AMERICAN ECONOMIC REVIEW

VOL. LVIII, NO. 5 PART 2 DECEMBER, 1968

SUPPLEMENT

STUDIES OF THE STRUCTURE OF ECONOMISTS' SALARIES AND INCOME

N. ARNOLD TOLLES AND EMANUEL MELICHAR

Price $1.00

STUDY II

FACTORS AFFECTING 1966 BASIC SALARIES IN THE NATIONAL REGISTER PROFESSIONS[1]

Does Profession Have a Net Influence On Salaries?

The 1966 National Register of Scientific and Technical Personnel obtained salary information from nearly 200,000 individuals who were employed on a full-time basis in civilian work.[2] Most registrants also supplied other data describing their scientific specialities, employer, work activity, education, experience, age and sex. Average basic salaries varied considerably among the various classes of these characteristics. For example, among the 13 major professions into which registrants were grouped, economists had the highest median salary, $13,100, as compared to medians of $12,000 for all registrants, and at the low end of the range, $10,000 for persons in linguistics and the agricultural sciences.

In viewing such data, one becomes curious whether a net influence on salary can actually be attributed to the characteristic in question—in this case, the scientific specialty. Did membership in the economics profession itself suffice to yield a higher salary or, perhaps, did the higher median merely reflect the fact that, as compared to all registrants, a higher proportion of economists had advanced academic degrees, more worked as managers, fewer were in the young age brackets, and fewer were women? These factors would tend to raise the average salary in the profession. But on the other hand, a higher percentage of economists were in teaching, worked for educational institutions, and were paid for an academic year only—and these characteristics would tend to lower the average salary. Did these latter influences more than offset those of the salary-augmenting factors, so that a net positive influence could still be attributed to the professional classification itself?

The net effect of the profession was quantified by estimating a regression model in which profession and six other salary-influencing characteristics were represented. The higher pay of economists was found to be largely unexplained by the other characteristics; with the latter held constant, economists tended to receive salaries 12 per cent above the geometric mean salary for all professions. But economics was not the profession with the largest positive net influence on salaries, being surpassed by mathematics for this distinction.

[1] By Emanuel Melichar.

[2] From the 242,763 registrants in the 1966 National Register, this study excluded persons not employed full-time, those working for the military services or the Public Health Service, members of religious orders, and persons who did not report salary.

Table II-1 first shows the median salary in each profession as published by the National Science Foundation, and also the geometric mean salary. The ranking of the professions was substantially the same by either measure. The third column shows a "standardized" geometric mean salary for each profession as obtained from the estimated regression model. Each standardized figure represents an estimate of what the geometric mean salary would have been had the respondents in that profession been distributed among the classes of the six other characteristics in the same proportions as all respondents in the study. This figure was obtained by applying the regression coefficient estimated for the profession to the national geometric mean salary of $12,050 for all professions combined.

As noted, membership in the profession of mathematics was associated with the highest positive net influence on salaries among the 13 professions studied. By experimenting with models containing alternative combinations of the other explanatory characteristics, it was found that the positive effect attributed to mathematics was markedly en-

TABLE II-1—RANKING OF PROFESSIONS BY ACTUAL AND STANDARDIZED SALARY AVERAGES
All Professions—1966 National Register

Profession	Average Salary		Standardized geometric mean	Ranking of professions by—		
	Median	Geometric mean		Median	Geometric mean	Standardized geometric mean
Mathematics	12,000	12,100	13,700	4[a]	6	1
Economics	13,100	13,600	13,400	1	1	2
Statistics	12,800	12,800	13,100	2	2	3
Physics	12,500	12,400	13,000	3	3	4
Anthropology	11,500	11,800	12,200	8[b]	8	5
Meteorology	11,700	11,900	12,000	7	7	6
Sociology	11,300	11,600	12,000	11	11	7
Psychology	11,500	11,700	11,900	8[b]	9	8
Earth sciences	11,400	11,700	11,700	10	10	9
Chemistry	12,000	12,100	11,500	4[a]	5	10
Biological sciences	12,000	12,300	11,500	4[a]	4	11
Linguistics	10,000	10,000	11,200	12[c]	13	12
Agricultural sciences	10,000	10,300	10,200	12[c]	12	13
Other	12,000	12,100	12,500	—	—	—

[a] Tie for 4, 5, and 6.
[b] Tie for 8 and 9.
[c] Tie for 12 and 13.

hanced by inclusion of highest academic degree in the model, and to a lesser extent was also increased by inclusion of age. A subsequent check of published distributions showed that the analysis was adjusting for the fact that there were relatively fewer Ph.D. degrees and more Master's degrees among mathematicians than among all registrants combined, and also for the fact that 51 per cent of the mathematicians were under 35, as compared with 37 per cent of all registrants. Some clues to important intercorrelations are thus garnered by observing the effect that addition of a specific characteristic to the model had on the regression coefficients estimated for each of the other characteristics. The more prominent findings of this nature are reported herein as part of the discussion of each characteristic.

