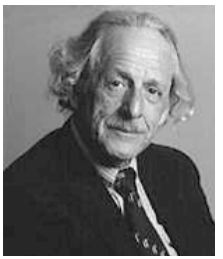

Current Comments®

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The Impact of Citation Indexes on Biochemists and Sociologists—A Survey by L. Hargens and H. Schuman. Part 2. Results and Conclusions: Who Uses What, When, and Why?

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As noted in my introduction to Part 1 of this essay,[1] the use of citation analysis, for faculty evaluation as well as research, has increased significantly. In their article, Lowell L. Hargens and Howard Schuman inform us that, in fact, the vast majority of biochemists and sociologists they surveyed had used the *Science Citation Index®* (*SCI®*), or the *Social Sciences Citation Index®* (*SSCI®*) primarily for information retrieval, though respondents also noted that it is used for tenure evaluations.

Hargens and Schuman collected data from two groups, biochemists and sociologists, to test the following three hypotheses as mentioned in their article:[2] (1) Scientists who are highly cited will be more likely to use citation counts for gauging scholarly contributions than will infrequently cited scientists. The former will also evaluate citation counts for this purpose more highly than the latter; (2a) Scientists in fields with relatively low levels of consensus on appropriate research questions and techniques are more likely to use citation counts to measure individuals' scholarly contributions than scientists in fields with relatively high levels of consensus. The former also will evaluate such use of citation counts more favorably than the latter; (2b) The relationship between one's own citation level and one's use of citation counts to measure scholarly contributions will be stronger in fields with less consensus than in fields with more consensus. Similarly, the relation between one's own citation level and one's evaluation of citation counts as a measure of scholarly contributions will be greater in low- than in high-consensus fields.

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Citation Counts and Social Comparisons: Scientists' Use and Evaluation of Citation Index Data

Continued from *Current Contents* (1):5-12, 7 January 1991.

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Results

Respondents in both fields [sociology and biochemistry] were almost universally familiar with citation indexes, and approximately two-thirds in each had consulted them at some time. As Table 2 shows, about half of the respondents in each field reported that they had used citation indexes to locate recent publications—the purpose for which citation indexes were originally designed. Thus, field differences in familiarity and use of citation indexes to identify publications are small and none was statistically significant. The fourth item shows that, consistent with hypothesis 2a, sociologists were more likely than biochemists to have used citation indexes to count how often particular individuals had been cited. Similarly, the fifth item shows that, on average, sociologists were more likely to favor using citation counts to measure scholarly contributions. Thus, the overall patterns of use and evaluation of the *Science Citation Index®* (*SCI®*)/*Social Sciences Citation Index®* (*SSCI®*) shown in Table 2 are consistent with hypothesis 2a.

In addition to the results for individuals, Table 2 shows data on *departmental* use of citation counts for making personnel decisions. We asked our respondents whether their departments had ever used citation counts in making decisions about salaries, hiring, and promotion. Although our study was not designed to gather highly reliable measures of departmental use of citation counts, the percentage of sociology departments in which at least one member reported that citation counts had been used for such purposes significantly exceeded that of biochemistry departments (see line 6 of Table 2).[8] Thus, the results for departments are consistent with those for individuals (see line 4)—in both cases sociology showed higher use of citation counts than biochemistry.

The results in Table 2 showing the overall levels of use and evaluation of *SCI*/*SSCI* in the two fields provide a first test of hypothesis 2a. To further test 2a and also hypotheses 1 and 2b, we carried out multivariate analyses of the two dependent variables that those hypotheses specified: use of citation indexes to count citations to particular individuals and evaluation of citation counts as a measure of scholarly contributions. In addition to the three independent variables that those hypotheses specified—researcher's

TABLE 2
Familiarity with and Use of *SCI®*/*SSCI®*, and Evaluation of Citation Counts for Evaluating Scholars, by Field

Item	Biochemists	Sociologists	*t*-value
1. Familiar with *SCI*/*SSCI*	97% (98)	93% (106)	1.17
2. Ever consulted *SCI*/*SSCI*	65% (95)	71% (99)	−.83
3. Used *SCI*/*SSCI* to locate recent work on a topic by examining citations to earlier papers on that topic	52% (98)	50% (106)	.29
4. Used *SCI*/*SSCI* to determine how frequently particular individuals have been cited	39% (98)	51% (106)	−1.75
5. Mean evaluation of citation counts as a way to evaluate individual scholars' contributions (1 = not useful, 10 extremely useful)	4.41 (91)	5.40 (96)	−2.90
6. Percentage of departments that have ever used citation counts in decisions about hiring, promotions, or salaries	35% (34)	60% (30)	χ^2 3.91 (1 *df*)

[8]We believe that our choice of at least one member reporting use of *SCI* or *SSCI* is appropriate because not all members of a department may be aware of such use. Using different numbers who report that their department has ever used citation counts for a cutoff, or using a certain proportion, yields different percentages than those reported in Table 2, but does not alter the disciplinary difference it shows.

own citation count, field, and the interaction of field and citation count—other variables are likely to affect the two dependent variables. For example, for sociologists we included positive/negative orientation toward quantitative data to test our final hypothesis. In addition, we examined other potential independent variables for which we had data to learn if they appreciably affected our dependent variables. Two such variables—respondent's sex and the average citation count in a respondent's department—did.

