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Source: *American Sociological Review*, Vol. 55, No. 4 (Aug., 1990), pp. 469-478

Published by: American Sociological Association

Stable URL: <http://www.jstor.org/stable/2095801>

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## DEPARTMENTAL EFFECTS ON SCIENTIFIC PRODUCTIVITY\*

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*Productive scientists tend to hold jobs at prestigious university departments, but it is unclear whether this is because good departments hire the best scientists or because good departments encourage and facilitate research productivity. To resolve this issue, we studied the antecedents and consequences of 179 job changes by chemists, biologists, physicists, and mathematicians. Those who were upwardly mobile showed substantial increases in their rate of publication and in the rate of citation to those publications, while those who were downwardly mobile showed substantial decreases in productivity. Earlier analyses of these job changes found only a small effect of prior productivity on destination prestige. These results suggest that the effect of department affiliation on productivity is more important than the effect of productivity on departmental affiliation.*

Scientists at prestigious university departments tend to have higher rates of publication and higher rates of citation to those publications than scientists at lower-ranked departments (Cole and Cole 1973; Hagstrom 1968). How this correlation is produced is a matter of some disagreement, however. Previous work in the sociology of science has generally assumed that the association between productivity and departmental prestige occurs because better departments are more successful at recruiting and retaining productive faculty members. This explanation is consistent with the hypothesis that positions in science are allocated according to the norm of universalism, which requires that scientific rewards be distributed on the basis of merit rather than functionally irrelevant characteristics (Merton 1973, p. 272). To the extent that appointments to prestigious departments are rewarding, they ought to be allocated largely on the basis of past or anticipated productivity.

A somewhat less popular explanation is that better departments are able to encourage and facilitate the productivity of their members (Crane 1965; Long 1978). This could happen in three major ways:

1. *Facilities.* Many studies have found high correlations, at the departmental or university level, between institutional prestige and such factors as laboratory facilities, computer hardware, library holdings, graduate student ability, and time available for research (Hagstrom 1971; Cartter 1966; Clark, Hartnett, and Baird 1976).
2. *Intellectual stimulation.* Scientists depend on other scientists for suggestions and constructive criticism. Close contact with other outstanding scientists may provide ideas that stimulate a scientist's own productivity.
3. *Motivation.* Departments vary considerably in the allocation of rewards and punishments for productivity or lack of productivity (Reskin 1977). Prestigious departments may have more rigorous publication requirements for advances in rank and salary. Equally important may be the desire to maintain informal esteem among highly productive colleagues (Zuckerman 1967).

We shall refer to these two general types of explanation as the *selection hypothesis* and the *departmental effects hypothesis*. They are clearly not incompatible and, indeed, the idea of cumulative advantage emphasizes their mutually reinforcing effects (Cole and Cole 1973; Allison and Stewart 1974; Allison, Long and Krauze 1982). Yet there is a need to assess their relative importance. If the correlation between productivity and prestige is largely the result of departmental effects, then a reassessment of universalism in science may be called for. An intensive study of the specific charac-

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\* This research was supported in part by grants from the National Science Foundation (SES78-11406, SES85-10570). For helpful suggestions, we are indebted to Mary Frank Fox, Lowell Hargens and Rachel Rosenfeld. We also thank Warren O. Hagstrom for the use of his data. This paper was presented at the annual meeting of the American Sociological Association, Washington, D.C., August 1990.

teristics of departments that affect productivity would also be indicated. On the other hand, if selection is the major factor, efforts to increase scientific productivity by upgrading facilities may be less successful than anticipated.

Unfortunately, what distinguishes these rival hypotheses is simply the direction of the causal relationship between productivity and departmental prestige, and with nonexperimental data, questions of causal ordering are notoriously difficult to resolve. Most studies on this topic have been cross-sectional and therefore shed no light on the causal ordering. The longitudinal studies of Long, McGinnis and Allison, however, suggest that the predominant effect is that of departmental prestige on productivity. For a sample of biochemists who received degrees in the late 1950s and early 1960s, they showed that prior productivity had virtually no effect on where these scientists took their first or subsequent positions, whether they received postdoctoral fellowships, or where they took postdoctoral work (Long 1978; Long, Allison, and McGinnis 1979; Long and McGinnis 1981; McGinnis, Allison, and Long 1982). On the other hand, these same studies showed that the prestige and sector of a scientist's job substantially affected later productivity.

