated pursuits. The absence of a consistent difference for job satisfaction suggests that people tended to consider the higher salaries to be an equivalent trade for the relatively higher number of work hours required for teamwork. Although our analyses cannot specify the precise degree to which hours worked—by teamworkers—accounts for the salary premium of teamworking, we can report additional patterns that are responsive to RQ1.

As illustrated in Figure 1, those who worked on a team tended to earn between approximately \$1,750 and \$6,000 more per year—depending on the kind of team—than the baseline salary for all PhD holders in STEM. Focusing more closely on the different types of teamwork, there is evidence that international collaboration was rewarded significantly more (approximately \$6,000 above baseline) than other types of teamwork (among which there was high overlap with respect to salary).

To provide a clear background for understanding the results in Figure 1, Table 1 presents an illustrative regression model from which the model-estimated means and standard errors represented in Figure 1 were drawn. Specifically, Table 1 provides the basis for the model-estimated means for the data point associated with being part of an on-site team in relation to salary earned in 2006, and Figure 1 reflects similar data points for the four survey waves and five different sets of factors—the four different teamwork measures plus the baseline that does not consider teamwork. Consequently, we note that a set of 20 models, including the one represented in Table 1, were estimated for Figure 1. The relative intensity of this analytic approach accounts for why our findings were mainly presented through model-estimated means in Figure 1.

As a complement to the calculations that we made to inform Figure 1, we also utilized the panel nature of the survey by restricting our sample to respondents who completed surveys in 2006, 2008, 2010, and 2013. This allowed us to control for individual time-invariant characteristics and capture the movement of salary, hours worked, and job satisfaction over time in relation to the four teamwork variables for the subsample of individuals who responded to all four survey waves. Most generally, the results of these time series analyses yielded patterns that are very comparable with those generated by the cross-sectional analyses. Specifically, time-series models for salary show significant, substantial, and positive coefficients for all four measures of teamwork. Similarly, time-series models for hours worked show the same general pattern, whereby teamworkers—by each of the four measures—tended to work significantly more hours than nonteamworkers. And, lastly, there was no consistent relationship generated by the time-series models with respect to the relationship between teamwork and job satisfaction.

As an additional robustness check on our findings, we created a variable that summed affirmative responses from a given individual to the four teamwork questions, so that, for example, anyone who answered “yes” to all four questions would be recognized with the value of 4. The four teamwork variables are as one would expect – positively correlated with each other with r values ranging from .15 to .37 and the range of their respective correlations with this “total teamwork” index variable ranges from .57 to .72. Although it is clear that the four measures of teamwork were not measuring redundantly the same variable, it offers an extra level of assurance to see that total teamwork yields a positive linear effect, whereby more teamwork was rewarded with higher salaries. Specifically, for 2006 salaries, the model-predicted means (and SEs) for the respective values of “total teamwork” are (0) \$68,870.41 (2,294.65); (1) \$70,363.92 (879.15); (2) \$75,782.20 (671.16); (3) \$79,927.31 (674.31); and (4) \$86,843.68 (1139.56). Based on these numbers, there is some overlap in the 95% confidence intervals for “0” (no teamwork) and “1” (only

one affirmative response to the four teamwork questions), but there is otherwise a solid affirmation generated by this test that teamwork was positively and robustly associated with higher salaries. Indeed, this pattern was maintained when examining model-estimated means for salaries in 2008, 2010, and 2013; further, a higher level of total teamwork corresponded with increasingly more hours worked in a given week and a slight change in job satisfaction. Focusing on hours worked, the model-predicted means (and SEs) for 2006 are (0) 42.22 (.57); (1) 44.20 (.26); (2) 46.41 (.18); (3) 47.66 (.17); and (4) 49.23 (.21); and, for job satisfaction, the comparable means (and SEs) are: (0) 1.63 (.03), (1) 1.63 (.02), (2) 1.62 (.01), (3) 1.57 (.01), and (4) 1.55 (.01).

