AN INFORMATION-THEORETIC MODEL OF PERSONNEL SELECTION AND PLACEMENT

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AN INFORMATION-THEORETIC MODEL OF

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Dedicated to the

Memory of My

Mother

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SUMMARY

It was the objective of this thesis to review and evaluate existing quantitative models for personnel selection and placement, and to propose an alternative model formulation utilizing certain basic information-theory metrics. Initially, a careful review was given of the research that centers around the psychological as well as the decision-theoretic aspects of selection and evaluation, defining the parameters that need to be taken into account in model formulations.

Basic model alternatives considered were the Bayesian approach and the regression approach. The latter contains the ANOVA paradigm and the correlational paradigm. The use of correlational statistics as employed by Brunswik's lens model was described as the most compatible basis for this research. Information theoretic model formulations were presented as alternatives to the linear regression model. Underlying assumptions were that information-theory measures are applicable to human decision-making, and that these measures can be employed analogously to cue values in a multiple regression model.

In order to test the model alternatives, empirical data collected in large industrial organizations were employed. Also, hypothetical case information provided to and evaluated by personnel officers in these organizations was utilized. The evaluation of the data was based on a large number of regression runs for eight different models. The multiple R^2 of the empirical cases ranged from .30 to .58, of the fictitious cases from .17 to .87. The general conclusion reached was that information-theoretic model alternatives appeared to be competitive with linear cue models but need more evaluation.

CHAPTER I

INTRODUCTION

Definition of the Problem

People differ greatly. Besides the easily discerned physical differences, there are those qualities which are of prime importance in a working environment, such as intelligence, abilities, skills, motivation, and temperament. In the world of work, men's efforts have been organized and directed toward production of the great variety of goods and services demanded and consumed by society. Thousands of jobs are encompassed by the world of work; the variety of requirements is vast, and the human qualities necessary to get the work done differ greatly from job to job. With such variability in demand, in jobs, and in workers, programs of personnel selection and placement in industry are essential.

The problem is to find ways and to devise methods which allow for an optimal match between men and jobs. This is desirable because of the high cost involved physically and morally for both employer and employee.

Purpose of the Research

Ideally, it would be desirable to develop a method that would allow placement of all persons in jobs perfectly suited to them and to society. This problem has two main aspects: Psychology attempts to measure and describe human variability, whereas methods of decision theory help to utilize these findings to select and place personnel systematically and rationally.

This work centers around the decision-theoretic aspects which have received extensive attention by a number of researchers. The objective of this study was to review and evaluate existing methods and models for personnel selection and placement, and to propose an alternative model formulation utilizing certain basic information-theory metrics. Initially, alternative models were tested using hypothetical pilot data. The most promising models thus developed subsequently employed empirical data for the estimation of the various model parameters. The statistical methodology employed was that of linear regression theory.

CHAPTER II

LITERATURE REVIEW

The field of personnel selection and placement may pose special requirements on methods and models in order for them to be applicable. Therefore, a careful review shall be given of the research that centers around the psychological as well as the decision-theoretic aspects of selection and evaluation, defining the parameters that need to be taken into account in model formulations.

The cost significance and the omnipresence of personnel selection problems have resulted in a vast body of research since the early part of this century. It is intended to review those publications in the field which characterize the present standard of knowledge and methodology. Though one should be concerned with the quantitative aspects of making selection decisions, it is also necessary to examine in considerable depth the origin of quantitative description of human work behavior: This is the contribution of industrial psychology.

Dunnette (1966, p. 2) pointed at the complexity of questions inherent in personnel selection.

> What aspects of the job need to be taken into account for determining the human qualities necessary to do the job? How should the job

> be analyzed and studied? What sorts of behavior constitute successful job performance and how may job behaviors best be described and measured? What methods should be used to 'size up' or measure the human qualities chosen as necessary for the job? What evidence shows adequately the relationships between certain measured human qualities and different job behaviors?

The interrelated topics touched on by these questions are centered around a major objective of personnel administration, the manpower development program of the firm (Dunnette, 1966).

Considerations in Selection and Placement

Several important considerations dictate the range over which an employment manager may exercise his judgment and the relative emphasis he may give to any placement problem (Dunnette, 1966). The number of applicants relative to the number of jobs characterizes different types of placement problems. It may be necessary to assign a certain number of persons to an equal number of different jobs. This is a pure classification situation which has been successfully dealt with through methods of Operations Research. In contrast, when the number of applicants is large relative to the number of jobs, much greater care in the matching of men and jobs may be exercised. However, the number of applicants varies greatly for different kinds of jobs and at different times.

For the institution, pure selection maximizes the over-all quality or effectiveness of job performance of employees. For the individual, however, the guidance approach is best, because he desires to choose a vocation or job best suited for him. It is also desirable from society's standpoint to avoid as much as possible the underutilization of the capabilities of individuals. The most usual approach involves a careful weighing of institutional and individual considerations (ibid.).

Wrong decisions have associated with them two kinds of relative costs that greatly affect personnel decision strategies. These related cost factors are due to the following kinds of errors (Dunnette, 1966, p. 7):

> First, an individual may be placed on a job on which he later fails; because a positive outcome (success) was predicted and failed to materialize, this kind of error is called a false positive error. Second, an individual may not be placed on a job in which he could have been successful; because this involves an inaccurate prediction of a negative outcome (failure), it is called a false negative error.

The purpose of training programs is to modify employees' knowledge, skills, and attitudes in order to equip them to do their jobs better. Personnel selection and job placement are inextricably intertwined with personnel training. This is due to the fact that trainability of persons has a direct influence on the need for selectiveness, i.e., these two factors are somewhat inversely related.

In a real setting, complete information about the relative odds of success for different people and for different jobs would rarely be available. But selection decisions and job placement strategies must still be made, even when information is sketchy and incomplete. At least the employment manager should be able to make a statement about the accuracy of prediction, the assessment of which this research is in part devoted to.

In the following sections attention is turned to the basic instruments involved in predicting performance and assessing accuracy of prediction which are requirements for making selection or placement decisions. The first group of tools comprises those used to assess the applicant. These are tests, interview, and application blank. Then the performance evaluation process shall be examined since it supplies the dependent variables against which the prediction would have to be compared. Finally, it can be shown how information thus obtained can alternatively be utilized in methodical selection systems, employing optimization approaches and statistical techniques, some of which allow for rational utilization of computer methods.

Applicant Assessment

As previously pointed out, tests, interview, and application blank are the tools employed in assessing applicants. These instruments shall now be reviewed in the above sequence.

Tests

In a variety of situations individuals have to make personnel decisions for which they have inadequate information. It is for that reason that psychological and educational tests exist.

Therefore, it is desirable that a theory of test construction and use consider how tests can best serve in making decisions (Cronbach, Gleser, 1965). Little of present test theory, however, takes this view. Instead, the test is conceived as a measuring instrument, and test theory is directed primarily toward the study of accuracy of measurement on a continuous scale (Cronbach, Gleser, 1965). Hull (1928, p. 268) voiced a principle that has been the root of nearly all work on test theory: "The ultimate purpose of using aptitude tests is to estimate or forecast aptitudes from test scores." It is this view that Cronbach and Gleser (1965) proposed to abandon. They acknowledged the usefulness of accurate estimation, but maintained that the ultimate purpose of any personnel testing was to arrive at qualitative decisions.

When they first came on the industrial scene in the 1920's, psychological tests were hailed as a basis for finally placing personnel selection on a scientific basis (Lipsett, 1972). Indeed, some evidence was accumulated to support this promise. Intelligence tests and clerical aptitude tests began to show significant validity for selecting clerical workers in a variety of situations (Lipsett, 1972). Some studies showed positive correlations between success in apprenticeship training and mechanical aptitude tests, as well as tests of intelligence, mathematics, and space relations.

Often, however, the scientific contribution of testing needs to be questioned. What can happen, if one neglects validation studies, was described by Lipsett (1972, p. 649):

> In many instances, the application of tests was actually counter-productive. Assuming that high intelligence was desirable in any job, many organizations used a test like the Wonderlic to screen out low scorers who would actually have performed with greater stability and satisfaction in routine jobs. . . .
>
> In the 1960's, widespread concern over civil rights and disproportionate rejection of applicants from minority groups led to the discovery that paper-and-pencil tests tended to eliminate an inordinate percentage of minority applicants. When social pressures began to force more employment of minority group members despite low test scores, it was discovered that many individuals with low test scores could perform fully as well in many jobs, especially those in manual factory work, as those with higher test scores.

A highlight in this development was the well-publicized Motorola Case raising the question of inadvertent racial discrimination by using psychological tests (cf. French, 1965). Berdie (1965, p. 146) explained: "We have assumed homogeneous populations when we may not have them. . . ."

Presently, employers are being asked to demonstrate the job-relatedness of their tests (O'Leary, 1972). The Civil Rights Act of 1964 sought among other things to ensure maximum employment of members of minority groups to overcome the social problems arising out of unemployment of these groups. To this end, the Equal Employment Opportunity Commission, which was established by this Act, issued guidelines providing that employment testing should not be done unless there was evidence for the validity of the test in the particular job situation (Lipsett, 1972).

At this point, it is important to understand what is considered a test in the eyes of the EEOC (O'Leary, 1972, p. 171):

> The term 'test' includes all formal, scored, quantified, or standardized techniques of assessing job suitability including, in addition to the above, specific qualifying or disqualifying personal history or background requirements, specified educational or work history requirements, scored interviews, biographical information blanks, interviewers' rating scales, scored application forms, etc.

This stand of the EEOC resulted in an enhancement of the proper use of testing. To quote U.S. Supreme Court Chief Justice Burger (Personnel Journal, 1972, p. 283): "What Congress has commanded is that any tests used, must measure the person for the job, and not the person in the abstract." Proper use means first of all proper validation. This must be done with respect to the job as well as taking into account the individuals filling the job.

"Test validation can't be imported. . . . (Personnel, Nov.-Dec., 1970, p. 6)." Each test has to be validated for the specific situation to which it applies. An exception would be if the number of employees in a workforce is fewer than the number usually required for validation. "Thirty employees is considered the minimum number necessary for validating; 100 is plenty (ibid.)." In case of an insufficient number, Ghiselli's (1966) work "The validity of occupational aptitude tests" may be a useful reference.

EEOC guidelines state ". . . that properly validated and standardized employee selection procedures can significantly contribute to the implementation of nondiscriminatory personnel policies (Personnel Journal, April, 1972, p. 283)." Significant effort has been spent in investigating the cultural bias of tests and in proposing alternatives (Bartlett, O'Leary, 1969; Berdie, 1965; Guion, 1965; Krug, 1966; Anastasi, 1966).