Despite advances in design over previous studies, the research of Long and his colleagues was limited in two important respects. First, they studied only biochemists, leaving open the question of whether the results generalize to other fields. Second, the bulk of their data was for scientists' first jobs, when they had had only a short time to establish a publication record. The analysis of second and later jobs was based on a sample of only 47 cases.

In a more recent longitudinal study, Allison and Long (1987) examined the determinants of destination prestige for 274 university job changes in four disciplines: physics, chemistry, mathematics, and biology. They found that number of prior publications had a modest and marginally significant effect on prestige of the destination job, controlling for the prestige of the origin job and several other variables. There was virtually no effect of number of citations on destination prestige. In the present study, we use the same data on job changes to examine the effect of prestige mobility on subsequent productivity.

## DATA

### *The Sample*

Our sample consists of 179 job changes<sup>1</sup> by scientists from one academic institution to another between 1961 and 1975. This sample originated in a survey of academic scientists conducted by Hagstrom (1974). He constructed a probability sample of 2,248 scientists in four disciplines who held faculty positions in graduate university departments in the U.S. in 1965. For all the scientists in this sample, we searched through several editions of *American Men and Women of Science* (Cattel Press, various years) for information about their educational background and subsequent career histories. Using the career history data, we selected all job changes meeting the following criteria:

1. Both origin and destination jobs were in university departments rated for faculty quality by Roose and Andersen (1970).
2. The move occurred between 1961 and 1975, inclusive.
3. The duration of both the origin and destination jobs was at least four years. This allowed sufficient time for departmental effects to operate.
4. Academic rank in the origin job was assistant professor or higher.

### *Prestige of Department*

To measure prestige of both the origin and destination departments we used the ratings of faculty quality obtained by Roose and Andersen (1970). Although these were published only as rankings, we obtained the unpublished three-digit mean scores for the departments in the study. These are properly regarded as prestige measures since they were obtained by surveying many faculty members in each discipline and asking them to rate the overall quality of the faculty in each graduate department on a five-point scale. We use the mean score multiplied by 100 to obtain a scale ranging from 0 to 500.

<sup>1</sup> This is smaller than the sample used in Allison and Long (1987) because approximately 100 of the destination jobs in that study were to colleges not rated in Roose and Andersen (1970). Of the 179 changes, 167 were made by single-move scientists with the remaining 12 coming from six scientists with two moves.

Table 1. Percent Distributions for Selected Characteristics of 179 Job Changes, 1961-75

Characteristic	Percent
<i>Field</i>	
Physics	17
Chemistry	26
Math	27
Biology	30
<i>Origin rank</i>	
Assistant professor	36
Associate professor	27
Full professor	37
<i>Destination Rank</i>	
Assistant professor	16
Associate professor	35
Full professor	49

The prestige of the departments from which scientists received their doctorates was measured by the ratings in Cartter (1966). These are quite similar to the Roose and Andersen ratings, except that they were made five years earlier. Again, we obtained the complete, unpublished three-digit scores for all rated universities.

### *Bibliographic Measures*

For each of the 179 job changes, we collected complete bibliographic data for all journal articles published by each scientist during the five years prior to the move and the five years after the move. These were obtained from the appropriate abstracting source for each discipline. For each *article*, we counted the number of times it was cited in the *Science Citation Index* (Institute for Scientific Information, various years), hereafter *SCI*. We use citation counts made three years prior to the move, in the year of the move, two years after, and five years after. For each of these years and for each scientist, we constructed counts of citations to all articles published in the preceding three-year interval.