As a final set of robustness checks for RQ1, we (a) replaced the number of hours worked with the number of people directly supervised by the respondent, (b) replaced age with the years since earning the PhD, and (c) delimited our analyses to consider responses only from the 3,824 people who stayed in the same job for the duration of the sampling period. Each of these modifications generated patterns that are comparable with those reported in the preceding paragraphs.

Focusing on RQ2, when one or more interaction terms are added into the regression models that informed our analyses for RQ1, we were able to examine whether—for the full sample of respondents—there existed a difference in the “teamwork-related differences” for individual-level variables such as gender, employment sector, and age. Starting with two-way interaction analyses that follow the example of Table 1, with the addition of a relevant two-way interaction term, the interaction term for gender and each of the four measures of teamwork was not significant for salary and job satisfaction although there was a significant tendency for women on teams to work more hours than women not on teams. Regarding the two-way interaction term for teamwork and employment sector, there was a positive relationship for those employed in industry with respect to salary (for two of the four teamwork variables), hours worked (for three of the four teamwork variables), and job satisfaction (for three of the four teamwork variables). We can infer from these sets of models that (a) there was not a clear benefit or cost to teamwork—across the full sample—with respect to whether someone was male or female while the interaction for hours worked warrants closer study and (b) people in industry appeared relatively likely (compared with other PhD holders in STEM fields) to enjoy a salary and/or job satisfaction premium as well as more hours worked if they engaged in teamwork.

The two-way interaction models for teamwork and age warrant closer attention because they yielded stronger patterns. Specifically, all four of the teamwork variables, when interacting with age, appear significantly and positively related to salary—indicating that older (compared with

younger) PhD holders in STEM fields earned more if they were part of teams. Interestingly, the interaction between age and the teamwork measures does not produce conclusive or consistent patterns for hours worked, despite the relatively large gap reflected by the interaction for salary. More specifically, the model-estimated means for salary indicate that an individual at Age 30 who participated in an on-site team earned \$70,320 compared with \$59,507 for those who did not. Moreover, the model-estimated means for an individual at Age 70 reveal a much larger gap: \$112,137 when part of an on-site team and \$72,697 when not part of an on-site team. Given this substantial difference, whereby teamwork appeared to pay the largest salary dividends for older teamworkers, it is remarkable that the older teamworkers did not consistently appear to be working more as measured by the interaction terms. Lastly, as with the overall findings, there was no robust relationship between the interaction term for age and teamwork with job satisfaction.

When we examine the three-way interactions for teamwork, gender, and employment sector, with respect to salary there were no significant patterns—as was the case for three-way interactions for teamwork, gender, and age with the exception of those indicating teamwork with people in the United States but outside of one's organizations whereby older women tended to earn less ($p = .04$). Look-

ing at the three-way interactions for teamwork, age, and employment sector, there were mostly nonsignificant relationships, except for a subset of interactions that were significant and positive that suggested that older employees who worked in industry tended to earn higher wages. For the four-way interaction models that considered teamwork, gender, employment sector, and age, we generally found that women working on teams in industry tended to earn higher salaries compared with others who do not although men still tended to earn more.

When we looked more closely at two-way interactions between employment sector and teamwork, we found—as illustrated in Figure 2—a common pattern whereby PhD holders in STEM who worked in industry and education were rewarded with a premium in salary for teamwork, whereas those in government were not. The main departure from this pattern emerged when looking at teamwork with others outside of one's organization in the United States as industry joins government for showing no two-way interaction effect in relation to salary. This is sensible because companies employing knowledge workers would not be expected to reward employees for teaming closely, at least with employees who work for other, rival organizations. Alternative explanations include the possibility that respondents working in government faced relatively more depression in wages during the Great Recession and variable cuts