Guion (1965) did not fail to point out that the very factors that depress test scores may also depress performance on the job, so that validity and racial discrimination need not be mutually exclusive. Bartlett and O'Leary (1969) discussed the possibilities that may be found in "culture-free" tests on the one hand and "culture-equivalent" ones on the other. Those of the latter group have been successfully developed by Schwarz

(1961). They were intended to be administered separately to groups of low socio-economic background.

Other efforts were directed toward more general improvement of test utilization in a total personnel assessment system (O'Leary, 1972), as well as toward the development of non-test methods. Non-test methods, however, would be a way out only if quantification of results is no longer desired since, otherwise, the EEOC's definition of a test would apply and these methods would consequently be open to scrutiny.

O'Leary (1972) suggested that discontinuing the use of valid employment tests could increase the probability of unfair practice through reliance on human judgment and raise costs through higher turnover and poorer performance.

Hasler's (1972) discussion suggested an alternative to generate assessment of individual work behavior for employee selection, placement, and promotion by means of descriptive validities: "Descriptive validity is the most appropriate kind of validity for global, over-all statements of probable work behavior of individuals. Such statements typically come from the interpretation by a psychologist of score profiles or assessment results (Hasler, 1972, p. 13)."

Interview

The interview is generally assigned prime significance in the selection process, although it is probably the one item with the least validity. Its effectiveness and utility has been seriously questioned as a result of several comprehensive reviews of the research literature (Wagner, 1949; England and Paterson, 1960; Mayfield, 1964; Ulrich and Trumbo, 1965; Wright, 1969).

Mayfield (1964) cited findings of lack of validity for the process and concluded that ". . . knowledge of the selection interview is only a little more advanced . . . (cf. Wright, 1969, p. 39)" than it was at the time of Wagner's review in 1949. However, he felt that two principal new approaches held promise. They were (Wright, 1969, p. 391):

(1) Research dividing the interview into units, providing, in effect, a microanalysis of the procedure in contrast to the usual macroanalysis, and,

(2) Renewed concern with 'studying the process of decision-making as it occurs in the selection interview' instead of viewing interview results only.

Mayfield (1964) made 15 prescriptive statements pertaining to (cf. op. cit.) (a) interview structure and process, and (b) validated outcomes of the interview. In regard to (a) he found that structured interviews generally provided higher inter-rater reliabilities than did unstructured interviews. With respect to category (b) he stated that interviewers were inconsistent in their interpretations of data obtained in the interview; they tended to make their decisions early in the unstructured interview; intelligence could be best estimated from an interview, but interviewer predictions based on interviews and test scores were no more accurate than those based on the score alone; negative rather than positive information appeared to be most influential on the interviewer.

This last point led Webster (1964) to the conclusion that "interviewers are more influenced by unfavorable than by favorable information (p. 87)." He suggested that, per unit of importance, interviewers gave less weight to positive information. This contradicts Bolster and Springbett (1961), who stated that interviewers gave more weight to negative information.

Wright (1969) considered as highly significant the report which summarizes nine years of work by Webster (1964) and his colleagues. Seven principal findings with respect to the problem of decision-making in the employment interview were as follows (Wright, 1969, p. 393):

> (1) Interviewers develop a stereotype of a good candidate and seek to match interviewees with stereotypes;
>
> (2) Biases are established by interviewers early in the interview and tend to be followed by favorable or unfavorable decisions;
>
> (3) Unfavorable information is most influential on interviewers;
>
> (4) Interviewers seek data to support or deny hypotheses and, when satisfied, turn their attention elsewhere;

(5) Empathy relationships are specific to individual interviewers;

(6) A judge's decision (and, by implication, an interviewer's) is different when fed information piece by piece rather than simultaneously; and

(7) Experienced interviewers rank applicants in the same order although they differ in the number they will accept.

A microanalytic study was conducted by Carlson and Mayfield (1967). They found that managers responded more readily to negative than to favorable information. Also, inter-rater reliability turned out to be significantly greater for unfavorable than for favorable applicants.

Conversely, a macroanalytic research approach is taken to study the validity of the interview, all of the research on the "structured" or "patterned" interview fitting this category (op. cit.).

Banta (1967) conducted an innovative study, comparing leaderless group discussions and individual interviews as selection devices. She found the two to be equally valid and reliable.

Downs (1968) reported an attempt to quantify the impressions interviewers and interviewees had of the interviewing process. One of his more interesting findings relate to the response of interviewers to the question of the confidence they had in their decision. Eighty-one percent of the interviewers indicated their confidence level was 75% or higher (3% of them indicated 100% confidence!).

This result contrasts interestingly with a 17-year experience of interviewing applicants for jobs as stock brokers, reported by Ghiselli (1966). He found a corrected validity coefficient of .51. However, the biserial coefficient of correlation between the criterion of success on the job (survival with the company for a three-year-period) and the interview rating was only .35. The usual selection interview has produced such low reliability and validity in study after study that many researchers recommended its discontinuance (Dunnette, 1962; England and Paterson, 1960).

Structured or patterned interviews received a good deal of attention. A recent study by Carlson, Thayer and Mayfield (1971) suggested that only the structured interview generated information that enabled interviewers to agree with each other. They reported a median inter-interviewer correlation of .62. This result was similar to that of Maas (1965). There was some evidence that structured interviews were being used increasingly as a selection and promotional tool (LIAMA, 1968).

Wright, Carter, and Fowler (1967) attempted to determine if the interview added anything of a substantive nature to an assembled civil service selection procedure. They found that apparently the written test and the oral interview were sampling different candidate behavior; there was no consistent relationship between candidate scores on the written exam and the oral interview. What might have added to the discrepancies could have been an error caused by coding of the interview responses as found by Crittenden and Hill (1971).

A question of obvious importance is the effect of experience on the performance of interviewers. It was investigated by Rowe (1960). He found that when evaluating the same recruits, interviewers with similar experiences did not agree with each other to any greater degree than did interviewers with differing experiences. It was concluded that interviewers benefit very little from day-to-day interviewing experience (Carlson, 1967). It was implied by Carlson et al. (1971) that systematic training would be needed, with some feedback mechanism built into the selection procedure, to enable interviewers to learn from their experience. The job performance predictions made by the interviewer ought to be compared with how the recruit actually performs on the job.

In the conclusions of his comprehensive review, Wright (1969) recommended more macroanalytic research on the structured interview, being the only technique that has demonstrated consistent reliability. Furthermore, he recommended work be expanded in the model-building area, involving a multi-disciplinary approach.

<u>Personal History Information</u>

The Application Blank, as well as measures such as the Biographical Information Blank, the Individual Background Survey, and the Life History Blank provide the so-called biographical items. There exist several categories of these types of items and it is quite controversial what items should be called biographical (Henry, 1965; cf. Asher, 1972, p. 251):

> For example, a biographical item may vary on any of these dimensions: verifiable - unverifiable; historical - futuristic; actual behavior - hypothetical behavior; memory - conjecture; factual - interpretative; specific - general; response - response tendency; and external event - internal event.

Some have advocated that only an individual's historical experiences, events or situations that are verifiable should be classified as biographical items (cf. Asher, 1972).

Asher (1972) listed a number of studies using historical and verifiable biographical items, which were conducted between 1960 and 1970. In the reviewed research, the scorable application blank was used to predict work behavior that ranged from unskilled to skilled. Where the biographical items were used in a combination as a predictor rather than as single items, the following cross-validated correlations were obtained from 11 studies: 35% were .60 or higher; 55% were .50 or higher; 74% were .40 or higher and 97% were .30 or higher.

A comprehensive comparison between the predictive power of biographical items and other predictors was conducted by Asher (1972), utilizing validity coefficients derived by Ghiselli (1966) and by Ghiselli and Barthol

(1953). On the whole, it was stated that biographical items were about 50% more reliable than other predictors, such as intelligence, aptitude, interest, and personality. It appeared that biographical items were more often related to criteria like job tenure, than to job performance measures as such (Tiffin and McCormick, 1965).

Asher (1972) presented a theoretical explanation for the superior performance of biographical items. "The data seem to suggest that accurate prediction is a function of a point-to-point correspondence between predictor space and the criterion space (p. 261)." An example would be the fact that the best single predictor of college grade point average is high school grade point average (Fishman and Pasanella, 1960; Freeberg, 1967).

Not all findings were quite as overwhelming as Asher's report. Roach (1971) described a substantial loss in predictive power of a weighted application blank for identification of probable early terminators. In a three to five year follow-up the biserial correlation coefficient reportedly dropped from .49 to .33 (Buel, 1964). Roach held changes in labor market conditions, manpower needs, and personnel policies responsible.

Considerable work has been done in an attempt to improve the biographical items. Owens, Glennon and Albright (1966) established a set of rules as heuristic aids in developing biographical items: 1. Brevity of the question; 2. Options should be expressed in numbers; 3. Options should contain all alternatives; 4. Items should convey a neutral or pleasant connotation. Owens suggested the following further guidelines (cf. Asher, 1972, pp. 261f): ". . . An item should not try to retrieve information beyond the memory of the respondent; extremes on the continuum of choices may be more consistent than those in the middle position; statements should be positively worded; and a response continuum should not be defined in qualitative terms as for instance, 'seldom, occasionally, and frequently.'"

The question of item accuracy was investigated by Mosel and Cozan (1952). The result was generally satisfying, although some applicants had a tendency to upgrade information, mainly with respect to job duties. It was proposed that accountability should be tested as it may be a powerful determinant of an item's accuracy.

The following is a brief summary of further research on different types of biographical items, all of which are intended to provide further and deeper insights into personality characteristics in order to project work behavior. Spiegel (1970) developed items beyond the verifiable factual level in an attempt to measure past work behavior. Harrel (1970) found certain contraindicated items which signaled unsuccessful performance. These were for instance too frequent change of address, excessive personal indebtedness, unexplained gaps in the employment record, and frequent change in jobs. Walther (1961) suggested self-descriptive multiple choice items in order to predict turnover and performance. He later showed (1962) that self-description items had biserial correlations of .64 and .60 with rate of promotion.

The methodology of analysis of biographical items was looked into by Buel (1972). He made specific recommendations as to the use of a validated biographical form. Novack (1970) developed a fairly sophisticated weighted application blank, defining a cutting score and "maximum differentiation." His method allowed for elimination of 90% of short term employees. Lunneborg (1968) and Webb (1960) attempted innovative statistical strategies to increase the predictive power of biographic items. Lunneborg used techniques developed by Horst (1954, 1955) to attain multiple absolute and multiple differential prediction.