In addition to the net influence of the professional classification, the net salary effects of other characteristics are also of interest. For instance, an intriguing case is posed by the median salaries of $10,700 for persons with the Master's degree and $11,000 for those with only a Bachelor's degree. Do these correctly indicate the relative net value of the two degrees in the marketplace? Or does the Master's degree really tend to give its owner a net salary advantage, when one considers how the holders of these degrees are distributed by work activity, type of employer, and other characteristics?

A Salary Model

The search for the net relationship between salaries and each of seven major characteristics on which data were obtained was approached through multiple regression of the selected characteristics on salary. A dummy variable was used to represent each class of each characteristic, a necessity in the case of characteristics with discrete classes, and a convenience in working with age and years of experience, for which nonlinear effects were expected.[3]

The design of the regression model was considerably influenced by experience obtained in similar analysis performed earlier on 1964 data for economists only.[4] The logarithm of salary was used as the dependent variable, so that the net influences of the characteristics would be measured in proportional rather than absolute terms, with their cumulative effect multiplicative rather than additive. The earlier work had shown that a logarithmic model would better reflect salary structure, at least for economists.

[3] For a detailed description of the regression technique and also additional references, see Emanuel Melichar, "Least-squares Analysis of Economic Survey Data," *1965 Proceedings of the Business and Economic Statistics Section,* American Statistical Association, Washington, D.C.

[4] "The Structure of Economists' Employment and Salaries, 1964," *American Economic Review,* Vol. LV, No. 4, Part 2 Supplement, pp. 63–70.

The analysis of data for economists also revealed that type of employer and years of experience interacted in affecting salaries in this profession. It was found that net salary variation ascribed to type of employer differed according to level of experience, and conversely that the net progression of salary with added experience differed for major employer groups (the progression in business and industry was much sharper than in educational institutions and government). In the expectation that similar interaction of a major nature might be found in the salary structure for all professions, the influence of experience on salary was measured separately for persons in three employer groupings: educational institutions, governments, and other (primarily industry and business). In the regression model this was accomplished by providing for each group a separate set of variables to represent the length of experience.

The expectation of a two-way interaction between employer and experience, however, was largely unfulfilled in the study of all professions. This finding is in itself of much interest, but it also serves to introduce a cautionary note about the analysis conducted. The divergent results for economists and for all professions are evidence of three-way interaction among profession, type of employer, and years of experience. The model used in the all-profession analysis did not allow for the possibility of such interaction—in other words, the differences in progression of salaries with added experience among economists are not revealed by the model reported in this chapter. Other interactions among the seven characteristics undoubtedly exist, and are similarily unrevealed because the model does not provide for their existence. It is naturally hoped that these interactions are minor in nature, but the reader is cautioned that no work was performed to verify this conjecture.

In addition to being influenced by the previous study of economists, the design of the model was necessarily affected by the very limited resources devoted to this project. The structural characteristics used in the analysis undoubtedly represent the more important and general influences on salaries, but (at proportionately greater cost) the role of other variables could have been explored. Among these are such intriguing possibilities as the colleges attended by the respondents, their major and minor subjects, the institutions for which they now work, their secondary work activity, the profession in which they class themselves and the profession in which they are currently employed (in contrast to the one in which they have the greatest scientific competence, which was used in the analysis reported),[5] the professional societies to

[5] *Cf.* Study IV of this series for an analysis of the influence on economists' salaries (and professional incomes) in 1964 of eight distinctive definitions of that profession.

which they belong, and the geographic area in which they were born, or where they were educated, or where they are currently working. Obviously, as with the incorporation of possible interaction effects, the line had to be drawn somewhere; we simply note that in both cases it was drawn early and with no experimentation to determine the importance of the characteristics and interactions that were being omitted.

