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ABSTRACT

The study deals with the job component method of establishing compensation rates. The basic job analysis questionnaire used in the study was the Position Analysis Questionnaire (PAQ) (Form B). On the basis of a principal components analysis of PAQ data for a large sample (2,688) of jobs, a number of principal components (job dimensions) were identified. Scores on these dimensions, and the ratings on the original individual elements of the PAQ, were used in a multiple regression procedure for predicting the actual compensation rates of the jobs in the sample. The results of the analyses generally supported previous related research to the effect that compensation rates for jobs might be established on the basis of quantitative job analysis from a structured job analysis procedure, but the level of prediction of compensation rates was not as high in the present study as it was in a previous parallel study. This can be attributed in part to the volatile nature of wages and salaries in the time period of data collection, and to the fact that the sample covered a wide variety of jobs from many industries and different geographical areas. It is still felt that the basic approach is valide. (Author/AG)

The Derivation of Job Compensation Index Values from the Position Analysis Questionnaire (PAQ)

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THE DERIVATION OF JOB COMPENSATION INDEX VALUES FROM FORM B OF THE POSITION ANALYSIS QUESTIONNAIRE (PAQ)

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This study deals with what is called the job component method of establishing compensation rates. This method is predicated upon the use of a structured job analysis procedure that provides the basis for quantifying various components of jobs, and the subsequent use of such data as the direct basis for deriving an index of the "compensation" value of any given job in relation to the compensation rates for a large and varied sample of jobs. The basic job analysis questionnaire used in the study was the Position Analysis

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Questionnaire (PAQ) (Form B). On the basis of a principal components analysis of PAQ data for a large sample of jobs, a number of principal components (called job dimensions) were identified. Scores on these dimensions, and the ratings on the original individual elements of the PAQ, were used in a multiple regression procedure for predicting the actual compensation rates of the jobs in the sample. The sample consisted of 2688 jobs. This total sample was divided into two sub-samples, and a double cross-validation procedure was followed. The results of the analyses generally supported previous related research to the effect that compensation rates for jobs might be established on the basis of quantitative job analysis data from a structured job analysis procedure, thus possibly avoiding the usual job evaluation procedures. However, the level of prediction of compensation rates in the present study was not as high as it was in a previous parallel study, based on a smaller sample. The lower level of prediction in this study probably can be attributed in part to the volatile nature of wages and salaries in the time period during which such data were obtained for the study, in particular during 1970-1973, and to the fact that the sample included a wide variety of jobs from many varied industries and geographical locations. Despite the lower level of prediction, however, the basic approach to the establishment of compensation rates implied by the job component method seems to be reasonably tenable.

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INTRODUCTION

The conventional method for establishing compensation rates for jobs is by the use of job evaluation procedures. This typically involves the following phases: the selection or development of a job evaluation system; the preparation of a job description for each job; the evaluation of each job with the job evaluation system; using the job description for the job; the carrying out of a wage or salary survey to obtain information on going rates for certain key jobs; the development of an orgainzation wage or salary curve that reflects a policy-determined relationship between job evaluation values (usually point values) and compensation rates to be paid; and the application of the relationships shown by that curve to specific jobs.

One of the objectives of such a procedure is of course that of providing a systematic basis for establishing differential compensation rates for jobs within the organization in question that reflect reasonably "true" differences between and among the jobs in the organization. Another objective is that of establishing an overall level of compensation rates for jobs in the organization at some policy-determined relationship with respect to compensation levels in the labor market in question. In these processes the job evaluation system that is used is intended to provide the basis for ordering jobs along a scale of relative values. These values presumably would reflect similarities and differences between and among jobs in terms of total values. The actual evaluation of jobs with the system in question typically requires the making of judgements or evaluation about jobs on the basis of the job descriptions that are available.

The Job Component Method of Establishing Compensation Rates

Since job data serve essentially as the basis for the establishment of compensation rates, it would seem that one might be able to use job data directly for this purpose, without the need for the intervening evaluation process, or, for that matter, for a job evaluation system as such. To do this one would need to carry out the following processes: (1) develop a structured job analysis procedure which would provide the basis for quantifying various components of jobs; (2) use this procedure for analyzing and quantifying a sample of jobs; (3) obtain information on the compensation rates applicable to those jobs; (4) identify by regression analysis the job components and their respective statistical weights that give the highest multiple correlation with the criterion of compensation rates; and (5) apply that regression equation to jobs for which compensation rates are to be established. Such a procedure might be called a job component method of establishing compensation rates.

Previous Try-out of Job Component Method

This basic scheme was carried out with a sample of jobs with encouraging results (Mecham and McCormick, Report No. 3, June 1969).