As areas for further research, Asher (1972) suggested among others the inspection of data for curvilinear relationships. "For instance, Schuh (1967) has pointed out that there is ample evidence at least when the criterion is turnover, that non-linear relationships exist for intelligence, aptitude, personality tests, and biographical items (p. 266)."

Performance Evaluation

Criteria

Any investigation of human behavior involves the use of some appropriate dependent variable, usually referred to as a criterion. If the purpose is one of analysis of individual variables, such as in personnel selection, the criterion measures for individuals would be related to individual characteristics. For example, the criterion would be a measure of job performance, and the individual characteristics would be test scores and biographical or interview information.

Job performance criteria are intended to reflect, in quantifiable or otherwise meaningful terms, the extent to which individuals are fulfilling the stated or unstated performance requirements of their jobs. Some of the specific types of job performance criteria are (Tiffin and McCormick, 1965): Quantity of work, quality of work, learning time, or its equivalent, training cost, tenure on the job, absenteeism, promotions, job sample, and ratings of employees by their supervisors. Ratings used as a criterion may be of over-all job performance, or of some particular aspect of performance.

Care is required to select or develop the criterion to be used. There are three basic considerations (ibid.). The first is relevance. It refers to the extent to which criterion measures of different individuals are meaningful in terms of the objectives for which such measures are derived. Freedom from contamination is the second and refers to the lack of influence of differences in situational variables that might serve to "contaminate" criterion measures for individuals. Third, reliability reflects upon the stability of the criterion. It describes to what extent the relatively permanent, or continuing, level of performance of several individuals on the job in question is accounted for by the criterion.

The multi-faceted nature of the purposes and objectives of jobs gives rise to what is called the various criterion dimensions (Ghiselli, 1956). As an example, if quantity and quality are pertinent aspects of a job, they might serve as the basis for two corresponding criteria. Seashore et al. (1960) presented an example of five such criteria which turned out to be all relatively independent from each other. These and other results were interpreted as contradicting the validity of "over-all job performance" as a unidimensional construct, and as a basis for combining job performance variables into a single measure having general validity. Dunnette (1963a) also argued for the use of criterion dimensions and suggested that we ". . . cease searching for single or composite measures of job success and proceed to undertake research which accepts the world of success dimensionality as it really exists (p. 252)." Ronan (1963) discussed the possibility of using factor analysis in singling out relatively independent underlying factors based on a larger number of variables describing the subjects.

On the other hand, in a research setting where one is interested in identifying personal factors that are associated with job success, the practical problem at hand is that of predicting some over-all level of performance for such purposes as making employment decisions. For this purpose, Brodgen and Taylor (1950) proposed the use of a "dollar criterion," where this common denominator could be used to establish the relative value of employees on a particular job. Several other bases for combining criteria were mentioned by Nagle (1953). These methods included:

1. Weighting subcriteria on the basis of judgments by 'experts' in terms of judged relevance to the ultimate criterion.

2. Weighting subcriteria on the basis of data from factor analyses.

3. Weighting subcriteria on the basis of their reliabilities (this gives more weight to those that are more reliable).

4. Other statistical methods.

With respect to the last point, Tiffin and McCormick (1965) suggested the use of multiple regression analysis. But they also expressed the view that the most rational basis for weighting of subcriteria be in terms of relevance.

In this context, another important factor deserves mention: There is evidence that criteria may be "dynamic" in nature (Ghiselli, 1956). Ghiselli and Haire (1960) reported, for example, that with a group of investment salesmen, performance was continuing to change (generally to improve) during a 10 year period after initial employment. They proposed that rate of change in performance could serve as a possible criterion.

Performance Appraisal

"Performance appraisal is a systematic evaluation of personnel by their supervisors or others who are familiar with their work performance (Tiffin and McCormick, 1965, p. 223)." It was estimated that over three-fourths of all U.S. companies now have performance appraisal programs (Spriegel and Mumma, 1961; Miller, 1959).

These are the common goals of performance appraisal programs (Oberg, 1972, p. 61):

1. Help or prod supervisors to observe their subordinates more closely and to do a better coaching job.

2. Motivate employees by providing feedback on how they are doing.

3. Provide back-up data for management decisions concerning merit increases, transfers, dismissals, and so on.

4. Improve organization development by identifying people with promotion potential and pinpointing development needs.

5. Establish a research and reference base for personnel decisions.

There exists a wide range of performance appraisal techniques, the more common ones being the following (ibid; Tiffin and McCormick, 1965):

1. Essay appraisal
2. Graphic rating scale
3. Field review
4. Forced-choice rating
5. Critical incident appraisal
6. Management-by-objectives approach
7. Work standards approach
8. Ranking methods
9. Assessment centers
10. Employee comparison systems

A brief look shall be taken at the most widely used among these methods. The essay appraisal asks the rater to write a paragraph or so, covering an individual's strengths, weaknesses, potential, and so on. The most common type of performance appraisal system employs graphic rating scales (Tiffin and McCormick, 1965). They may not yield the descriptive depth of an essay appraisal but are more consistent and reliable. Typically, a graphic scale assesses a person on the quality and quantity of his work (is he outstanding, above average, average, below average, or poor?) and on a variety of other factors that usually include personal traits like reliability and co-operation. The other methods are less frequently used in industry. They were described e.g. by Tiffin and McCormick (1965) and by Oberg (1972).

There are several limitations and sources of error associated with conventional rating scales. Ronan classified these as:

1. Defect in the instrument itself;
2. Errors inherent with the rater;

3. Error in compilation and use of data derived.

He discussed the following to avoid a defect in the instrument: One ought to consider the relevance of the criterion to job requirements. Furthermore, the proper number of steps of the rating scale would need to be assessed. Conklin (1923) suggested for untrained raters a maximum of five steps on a unipolar or nine steps on a bipolar scale. Symonds (1924) said that seven steps were optimal. The subjectivity in the interpretation of terms like "average," "excellent," "very poor" prompted Helmstadter (1965) to advise against their use. He also suggested to avoid extreme words like "never" or "always," since raters presumably did not use them.

Common errors inherent with the rater are: (1) personal bias, (2) central tendency, (3) halo effect, and (4) logical error (Cangemi, 1970). Personal bias, or constant errors (Tiffin and McCormick, 1965) result when the evaluator rates consistently most individuals too high or too low. The error of central tendency signifies that the evaluator seldom ever gives ratings at the extremes of the scale. The halo effect usually is found in those operating under the presence of strong personal biases toward the individual. That is, the rater rates an individual the same or nearly the same on all characteristics, as first pointed out by Thorndike (1920). To minimize the halo effect, Tiffin and McCormick (1965) recommended that each supervisor rate all his men on one trait before going on to the second trait, and so on. They also suggested arranging the chart itself so that the desirable end of some traits is on the right-hand side, whereas the desirable end of others is on the left-hand side of the scale. The fourth error, the logical error, was said to result from a misunderstanding of the characteristic to be rated (Cangemi, 1970). The rater rates an individual on his narrow conception of the trait he is measuring. "The logical error can be expected with high frequency when no definitions are found regarding the characteristics being rated (Cangemi, 1970)." Two creative approaches to minimizing common rater errors deserve mention. Cangemi (1970) presented a professional-supervisory rating scale, offering the opportunity of letting an individual rate himself, using the identical scale as is used by his supervisor. Cohen (1972) suggested a new version of the critical incident checklist, the format of which supposedly minimized common appraiser errors. The specimen checklist, as it was called, required the appraiser to diagnostically report behavioral incidents observed, based upon prompted recall.

Errors in compilation and use of data derived can be manifold. First of all, there may be several factors unduly and unknowingly influencing the rater, so that care should be taken when evaluating the data by statistical means. Among such factors are department, job, age, and length of experience (Tiffin and McCormick, 1965). For the purpose of statistical evaluation, it may be useful to pool the ratings of several raters. A study by Bayroff, Haggerty, and Rundquist (1954) suggested that pooled ratings by competent raters were better than single ratings. In case of inter-rater differences, another major undesirable influence in compilation of data derived, the ratings should not be compared or pooled across different raters, unless they are adjusted for the differences. There are two basic methods to accomplish this (op.cit.). If there is only a contaminating difference in the means, one would have to compute the average of the ratings given by each rater as well as the average over all raters. Then the difference between the two averages has to be added to or subtracted from the individual rater's mean, in order to bring his ratings into alignment with those of other raters. A systematic method of adjusting for differences in both mean and variances, is to convert all ratings to a common set of numerical values. Such a standard score as e.g. a z-score, indicates the relative position of an individual case in a distribution (Tiffin and McCormick, 1965).

Once the ratings have been obtained and adjusted as necessary, one has to ascertain their reliability and validity. The concept of reliability refers to their consistency with respect to different raters and with respect to different rating times. The reliability of rating scales is typically between .35 and .50 for individual trait ratings and somewhat higher for "total" ratings (ibid.). With a ranking procedure, ratings with reliabilities as high as .85 to .95 were obtained (Taylor, 1955). The validity of ratings is the degree to which they are truly indicative of the intrinsic "merit" of employees. It is usually difficult to obtain quantitative evidence of the validity of ratings.

Strategies for Personnel Decisions

From among the major steps undergirding any program of personnel selection and placement, individual differences measurement and job behavior observation have been discussed. Only job analysis has been omitted since it is of minor importance in the framework of this research. In selection, one seeks to predict later job behavior from the results of measures administered when candidates apply for the job. To do this, one needs a blueprint summarizing all the things to take into account as one attempts to establish predictive and stable relations between the attributes of people, their jobs, and the behavior they show on their jobs (Dunnette, 1966).

In the last decade, formal decision models have proven to be a valuable tool as a basis for effective decision making. Clarke (1969) suggested a five step procedure for the formal decision-making approach to problems:

1. Define the problem and state the objective(s);
2. Quantify the variables;
3. Develop a model of the system under study;
4. Test the model;
5. Implement the quantitative tool.

Clarke (1969) examined the literature dealing with those types of decision models for personnel selection and assignment which are concerned with optimization in terms of dollar values or utilities. It was proposed to define a mathematical model as an abstraction or an explicit representation of reality.

The advantages and limitations of mathematical models for personnel selection were summarized succinctly by Cronbach and Gleser (1965, p. 5) follows:

> The advantages lie in the precision with which conclusions can be stated, the finality with which they can be established, and the wide range of circumstances to which a derivation can apply. . . . The disadvantage of the mathematical attack is that it involves assumptions about postulated variables that have never been observed.