If additional work with these data were to reveal another important relationship, the findings for other characteristics in the model might be somewhat altered from those reported herein, but probably not to a worrisome extent. The principal characteristics already included in the study—degree, employer, experience, work activity, and profession—almost certainly dominate others that could be derived from the data collected. And for certain personal characteristics that might have important effects on salaries—intelligence, ambition, and so forth—no data were available in any event.

Relative Importance of the Characteristics

The seven characteristics used in the model, represented in the regression equation by 58 independent variables, explained 54 per cent of the total variation among the logarithms of salaries. A measure of the contribution of each characteristic toward explanation of salary variation is provided by the coefficients of partial determination shown in the first column of Table II-2.

TABLE II-2—IMPORTANCE OF SELECTED CHARACTERISTICS IN EXPLAINING VARIATION IN PROFESSIONAL SALARIES
All Professions—1966 National Register

Characteristic	Net relationship		Gross relationship		Number of variables used
	Partial R^2	F-ratio	R^2	F-ratio	
Highest academic degree	.159	9260	.065	3439	4
Years of experience and type of employer	.149	1185	.340	3492	29
Profession	.066	1062	.017	263	13
Primary work activity	.065	3417	.146	8399	4
Sex	.024	4923	.037	7474	1
Age	.019	555	.243	9021	7

Note: All relationships are significant at the .01 probability level.

The greatest effect was exerted by the level of the highest academic degree held by the respondent. Almost equally important was the combined influence of type of employer and length of professional experi-

ence, whose effects are not reported separately because of the interaction variables included in the model.[6]

Considerably less important than these factors, but still exerting major influences, were the profession and the primary work activity. Sex was of minor importance in explaining total salary variation, but only because of the relatively small proportion of women among the respondents. The difference between salaries of men and women was highly significant, as demonstrated by the F-ratio reported in the second column of Table II-2. Age was relatively unimportant, once length of professional experience was already represented in the model.

As shown by the F-ratios, all seven characteristics were statistically significant far beyond the .01 probability level. Even minor contributions to explanation of variation, it seems, were statistically significant in this analysis, based as it was on 196,428 observations.

Table II-2 also shows the R^2 and F-ratio calculated for the gross relationship between salaries and each characteristic. (The gross relationship is defined as that found for a single characteristic when no other characteristics are taken into account; i.e., the percentage difference between the geometric mean salary of all registrants and that of the registrants in each class of the characteristic.) For five characteristics, net influence on salaries was less important than one might have assumed from study of the gross relationship only, as part of the apparent effect was found to be attributable to other influences. Age, in particular, was found to have only minor net effect after length of professional experience was considered. Net influences of work activity, sex, and the employer-experience combination were also smaller than the gross. However, the full influence of the level of academic degree emerged only in the net relationship, having previously been obscured by intercorrelation with the employer-experience characteristics. The influence of profession was also more marked in the net than in the gross relationship.

The Net Relationships

The regression coefficients obtained through estimation of the model describe the nature of the net relationships. Each coefficient is expressed as the net percentage difference from the overall geometric mean for all professions, which was $12,050. Thus each coefficient shows the net percentage effect on salary that was associated with

[6] For eight variables representing only employer types, including the academic year—calendar year dichotomy at educational institutions, the coefficient of partial determination was .041. For 21 other variables representing years of experience separately for each of three major employer groups, the coefficient of partial determination was .054.

membership of a registrant in the class to which the coefficient applies. In this section, the values are reported in the tables and also charted.

Type of employer. Net coefficients for employer-experience groups are shown in Table II-3 and are charted in Figure II-1.

Being paid on an academic year basis by an educational institution had the expected depressing effect on basic salaries. Many respondents in this group earned additional income during the remaining months of the year, but these earnings were not included in the salary data.[7] Employment on a calendar year basis tended to raise salaries by 12 per cent over those based on an academic year.

Among employers hiring on a full-year basis, state and local governments tended to pay the least, about 6 per cent less than calendar-year salaries at educational institutions. Jobs with the Federal government or with nonprofit organizations tended to yield 17 per cent more than those with other governments, and about 9 per cent more than the full-year positions at schools and colleges.

Industry and business tended to pay considerably higher salaries than other major employers—about 11 per cent more than the Federal government and 21 per cent more than calendar-year salaries at educational institutions. Self-employed individuals tended to have even higher salary earnings—about 13 per cent above persons employed by industry.