That study involved the use of a structured job analysis questionnaire called the Position Analysis Questionnaire (PAQ),[1] The PAQ form used in that study (Form A) consisted of 189 job elements that generally provided for characterizing the human behaviors in jobs, what are sometimes referred to as "worker-oriented" job activities (McCormick, 1959). In the use of the PAQ each job element is rated in terms of its relevance to the job using an appropriate rating scale such as importance, time spent, etc. The PAQ had been subjected to principal components analysis, with 32 components having been identified (McCormick, Jeanneret, and Mecham, 1972). These components, referred to as job dimensions, provide the basis for deriving job dimension scores.

In the previous study with the PAQ (Mecham and McCormick, Report No. 3, June 1969) job dimension scores and ratings on certain of the job elements of the PAQ were used as predictors of compensation rates for a sample of 340 jobs. A double cross-validation procedure was used. In general terms, the multiple correlations and cross-validation coefficients generally were in the mid- and upper 80's, thus suggesting substantial promise for the job component method of establishing compensation rates.

Purpose of Present Study

The intent of the present study was that of further testing the job component method with a larger sample of jobs, toward the possible end of establishing a more solid statistical base for establishing compensation rates with this procedure. In the current study a subsequent form of the PAQ, Form B, was used. (This form substantially parallels Form A, but there are some modest differences in the job elements and rating scales used).

PROCEDURES

The basic procedures followed in the study consisted of: the selection of a sample of jobs for which PAQ analyses were available and for which compensation data were available; the derivation of job dimension scores for the sample jobs; and the use of regression analysis using the job dimension scores for the sample jobs as predictors of their compensation rates.

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1. The Position Analysis Questionnaire (PAQ) is copyrighted by the Purdue Research Foundation. The PAQ and related materials are available through the University Bookstore, 360 State Street, West Lafayette, Indiana 47907

Sample of Jobs

The sample of jobs was drawn from a pool of 8000 jobs for which PAQ analyses were available. More specifically, it was drawn from a sample of 3700 jobs which had been selected from the 80000 for use in a principle components analysis (Marquardt and McCormick, Report No. 4, June 1974). That sample of 3700 had been drawn to be roughly representative of the employment by major occupational categories of the United States labor force. The analyses came from about 125 different organizations in a wide variety of industries and from many geographical locations.

The sample selected for the present study included all those jobs within that sample for which sutiable compensation data had been reported at the time of the PAQ analyses. Such data were available for 2762 jobs. This sample was reduced to 2688, however, by the elimination of 74 "outlying" jobs with high and low compensation rates, as discussed below.

Compensation Data for Jobs

The PAQ provides for compensation data for jobs to be reported in terms of whatever methods are actually used, such as salary, hourly wages, commissions, tips, etc. When methods other than hourly wages were used, the data were to be reported as averages for the most convenient time period, such as weekly, monthly, or yearly. When several people might be on the same job, on which there might be some individual differences in compensation, the employing organizations were asked to report the median compensation rate for the job. When this was reported it was used in the study.

Because of the different time bases for which the compensation data had been reported the data were converted to a common metric of dollars per month, this value being computed as follows for the various reporting time periods:

Reporting period	Multiplier used
Hourly wages	173.000
Weekly	4.333
Monthly	1.000
Yearly	.083

The computations were based on the rationale that employees usually work a 40 hour week and receive pay during vacations. While this assumption would not be universally valid, it was considered to be the most appropriate assumption to make.

Most of the PAQ analyses and compensation data had been obtained during 1973. However, data for some jobs had been obtained during 1970, 1971, and 1972. This time difference in reporting compensation presented a potentially complicating problem because of typical increases in earnings due to inflationary tendencies. As it turned out, a good share of the compensation data reported in 1970, 1971 and 1972 had been reported by a limited number of organizations, each of which had covered a number of jobs. In the case of the jobs in some of these organizations it was possible to obtain from the organizations compensation data for the jobs in question, up-dated to 1973. For various reasons it was not possible to obtain such up-dated information from certain organizations, as for example because of personnel or organizational changes that had removed the previous content "personnel." Further, in some cases the jobs had been eliminated or changed during the interviening years. Also, there were scattered jobs in a number of organizations for which it was not considered to be feasible to try to obtain up-dated compensation data. In most such instances only one job, or only a few jobs, had been analyzed by the organizations.