By counting citations to articles rather than to scientists, we avoided two problems that have plagued most citation counts (Long, McGinnis, and Allison 1980). First, citations appearing under a given scientist's name in *SCI* are only to articles on which that scientist was first author. Our procedure, by contrast, yields citation counts to all articles regardless of authorship

Table 2. Means and Standard Deviations for Selected Characteristics of 179 Job Changes, 1961-75

Characteristic	Mean	S.D.
Ph.D. prestige	354.0	102.0
Origin prestige	304.0	88.0
Destination prestige	280.0	84.0
Origin publications	12.3	12.0
Destination publications	11.9	13.0
Citations, $t = -3$	2.7 <sup>a</sup>	---
Citations, $t = 0$	4.1 <sup>a</sup>	---
Citations, $t = 2$	4.1 <sup>a</sup>	---
Citations, $t = 5$	3.5 <sup>a</sup>	---
Year of move	1966.2	3.2
Career age	11.4	7.0
Age	38.7	6.9

<sup>a</sup>Geometric means are reported for citations. These were obtained by adding .5 to all scores, calculating the geometric mean, and subtracting .5 from the result. Standard deviations are not meaningful for geometric means.

position. Second, since *SCI* only identifies scientists by their first two initials, there is often confusion between different scientists with the same surname and initials. The problem is much less severe in locating articles in abstracting sources, since complete names (and often institutional affiliations) are listed, and because only a single discipline is involved. Once the correct articles are located, there is no longer a homonym problem when consulting *SCI*.

### *Other Variables*

The career history data also include several other variables that appear in some of our regression models as controls: the calendar year in which the move occurred, academic rank in the origin and destination jobs (coded as two dummy variables, one for associate and one for full professor), career age (year of the move minus year that the doctorate was awarded), and field (coded as a set of three dummy variables).

## ANALYSIS

Our aim is to determine whether changes in the prestige of the employing department result in changes in the rates of publication and rates of citation to those publications. Tables 1 and 2 give descriptive statistics for the 179 job changes. There is a decline of 24 points in mean

Table 3. Mean Number of Publications and Citations, Before and After a Job Change, By Level of Mobility

Mobility	N	Mean Publications		% Change	Mean Citations <sup>a</sup>		
		Before	After		Before	After	% Change
Up > 50	43	12.3	15.4	+25	4.7	6.5	+38
Up ≤ 50	30	8.4	8.0	-5	2.1	2.7	+29
Down ≤ 100	64	14.1	13.2	-7	4.3	3.6	-16
Down > 100	40	12.1	9.4	-22	5.3	2.3	-57

<sup>a</sup>Geometric means are reported for citations. These were obtained by adding .5 to all scores, calculating the geometric mean, and subtracting .5 from the result.

prestige from origin department to destination department. There is also a slight decline in the mean five-year publication count from 12.3 to 11.9.

Table 3 gives the central results of our analyses. We divided the sample into four groups according to the magnitude and direction of the prestige change: upward mobility of more than 50 points, upward mobility of less than 50 points, downward mobility of less than 100 points, downward mobility of more than 100 points. A more extreme cutpoint was chosen for the downwardly mobile because there were many more large downward moves.

For each mobility group, we calculated mean counts of publications and citations before the move and after the move.<sup>2</sup> The publication counts were five-year cumulations ending in the year of the move (the "before" measure) and in the fifth year after the move (the "after" measure). The citation measures were taken in the year of the move and five years later. Both citation measures were counts of citations to articles published in the immediately preceding three-year interval. For both outcome measures, there were dramatic differences between the upwardly and downwardly mobile. Scientists who moved up more than 50 points on the prestige scale increased their publication rate by 25 percent and their citation rate by 38 percent. Those who moved down more than 100 points experienced, on average, a 22 percent decline in publications and a 57 percent decline in citations.

<sup>2</sup> Arithmetic means were calculated for publications. Geometric means are used for citation counts because the extreme skewness of the distribution gives high scores inordinate influence on the arithmetic mean. Since geometric means cannot be calculated when some scores are zero, we first added .5 to all scores, calculated the geometric mean, and then subtracted .5 from the result.

To get a better picture of the long-term trend, we collapsed the mobility groups into upwardly and downwardly mobile, disaggregated the publication counts into annual counts, and included additional citation counts for three years before and two years after the move. Figure 1 shows the mean number of publications for each of the ten years surrounding the move, displayed separately for 76 downward moves, and 55 upward moves.<sup>3</sup>

For downward moves, the rate of publication is noticeably lower after the move. For upward moves, the rate of publication increases steadily after the move, from around two papers per year to nearly three papers per year. Thus, the downwardly mobile group published about one-half paper per year more than the upwardly mobile at the beginning of the series, but about one-half paper less at the end of the series. Figure 2 presents the same graph but restricted to those scientists whose moves resulted in more extreme prestige changes (more than 50 points up or down). As might be expected, the post-move differential in productivity is greatly increased.