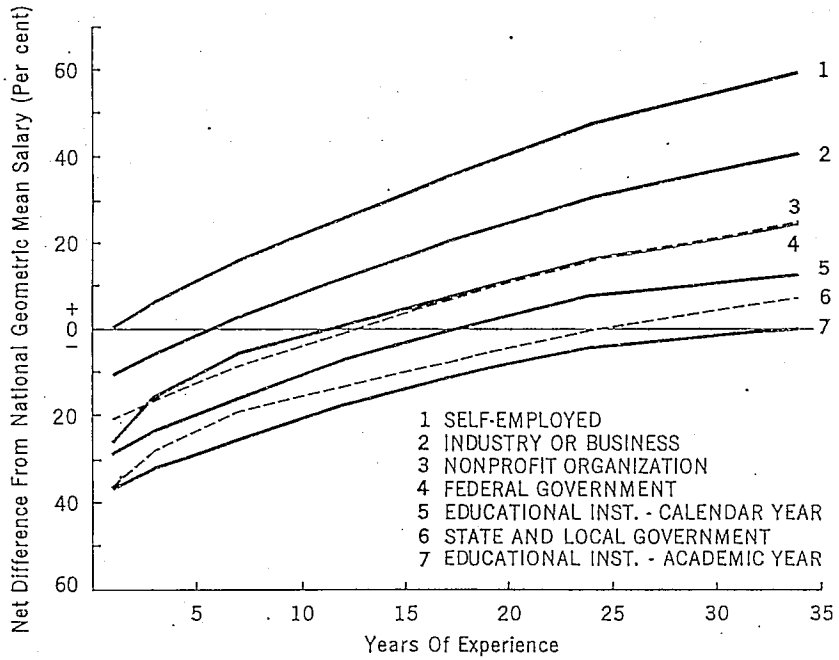
TABLE II-3—NET RELATIONSHIP BETWEEN PROFESSIONAL SALARIES AND EMPLOYER-EXPERIENCE CHARACTERISTICS
All Professions—1966 National Register

Type of employer	Years of experience						
	1 or less	2 to 4	5 to 9	10 to 14	15 to 19	20 to 29	30 and over
	Percentage difference from national geometric mean						
Educational institutions:							
Academic year base....	−36.6	−31.9	−25.7	−17.6	−11.5	−4.3	0
Calendar year base....	−28.8	−23.4	−16.5	− 7.3	− .5	7.6	12.4
Government:							
Federal.....	−26.0	−15.8	− 5.7	.9	7.2	16.0	24.7
Other.....	−36.5	−27.8	−19.1	−13.5	− 8.0	− .5	7.0
Other employer:							
Nonprofit organization.	−20.9	−16.7	− 9.0	−11.2	6.5	15.6	24.8
Industry or business...	−10.8	− 6.0	2.7	11.5	20.2	30.5	40.8
Self-employed.....	.7	6.1	15.9	25.9	35.7	47.4	59.0

[7] Cf. Study I of this series for an analysis of the relationships in 1964 between the total professional incomes and the basic salaries of the economists.

FIGURE II-1

NET RELATIONSHIP BETWEEN PROFESSIONAL SALARIES AND YEARS OF EXPERIENCE, BY EMPLOYER GROUPS - ALL PROFESSIONS, 1966 NATIONAL REGISTER



In evaluating the net influence of employer group on salaries, note particularly that both work activity and level of academic degree were included in the model. If work activity had not been represented, the gap between educational institutions on the one hand and governments, nonprofit organizations, and business employers on the other would have been substantially wider. In the model reported, part of this relationship was picked up by the teaching and management variables of work activity. The reverse effect on net salary differences among employers resulted from inclusion of variables representing academic degrees—the net gap between business and academic salaries widens when the model takes account of the higher proportion of advanced degrees among the academicians.

Experience. As already noted, the effect of experience on salaries was estimated separately for three employer groups—educational institutions, government, and all other employers. Industry and business dominated the latter grouping, but over 10 per cent were employed by nonprofit organizations and small proportions were self-employed, worked for "other" employers, or did not report their employer.

The progression of salary with additional experience was much the same for each of these major groups, as inspection of Figure II-1 readily conveys. In both educational institutions and industry, the posses-

sion of 30 or more years of experience was associated with a net salary advantage of 58 per cent over persons just beginning their professional career. The total net gain in government was estimated at 68 per cent, but the greater total progression was all accounted for by the greater advantage that persons with 2 to 4 years of experience had over those just starting. If the span between one year of experience and "30 and over" is assumed to cover 33 years, then the average annual net progression was 1.4 per cent at educational institutions and in business, and 1.6 per cent in government.