In the case of jobs for which 1970, 1971 and 1972 earnings had been reported, but for which 1973 up-data were not available, the reported compensation data were up-dated by constants that were considered to reflict the typical annual increases in wages and salaries. For this purpose data from certain federal government reports were used, in particular two reports from the Bureau of Labor Statistics (1973 a and 1973 b) and two from the Department of Commerce (1974 a and 1974 b). The average annual increase given in the these reports were quite similar for any given year and for various occupational categories. For purpose of making adjustments, "average" values of the various reported averages weredervied, these being as follows, along with the correction factor used to derive the up-dated values:

Year	Average Increase to 1973	Correction factor
1972	5.98%	1.0598
1971	11.83%	1.1183
1970	17.325%	1.17325

These corrections were made for 1438 jobs. It is realized that these adjustments would not necessarily represent actual increases in the compensation rates for the jobs in question, but it was considered desirable to apply these "average" adjustments in order to retain these jobs in the sample, assuming that the specific adjustments so made would approcimate increases for jobs of the types in questions. Of the sample of 2762 jobs initially selected 74 were eliminated as being "outlying" cases in particular those with monthly compensation rates below $326.00 and above $1,450.00. These were eliminated after an initial division of the total sample into two subsamples revealed noticably different standard deviations in the compensation criterion for the two samples. In other words, chance allocations of these few "outlying" cases to one subsample or the other seemed to have a disproportional effect on the standard deviations of the two samples which in turn, could affect the subsequent analyses.

For each of the 2688 jobs included in the sample, then, there was a criterion of dollars per month that was used in the subsequent phases of the study.

PAQ-based Data Used as Predictors

As indicated above, the jobs included in the sample were those for which PAQ analyses were available. Three types of PAQ-based data were used as possible predictors of the criterion values of compensation rates per month. Two of these types of data consisted of job dimension scores for the job dimensions previously derived from a series of principle components analyses of PAQ data (Marquardt and McCormick, Report No. 4, June 1974). In that study one set of 30 job dimensions was derived from the principle components analysis of the job elements within each of the six divisions of the PAQ, using the sample of 3700 jobs mentioned above. These are referred to as "divisional" job dimensions. The other set of dimensions (of which there were 14) was based on the principle components analysis of the same sample of jobs in which most of the job elements were pooled together. These are referred to as the "overall" or "general" (G) dimensions. The third set of PAQ-based data used as predictors consisited of the ratings for the jobs on the elements themselves. There are a total of 187 items in form B of the PAQ, but not all of these were used, since it was considered desirable to restrict somewhat the number of job elements used in this analysis in order to keep the ratio of the number of predictors to the number of jobs within some reasonable bounds. A few items are of a write-in nature and would not be amenable to this analysis in any event. There are a number of dichotomous items in the PAQ which were also omitted. (This decision was based on a study of the distributions of the responses to these items in the sample. Due to the nature of the items, the distributions were highly irregular and highly skewed, and it was feared that these items could disproportionately affect the results).

Eliminating these items still left a number that was considered too large to be used in a multilple regression analysis because of the analysis. As a further step in reducting the number of predictors, a correlation of the ratings on each item with the criterion values of compensation rates was calculated across all jobs. In turn, the items with the lowest correlations were eliminated, leaving a pool of 99 items, and these were used in the subsequent analyses.

Thus, for each of the 3700 jobs there were the following sets of predictors:

1. Job dimension scores on 30 divisional job dimensions
2. Job dimension scores on 14 overall or general (G) job dimensions
3. Ratings on each of 99 job elements of the PAQ

Analysis Procedures

Since a double cross-validation procedure was to be used, the total sample 2688 jobs was divided into two subsamples (A and B), each consisting of 1344 jobs. This was done by first ordering the 2688 jobs in terms of this compensation index, and then selecting jobs alternately for the two samples, in effect taking the 1st, 3rd, 5th, etc. for one sample, and the 2nd, 4th, 6th, etc. for the other sample. The mean compensation rates for jobs in these two samples, and their standard deviations, are given below:

	Mean	Standard deviation
Sample A	744.6317	218.3092
Sample B	745.0618	218.5884

A step-wise regression analysis was carried out for each sample (A and B), and a regression equation was derived for each sample for each of the three types of predictors. The regression equation for a given predictor based on sample A was then applied to the jobs in sample B, and vice versa. In addition, a regression analysis was carried out with the total sample (A+B).

As a final step, the data for the total sample (A+B) was used for presenting a comparison between predicted compensation rates and actual compensation rates, this being carried out for the predicted rates based on all three types of predictors. This was done by deriving the residuals (actual rate - predicted rate = residual), and dividing them into fifty-dollar class intervals. The results are presented graphically, along with the actual standard deviation of the class intervals, and a generalized expected standard deviation of the actual compensation rates.