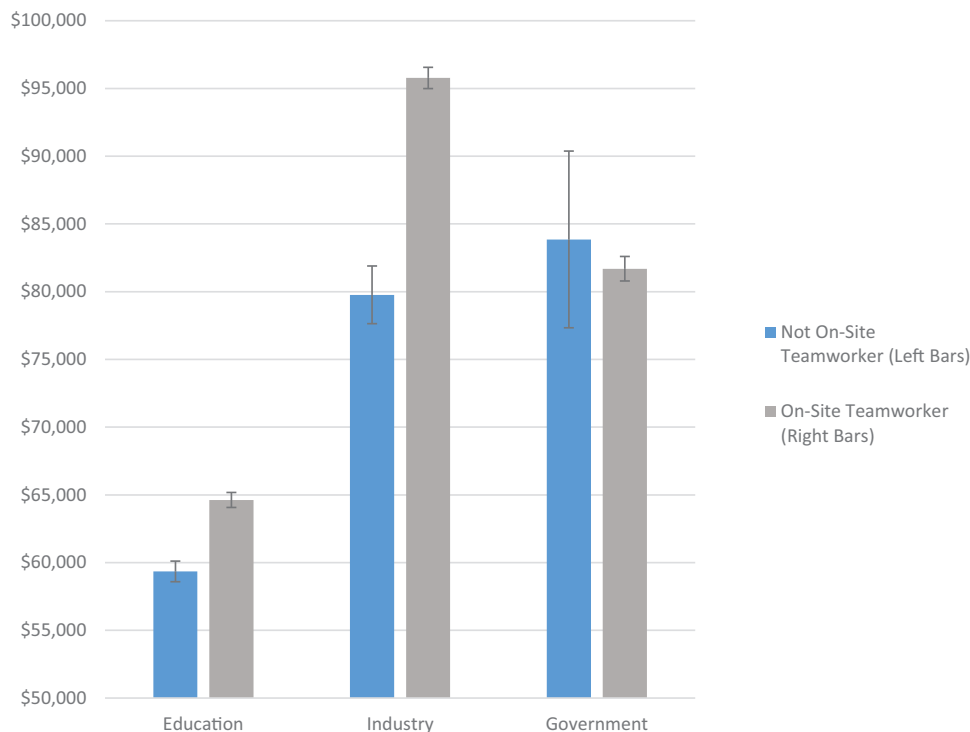


Figure 2. Positive associations exist between teamwork and salaries in education and industry but not in government, based on responses to the 2006 Survey of Doctorate Recipients. See the online article for the color version of this figure.

to relevant programs at points during our sampling period. Additionally, it is notable for any consideration of government positions that employees often face relatively unique minimum waiting periods for within-position increases, and that any potential raises often require approval from local, state, or federal legislative bodies.

Discussion

Although prior research has shown that teamwork tends to produce higher quality products, our exploration of RQ1 reveals that (a) there is a robust salary premium that is paid to people for participating in teamwork; (b) teamwork requires more time working; and (c) there is not a robust difference with respect to job satisfaction as a function on being part of a team. Among other benefits, these findings help to explain why people do not uniformly seek to work in teams. Indeed, although there are certainly other reasons why people with discretion to do so might opt to *not* participate in teamwork, our findings suggest that people might unfavorably view the trade-off that appears to be common of extra salary in exchange for more work.

With respect to RQ2, the two-way interactions that we calculated, respectively, for teamwork and age, as well as teamwork and employment sector, are especially remarkable. Complementary to research demonstrating the “Matthew effect” (Merton, 1968), such as Larivière et al.’s (2016) analysis of contributorship statements, our findings relating to age add important and concrete insights regarding the substantial salary premium associated with teamwork for relatively older individuals partly because the premium is not matched by a clear change in hours worked. Regarding our findings related to employment sector, although prior research (e.g., Hanks & Kniffin, 2014) has shown high salary differentials across sectors, it is interesting to see that—independent from those effects—there are separate benefits (in Industry and Education, at least) for participating in teamwork.