Cronbach and Gleser (1965) developed a selection and placement model in which the expected utility of decisions was obtained by summing the expected payoff per man accepted and subtracting the cost of the testing. The object was to determine the strategy that maximized utility.

Kao and Rowan (1959) examined the problem of filling a personnel quota where the quota was stated in terms of people productivity on the job rather than in terms of people hired. The model developed minimized cost, subject to a given probability that a specific number of successful employees were hired.

Mahoney and England (1965) discussed the drawbacks of traditional methods of statistical decision rules for employee selection:

> These traditional approaches . . . are inadequate since they fail to consider the cost consequences of their application. The maximum differential approach, for example, implicitly assumes that errors of accepting a failure candidate or rejecting a successful candidate are of equal consequence. . . . Realistically, there should be a balancing of recruitment costs and misclassification costs in the determination of the selection decision rule without a focus solely on one cost or the other. Further, the relative costs . . . or misclassification error should be explicitly taken into account and permitted to vary with the situation (pp. 366 f).

An optimal solution was developed for the relatively clearcut assignment problem, as defined by Flood (1956, p. 61):

> . . . The assignment problem is to assign N men optimally to N different jobs. In this application it is supposed that a numerical performance rating is given for each of the N! man-job combinations and an optimal assignment is one that minimizes the sum of the N applicable ratings. For example, the ratings might be estimated times, or costs, for the various man-job combinations.

Kuhn (1955) described the Hungarian method, which is an algorithm for solving the assignment problem based on the work of D. Konig and J. Egervary. Further problems of related nature were discussed by Belinski and Gomory (1964) - the dual to the Hungarian method; by Votaw (1958) - the quota problem, who also considered priority sequenced allocation.

The last one in the series of allocation problems which are based on linear programming techniques, is the unique model developed by King (1965). He considered personnel assignment as a two-stage process: (1) prediction on the basis of test results; (2) optimal allocation of personnel to job vacancies. King attempted to integrate the two phases into one model, assigning subjective value-judgments to the variables of the model.

Holt and Huber (1969) finally developed a fairly comprehensive personnel selection model. A formal optimization approach using functional estimates of satisfactions and productivities and of probabilities of job offers and acceptances was presented. Socioeconomic payoffs appeared to justify the cost of making the concepts operational. The employment service operations proposed in this article included a man-machine system in which the computer served as aide to the placement counselor.

Teach (1971) criticized the "hard match" often required by optimizing models that try to match men and jobs. The resulting dissatisfaction with the achieved results was assigned to a limitation in the flexibility of the search request as well as to the possibility that an inordinately high number of people may possibly simultaneously meet the search criteria. Teach suggested the use of an Index of Relevance and a computerized search logic to overcome these drawbacks. The theoretical foundation of the Index of Relevance is that no individual is a perfect match to a specific job but that some individuals, because of their profile, skills and performance, are more relevant to a job than others.

Besides the techniques based on operations research methods, there are those taking an empirical data base to develop a man-job matching model by use of statistical techniques. In the simplest case this could be achieved by using the relationship between test and criterion scores, the validity coefficient, in order to predict job performance. A systematic treatment of this topic was given by Ghiselli (1966), in his book "The Validity of Occupational Aptitude Tests."

Inskeep (1970) proposed a statistically guided employee selection procedure by means of which biographical data were compared with tenure in a particular job as performance criterion. The independent variables included:

> . . . Age, marital status, commuting distance, years of schooling, years of prior work experience, average length of previous employment, home ownership, months of military service and test scores. For women applicants such additional information as husband's occupation, and number and ages of children would be relevant.

Then, as a method to demonstrate relationships between independent variables and criteria of performance, the author suggested a contingency table analysis with a Chi-square test (Richmond, 1964, pp. 290-299) which could be done manually or with an appropriate computer program. The contingency table hypothesis to be tested was that the means of classification were independent. Weighting factors could then be assigned to the appropriate independent variables in order to evaluate job applicants.

The application of more sophisticated prediction systems including regression analysis was discussed by Raubenheimer and Tiffin (1971). This attempt to link predictors directly with criteria, was sharply criticized by Dunnette (1966, pp. 104 f):

> Such a simplified approach tends to ignore the careful methods designed to pinpoint jobs and job circumstances and the methods of job behavior observation. . . . Moreover, such a simple linkage of predictors and 'criteria' is seriously oversimplified when viewed against the many complexities in predicting human behavior. . . . Nor does the classic model take proper note of job differences, possible changes due to training in the man-job interaction, or the differing situational and social circumstances of the job. . . . The result has been that attempts to predict job 'success' and job 'failure' have yielded disappointing outcomes, rarely exceeding correlation coefficients of .50.

In an attempt to take the actual complexities of real prediction situations into account, Dunnette (1963) presented a new and more complicated model. This model essentially discriminates for different combinations of predictors, applicants, job behaviors, and situations, thus yielding an array of prediction equations.

Presently, much research effort is directed toward computerized systems for the job matching process. Such systems were discussed by Dear (1970), Patterson (1971), and Hinrichs (1968). Some statistics were presented in Nations Business (Nov. 1970, pp. 74-76). In 1970, there were 8,600 private employment agencies in the United States using computer "skills banks" to match individuals with jobs requiring particular talents.

Summary of Literature Review

The foregoing discussion on applicant assessment, performance evaluation and strategies for personnel decisions can be summed up as follows:

Tests can be used when only inadequate information for decision-making is available. In this case test scores are employed to forecast aptitudes. A major problem poses the validation required by the EEOC. In accordance to the EEOC, a test is a formal, scored, quantified technique for assessing job suitability.

Prime significance is generally assigned to the interview. However, it was found to have consistently low validity. New approaches are represented by the structured interview and by validation in order to improve inter-rater reliability.

On the other hand, items pertaining to personal history information, as obtained from the application blank, have 50% higher reliability than most other predictors.

The criteria of performance evaluation reflect the extent to which the performance requirements are fulfilled. Independent as well as overall criteria of job success can be employed in the performance appraisal. The various appraisal techniques aid the evaluation of personnel in order to assist supervisors in coaching, motivate employees, and function as a management tool. The validity of performance appraisals is uncertain, as there is a lack of quantitative evidence.

Strategies for personnel decisions have been developed with the purpose of predicting job behavior. The following are the formal decision models described in literature: Optimization techniques, using a dollar criterion, maximizing utility, or presenting solutions to an allocation problem; statistical techniques, employing correlation tests or regression statistics; search logics and sequential methods.

CHAPTER III

MODEL ALTERNATIVES

Objective and Approach

If the purpose of this research is to propose a model formulation for personnel selection and placement, it first has to be decided what type of approach ought to be taken. As seen in the review of relevant literature, models can be established with varying subgoals and degrees of comprehensiveness pertaining to the realm of man-job matching problems. There are mainly three categories: The first tries to explain and establish methods to determine the relationships between predictors of job success and certain criteria thereof; the second is concerned about an analytical approach to minimizing cost (or maximizing utility) of the man-job match using optimization techniques; and the third group comprises all those procedures which are centered around establishing formal processes, such as search logics and sequential methods which are intended to standardize the selection decision. Complex combinations of several of these categories allow for comprehensive selections systems, as presented by Dunnette (1963), and by Holt and Huber (1969). The application of electronic data processing systems is frequently implied, allowing for rational and accurate utilization of these quantitative tools.

This thesis research is concerned with the first category of the foregoing classification. It is the objective to investigate how the predictors of job success are related to measures of performance such that a normative model for the personnel selection process can be suggested. This approach should also allow for a descriptive model for evaluating how personnel managers utilize available information. Thus it should be possible to determine the precision, consistency, and overall effectiveness of classical selection and placement decisions, based on the clinical inference process.

There exist several statistical approaches which can be applied to the study of information processing in judgment. These shall be compared for the purpose of deciding on the most appropriate one for the present study. Subsequently, hypotheses concerning the usefulness of certain information-theory metrics can be stated and incorporated into the model.

Discussion of Variables

Following Clarke's (1969) procedure, the variables involved have to be examined in order to obtain a clearer picture of the problem's detailed structure. Two broad categories are distinguished: the independent and the dependent variables. Independent variables are those which are established in the process of applicant assessment and as such serve as predictors. They have been described as test scores, interview results, and data from the personal history of the applicant. The dependent variables represent the range of criteria that are the measures of success derived in the performance appraisal. The nature of these variables shall be described in terms of their quantitative properties, as these are of prime significance in developing an adequate quantitative model. These descriptions will be based on systems generally used by industry today.

Although the use of tests has experienced a sharp decline over the past few years, there are areas where they continue to be used consistently. This comprises mainly all types of pre-employment tests for professional jobs, and still a limited number of tests for hourly rated employees, such as clerical and mechanical aptitude tests (Ghiselli, 1955). Obviously, these quantified techniques supply score ratings as immediate result. These scores can be anchored along an arbitrary scale, as for instance in the case of mental ability tests. On the other hand, they may reflect directly a certain job success factor, such as the very common typing test for clerical employment. Occasionally a score may be the aggregate result of a test battery. An example would be the determination of the spatial perception score from a spatial relations test and a locations test (ibid.).

Difficulties become imminent as soon as one attempts to quantify interview results. Unstructured interviews furnish at best a set of notes describing the subjective impressions interviewers have received from candidates. Occasionally, interviewers are asked to sum up their opinions with a rating along a quantitative scale. This becomes somewhat more realistic if an interview appraisal sheet is provided, the formal structure of which aids the appraiser in making more consistent and reliable use of gathered information. Such forms may for instance contain categories pertaining to personal appearance, speech, and general behavior. But here again, the ratings are highly subjective and difficult to quantify. Only the structured or patterned interview can be assumed to possess significant reliability (Maas, 1965). Its results are accessible to quantification and thus may be utilized as predictor variables.

Personal history items can be obtained from application blanks, supplementary background forms, and from letters of recommendation of previous employers. Generally, the information on application blanks is of qualitative nature. However, there have been several successful approaches to creating weighted application blanks which supply the pertinent data quantitatively (Buel, 1972; Novack, 1970). Some items will obviously present difficulties in quantification, such as the quality of previous work experience and certain types of special training. This type of information may possibly be rated by the evaluator along an arbitrary discrete scale. Questions concerning formal education generally ask for quantitative ratings like class standing or grade point average. A few items typically are of dichotomous nature and as such present no problem to quantification. In this last category fall yes-no questions pertaining to military service, security clearance, citizenship, and criminal conviction. The relatively high degree of reliability of biographical items (Asher, 1972) makes it appear well worthwhile to attempt quantification as much as possible such that these variables can be used effectively for the process of statistical prediction.