RESULTS

The results are summarized in Table 1, this showing the multiple correlations and the cross-validation coefficients for the three sets of predictors. (The regression requations are given in the Appendix as Tables 2,3, and 4. Tables in the Appendix gives the residuals). Graphic representations of the relationship for each of the sets of predictions between the predicted compensation rates and the actual rates are given in figures 1, 2, and 3.

Table 1

Multiple Correlations and Cross-Validation Coefficients of Regression Equations Based on Job Data of the PAQ Used to Predict Compensation Rates

Type of Predictor	A	B	A+B	A on B	B on A
Overall Dimensions	.65493	.65396	.64746	.6407	.6449
Divisional Dimensions	.69931	.69484	.68921	.6726	.6753
Raw Data	.70149	.69161	.68207	.6364	.6450

DISCUSSION

The multiple correlation and cross-validation coefficients shown in Table 1 are generally around .64, these being relatively respectable coefficients. However, they are of an order of magnitude below those reported in the preceding study (Mecham and McCormick, Report No. 3, June 1969), those coefficients being in the mid- to upper - 80's. Although it had been hoped that the present study would result in substantially the same level of prediction, the economic changes that took place during the time period in which the data were obtained raised doubts as to whether that same level of prediction would be achieved.

The time period during the data-collections phase--from 1970 through 1973--was one of marked inflation, especially 1973 during which most of the data were obtained. During such periods all price levels and earnings do not increase evenly, but rather increase irregularly, some jumping ahead of others, and some following an erratic leap-frog pattern of movement. This very volatile wage and salary situation could cause the compensation rates for individual jobs obtained at any given time during such a period to be higher, or lower, relative to all other jobs than would be the case during a period of more economics stability. (During a period of economic stability the compensation rates for individual jobs presumably would tend to "settle down" at levels relative to other jobs that would reflect the normal supply and demand factors for people to perform the various jobs). It is the considered opinion of the investigators that this volatile nature of wages and salaries during the data-collection phase did in fact significantly alter the relative positions of some jobs on the compensation scale from what they would have been under more "normal" economic conditions.

The test of the basic hypothesis (that compensation rates can be predicted from job-related data) would of course be dependent upon having criterion values (i.e., compensation rates) that represent "appropriate" values for the jobs. To the extent that the relative positions of jobs on the compensation scale are the consequence of the fortuitous timing of increments during an inflationary period, the prediction of such rates would of course be adversely affected.

As a somewhat related matter, it will be recalled that the compensation data that were obtained during 1970, 1971 and 1972 were adjusted upwards by values that reflected "average" increases in earnings during these years. Although this adjustment was considered to be desirable, it is of course possible that its across-the-board nature may have resulted in some misalignment of jobs on the compensation scale.

Another factor that needs to be taken into account in evaluating the results is the variety of jobs included, these having come from about 125 different organizations in a wide variety of industries and geographical locations. The sample included jobs from various private industries (manufacturing, utilities, trade, service, communications, etc.) and from certain government organizations (federal and local). It is of course generally recognized that earnings do vary by industry and geographical location. In this regard, the corresponding data for the previous study (Mecham and McCormick, Report No. 3, 1969) for the 340 jobs came from a samller number of organizations, and thus might not have reflected as wide a variability in compensation rates across industries (and possibly across geographical locations) as was represented in the present study.

Thus, although the results of this study were somewhat lower than those of the previous study, it is reasonable to attribute this in large part to the consequence of the combination of industrial and geographical variability in compensation rates and of the volatile nature of wages and salaries during the data collection period.

These influences on the criterion values would not invalidate the basic concept involved in the study--that compensation rates can be predicated on quantitative job analysis data. But the results do suggest that the statistical analyses directed toward such estimation might well be based on the jobs within more restricted contexts (such as those within a single organization or "class" of organizations, or within a given labor market, or within some geographical area). In this regard, for example, similar analyses in the case of individual organizations have resulted in correlations between predicted job values and actual compensation rates as high as .93 and .94, thus lending credence to such an approach.

In order to explore the possibility that the prediction of rates of compensation might be greater within individual organizations, the PAQ's for five organizations were examined, in particular organizations for which a fairly large number of PAQ's had been prepared. In the case of four of these organizations there was an obvious restriction of range of compensation rates. There was only one for which the range of compensation rates was reasonably wide, this being a utility company for which there was 312 jobs. In this particular instance the correlation between predicted rates and actual rates was .79. Similar correlations were also run in the case of the other 4 organizations but, as expected, the correlations in these instances were somewhat lower, ranging from .61 to .67. The correlation of .79 in the case of the utility company for which there was a reasonable range of rates lends some support to the hypothesis that prediction of rates of pay within restricted contexts can be based on a structured job analysis procedure.