Regarding our examination of the interaction between teamwork and gender, we did not replicate the pattern reported by Sarsons (2017) for the field of economics, in which women were more penalized than men for engaging in teamwork. Although our study does not consider the measures that Sarsons utilized, it is plausible that the pattern that she reported is relatively isolated to either the field (economics) or employment sector (education), or perhaps some finer-grained employment situation (e.g., economists working in research-intensive universities). It is also worth highlighting with respect to the problematic discrimination reported by Sarsons that it (i.e., discrimination) can be improved through interventions and time. Indeed, research on the practice of teamwork training—similar to diversity training—has been shown to help organizations improve operations and function with fewer inefficiencies (Salas &

Frush, 2012). A benefit of our study is that we have effectively established an array of benchmarks that should help inform future interventions designed to improve individual-level experiences with teamwork.

Practical Implications

Implications of the present study apply to (a) individuals involved in the training of doctoral students in STEM, (b) researchers interested in the generalizable dynamics related to teamwork that are found in our sample, and (c) the community of policymakers and researchers who focus on the measurement and growth of team science. For example, current and future doctoral students should benefit from greater awareness of the dynamics that we report in the STEM labor market. Alongside students, faculty who serve as mentors, department chairs, and/or university administrators would be well served by greater awareness about the apparent career consequences for participating in teamwork. In these respects, our study helps resolve some of the “naïve optimism” that often characterizes graduate students’ perceptions of the post-PhD labor market (Golde & Dore, 2001), and instead facilitates evidence-based decision making for graduate students and their advisors.

With respect to the broader SciTS community as well relevant policymakers, our study responds and contributes directly to recent calls for more systematic investigations into the ways in which scientists—and science—work (e.g., Andersson, Freedman, Haltiwanger, Lane, & Shaw, 2009; Lane, 2009, 2010; Lane & Bertuzzi, 2011; Lane, Owen-Smith, Rosen, & Weinberg, 2014; Largent & Lane, 2012; Weinberg et al., 2014). The pattern of findings that we report on the basis of four teamwork questions included in the 2006 SDR also helps to highlight (a) the power that can be created by asking questions in such a survey, and (b) the opportunity that appears to exist for the SDR and/or other longitudinal surveys such as the Panel Study of Income Dynamics or American Time Use Survey to integrate additional or comparable measures of teamwork in future surveying to help better understand the patterns that we report—both among PhD holders in STEM fields as well as any number of other populations of knowledge workers. We also expect that the fine-grained transaction-level data being organized and released by the Institute for Research on Innovation and Science (e.g., Lane et al., 2014) can potentially help researchers better understand the ways in which differential degrees of teamwork correspond with the kinds of variables that we report in this article.

More generally, to the degree that members of any given profession imagine their field to be unique or idiosyncratic in relation to other professions, our study is aligned with one of the recommendations of the National Research Council’s (2015, p. 9) report to help demystify the ways in which PhD-holding employment might be popularly regarded, and

instead encourage researchers to think about PhD-holding professionals in ways that they would typically consider knowledge workers in other fields. Of course, in the case of studies concerning tenure-track faculty, the focus on promotion to tenure as an up-or-out organizational decision is a dramatic outcome that is popularly understood to be relatively unique to academia; however, given that a growing majority of people with the PhD do not work on the traditional academic tenure track, our focus on more commonly interesting—and generalizable—outcome variables (e.g., salary, hours worked, and job satisfaction) invites close juxtaposition of our analysis with studies of professional employees who are not PhD holders in STEM fields.