Figure 3 presents similar results for citation counts. Here only four time points are available. Before the move, both the upwardly mobile and the downwardly mobile exhibit a sharp upward trend in citations per year.<sup>4</sup> After the move, the citation rate for the downwardly mobile declines dramatically, so that they end up a little lower than where they started out. For the upwardly mobile, there is a continuing increase after the move, so that the final citation rate is more than double the initial rate.

<sup>3</sup> Job changes were excluded if data were missing for any of the ten years.

<sup>4</sup> This steep rise for both groups may be due, in part, to a rapid increase in the number of journals included in the *Science Citation Index* during the early 1960s.

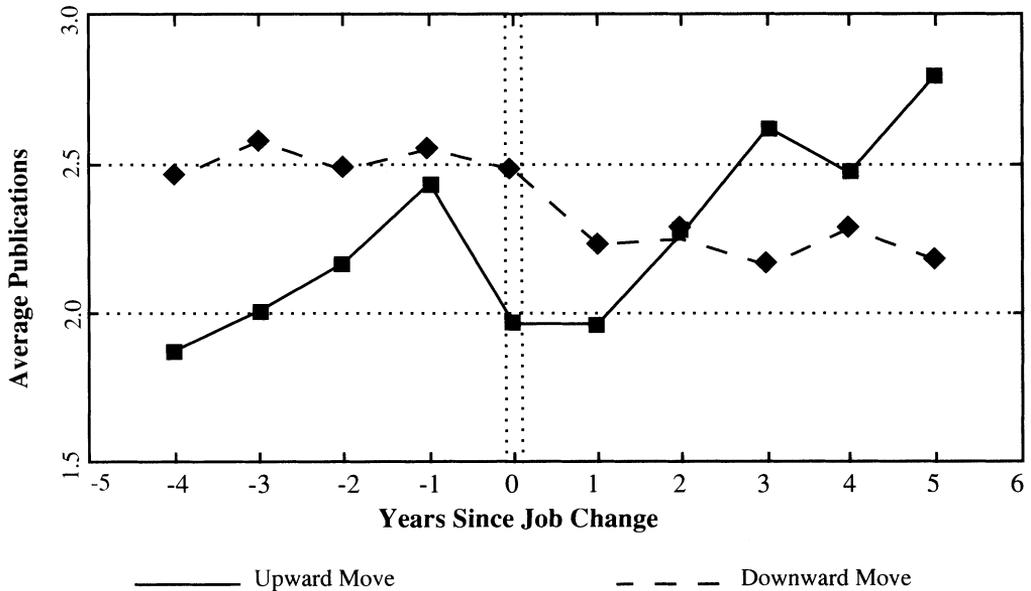


Figure 1. Publications by Years From Job Change

When the sample is restricted to moves of more than 50 points up or down, the graph (not shown) is virtually identical.

In all three figures, the upwardly mobile group starts out with lower productivity than the downwardly mobile group, a somewhat surprising pattern. This is because the downwardly mobile scientists started out at departments with higher prestige than the upwardly mobile scientists and, as we already know, prestige is correlated with productivity. The mean prestige of the origin department for the downwardly mobile scientists is 352, as compared with 263 for the upwardly mobile. This is almost certainly a ceiling/floor effect: scientists near the top of the prestige hierarchy have nowhere to go but down, while scientists near the bottom have many opportunities to move up. The outcome of their mobility is a neat reversal in relative position: upwardly mobile scientists have a mean destination prestige of 304, compared to 235 for the downwardly mobile. As the figures show, the prestige reversal is followed by a reversal in productivity measures by the fifth year after the job change.

These results are clearly consistent with the hypothesis that changes in the prestige of the job result in changes in publication and citation rates. But there are alternative explanations and unanswered questions that must be considered: Are these changes statistically significant or

could they have occurred by chance? Are there other variables that might account for all or part of the difference between the upwardly mobile and downwardly mobile? Are the changes in citation rate entirely a consequence of changes in the publication rate, or are there additional effects? Does the magnitude of the effect of mobility on productivity vary by academic rank or discipline?