With respect to the results of the present study, there was no appreciable difference in the predictiveness of the three types of PAQ-based data, i.e., the divisional job dimensions, the general (G) dimensions, or the specific job elements. Thus, it would seem that the various ways of statistically "combining" the PAQ-based data are equally effective.

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Figure 1

The Mean and Standard Deviation of Monthly Compensation Rates as Compared with Predicted Rates, and the Generalized Standard Deviation of Observed Rates Around Predicted Rates for Divisional Job Dimensions

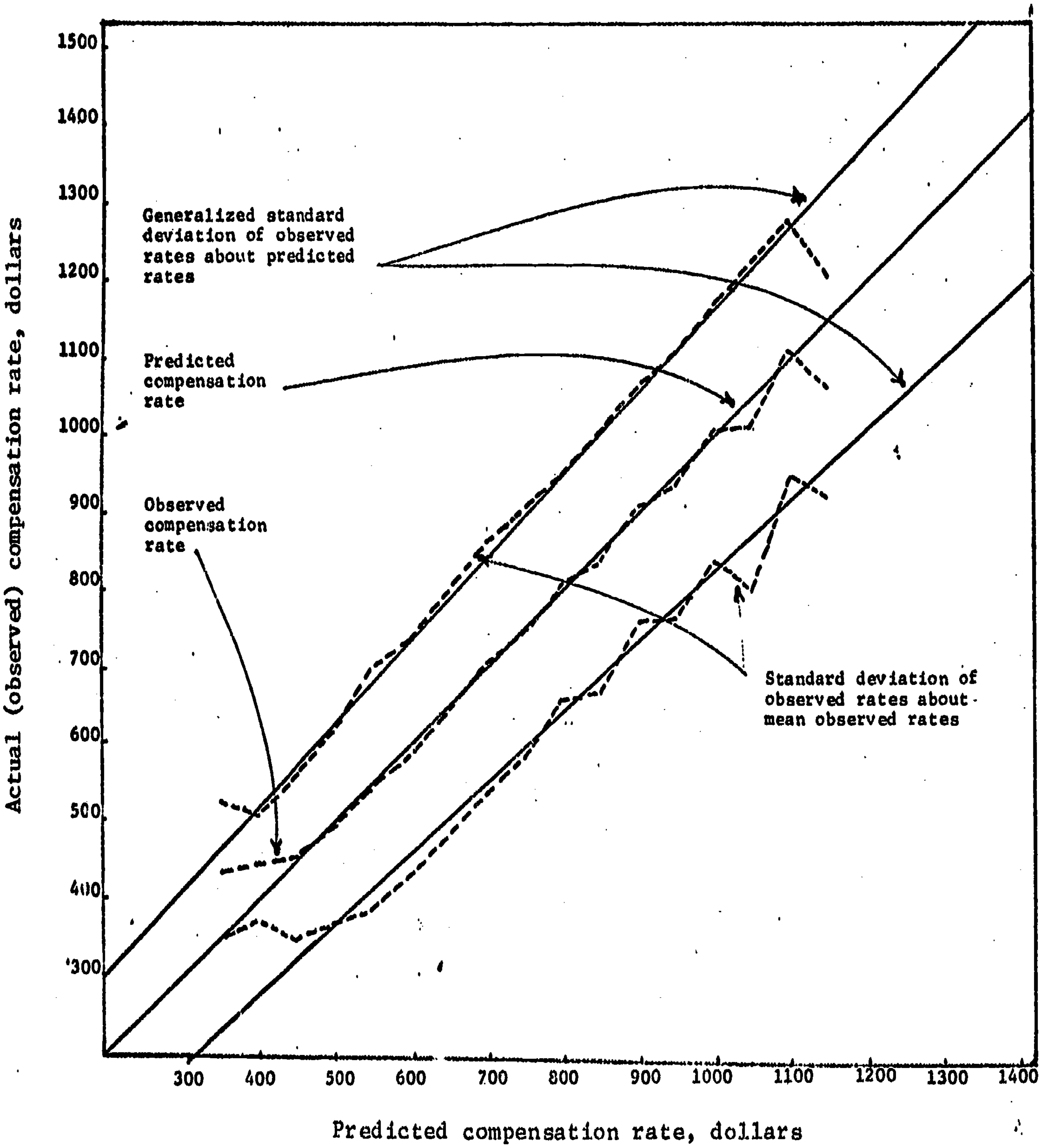


Figure 2

The Mean and Standard Deviation of Monthly Compensation Rates as Compared with Predicted Rates, and the Generalized Standard Deviation of Observed Rates Around Predicted Rates for Overall Job Dimensions