As mentioned earlier, the degree of job success is established by means of the performance appraisal procedure. The criteria therein constitute the dependent variables of the problem. The most common method of conducting a performance review is to use a graphic rating scale, frequently supplemented by a question for subjective overall evaluation (Tiffin and McCormick, 1965). This type of performance rating is generally conducted by the immediate superior of the employee under consideration, with the overall evaluation occasionally being carried out as well by higher levels of supervision, especially in professional employment. Thus, pooled ratings may be obtained for improved reliability. The individual ratings are conducted along a continuous or discrete scale. A comment is usually added to clarify the meaning of the value on the rating scale. These are the most commonly considered criteria (Tiffin and McCormick, 1965): quality, quantity, cooperation, initiative, dependability, personality, health, safety, industry, versatility, leadership, judgment. The number of traits rated was found to range between four and 21 (ibid.).

Having discussed the variables individually, it is also important to see how they interrelate. As shall be shown, this has some bearing on the selection of an appropriate statistical method. Obviously, the criteria will not be mutually independent. This does not matter, however, as they can be considered one at a time. The situation is different with the predictors of job success. These measures shall be used jointly with the intention to obtain an estimate about a certain criterion. It seems reasonable to assume that some of the independent variables may be significantly correlated with others. As an example, one would expect job tenure to be non-independent of stability of residence.

Basic Models

Much of the recent work on processes and strategies that humans employ in order to integrate discrete items of information into a decision has been accomplished within two basic schools of research. These are called the "Bayesian" and the "regression" approaches (Slovic and Lichtenstein, 1971). Within each, the types of models that have been developed for describing and prescribing the use of information in decision making will be examined. Also, some major experimental paradigms, including the types of judgment, prediction, and decision tasks and the kinds of information available to the decision maker in these tasks shall be discussed. These approaches will then be compared in terms of applicability to the problem at hand.

Bayesian Approach

The basic tenets of the Bayesian approach are that ". . . opinions should be expressed in terms of subjective or personal probabilities, and that the optimal revision of such opinions, in the light of relevant new information, should be accomplished via Bayes' theorem (ibid., p. 665)." The output of a Bayesian analysis is not a single prediction, but rather a distribution of probabilities over a set of hypothesized states of the world. These probabilities can be used to implement any type of decision rule, including the maximization of expected value or expected utility.

Bayes' theorem is thus a normative model: It serves to describe how men should think or decide. In its common form (cf. Cochran and Cox, 1957), it is appropriate for discrete hypotheses; however, using integrals instead of summations, it can be rewritten to handle a continuous set of hypotheses and continuous data. For convenience, Bayes' theorem can be taken with respect to two hypotheses, the ratio of which represents the posterior odds. Sequential use makes it possible to measure the impact of several data, affecting the final posterior odds multiplicatively.

The use of Bayes' theorem assumes that the data are conditionally independent (op.cit.). Where this assumption is not met, an expanded combination rule has to be applied. As more data are received, the equation requires further expansion and becomes difficult to implement (ibid.). The requirement of conditional independence may be difficult to meet if the hypothesis is to predict whether a person will be either a success or a failure on the job. To clarify by an example, grade point average and a mental ability score may be two data used for making the decision. These two variables are typically positively correlated, and are thus unconditionally nonindependent (cf. ibid.). However, grade point average and mental ability are also correlated within subgroups of success and failure, and are thus also conditionally nonindependent, which means that the postulated requirement of conditional independence is not met.

Regression Approach

The regression approach to studying the use of information in a decision-making process offers analysis of variance and multiple regression analysis as two alternatives.

The ANOVA Paradigm. If the judge's weighting of an item of information varies according to the nature of other available information, he is said to combine cues in a configural manner. In order to account for such nonlinearity, one can incorporate interaction terms into the (descriptive) policy equation. Analysis of variance (ANOVA) was found to be an appropriate method to describe complex judgmental processes, as it permits one to take cross-product terms of independent variables into account.

The factors that describe the cases can be either continuous or categorical, but each must be partitioned into a relatively few discrete levels. If, in addition, the factors are made orthogonal to one another, the ANOVA technique provides a statistically efficient mechanism for detecting curvilinear and configural use of information. Within the framework of the ANOVA model, it is possible to calculate an index of the importance of individual or patterned use of a cue, relative to the importance of other cues (cf. Slovic, 1969).

In laboratory studies, the usual way to produce orthogonal stimulus dimensions is to construct all possible combinations of the cue levels in a completely crossed factorial design. Such an arrangement becomes unmanageable when the number of cues is large, or when it is desirable to include many levels of each cue (cg. Cochran and Cox, 1957).

An extension of the ANOVA approach is integration theory stemming from the work of Norman Anderson (cf. Anderson, 1970). Technically, integration theory relies upon factorial designs. It ". . . attempts to discover . . . subjective scale values and to determine rules of composition based on these values, whereas the regression and ANOVA approaches . . . attempt to discover the combination rule based on the objective dimensions (Slovic and Lichtenstein, 1971, p. 663)."

The Correlational Paradigm. In the correlational paradigm, a judge's integration of information is described by means of correlational statistics. Egon Brunswik's "probabilistic functionalism" led to an emphasis on the adaptive interrelationship between the organism and its environment. "Thus, in addition to studying the degree to which a judge used cues, he analyzed the manner in which the judge learned the characteristics of his environment" (ibid.). Brunswik developed the "lens model" to represent the probabilistic interrelations between organismic and environmental components of the judgment situation (cf. Brunswik, 1952, 1956).

The lens model has proved to be an extremely valuable framework for conceptualizing the judgment process. In this model the world is divided into two parts. The distal variable is the part of the environment about which the subject is concerned, e.g., job potential of an individual. It is the source of a number of cues, here the predictors of job success, such as grade point average, interview rating, etc. These cues are thus related to the distal variable and reflect its various states. The other side of the lens represents the subject's judgmental system. In the middle is the interface between subject and his environment, and it is here that he receives the cues about the state of the distal variable (Beach, 1967).

The cue dimensions must be quantifiable, if only to the extent of a 0-1 coding. Several different types of correlations can be established and computed. Both the criterion and the judgment can be predicted from linear combinations of the cues by means of regression equations. The coefficients of the regression equation represent the relative importance given each cue. Hoffman (1960) proposed an alternative index, "relative weight," which is different insofar as these weights sum up to 1.0. However, Darlington (1968) has emphasized that all indices of relative weight become suspect when the factors are intercorrelated.

Besides the linear model, other types of methods have been developed to relate cues to the decision, yet most tasks involving human judgment can be described reasonably well by the linear model (cf. Goldberg, 1971; Slovic and Lichtenstein, 1971). Curvilinear functions would for instance include squared terms of the variables, while configural models might incorporate interaction terms. "When models become this complex, however, the proliferation of highly-intercorrelated terms in the equations becomes so great that estimation of the weighting coefficients is unreliable unless vast numbers of cases are available (Hoffman, 1968, from Slovic and Lichtenstein, 1971, p. 661)."

If the decision rules employed in personnel issues do not involve configural cue utilization, the correlational paradigm can be employed in a straightforward manner. Besides, one is not limited to relatively few discrete levels of the variables, as required for the ANOVA paradigm. This would limit the utilization of cues like age or grade point average, for instance. Since Bayes' theorem expects data to be conditionally independent it remains to be concluded that the correlational model promises the greatest applicability to selection decisions.

The purpose of this chapter was to suggest a statistical approach toward normative and descriptive modeling of personnel decisions. The predictors that are obtained by means of applicant assessment were described as independent variables, whereas the criteria were called the dependent variables. The basic model alternatives considered were the Bayesian approach and the regression approach. The latter comprises the ANOVA paradigm and the correlational paradigm. The use of correlational statistics as employed by Brunswik's lens model was described as the most compatible basis for this research.

CHAPTER IV

BASIC MODEL FORMULATION

Regression Model in Cues

In the personnel selection and placement process the personnel manager is interested in assessing a candidate's expected performance on a particular job. No immediately apparent information is perfectly correlated with over-all job performance or, for that matter, with a more specific criterion. So, the decision maker's judgment relies on the diverse types of information from personal history, tests, and interview, each of which has a different degree of correlation with job performance and none of which is a perfectly correlated cue.

As previously mentioned, the lens model is potentially valuable for describing how the variables involved are tied together and ought to be related. The details are illustrated in Fig. 1. The variables X_1, X_2, . . . X_I are cues or information sources that characterize the stimulus object. Thus, if job performance is to be predicted, the X_i might represent interview evaluation, previous work experience, college activities, grade point average, etc. While the distal or ecological variable on the far left in Fig. 1 represents the true criterion value in terms of job performance to be expected, the