In each employer group, the net annual rate of salary progression attributed to experience was relatively high early in the career and decreased steadily at higher experience levels. At educational institutions, the annual rate was 2.7 per cent over the first six years of experience, 1.8 per cent over the next 10 years, and 0.7 per cent over the next 17 years. In government, it averaged 4.1 per cent during the first six years, but fell off to 1.3 per cent over the next ten years and 0.9 per cent during the following 17 years. Business salary progression attributable to experience proceeded at annual rates of 2.4 per cent during the first six years, 1.6 per cent over the next 10 years, and 0.9 per cent over the subsequent 17 years.

In evaluating these net progressions of salary with added experience, one should be particularly aware that a net influence attributable to increased age has been excluded, having been separately estimated. With age left out of the model, the salary progression attributed to experience would have been greater in total over the career range, much steeper during the early years of experience, and flatter at high levels of experience, particularly at educational institutions.

The presence in the model of variables representing work activity and level of academic degree also influenced the net salary progression attributed to experience. If the primary work activity had not been included, the salary progression would have been steeper at advanced levels of experience. With work activity included, some of this apparent progression was ascribed to movement of registrants into management positions, rather than simply to added experience. The introduction of academic degree into the equation had a more complex effect; it reduced the progression attributed to age but simultaneously increased the progression ascribed to experience. The effect on age was larger, and so the overall effect was to reduce net salary progression related to the passage of time, by attributing part of the gains to the attainment of higher degrees.

Academic degree. The academic degrees attained by a respondent accounted for more of the variation among professional salaries than any of the other characteristics studied. Their apparent influence on sa-

ries was enhanced rather than reduced by including other characteristics, especially employer and experience, in the model. Regression coefficients for degree and the remaining characteristics are shown in Table II-4 and charted in Figure II-2.

A professional medical degree tended to reward its holder with a considerable salary advantage over any other degree—for instance, 20 per cent over the Ph.D. However, only 2.5 per cent of the registrants held a medical degree.

The Ph.D. led to a net salary advantage of 26 per cent over the Master's degree and 34 per cent above the Bachelor's. A Master's degree brought a 6 per cent advantage over the Bachelor's degree, thereby reversing the gross relationship mentioned earlier.

Primary Work Activity. Work in management had a pronounced positive net effect on salaries, tending to raise them 17 per cent above those in research, 22 per cent over those paid in production and inspection, and 27 per cent higher than in teaching. Work in research offered a 9 per cent advantage over teaching and a smaller edge over production and inspection.

These net effects were substantially smaller than the gross relationships. Taking account of experience, employer, and level of academic degree all pared the influence remaining attributable to the primary work activity.

Age. Age is obviously intercorrelated with length of experience and also with level of degree held (a smaller proportion of young workers hold an advanced degree). When these two characteristics are also in the model, the influence of age is much reduced from the apparent gross relationship. The remaining effect, however, has the same general pattern—a rather strong positive progression of salary with advancing age in the early years, then a small positive effect continuing into middle age, and finally a gradual negative influence. In the net relationship, however, the downward trend starts around age 50, whereas in the gross relationship the influence of added experience keeps salaries rising until 65 or so.

The greatest negative influence exerted by age occurred in the youngest age category studied, while the peak positive influence occurred in the 45 to 54 age group. Between these two groups, the total net salary progression attributed to advance in age amounted to 21 per cent, or about 1 per cent per year. In the first five years of this period, however, the annual rate of progression averaged 1.9 per cent, whereas by the last seven years it had fallen to only 0.2 per cent.

After age 50, advancing age exerts a slight negative influence on salary progression. The decline apparently accelerates after age 65, but the annual rate between the two most advanced age classes studied was