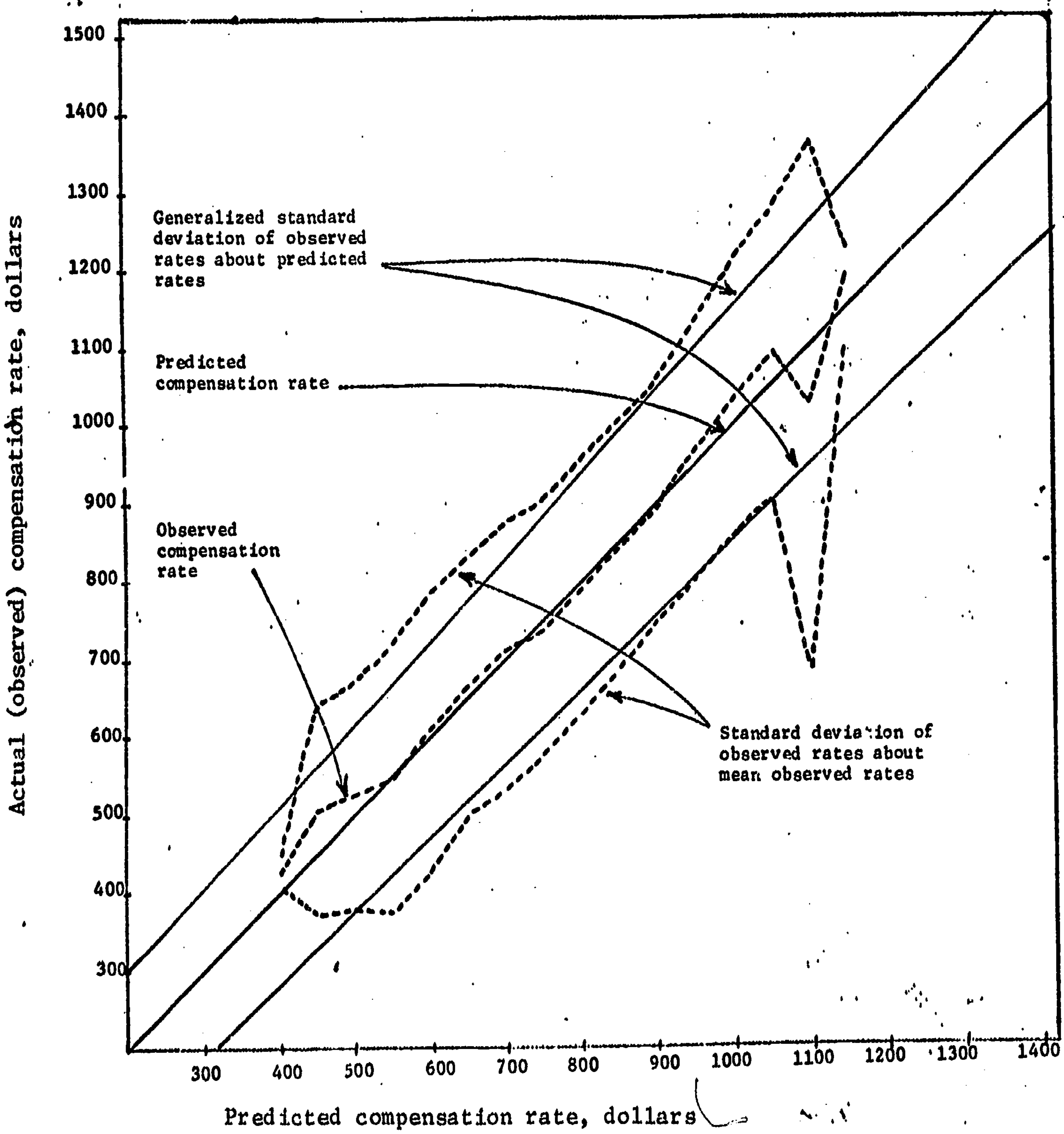
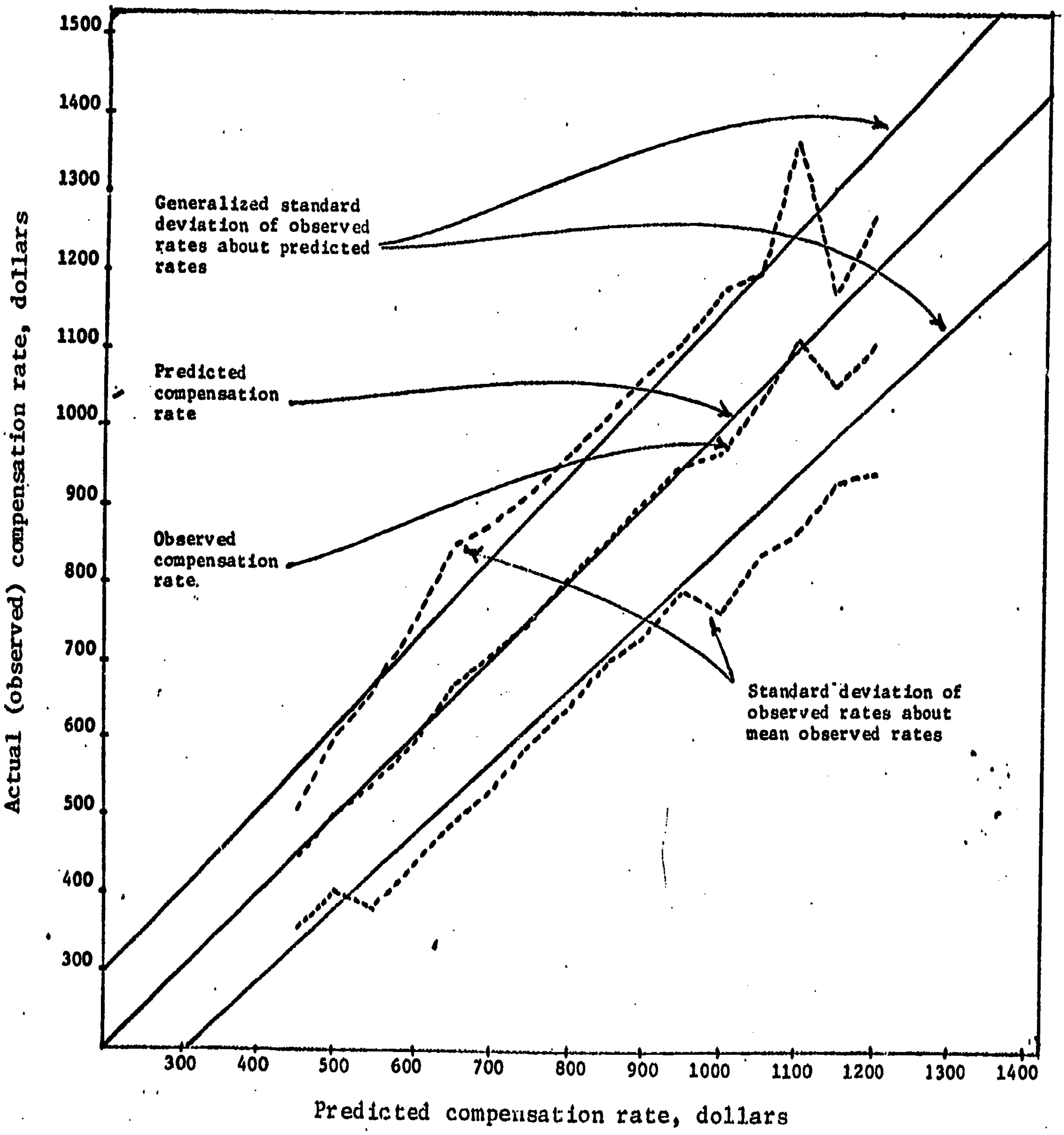