#### *A Model for Productivity Data*

To answer these questions in a rigorous fashion, we first formulate a statistical model of the productivity process. Our model is an extension of models considered by Allison (1990) for the analysis of data with measurements at two points in time. Let  $Y_{it}$  be the number of publications (or citations) for person  $i$  at time  $t$ , where  $t = 1$  or  $2$ . Following Allison (1980), we assume this variable has a Poisson distribution with an expected value of  $\lambda_{it}$ . The Poisson distribution is particularly appropriate where the data are counts of "events" occurring in some interval of time. We also assume that the variables  $Y_{i1}$  and  $Y_{i2}$  are independent, conditional on the values of  $\lambda_{i1}$  and  $\lambda_{i2}$ . In a sense,  $\lambda_{i1}$  and  $\lambda_{i2}$  can be regarded as latent variables which mediate the effects of any other variables on  $Y_{i1}$  and  $Y_{i2}$ . Next, we must specify how  $\lambda_{i1}$  and  $\lambda_{i2}$  depend on those other variables. Since  $\lambda_{it}$

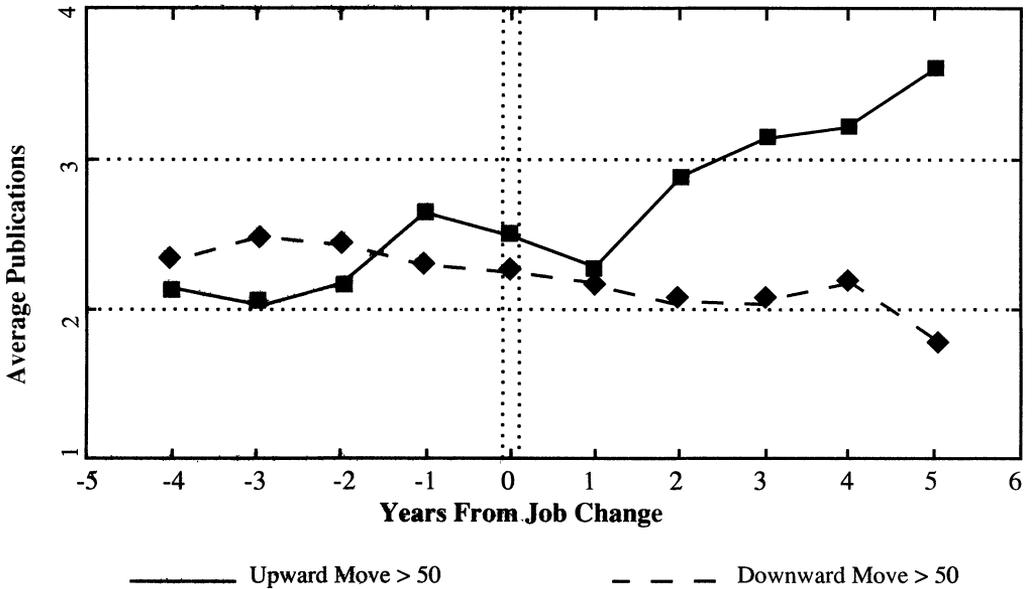


Figure 2. Publications by Years From Job Change for Moves of More Than 50 Points in Prestige

cannot be less than zero, we chose a log-linear specification:

$$\log \lambda_{it} = \beta_{0t} + \beta_1 X_{it} + \beta_2 W_i + \beta_3 Z_i \quad (1)$$

where  $t = 1, 2$

Equation 1 has three kinds of independent variables:  $X_{it}$  is a vector of variables that change in value from time 1 to time 2 but whose effects are the same at each time. Prestige of the department and academic rank are included in this set of variables.  $W_i$  is a vector of variables with constant values over time but whose effects are different at times 1 and 2. All other measured variables are potentially in this set. Finally,  $Z_i$  is a vector of variables with constant values and constant effects. This vector may include any unmeasured but stable characteristics of the scientists.

Next, we take the difference between the equations for time 1 and time 2:

$$\log \left[ \frac{\lambda_{i2}}{\lambda_{i1}} \right] = (\beta_{02} - \beta_{01}) + \beta_1 (X_{i2} - X_{i1}) + (\beta_{22} - \beta_{21}) W_i \quad (2)$$

This eliminates  $Z$  from the equation. Equation 2 can be estimated very simply by the method of conditional maximum likelihood. If we condition on the sum of  $Y_{i1}$  and  $Y_{i2}$ , we find that

$Y_{i2}$  has a binomial distribution with parameters  $N_i = Y_{i1} + Y_{i2}$  and  $p_i = \lambda_{i2} / (\lambda_{i1} + \lambda_{i2})$ . It follows that the logit of  $p_i$  is given by the right hand side of equation 2. Consequently, equation 2 can be estimated by a logit regression program for grouped binomial data.