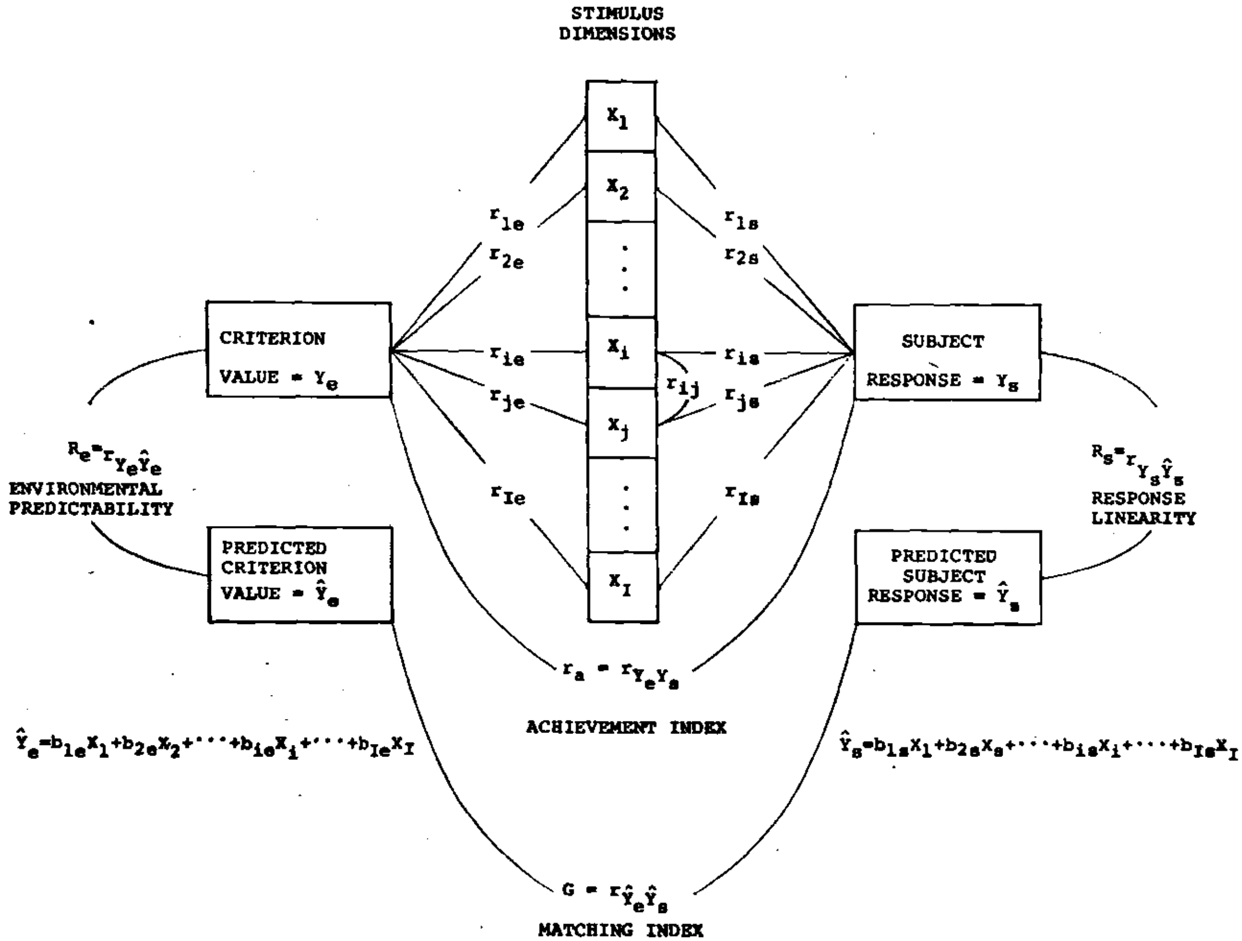

Figure 1. Diagram of the lens model showing the relationship between cues, criterion values, and responses. (Based on Beach, 1967).

right side of the lens provides a model of the decision maker's strategy. The line between the ith cue and the criterion value indicates the relevance of the ith predictor, the ecological validity r_{ei}, to the true state of the criterion Y_e. The intercorrelations among cues, r_{ij}, are measures of the cues' redundancy. On the decision maker's side, the correlation of his judgment with the ith cue is r_{si}. It is called the utilization coefficient for the ith cue.

Both the criterion and the judgment can be predicted from linear combinations of the cues. The left side of Fig. 1 can be summarized by the multiple-regression equation

$$\hat{Y}_e = b_{e1} X_1 + b_{e2} X_2 + \cdot \cdot \cdot + b_{eI} X_I \qquad (1)$$

where each b_{ei} is an optimal weight determined by the validity of each cue source. A similar equation for the right side of Fig. 1 results from the multiple-regression analysis of the decision makers judgment and the presented cues. Thus,

$$\hat{Y}_s = b_{s1} X_1 + b_{s2} X_2 + \cdot \cdot \cdot + b_{sI} X_I. \qquad (2)$$

The descriptive adequacy of Egs. (1) and (2) is given by the multiple correlation coefficients between Y and $\hat{Y}$ on both sides of the lens, R_e and R_s respectively (see Fig. 1). The major summary measure of the judge's performance is the achievement index r_a, which is the correlation between prediction Y_s and the actual state of the environment Y_e. If R_e and R_s are high, then $\hat{Y}_e \cong Y_e$ and $\hat{Y}_s \cong Y_s$. Thus, the more closely $\hat{Y}_s$ approximates $\hat{Y}_e$, the more accurate the decision maker's prediction of Y_e are. The correlation between $\hat{Y}_s$ and $\hat{Y}_e$ is called the matching index G. Finally, there is the optimality coefficient r_o, which is the correlation between the subjective responses Y_s and the optimal prediction of the distal variable from the cues Y_e (Beach, 1967).

The model may be further expanded to express nonlinear cue utilization by the introduction of the C coefficient. "C is the correlation between the residual which cannot be linearly predicted in the criterion and the residual which cannot be linearly predicted in the judgment (Slovic and Lichtenstein, 1971, p. 657)." The indices of the lens model are related in a general equation for achievement via the so-called lens model equation (ibid.).

$$r_a = R_e\ R_s\ G + C\ [(1-R_e^2)(1-R_s^2)]^{\frac{1}{2}} \qquad (3)$$

As has been stated earlier, it may be useful to group data obtained by several judges across identical cases. This would require obtaining mean values for Y_s and then computing a group regression equation and resulting group values for optimality, achievement, and R_s.

Information-Theoretic Model

Since the basic theory of information and communication was first formulated in the late 1940's (Shannon and Weaver, 1949) it has been increasingly realized that this theory lends itself quite nicely to the measurement of various aspects of human performance (cf. Attneave, 1959). One of the basic postulates underlying the present study was that some of the information-theory measures may be applicable to the modeling of human decision-making involving multiple cues. It was assumed that such metrics might be employed analogously to the values of cues in a multiple regression model.

Decision problems in the area of selection and assessment typically involve inferences regarding some unknown stochastic variable - the ecological variable - on the basis of knowledge of certain other variables - the cues that relate to the distal variable. Since a number of the information theory metrics carry the usual connotation of information gain and uncertainty as used in everyday language, and since furthermore the type of multiple cue decision model concerned seems to fall within such a category, it seemed intuitively appealing to employ some quantitative information theory measures within the framework of such a decision model.

In particular, it would seem reasonable to suggest that the ecological variable be somehow related to the gain in information about this variable, resulting from the knowledge about each of the different cues X_i.

Similarly, the uncertainty measures basic to information theory were proposed as measures of the prior uncertainty regarding the different cues X_i prior to the decision maker being provided with any knowledge about them. Furthermore, it was assumed that a measure of the a posteriori uncertainty could be defined, remaining after such knowledge has been made available to the decision maker.

It was the objective of this research to develop such a model and then test its descriptive and predictive power in a real-life situation. Then these models could be compared with those involving only the cues themselves.

In order to describe the models used, the basic theoretical measures considered and their empirical estimates are defined below. Thus, there exists a set of cues $\{X_i;\ i=1,\ \ldots,\ I\}$, where X_i may be a random variable or a set of random events (X_i may be either discrete or continuous if it is a random variable). Furthermore, consider x_{ij} to be a subevent of X_i (or a value of the random variable X_i). Then we have that $X_i = \{x_{ij};\ j=1,\ \ldots,\ J\}$. Note also that when x_{ij} is an event, it may be associated with a random variable X_i, e.g. $x_{ij} \equiv \{a_j \leq X_i \leq b_j\}$.

Let X_i be related to a complete finite probability scheme, i.e. $\bigcup_{j=1}^{J} x_{ij} = U_i$, where U_i is the universal set and $p(\bigcup_{j=1}^{J} x_{ij}) = \sum_{j=1}^{J} p(x_{ij}) = p(U_i) = 1.$

Then, let y_{ek} denote the k-th value of Y_e if Y_e is discrete or the k-th interval defined for Y_e, if Y_e is continuous.

As stated previously, the underlying idea is as follows: Whenever an individual is informed about some event x_{ij} having occurred, he thereby obtains information about Y_e, assuming, of course, that x_{ij} and Y_e are not uncorrelated. The basic statistics used to quantify such information gain are the following measures of information transmission:

By definition,

$$I(Y_e/x_{ij}) = \sum_{k=1}^{K} p(y_{ek}/x_{ij}) \log_2 [p(y_{ek}/x_{ij})/p(y_{ek})] \quad (4a)$$

$$= \sum_{k=1}^{K} p(y_{ek}/x_{ij}) \log_2 p(y_{ek}/x_{ij})$$

$$- \sum_{k=1}^{K} p(y_{ek}/x_{ij}) \log_2 p(y_{ek}) \ . \quad (4b)$$

Since the a posteriori uncertainty is given by

$$H(Y_e/x_{ij}) = -\sum_{k=1}^{K} p(y_{ek}/x_{ij}) \log_2 p(y_{ek}/x_{ij}), \quad (5)$$

it follows that the information gain may be expressed as

$$I(Y_e/x_{ij}) = -H(Y_e/x_{ij})$$

$$- \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(y_{ek}). \quad (6)$$

Alternatively, the following relationships may be obtained from Eq. (4):

$$I(Y_e/x_{ij}) = \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(y_{ek}, x_{ij})$$

$$- \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(x_{ij})$$

$$- \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(y_{ek}). \quad (7)$$

Thus,

$$I(Y_e/x_{ij}) = \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(y_{ek}, x_{ij})$$

$$- \log_2 p(x_{ij})$$

$$- \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 (y_{ek}). \quad (8)$$

Eq. (8) may also be expressed as

$$I(Y_e/x_{ij}) = h(x_{ij}) + \frac{1}{p(x_{ij})} H(Y_e; x_{ij})$$

$$- \frac{1}{p(x_{ij})} H(Y_e, x_{ij}). \quad (9)$$

Here, the joint a priori uncertainty

$$H(Y_e; x_{ij}) = -\sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log_2 p(y_{ek}), \quad (10)$$

where $H(Y_e; x_{ij})$ is not "standard" information theory measure. Eq. (8) may also be expressed as

$$I(Y_e/x_{ij}) = \frac{1}{p(x_{ij})} \sum_{k=1}^{K} p(y_{ek}, x_{ij}) \log \frac{p(y_{ek}, x_{ij})}{p(y_{ek})}$$

$$- \log_2 p(x_{ij}). \quad (11)$$

In terms of the new symbols used in Eq. (9), Eq. (6) may be written as

$$I(Y_e/x_{ij}) = \frac{1}{p(x_{ij})} H(Y_e; x_{ij}) - H(Y_e/x_{ij}) . \qquad (12)$$

When the probabilities in Eqs. (4a) and (8) are replaced by their frequency estimates, the following relationships result:

$$\hat{I}(Y_e/x_{ij}) = \sum_{k=1}^{K} \frac{n_{ijk}/N}{n_{ij.}/N} \log_2 \frac{n_{ijk}/N}{(n_{ij.}/N)\ (n_{i.k}/N)}$$

$$= \log_2 N - \log_2 n_{ij.}$$

$$+ \frac{1}{n_{ij.}} \sum_{k=1}^{K} n_{ijk} \log_2 \frac{n_{ijk}}{n_{i.k}} \quad , \qquad (13)$$

where n_{ijk} denotes the number of joint occurrences in the j-th interval of the independent variable i and the k-th interval of the dependent variable. Then,

$$n_{i.k} = \sum_{j=1}^{J} n_{ijk} \quad ,$$

$$n_{ij.} = \sum_{k=1}^{K} n_{ijk} \quad , \text{ and}$$

$$N = n_{i..} = \sum_{j=1}^{J} \sum_{k=1}^{K} n_{ijk} \quad .$$

Thus, Eq. (8) becomes

$$\hat{I}(Y_e/x_{ij}) = \frac{1}{n_{ij.}/N} \sum_{k=1}^{K} \frac{n_{ijk}}{N} \log_2 \frac{n_{ijk}}{N}$$

$$- \log_2 \frac{n_{ij.}}{N}$$

$$- \frac{1}{n_{ij.}/N} \sum_{k=1}^{K} \frac{n_{ijk}}{N} \log_2 \frac{n_{i.k}}{N} \qquad (14a)$$

or,

$$\hat{I}(Y_e/x_{ij} = \log_2 N - \log_2 n_{ij.}$$

$$+ \frac{1}{n_{ij.}} \sum_{k=1}^{K} n_{ijk} \log_2 \frac{n_{ijk}}{n_{i.k}} \quad , \qquad (14b)$$

which agrees with Eq. (13).