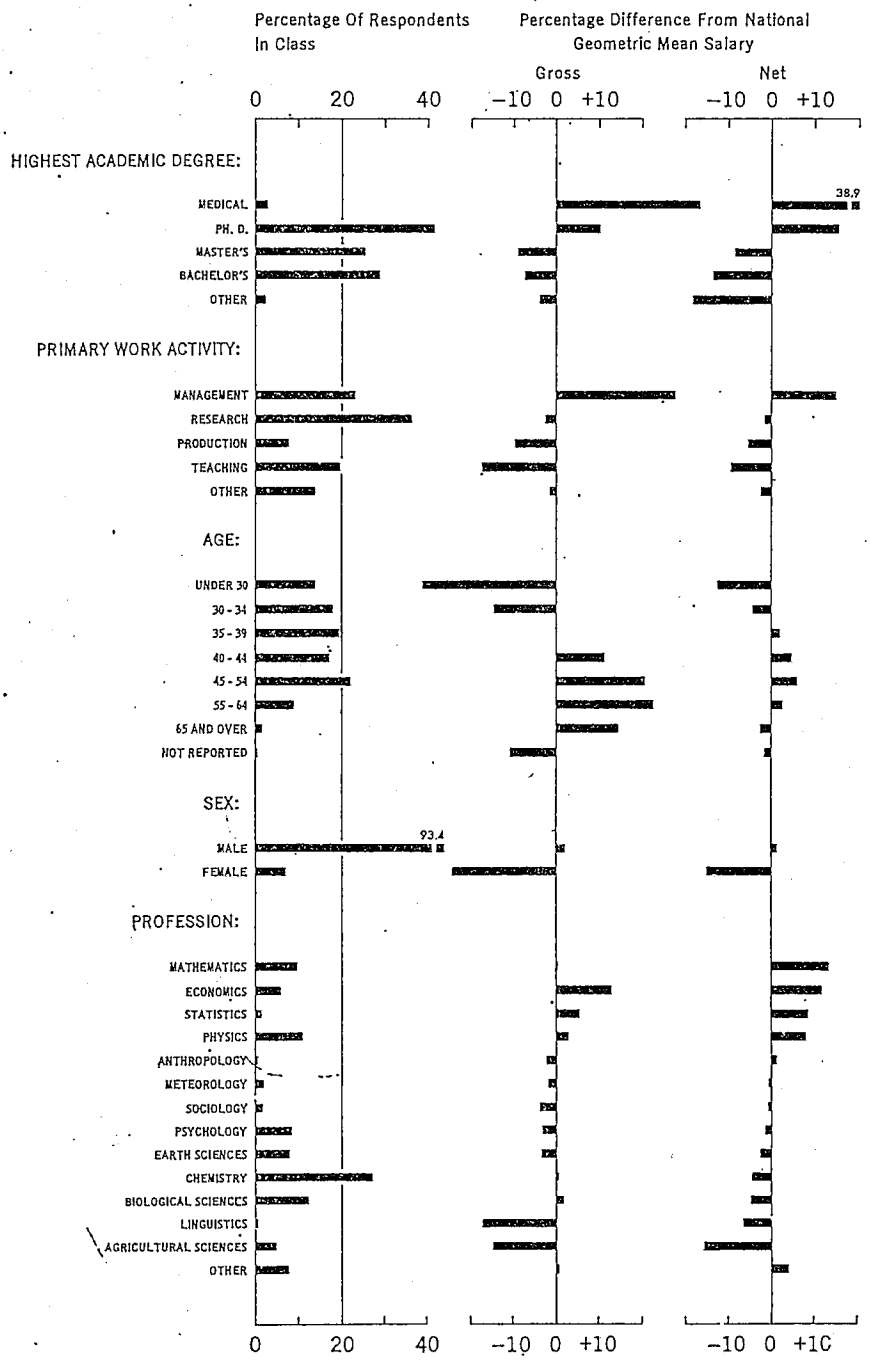
TABLE II-4—RELATIONSHIPS BETWEEN PROFESSIONAL SALARIES AND SPECIFIED CHARACTERISTICS
All Professions—1966 National Register