There are two advantages of this technique over more conventional methods. First, it is tailor-made for the specific distributional features of the dependent variable — it does not assume a continuous distribution or impose linearity. Second, and more important, it controls for *all* stable, unmeasured variables, provided that their effects are constant over time. Thus, we needn't worry about whether these scientists had different ability levels or came from different ethnic backgrounds.

### Results for Publications

We applied this method to the publication data, with  $Y_{i1}$  = the number of articles published in the five years prior to the move and  $Y_{i2}$  = the number of articles published in the subsequent five years. Independent variables are those listed in Tables 1 and 2, with sets of dummy variables used for rank and field. Departmental prestige was entered as the destination score minus the origin score. For each academic rank (professor and associate professor), we took the difference between the dummy variables for ori-

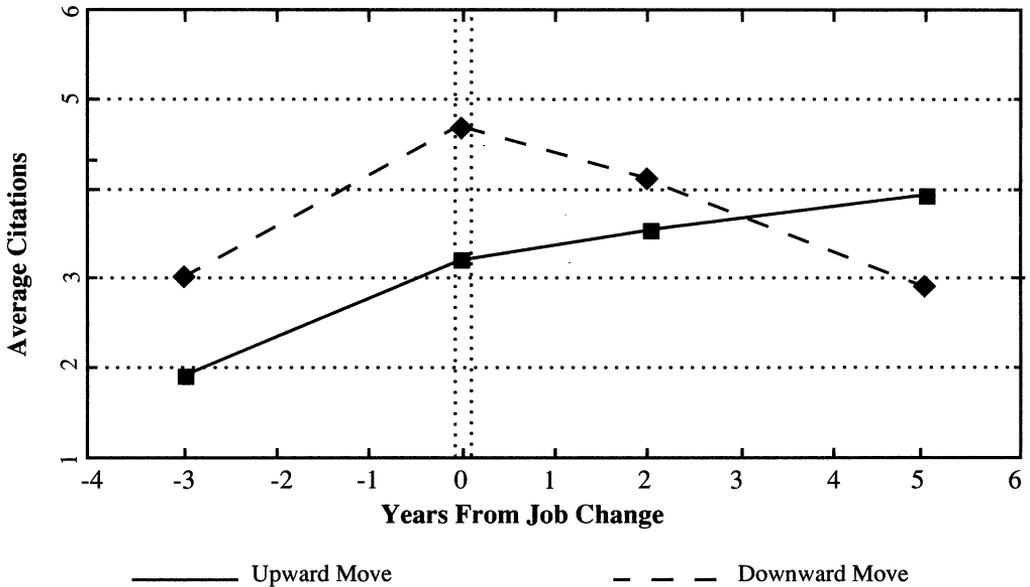


Figure 3. Citations by Years From Job Change

gin and destination.

Using a conventional logit program (SAS CATMOD), the  $\chi^2$  goodness-of-fit statistic was more than double the degrees of freedom ( $p < .0001$ ), suggesting that something was wrong with the model. While this has theoretical implications that will be discussed later, the practical implication was that the standard errors were grossly underestimated. To correct for this problem, we reestimated the model using a modified logit program that assumes the data have a beta-binomial rather than a binomial distribution (Allison 1987). (This problem was more serious for the analysis of citations where the  $\chi^2$  was typically more than six times the degrees of freedom. The same correction procedure was applied).

Many different models were estimated, but it is unnecessary to report the detailed numerical results here. The only variable that approached statistical significance at the .05 level (two-tailed test) was the difference between origin and destination prestige. When that was the only variable in the model, its coefficient was .0013 with a t-statistic of 2.53. When the other variables were entered in the model, the coefficient decreased to .0012 with a t-statistic of 2.38. To get an idea of what this coefficient means, we calculated the effect of a 10-point increase in prestige as  $100(e^{.012} - 1) = 1.2$  percent. This means that each 10-point increase on the pres-

tige scale should yield a 1.2 percent increase in number of publications per year. Similarly, a 100-point decrease in prestige would bring an expected 13 percent decrease in publication rate. (The decrease is not 12 percent because of the nonlinearity of the relationship).