We measured field and sex with dummy variables whose reference categories (coded zero) are respectively biochemists and males. Because biochemists receive considerably more citations than sociologists do, to avoid conflating effects of field and citation counts we measured the degree to which our respondents' work is cited with *field-specific standard scores* rather than with raw citation counts (see Hargens, 1976). Our measure of the average citation count for a respondent's department, a contextual variable, is the field-specific standard score of the *median* number of citations to the associate and full professors in the department. We used field-specific standard scores here too to control for field differences in citations. We chose the median to measure central tendency because citation counts within departments, as in entire fields, are highly positively skewed. To measure sociologists' orientations to quantitative data, we assigned those we categorized as qualitatively oriented a score of zero, those we categorized as mixed a score of 1.0, and those we categorized as quantitatively oriented a score of 2.0. Because only sociologists have scores on this variable, we made it independent of field by assigning all the biochemists the mean score for the sociologists (see Cohen, 1968, for a discussion of this method for handling missing data). Finally, in order to test our third hypothesis, we created a field-by-citations interaction term by multiplying these two variables.

Table 3 presents the results of regressing our two dependent variables, (a) whether one has consulted a citation index to count a particular individual's citations and (b) one's evaluation of citation counts as a measure of scholarly contributions, on the six independent variables discussed above. Because the first of these dependent variables is dichotomous, the assumptions of OLS analysis are not met (Hanushek and Jackson, 1977:179-186), so we carried out a logistic regression analysis. Thus, the results in the first column show the effects of each

TABLE 3
Regressions of Use and Evaluation of Citation Indexes for Pooled Samples of Biochemists and Sociologists

	Dependent variables			
	Logit of probability of using citation index to count citations		Evaluation of citation counts	
Independent variables	Coefficient	Coefficient/SE	Coefficient	Coefficient/SE
1. Citations to respondent's work	.18	.68	.51	1.76
2. Field (Biochemistry = 0)	.64	2.06	1.02	3.09
3. Field-by-citations to respondent's work interaction term	1.27	2.43	.15	.34
4. Median number of citations to members of one's department	−.45	−2.28	−.65	−3.19
5. Sex ($M = 0$)	−.29	−.61	−1.22	−2.19
6. Orientation to quantitative data	.69	2.23	.88	2.64
Constant	1.19	22.39	3.57	8.33
R^2		—		.15
N		(204)		(187)

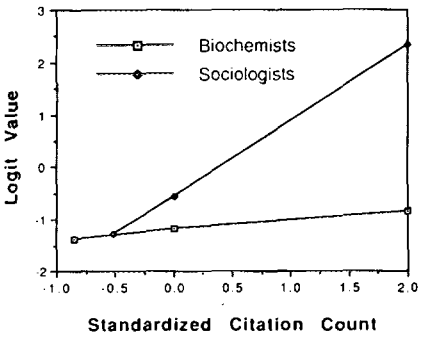

Fig. 1. Relation between Citations to One's Own Work and Logit Values for Using a Citation Index to Count Individual's Citations, by Field.

independent variable on the logit of the estimated probability that a respondent has consulted a citation index to count an individual's citations.

The coefficients in the first three rows and the first two columns in Table 3 bear on hypotheses 1, 2a, and 2b as those hypotheses pertain to having used a citation index to count individuals' citations. Specifically, the coefficient for the field-specific standardized individual citation counts (.18, n.s.) represents its slope for biochemists. The coefficient for "field" (.64, $p < .05$) represents the difference between the two regression lines for biochemists and sociologists who score at the mean of their respective field's citation distributions (i.e., those whose field-specific standardized citation counts equal zero). The coefficient for the interaction term represents the difference between the slopes for biochemists' and sociologists' citation counts (see Hanushek and Jackson, 1977:106-108).