Figure 3
The Mean and Standard Deviation of Monthly Compensation Rates as Compared with Predicted Rates, and the Generalized Standard Deviation of Observed Rates Around Predicted Rates for Job Elements



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APPENDIX

Table 2

Regression Analysis Data for PAQ Job Elements Selected as Final Predictors of Wage and Salary Rates

PAQ Job Element	Regression Weights of Samples		
	A	B	Combined
1	14.23	—	8.36
2	14.84	26.57	21.05
3	-7.06	-13.50	-9.54
4	—	—	—
5	—	—	—
6	—	—	—
7	—	—	—
8	-9.48	-15.29	12.03
9	—	—	—
10	—	—	—
11	—	—	—
12	—	-16.07	-8.04
13	—	8.29	6.86
14	—	—	—
15	—	—	—
16	—	—	—
17	10.20	8.78	8.84
18	—	9.74	—
19	5.56	—	—
20	—	-12.17	-6.31
21	5.96	—	—
22	—	18.59	11.11
23	21.28	18.20	20.71
24	8.89	—	—
25	-7.98	-9.44	—
26	—	—	—
27	—	—	—
28	—	—	—
29	—	—	—
30	29.76	30.63	28.28
31	—	—	—
32	-16.74	-11.61	-12.11
33	—	—	—
34	—	—	—
35	—	—	—
36	—	—	—
37	9.57	—	—
38	—	—	—
39	-8.59	-13.98	-12.55
40	4.96	11.84	9.60
41	—	—	—
42	-14.70	-7.57	-10.42
43	—	—	—
44	—	—	—
45	—	—	—

Table 2 (cont.)