What should we make of the fact that none of the other variables had significant effects? For the variables that were constant over time, the absence of significant coefficients does not mean that they do not affect publication rates, only that their effects on publications were also constant over time. Put another way, they were Z-variables in equation 1 rather than W-variables. For the other time-varying variable, academic rank, the null result suggests that rank has no effect on productivity. In some of the models, we included origin prestige along with the prestige difference, but its effect was virtually zero, corroborating our assumption that the effect of prestige on publication rates is the same for origin and destination departments.

We also fit models to test for the (log) linearity of the effect of prestige, but there was no evidence of any departure from the functional form in equation 2. Finally, we estimated models to test for interactions between prestige and academic field, prestige and career age, and prestige and academic rank. None of the interactions approached statistical significance.

*Results for Citations*

We repeated this process with citation counts as the dependent variable. In this case,  $Y_{i1}$  was the number of citations received in the year of the move to articles published in the previous three years.  $Y_{i2}$  was the number of citations received in the fifth year after the move to articles published in the previous three years. The results are similar to those for article counts. The only variable with a significant coefficient was the prestige difference. When it was the only variable in the model, its coefficient was .0040 with a t-statistic of 4.07. Including the other variables, the coefficient was .0038 with a t-statistic of 3.61. Using the exponential transformation described above, this coefficient translates to about a 4 percent increase in citations for each 10-point gain in prestige; or a 46 percent decrease for a 100-point loss in prestige. We found no evidence of nonlinearity, interactions with other variables, or change in the effect of prestige from origin to destination. We also replicated the analysis with  $Y_{i2}$  equal to the number of citations in the second year after the move, rather than the fifth year. The results were virtually identical, except that the effect of prestige change was somewhat weaker, with a coefficient of .0027 and a t-statistic of 3.55.

To receive citations, a scientist must first publish articles. Perhaps the effect of prestige on citations is merely a consequence of the effect of prestige on the number of publications. To test this hypothesis, we estimated a model for citations with two independent variables: the difference in prestige, and the difference between the (logged) number of publications in the five years before and five years after the move.<sup>5</sup> The difference in publications had a very strong effect with a t-statistic of 7.12. Its coefficient of 1.11 is very near the 1.00 that would obtain if the number of citations were directly proportional to the number of publications. The coefficient for prestige declined from .0040 to .0027, but was still highly significant with a t-statistic of 3.05. We conclude that the effect of prestige on the number of citations is only partially explained by its effect on the number of publications. The residual effect of prestige on citations is still greater than its effect on publications.

<sup>5</sup> Since the logarithm of zero is undefined, a constant of .5 was added to all publication counts before taking the logarithm.

## DISCUSSION

When academic scientists change institutions, those who move up in departmental prestige tend to show an increase in both the number of publications and the number of citations; those who move down suffer corresponding decreases in productivity. The effects are substantial, especially for citations, and approximately (log) linear. There is little evidence of differences by discipline in the effect of prestige, although that may be a consequence of the relatively small sample size. The effect of prestige on citations is a consequence of both a change in the number of publications and a change in the number of citations per publication. Academic rank has no detectable effect on these productivity measures.

Can we conclude that prestige causes productivity? To answer that, we need to consider the merits of some alternative explanations. At first glance, we can reject the claim that the direction of causality is the reverse, that productivity changes cause the prestige changes. Changes in the productivity measures clearly occur after prestige changes. But there is a way to salvage this explanation: Perhaps prestigious departments search out and recruit scientists who are on an upward productivity trend; or perhaps scientists who are on an upward productivity trend invest special efforts in improving their employment situation. These are plausible hypotheses, although anyone who has sat on a departmental hiring committee might be skeptical of recruiters' ability to detect and exploit such productivity trends. Moreover, the patterns in Figures 1 - 3 do not offer much support for these hypotheses. For citations, the pre-move trend is virtually identical for the upwardly and downwardly mobile. For publications, it appears that there is a slight tendency for the upwardly mobile scientists to have an upward trend in publications before the move, together with a slight downward trend in pre-move publications among the downwardly mobile scientists. These differences are not statistically significant, however.<sup>6</sup>