Our first hypothesis, that the number of citations a researcher receives should be positively related to using citation indexes to count citations, is only weakly supported by the data for biochemists because the coefficient in the left column of line 1 in Table 3, although positive, is not statistically significant. The first hypothesis clearly holds for sociologists, however (line 3), and it is also clear that the relation between one's own citation count and use of citation indexes is significantly stronger among sociologists than among biochemists. Finally, line 2 shows that sociologists who received the mean number of citations for their field are more likely to have counted citations than biochemists who received the mean number of citations for their field. In order to show the results for the complete range of citation counts for the two fields, Fig. 1 presents the field-specific regression lines for cases with values of zero on the other three independent variables.[9] The results in Fig. 1 show that except for researchers with low standardized citation counts (who show no disciplinary difference in counting citations), sociologists are more likely to have done so than biochemists. Thus, the results in the two leftmost columns of Table 3 are consistent with the three hypotheses, except that the effect of one's citation count on the probability of having used a citation index to count citations is not statistically significant for biochemists.[10]

The results in the first three rows and last two columns in Table 3 address the extent to which the data support the three hypotheses regarding respondents' *evaluations* of citations as information about individuals'

[9]We chose values of zero for convenience; the pattern of results would be the same for any other combination of values for the other independent variables, although the values of the logit represented on the *y*-axis of the graph would vary if we chose different values. Note that Fig. 1 does not cover the entire range of the positive values of the independent variable since the results for higher values are just extensions of the two regression lines. Also, the two regression lines have left-hand endpoints corresponding to the field-specific standard scores for those who received no citations—for biochemists this lowest possible score equals −.85 and for sociologists, −.52.

[10]We explored whether additional interaction terms besides the field-by-citations received variable significantly improved our ability to predict counting citations by testing whether the set of all possible two-variable interaction terms significantly increased the coefficient of determination. Doing this increased that coefficient from .10 to .14, a nonsignificant increment (F equals 1.10 with 8 and 189 df).

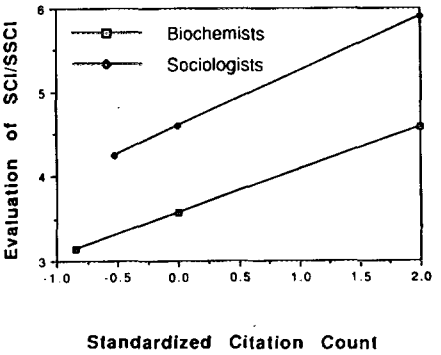

Fig. 2. Relation between Citation to One's Own Work and Evaluations of Citation Indexes, by Field.

scholarly contributions. These results indicate that (1) the number of citations both biochemists and sociologists receive are significantly positively related to their evaluations of citation indexes, (2) sociologists evaluate citation counts more highly than biochemists with equivalent standardized citation counts, and (3) the relationship between citations to one's work and evaluations of citation counts is *no* stronger among sociologists than among biochemists. Figure 2 presents these results graphically and shows that even among those who receive relatively few citations, sociologists evaluate citation indexes more highly than biochemists. The interaction term in this equation is not significant, so we also estimated an equation that omits it. The coefficients in the latter completely additive model were all within .02 of the coefficients reported in Table 3, except for citations to own work, which increased from .51 to .55 and became 2.2 times its standard error.

Thus, the results shown in Table 3 are consistent with hypotheses 1 and 2a, but only partly consistent with hypothesis 2b. We are unable to conclusively explain this exception, especially as the two dependent variables—counting citations and evaluations of citation indexes—are moderately positively correlated (for the two fields combined $r = .48$; for biochemists and sociologists separately, .48 and .44, respectively).[11]

In addition to the results pertinent to hypotheses 1, 2a, and 2b, Table 3 shows the effects of three other variables on our two dependent variables. The most noteworthy are those for the average citation level of one's department, whose effect can be interpreted as a contextual effect (Alwin, 1976).[12] Its significant negative effects in Table 3 indicate that respondents from departments whose members tend to be highly cited are *less* likely both to have counted individuals' citations, and to evaluate citation indexes as good sources of information about scholarly contributions, than respondents who have received the same number

[11]Adding all possible two-variable interaction terms to the equation increased the coefficient of determination from .15 to .20 ($F = 1.38$ with 8 and 172 *df*). Although one would normally conclude from this result that there is no substantial evidence that these interactions exist, one of the interactions in the set, field-by-median citations to the members of one's department, appears to differ significantly from zero ($t = 2.48$ with 172 *df*). The term shows that the relationship between evaluations of citation counts and departmental citations is weaker in sociology than in biochemistry (for sociology alone it still has a negative sign, but does not differ significantly from zero). When we added this term to the equation in Table 3, the coefficients for existing variables changed little and had *t*-values of at least |2.0|, except for the field-by-citations received interaction, which became negative but remained nonsignificant. We also note that when one analyzes the two fields separately, the slope for citations received is smaller in sociology than in biochemistry. Given the robustness of the findings for the "main effects" in Table 3 across alternate specifications of our model, and the consistent lack of significance for the hypothesized interaction term, we believe that our third hypothesis is not supported even though the sign for the interaction term shown in Table 3 is positive.