Alternatively, the model could employ the following information theory terms. From Eq. (5), it follows that

$$\hat{H}(Y_e/x_{ij}) = -\sum_{k=1}^{K} \frac{n_{ijk}}{n_{ij.}} \log_2 \frac{n_{ijk}}{n_{ij.}}$$

$$= \log_2 n_{ij.} - \frac{1}{n_{ij.}} \sum_{k=1}^{K} n_{ijk} \log_2 n_{ijk}. \qquad (15)$$

From the definition of $H(Y_e, x_{ij})$ in Eqs. (8) and (9), we also obtain:

$$\hat{H}(Y_e, x_{ij}) = \frac{n_{ij.}}{N} \log_2 N - \frac{1}{N} \sum_{k=1}^{K} n_{ijk} \log_2 n_{ijk}. \qquad (16)$$

Then the basic models to be tested were the following:

$$\hat{Y}_{sn} = b_o + \sum_{i=1}^{I} b_i \; \hat{I}(Y_e/x_{i[n]}); \; n= 1, 2, \ldots, N; \qquad (17a)$$

$$\hat{y}_{sn} = b_o + \sum_{i=1}^{I} b_i \hat{H}(Y_e/x_{i[n]}); \; n= 1, 2, \ldots, N; \qquad (17b)$$

and

$$\hat{y}_{sn} = b_o + \sum_{i=1}^{I} b_i \hat{H}(Y_e, x_{i[n]}); \; n= 1, 2, \ldots, N, \qquad (17c)$$

where $x_{i[n]}$ denotes that level of, or that event associated with the i-th cue that corresponded to the n-th case or observation. Analogous equations were used for the normative models. Here, the $\hat{y}_{s[n]}$ of the descriptive models were replaced by $\hat{y}_{e[n]}$.

Summary

In this chapter the lens model was described as a tool relating the independent variables to both, the true state of the criterion, and the decision maker's strategy. There are a number of parameters which characterize the various relationships.

An information-theoretic model formulation was presented as an alternative to the linear regression model. The following assumption had to be made:

1. Information-theory measures are applicable to human decision-making.

2. These measures can be employed analogously to cue values in a multiple regression model.

3. The ecological variable is related to gain in information resulting from knowledge about each of the cues X_i.

CHAPTER V

DATA BASE

The evaluation of the proposed models generated certain requirements for the nature of the data that had to be collected. It was intended to gather two different sets of information. First, the one for the normative part of the study, referring to the mechanism relating cues and criterion value. Second, data had to be obtained for the descriptive part, to model the judgmental process of the personnel manager.

The former category required data from the personnel records of a number of employees. The cues were obtained from application blank, interview evaluation, and from test records, while the criterion values were found in performance appraisals. These data were intended to represent characteristic employment groups, both nonprofessional and professional job categories. The need for a relatively large sample size limited the kinds of industries as well as the types of professions that could be investigated.

For the descriptive portion of the study, the decision-makers were asked to rate fictitious cases presented to them. These cases included cue ratings such as those that were available in preemployment records for the professions under consideration. The fictitious cases were similar to the empirical ones. This means the construction rule for the fictitious cases was based on the assumption that, e.g. a young employee would not generally be expected to have many children, or a person with an excellent record of scholastic activities would not be likely to have a very low college grade point average.

Preliminary Work

The companies selected for the study represent large-scale employers in the manufacturing and service industries. After initial interviews there turned out to be two main contributors and two supplementary contributors to the data collection process. Main contributors were those companies that were willing and able to provide access to the requested records, supplementary contributors were companies for which the data of interest were only partially available, or where requirements of confidentiality limited the usefulness of the data. The subsequent discussion will center around the data obtained from the main contributors, although the results will include some information pertaining to the other two firms.

The following were the job classifications selected for this research: Firm A provided data pertaining to clerical jobs; later, this relatively broad category was limited to two specific jobs, General Clerk-Typist and Technical Typist. Firm B supplied data for the job classification Associate Design Engineer with a general requirement for a Bachelor of Mechanical Engineering degree. The jobs chosen were typical positions at the entry level in both companies.

Job descriptions are included in Appendix E. An Occupational Summary for General Clerk-Typist was given (Appendix E) as follows:

> Must operate a typewriter at a net speed of 50 words per minute and perform the general clerical duties of a simple routine nature. Occasionally operate and use office machines incidental to the performance of assignments.

For Technical Typist the Occupational Summary was given as:

> layout and type for reproduction purposes, technical manuals, reports and publications requiring typing of various formulae, and preparation of charts, graphs and schedules and forms.

The purpose of position of the Associate Design Engineer was described as follows (Appendix E):

> To design, redesign, layout, and detail component parts and assemblies under close supervision.

Standard type application forms and performance review forms were used in both companies. The performance review form for hourly employees of Firm A contained five items to be evaluated along a graphic rating scale. For reviewing engineers in Firm B there were nine such categories, plus an "overall evaluation" item, provided for ratings by three levels of supervision (Appendix E).

Firm B also made use of an interview appraisal sheet which included a few specific questions, but other than that, it was intended to accompany a completely unstructured interview. Besides plenty of space for interviewer comments there were a number of multiple choice items pertaining to personal appearance, speech, and general behavior (Appendix E).

Firm A used the following method for hiring hourly employees: There were two main steps in the decision logic. The first one described the "musts" for the job. These comprised, e.g. a specific amount of formal education, experience requirements, and the absence of certain physical limitations. If all these prerequisites were met, the existence of certain "wants" was investigated and assessed. To these belonged e.g. additional education, quantity of related work experience, team work experience or individual work experience as needed on the job, and stability of work history. These predictors of job success were used for the purpose of "clinical" overall evaluation of the applicant.

Other employers tended to use less systematic approaches to their hiring problem. One method, reported to the writer in an interview with a personnel manager, involved mainly the following steps for hiring blue collar workers (Firm D, Appendix E):

> If the candidate had previous related experience he was assessed by the interviewer on the following factors in the order in which those factors appear here.

> Quality and applicability of previous experience,
> The candidate's expressed attitude toward those jobs,
> Attendance and punctuality record,
> Reason for leaving previous jobs.

> If the candidate had no experience but had participated in a vocational training activity he was assessed against the following, again in the order presented here.
> Quality and applicability of training,
> Reasons expressed by the candidate for acquiring skills necessary to perform the functions of the position.

A small company, with little and sporadic demand for new hires, reported an approach similar to the following: After initial screening by a secretary, prospective employees are interviewed by a personnel officer, who also takes a look at their application forms. Then the personnel officer in turn refers a final selection of applicants to the immediate supervisor of the prospective employee. The supervisor makes his final choice from among the candidates left, deciding on the man whom he would like to have on the job. His evaluation is then relayed back to the personnel office in a statement like: "Good impression, make offer."

Several companies were found to no longer search for the man who was <u>best</u> qualified to do the job. It was stated that when a member of a minority group applied, and it was found that he <u>could</u> do the job, he was given preference. Employers felt that they were put under pressure by the Equal Employment Opportunity Commission. This was pertaining to quotas for minorities as well as to test validation regulations as established by the EEOC. As a result, many employers have abandoned testing and other objective means of personnel evaluation altogether. An exception was a typing test for clerical personnel, but it was found to be used more as a device to facilitate placement, rather than to screen out applicants.

Generally, a resistance against introducing scientific methods was found to exist. A preliminary observation was that the degree of sophistication applied to the hiring methods depended on the magnitude of demand for new personnel, it was somewhat directly related to competitiveness within the industry and appeared to decrease with increasing profitability of a certain business sector.

Data Collection

Empirical Cases

Before a final decision on the types of data to be collected could be made, certain problems and questions had to be dealt with in view of the validity and usefulness of conclusions this research was intended to generate. It was felt that a subgroup of cases within the selected professions had to be chosen such that a maximum degree of homogenity would be achieved. For this reason samples were intended to be uniform in terms of age, class, sex, educational background, and job experience, thus considering

Tiffin and McCormick's (1965, p. 36) warning against error in data compilation. These restrictions, however, had to be relaxed to a certain extent, in order to ensure sufficiently large sample sizes. No limit was set to age in the clerical classifications. Educational background and related work experience also varied.

In order for the data to be representative of the employees, it was intended to include cases of termination for voluntary as well as involuntary reasons. Also, it would have been desirable to include cases of candidates who have been declined employment. The latter category might have been useful in disclosing cue values which were related to "unsuccessful" ratings by personnel managers. However, actual performance ratings obviously could not be obtained. On the other hand, terminated employees who remained with the company beyond the first performance appraisal, were included in the data collection if their records were available. It was found that most terminations did not necessarily signify unsuccessful performance. Rather, the actual number of people being fired was very small. For this reason, unavailable records of cases of termination were assumed to be distributed over all performance groups, thus their elimination would contribute little to contaminate the actual distribution of successful and unsuccessful employees.

The decision on cues to be selected for this research was based on suggestions of personnel managers in accordance with what they considered to be of significance with respect to job success. General conformance with Inskeep's (1970) suggestions was verified (cf. p. 45). A second criterion was the facility of quantification. Performance measures were chosen in accordance to the companies' performance review forms (Appendix E). The performance ratings were taken from the first appraisal which took place within five to 10 months after hiring.