Limitations and Future Directions

Beyond reiterating the exploratory nature of the research that we presented, the main limitation of our review is that we relied mainly on self-reported behavioral measures. At the same time that such a reliance is a limitation, our consideration of job satisfaction alongside measures such as salary and hours worked offers a model for the value to be gained by integrating measures that tend to be relatively field-specific. For example, when one reasonably assumes that the measures of teamwork examined through our study are closely related to measures such as anticipatory helping (e.g., Grant, Parker, & Collins, 2009) or organizational citizenship behavior (e.g., Organ, 1997), then we are hopeful that our review can encourage more attention to the individual-level career outcomes (e.g., salary) that might be associated with such measures. In this respect, although our study clearly aims to expand the scope of variables that are considered in relation to teamwork within the enterprise of STEM fields (i.e., to consider individual-level career impacts), we also hope, more broadly, that our review offers a roadmap for future interdisciplinary work that juxtaposes more traditional psychological measures such as job satisfaction alongside “econ” variables such as salary and hours worked. For example, although psychologists discussing team effectiveness typically and sensibly examine the importance of variables that reflect individual attitudes and interpersonal relations (e.g., Graen, 2009), our study illustrates the potential insights to be gained by concurrently considering “econ” and “psych” measures.

A second limitation regarding our study involves the potential importance of unobservable characteristics such as a person’s preference for teamwork, general work ethic, and interest in or ability to work with others. Factors such as these potentially influence a person’s decision to work more hours, participate effectively in a team environment, or put forth the effort that is necessary to accomplish challenging tasks. In light of such unobservable characteristics, it could certainly be true, for example, that people who work on teams tend to have a higher skill level and thus earn more

because of their skills rather than anything specific to being part of a team. Similarly, our results show that large premiums for international teamwork may be driven by a person’s general set of abilities and skills rather than teamwork per se. Future research that is able to consider the potential relevance of such underlying characteristics would clearly have value for building upon the observations that we are able to make.

The four measures of teamwork that we utilized also constitute a limitation because of their relative lack of precision; however, in response to RQ1, at least, the myriad robustness checks that we conducted offer support for the main findings. Future research might generate sharper findings by measuring the various kinds and degrees of respondents’ teamwork with greater precision. For example, questions that differentiate collaboration on service efforts (e.g., membership on a hiring committee) and outward-facing products (e.g., a patent or publication) would offer the opportunity to dive deeper into the patterns that we report. Similarly, it would be ideal for measures of teamwork to be more granular than the binary variables that we have analyzed, as people often engage in a mix of team and solo work that would be better reflected in finer-grained measures. Likewise, objectively measured aspects of teaming among PhD holders in STEM would also carry important value as a complement to the self-reported variables that we have studied. Lastly, measures of teaming that take into account relatively fine-grained temporal snapshots (e.g., over months instead of years) would contribute significantly to understanding the dynamic aspects of teamwork processes that Salas, Kozlowski, and Chen (2017) highlight in their recent review.

With respect to understanding what factors help account for why someone might participate in teamwork, our data provide limited ability, but we did—in the spirit of helping to identify possible directions for future research—conduct a logistic regression for “total teamwork.” Specifically, we estimated a logistic regression model wherein the dependent variable was whether or not someone declared participating in teamwork, and the independent variables were field of dissertation research, gender, marital status, age, ethnicity, U.S. citizenship status, whether they conducted an interdisciplinary dissertation, tenure status, and whether they worked for a large organization with at least 1,000 employees. This preliminary analysis—complementary to Frehill and Zippel’s (2011) focus on international collaborations—suggests that women were much less likely to participate in teams than men, whereas people with tenure were substantially more likely to participate than people without tenure. We emphasize the preliminary nature of these results but also highlight the potential avenues for additional research. For example, if men are more likely to engage in teamwork, what factors are related to this outcome? Further, what does this mean for women’s careers? In this context, it would be

valuable for future research to also consider what policies or organizational structures can be implemented to encourage teamwork more broadly in the PhD-holding labor force in STEM given the kinds of benefits that appear to exist with respect to salary. Although these questions are outside the scope of our study, we shed light on them as important for future consideration.