PAQ Job Element	Regression Weights of Samples		
	A	B	Combined
46	———	———	———
47	———	———	———
48	———	———	———
49	-15.25	-15.69	-13.78
50	———	———	———
51	-9.97	———	-8.08
52	23.41	———	14.76
53	———	———	-8.42
54	-14.80	———	-12.74
55	26.88	16.38	25.57
56	-20.97	———	-12.62
57	———	15.56	10.94
58	-11.15	-11.89	-11.48
59	———	7.58	———
60	———	———	———
61	22.88	12.24	19.09
62	———	———	———
63	———	-8.88	-5.86
64	10.61	22.79	18.18
65	———	———	———
66	———	———	———
67	———	———	———
68	-9.31	-11.93	-10.50
69	-12.24	———	———
70	———	———	———
71	———	———	———

Table 3

Regression Analysis Data for Overall Job Dimension Scores Used to Predict Wage and Salary Rates

Dimension	Regression Weights for Sample		
	A	B	Combined
1.	118.98	123.37	120.88
2.	14.24	15.99	16.44
3.	______	17.75	______
4.	62.88	67.92	65.57
5.	-20.69	-19.73	-19.57
6.	36.97	42.64	38.88
7.	19.30	______	______
8.	______	______	______
9.	______	______	______
10.	22.73	24.69	22.88
11.	54.51	56.50	55.40
12.	______	______	______
13.	-21.05	-28.25	-23.63
14.	41.59	22.34	32.22

Table 4

Regression Analysis Data for Divisional Job Dimension Scores Used to Predict Wage and Salary Rates

Divisional Job Dimension	Regression Weights of Samples		
	A	B	Combined
1	-10.01	—	—
2	—	-20.08	-9.79
3	6.73	27.36	19.31
4	12.88	—	—
5	-11.85	-12.69	-12.89
6	95.32	81.59	86.69
7	20.78	13.10	16.27
8	—	—	—
9	—	-13.18	—
10	—	—	—
11	-28.87	-10.24	-20.44
12	—	—	—
13	—	-11.36	—
14	-14.09	-19.08	-14.15
15	-38.20	-72.51	-61.16
16	11.85	33.24	24.31
17	9.34	9.93	10.20
18	14.26	—	—
19	10.05	6.20	8.49
20	-10.18	—	—
21	—	—	—
22	—	—	—
23	12.50	—	—
24	—	—	—
25	-13.46	-44.00	-27.58
26	-25.41	-29.93	-28.08
27	29.97	26.78	28.11
28	58.70	38.50	48.58
29	11.03	12.01	13.03
30	—	—	—

Table 5

Predicted Wage and Salary Rates, Residuals, and Standard Deviations by Wage and Salary Class Interval for Three Types of Predictors

Compensation Class	Number of Jobs by Predictor			Mean Residual by Predictor			Standard Deviation of Residuals by Predictor		
	Job Elements	Overall	Divisional	Elements	Overall	Divisional	Elements	Overall	Divisional
326-375	1	1	8	259	48	91	0	0	90
376-425	12	3	19	65	24	46	83	21	68
426-475	27	40	50	-24	56	9	74	134	104
476-525	108	82	130	1	25	-5	99	145	127
526-575	208	194	156	-28	-5	-4	141	169	159
576-625	284	293	264	-7	7	-10	155	175	153
626-675	303	331	294	17	-15	-5	176	165	160
676-725	291	295	306	5	4	3	173	172	162
726-775	318	326	321	3	-12	0	163	163	165
776-825	293	302	290	2	-7	10	161	161	149
826-875	308	258	268	7	-7	-9	156	160	166
876-925	213	254	242	4	-1	17	167	153	151
926-975	160	168	182	2	13	-6	158	168	171
976-1025	98	89	83	-30	34	11	207	177	167
1026-1075	38	40	50	-28	44	-33	180	187	211

Table 5 (cont.)

Compensation Class	Number of Jobs by Predictor			Mean Residual by Predictor			Standard Deviation of Residuals by Predictor		
	Job Elements	Overall	Divisional	Elements	Overall	Divisional	Elements	Overall	Divisional
1076-1125	20	9	18	17	-77	18	250	341	163
1126-1175	3	2	7	-92	45	-80	121	30	142
1176-1225	2	1	0	-90	-259	___	166	0	___
1226-1275	1	0	0	5	___	___	___	___	___

Note--All values are rounded to nearest whole number.

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