[12]Specifically, Alwin showed that when one includes both individuals' scores on a variable and organizational means for that variable in a regression model, the coefficient for the latter measures the difference between individual-level and organizational-level slopes for that variable. As noted above, however, in our study we used organizational medians rather than means.

of citations but who are located in departments whose members are cited less often. Since our measures of individuals' citations and average departmental citations are substantially positively correlated (r = .54), each of these variables exerts a "suppressor effect" on the bivariate relation between the other and the two dependent variables. One possible interpretation of this contextual effect is that it reflects a "frog pond" effect (Davis, 1966; Firebaugh, 1980) wherein low-cited respondents in highly cited departments tend to be more negative toward citation counts because such counts suggest that they are relatively weak members of their own departments. If this mechanism is operating, we would expect more highly cited faculty in departments whose members tend to be cited less frequently to be positive toward citation counts because the counts will confirm that they are doing well relative to departmental colleagues. Another possibility, however, is that regardless of their own citations, scholars in departments whose members tend to be highly cited tend to disparage citation counts because they believe them to be a poor measure of true scholarly contributions. Just as the wealthy disparage pecuniary wealth as only an imperfect signal of more important personal qualities (Veblen, 1899), members of highly cited departments may deny that simple citation counts accurately reflect their superior scholarship. Whatever the exact mechanisms that produce the negative effect of departmental citation levels on use and evaluation of citation counts, it is noteworthy that they work in opposition to the tendency for highly cited scholars to think well of such counts because such scholars tend to be found in highly cited departments.

Table 3 also shows that, as hypothesized, sociologists who are quantitatively oriented are more likely than those who are qualitatively oriented to have counted individuals' citations and to positively evaluate citation counts for measuring scholarly contributions. We did not predict the finding in Table 3 that women are significantly less favorable toward using citations to evaluate scholarly contributions than men. In part, this difference may be due to a tendency for women to emphasize the desirability of egalitarian rather than hierarchical social patterns (Chodorow, 1974), or for women to be more likely than their male colleagues to attribute career outcomes to uncontrollable causes rather than to personally controllable ones (Wiley, Crittenden, and Birg, 1979). Indeed, in some circumstances citation counts are not a sex-neutral measure of scholarly merit (Ferber, 1986).

Conclusions

Over the last two decades academics have increasingly used citation counts to measure the contributions of individual scholars. Indeed, our survey data suggest that a substantial proportion of biochemistry departments, and a majority of sociology departments, have used such information in hiring, promotion, and salary decisions. Our study investigated several possible sources of variation in individual's use and evaluation of citation counts as measures of scholarly contributions. We developed three hypotheses about such variation from social comparison theory. Of the six tests of these hypotheses, only one—that for hypothesis 2b using respondents' evaluations of citation counts—did not yield results consistent with the theory.

Of course, any one of our tests taken in isolation from the others, and from other results we present, is subject to possible alternative explanations. For example, one might argue that the results supporting hypothesis 2a stem not from a difference in consensus as we postulate but from other differences between sociologists and biochemists. One possibility might be that sociologists are more likely to count citations because they know this is a common practice among their colleagues who study social stratification in science. Data in Table 2 show that biochemists are as familiar with

citation indexes as sociologists, however, and that members of the two fields are equally likely to have consulted them for bibliographic purposes. In addition, the greater likelihood that sociology departments have used citation counts in personnel decisions suggests that more than familiarity is involved. Thus, we believe that our results generally support the hypotheses we developed from social comparison theory.

We advanced one other hypothesis: that sociologists whose style of work is qualitative, holistic, or theoretical would more often oppose using citations to evaluate scholarly contributions than those accustomed to using quantitative data in their own research. We tested this hypothesis by classifying sociologists in terms of their areas of specialization, and found that the results for both dependent variables supported it.

Thus, our analysis suggests that academics' ambivalence about citation counts as a measure of scholarly contributions stems from the interaction of individual and structural factors. Citation counts may appear to affirm or deny scholars' beliefs that their published work is valuable, and their reactions to citation counts tend to protect these beliefs. But use and evaluation of citation counts also varies by the level of consensus in a scholar's discipline, specialties' orientations about the value of empirical data, and the prestige of one's department. These and other sources of ambivalence toward citation counts are likely to continue to fuel controversy over their use as measures of scholarly contributions.

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