We can also acknowledge the selective nature of teamwork, as it is reasonable to expect that some people differentially choose jobs that tend to have fewer (or more) opportunities for teamwork. Indeed, among the reasons that we emphasize the preliminary nature of the logistic regression for total teamwork is that we expect—partly based on comparable studies among other populations of workers (e.g., Driskell, Salas, & Driskell, 2017)—that a much broader set of variables would offer significant value for more fully understanding the reasons that PhD holders in STEM fields do or do not engage in teamwork. Personality variables, for example, that might contribute to a person's propensity to participate in teams include conscientiousness, patience, and extraversion/introversion (e.g., Cain, 2013). Our expectation is that these relationships are not necessarily linear, as we can imagine, for example, that above-average conscientiousness would be a positive factor in relation to teaming, but that high levels of the trait would counterproductively predict difficulty making compromises with fellow team members. Comparably, although above-average agreeableness might be a positive factor for teaming among PhD holders in STEM, we expect that people with high levels of the trait might tend to be part of teams that do not show the premium benefits of teamwork, when, in fact, a reason that teamwork appears to fare better is partly because of a “meeting of the (independent) minds.”

Independent from personality variables that we expect to be potentially important in relation to understanding individual-level decisions and outcomes with respect to teamwork, there are also demographic variables that future research might find to be important but are not explored closely in the current study. For example, citizenship status is likely important with respect to international collaborations, as Falkenheim and Kannankutty (2012) explored; and an individual's socioeconomic status in their childhood is increasingly gaining attention as a factor with longer-range consequences for how adults operate in various kinds of professional work organizations. For example, given evidence that parental education influences the choice to pursue doctoral research (e.g., Kniffin, 2007; Kniffin & Hanks, 2017; Mullen, Goyette, & Soares, 2003), and given that teamwork requires more social interactions than individual work, it is plausible—and worth examination in light of work by Belmi and Laurin (2016)—that people from lower childhood SES self-select themselves into less interactive situations. Recent work by Haeussler and Sauermann (2016) offers additional candidates for under-

standing why people seek teamwork differentially by focusing on skill-set-based variables such as whether someone is a generalist or specialist. Additionally, in light of prior research on the potentially persistent impacts of relative age (e.g., Kniffin & Hanks, 2016), it is plausible that people who were accustomed to being relatively old among their childhood classmates are more comfortable joining teams than people who were typically the youngest or least senior within their childhood cohorts.

Lastly, beyond considering additional measures of teamwork as well as potential antecedent factors, it is important for future research to broaden the scope of outcome variables, given the patterns that we find with respect to salary, hours worked, and job satisfaction. Among the candidates that we can propose for future research to consider, it would be interesting—to build on recent work by Bikard, Murray, and Gans (2015)—to know whether teamworkers enjoy more frequent promotions than nonteamworkers and/or whether teamworkers are more likely to switch employment sectors than nonteamworkers. Total career length would be another outcome that we expect to be valuable to study alongside any related measures that help to assess how quickly or slowly people approach retirement and whether teamworkers do so at a different pace than nonteamworkers.

Conclusion

The present study fills an important gap in the literature of team science by providing novel insights into the individual-level career outcomes of PhD holders in STEM as a function of their engagement on teams. Our primary finding of a robust salary premium for teamwork appears to be partly offset by more hours worked; and, it is this apparent trade-off that seems to explain why there is no comparable difference in job satisfaction ratings among those who work on or outside of teams. Although our study helps to identify why some people do not opt for the trade-off between salary and time to participate in teamwork, our interdisciplinary approach to juxtapose measures that are more typically considered in isolation from each other offers a model for psychological research to integrate measures such as salary and hours worked more commonly. Future research is needed to explore (a) the psychological and environmental factors that account for why people choose to engage or avoid teamwork, as well as (b) the psychological consequences and, perhaps, coping mechanisms that people face or apply as a result of participation in teamwork.

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