A second alternative explanation is that some omitted variable associated with the prestige changes also affects productivity. The poor fits obtained with conventional logit estimation strongly suggest that important variables were

<sup>6</sup> Hotelling's  $T^2$  was used to test the null hypothesis that the two lines are parallel (Morrison 1976, p. 155).

omitted from the model. What might those variables be? The model itself controls for all variables that are stable over the study period and whose effects are stable. That leaves variables whose values or effects change with the move. Clearly, many things change when a scientist moves from one university to another, but we have included only two such variables, departmental prestige and academic rank. Many of these variables — such as quality of laboratory facilities or productivity of one's colleagues — are associated with departmental prestige, which is entirely consistent with our hypothesis. We regard prestige as merely a proxy for these more proximate conditions in a scientist's working environment. It is difficult to imagine variables that are associated with prestige but do not fall within our categories of facilities, intellectual stimulation, and motivation.<sup>7</sup>

Thus, while the poor fit of our models suggests that we have not done a good job of measuring and incorporating factors that affect productivity, our basic hypothesis, that academic context influences productivity, is not necessarily discredited. We hope our confirmation of that hypothesis will stimulate others to tease out the specific factors that are most important (e.g., see Fox, forthcoming).

In an effort to see what it is about prestigious departments that affects productivity, we take a closer look at interactions with academic field. Three of the four fields studied — physics, chemistry, and biology — are heavily dependent on laboratory facilities, and we might expect departmental variation in these facilities to have a major impact on productivity. For mathematicians, on the other hand, the major departmental factors affecting productivity ought to be intellectual stimulation and motivation. If prestige mobility has weak or nonexistent effects for mathematicians but strong effects for the other fields, it would suggest that facilities are the most important departmental characteristic affecting productivity.

As already mentioned, there were no significant interactions of mobility with field in either the publication or citation models. It is worth

examining the coefficients, however, since the absence of statistical significance may simply reflect the modest sample size. Decomposing the effect of prestige mobility on publications by field, we get math .0003, physics and chemistry both .0013, and biology .0021. The picture is similar for citations: mathematics .0027, biology .0035, physics .0041, and chemistry .0042. These results are consistent with the hypothesis that facilities make the difference. Nevertheless, another result suggests there may be other effects as well. When we decomposed the effect of mobility on citations, *controlling for number of publications*, the pattern is very different: mathematics .0040, physics .0040, chemistry .0024, and biology .0008. It appears that mathematicians experience the strongest effect of prestige mobility on *citations per paper*. These results suggest that facilities affect the number of publications while other factors (motivation and intellectual stimulation) have greater impact on the "quality" (as measured by citations) of the work published. In any case, this interpretation must remain highly tentative in view of the lack of direct measures of these factors and the absence of statistically reliable field differences.

The effect of mobility on citations raises another important question that this paper cannot adequately answer. Departmental prestige appears to affect both the number of publications and the number of citations per publication. Is the effect on citations due to an increase in the "importance" of the work itself or merely a consequence of the greater visibility enjoyed by scientists at prestigious universities (Cole and Cole 1973)? This question is difficult to answer because we have no measures of importance that are independent of citation counts. On the other hand, articles published *before* a scientist changes institutions do not change in their intrinsic merit, but could experience a change in citation rate. If early articles of upwardly mobile scientists receive more citations after a move, we might ascribe this to increased visibility. However, we find no evidence for such an effect. When we estimated models in which counts of citations to recent publications were subtracted from counts of citations to all earlier publications, prestige mobility had no effect. Again, however, we caution against making too much of these results. There could still be major effects of visibility on citations to articles published after a move.

The results reported here and in Allison and

<sup>7</sup> An anonymous referee suggests that getting a job at a prestigious institution is likely to be intrinsically rewarding, and that the consequent "reinforcement" may spur a scientist to greater productivity. Such a motivational effect would operate independently of the actual working conditions at the destination department.

Long (1987) tend to corroborate the earlier findings of Long and his colleagues. Where scientists work makes a big difference in how much they publish and how frequently their work is cited. On the other hand, scientists' prior publication and citation records have, at most, a marginal influence on the prestige of jobs they obtain.

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