Characteristic	Percentage difference from national geometric mean, 1966		Percentage of respondents in class
	Net	Gross	
Highest academic degree:			
Professional medical	38.9	33.3	2.5
Ph.D.	15.5	10.1	41.5
Master's	− 8.5	− 9.1	25.1
Bachelor's	−13.6	− 7.7	28.8
Other or not reported	−18.3	− 4.0	2.1
Primary work activity:			
Management	14.9	27.9	23.0
Research and development	− 1.5	− 2.5	35.4
Production and inspection	− 5.5	− 9.8	7.9
Teaching	− 9.4	−17.5	19.9
Other or not reported	− 2.3	− 1.4	13.8
Age:			
Under 30	−12.8	−31.2	13.8
30–34	− 4.2	−14.7	17.6
35–39	1.9	.0	19.2
40–44	4.7	11.2	17.0
45–54	5.9	20.6	22.0
55–64	2.7	22.6	8.8
65 and over	− 2.8	14.7	1.4
Not reported	− 1.5	−10.8	.2
Sex:			
Male	1.1	2.0	93.4
Female	−15.0	−24.6	6.6
Profession:			
Mathematics	13.3	.1	9.6
Economics	11.6	12.9	5.7
Statistics	8.5	5.7	1.3
Physics	7.9	2.9	11.0
Anthropology	1.0	− 2.1	.4
Meteorology	− .4	− 1.8	1.7
Sociology	− .6	− 3.8	1.5
Psychology	− 1.4	− 3.1	8.2
Earth sciences	− 2.7	− 3.2	7.9
Chemistry	− 4.7	.3	27.2
Biological sciences	− 4.9	1.7	12.4
Linguistics	− 6.7	−17.3	.5
Agricultural sciences	−15.5	−14.9	4.8
Other	3.7	.4	7.7

only —0.5 per cent, which was not great enough to offset the net positive salary progression resulting from increasing experience, even at advanced experience levels.

FIGURE II-2

GROSS AND NET RELATIONSHIPS BETWEEN PROFESSIONAL SALARIES AND SPECIFIED CHARACTERISTICS - ALL PROFESSIONS, 1966 NATIONAL REGISTER



Sex. Being a woman tended to depress salary 16 per cent below that paid to a man. This net difference was about three-fifths of the gross relationship, the remainder of the latter being attributed to fewer years of experience and fewer advanced degrees among women. The net difference was highly significant statistically, and large enough to be important to those on the short end. The only reason that Table II-2 shows sex as relatively unimportant in explaining total salary variation is that only 6.6 per cent of the respondents were women.

Profession. The field of science emerged as a fairly important net influence, ranking about equal with work activity in explaining total salary variation. Competence in mathematics was most highly rewarded, tending to lead to salaries 13 per cent above the all-profession mean and 34 per cent higher than those of the agricultural scientists found at the bottom of the range.

Economics ranked just after mathematics, and was followed closely by statistics and physics. Competence in anthropology, meteorology, sociology, psychology, and the earth sciences was not associated with deviation from the all-profession salary mean, while a specialty in chemistry or the biological sciences tended to depress salaries 5 per cent below that figure.

Among the other characteristics in the model, inclusion of the employer-experience and academic degree variables had the more pronounced effects on the net relationship between salaries and profession. If the employer-experience characteristics had not been in the model, a significantly less negative salary influence would have been shown for chemistry, and a greater negative influence would have appeared for meteorology, anthropology, sociology, psychology, linguistics, and the biological and agricultural sciences. If the level of academic degree had been excluded from the model, positive influence on salary would have been recorded for biological science, in which the professional medical degrees were concentrated, and for anthropology, sociology, and psychology. Counterbalancing these effects, the positive net influence of mathematics would have been reduced, and larger negative influences would have been shown for meteorology and the earth and agricultural sciences. The positive coefficient for economics would not have been significantly altered by omission of any other characteristic from the model.

Estimating Individual Salaries

The coefficients reported in Tables II-3 and II-4 can be used to compute an estimated 1966 salary for an individual with specific values for each of the seven characteristics in the model. The all-profession geo-

metric mean salary of $12,050 must be multiplied in turn by each of the applicable coefficients.

As an example, consider the following case (applicable coefficients, expressed as percentage effects on salary, are shown in parentheses): a male (+1.1) economist (+11.6), age 34 (−4.2), with Ph.D. (+15.5), engaged in teaching (−9.4) at an educational institution on an academic year basis (−25.7). The 1966 basic salary estimate is computed by multiplying:

$$\hat{Y} = (\$12{,}050)\ (1.011)\ (1.116)\ (.958)\ (1.155)\ (.906)\ (.743)$$
$$= \$10{,}127$$

A relatively high standard error is attached to such an estimate, because a large proportion of the total variation was not explained by the model: The standard error of the estimate ranges from —23 per cent to +30 per cent of the estimated salary. Thus, assuming a normal distribution of the logarithms of salaries, the salary range of $7,798 to $13,165 is estimated to have in 1966 covered about two-thirds of the persons with the specific characteristics given in the example.

Individual salaries for economists alone can presumably be more accurately estimated by using the model reported in Part A of Study III, which follows immediately hereunder.