The following were the I=10 cues chosen for the secretarial jobs in Firm A:

(1) Age

(2) Marital status

(3) Typing speed

(4) Years of additional education

(5) Years of related job experience

(6) Average number of years each job held during the past ten-year period

(7) Verbal comprehension score

(8) Numerical reasoning score

(9) Visual speed and accuracy score

(10) Estimated mental ability score

Cue (2), marital status, was arbitrarily quantified in the following way: 1 = married, 2 = single or widowed, 3 = divorced. In cue (4), years of additional education, "additional" referred to schooling beyond a 12-year standard for these jobs. Cues (7) through (9) were available in some of the older records only. The company had since eliminated them from the employment procedure. As a result, these cues were not utilized for a major portion of the statistical evaluations.

The five performance criteria with ratings along a scale from one to five were these:

(1) Industriousness

(2) Quantity

(3) Adaptability

(4) Job knowledge

(5) Quality

The total number of cases compiled was 88, of which 31 were General Clerk Typists and 12 were Technical Typists. The remaining 45 employees represented diverse other office occupations. All employees were female. Elimination of cases with insufficient data and of those which did not meet the set standards for homogenity, yielded a useful sample size of n = 32, which were close to the minimum required for test validation (cf. Chapter I).

For the data on Associate Design Engineers (Firm B) the following cues were chosen:

(1) Age

(2) Marital status

(3) Number of dependents including children

(4) College overall gradepoint average

(5) Scholastic activities

(6) Professional organizations

(7) Interview rating.

Cue (2), marital status, was quantified as in the secretarial job group. The ratings for cue (5), scholastic activities, were: 1 = none, 2 = membership in campus organizations, 3 = office held in campus organizations. Similarly, for cue (6), professional organizations: 1 = none, 2 = membership, 3 = office held. For cue (7), interview rating, the evaluation on the Interview Appraisal Sheet (Appendix E) was utilized: 1 = not suitable, 2 = average, 3 = good, 4 = excellent, 5 = outstanding.

The ten performance measures, with a continuous rating scale from zero to 100, were the following:

(1) Accuracy

(2) Volume

(3) Technical knowledge

(4) Ability to generate ideas

(5) Ability to make sound decisions

(6) Ability to act on own responsibility

(7) Reliability in completing assignments as expected

(8) Attitude to work harmoniously

(9) Ability to plan, lead, and delegate

(10) Overall evaluation

The total number of cases compiled from Firm B was 51. Elimination of cases with insufficient data or defective conformity yielded a useful sample size of 43. All employees were male and had little or no previous job experience.

Further data were made available by Firm C. Age, level of education, and 14 different test scores served as performance predictors on a specific manual job. The performance score was assessed by means of specifically designed tasks of increasing difficulty. The total number of cases was 95. The company wished not to disclose specifics pertaining to the nature of the data.

Firm D supplied a sample of 15 cases of the basic entry level job of assembler. Information on each individual included: months of previous experience, predicted job success at time of hiring, performance review rating, service in months at time of appraisal, sex and age. Detailed preemployment records with the specific cues utilized were not available. For this reason it was not possible to make use of these data.

Fictitious Cases

In order to model the personnel manager's decision process, 30 cases of fictitious employment candidates were rated by two personnel officers in both Firms A and B (Appendix F). For Firm A, the following six cue ratings were provided, representing the two jobs General Clerk-Typist and Technical Typist:

(1) Age

(2) Marital status

(3) Years of additional education

(4) Years of related job experience

(5) Average number of years each job held during the past ten-year period

(6) Typing speed

The personnel officers were asked to rate the fictitious cases along the following six criteria:

(1) Industriousness

(2) Quantity

(3) Adaptability

(4) Job knowledge

(5) Quality

(6) Overall predicted job success

A five point continuous rating scale was used, where: k = 1 = poor, 2 = below average, 3 = average, 4 = above average, 5 = excellent.

The cases presented to the two personnel officers of Firm B contained seven cue variables:

(1) Age

(2) Marital status

(3) Number of dependents including children

(4) College overall grade point average

(5) Scholastic activities

(6) Professional organizations

(7) Interview rating

The rating scales for these independent variables corresponded to those of the empirical cases discussed in the preceding section. The raters were asked to evaluate the fictitious cases using an assumed measure of expected overall job performance along a scale from zero to 100. They were to appraise the cases under two sets of conditions. First it was assumed that interview ratings were not available, as this situation was found in most of the empirical cases. The second assessment was to include all seven cues.

CHAPTER VI

PROCEDURE AND RESULTS

Procedure

The data obtained were analyzed as follows:

1. Multiple linear regression analysis using the values of the predictor variables against the criteria as dependent variables. This was done for both the data from the empirical cases and those from the fictitious cases.

2. Where "total" ratings were available, multiple linear regression analysis was used to relate the subcriteria to the overall criterion with the latter being the dependent variable.

3. For those sets of independent and dependent variables that consistently yielded a relatively high coefficient of multiple determination in both the empirical and fictitious cases, the information measures as defined in Chapter IV were computed, based on the empirical cases. The empirical as well as the fictitious cases employed the three information-metric terms $\hat{I}(Y_e/x_{ij})$, $\hat{H}(Y_e/x_{ij})$, and $\hat{H}(Y_e, x_{ij})$, thus yielding three regression models.

4. Further model hypotheses were examined for the

fictitious cases. These were linear combinations of the models under (1) and (3) above and also nonlinear models in the information measures, employing logarithmic functions of the independent and/or dependent variables.

5. Histograms and plots were obtained to describe the distribution of the variables and relationships between independent and dependent variables. Further plots were prepared to illustrate the functional characteristics between the independent variables and corresponding information measures $\hat{I}(Y_e/x_{ij})$.

6. The results of selected regression runs were presented in tabular form, including the variables entered, and the cumulative coefficient of multiple determination. For the final step this tabulation included coefficients, t-statistics and normalized coefficients of partial multiple determination $R_i{*}^2$ defined below.

7. Values $\hat{I}(Y_e/X_i) = \sum_{j=1}^{J} p(x_{ij})\ \hat{I}(Y_e/x_{ij})$ were computed and plotted against corresponding $R_i{*}^2$ values. Correlations between the two were computed.

8. Lens model coefficients were computed for selected results from Firm A.

Results from Firm A

Summary of Computer Runs

For all regression runs the computer program BMD02R - Stepwise Regression, Health Sciences Computing Facility, UCLA, Version 4/13/65 was used. The 32 empirical cases did initially employ regression runs with the following independent variables: 1. Age, 2. Marital Status, 3. Typing Speed, 4. Additional Education, 5. Related Job Experience, 6. Time Job Held, 7. Verbal Comprehension, 8. Numerical Reasoning, 9. Visual Speed and Accuracy, and 10. Mental Ability. These, as well as the following dependent variables, were defined in Chapter V: 1. Industriousness, 2. Quantity, 3. Adaptability, 4. Job Knowledge, and 5. Quality. The highest multiple R^2 was obtained for Quantity and Adaptability with $R^2 = .5298$ and .6442, respectively (see Table 1). Since the independent variables 7, 8, and 9 were no longer in use at the time of the study, they were eliminated in subsequent computations. Repeated calculation of R^2 under exclusion of these variables resulted in decreased values with .2731 for Quantity and .3900 for Adaptability. In the regression run with Adaptability as the dependent variable, only five of the six predictor variables did enter the regression. Cue number four, Additional Education, was not significant at the .5% level, thus was excluded by the computer program. The above results are summarized in Table 1.

Then the data based on the fictitious cases were examined. Regression runs in the six cues were prepared for the results of each of the two Raters. In addition to the previously mentioned dependent variables, "Total" ratings were available from the data collection phase. The coefficients of multiple determination for Quantity and Adaptability were .4544 and .4863 for Rater 1, .8807 and .3586 for Rater 2 respectively. Rater 2 was generally more linearly consistent than Rater 1 as indicated by the results in Table 2. The overall ratings could be explained as linear combinations of the subcriteria with a fair degree of accuracy, as indicated by the multiple R^2 of .9164 and .8467 for Rater 1 and 2, respectively.

Next, it was decided that the criteria Quantity and Adaptability could be employed in the three model alternatives with the information measures $\hat{I}(Y_e/x_{ij})$, $\hat{H}(Y_e/x_{ij})$, and $\hat{H}(Y_e, x_{ij})$. These measures had to be obtained from the empirical data. The computation involved the following. For the estimation of the various probabilities (cf. Chapter IV), certain frequencies had to be determined that were four-dimensionally defined. This was accomplished with the aid of the computer program BMD09D - Cross Tabulation, Incomplete Data - Version of July 22, 1965, Health Sciences Computing Facility, UCLA. Next a small Focal program was used on a PDP-8 computer to calculate the various information measures. Then the cue values were replaced by corresponding information-metric terms, yielding the converted data matrices. These finally could be employed in regression runs against the chosen dependent variables.

Some more detailed explanation is necessary at this point. As mentioned, the frequencies that needed to be calculated were defined by four dimensions. The first was the dependent variable under consideration, the second was an interval of the dependent variable, the third was a particular cue variable and the fourth was an interval of the cue variable.

The interval width of all dependent variables was clearly given by their definition along a five point scale. Thus K = five intervals with width 1 were used. For the independent variables these were the decisions made:

1. Age: lower limit = 17, width = 5;
2. Marital Status: lower limit = 1, width = 1;
3. Typing Speed: lower limit = 45, width = 10;
4. Additional Education: lower limit = 0, width = 1;
5. Related Job Experience:

$$\begin{aligned} &\text{Interval } 1 = 0 \\ 1 \le\ &\text{Interval } 2 \le 3 \\ 4 \le\ &\text{Interval } 3 \le 8 \\ 9 \le\ &\text{Interval } 4 \le 15 \end{aligned}$$

6. Time Each Job Held: lower limit = 1, width = 1.

Then the following frequencies could be determined for each pair of the i = 1, ..., I predictors and the criterion (cf. Chapter IV):

1. The number of joint occurrences for the j-th interval of the independent and the k-th interval of the dependent variable: n_{ijk} .

2. The sum of occurrences over all values of the

i-th independent variable with respect to the k-th interval of the dependent variable: $n_{i.k}$.

3. The sum of occurrences over all values of the dependent variable with respect to the j-th interval of the i-th independent variable: $n_{ij.}$.

After the three information measures were computed with the program depicted in Figure 2, the converted data matrices shown in Appendix C were generated manually. As the intervals of the independent variables, for which the information terms were computed, included all possibilities, values could be assigned to each of the empirical as well as the fictitious cases. Thus every column triplet of the converted data matrices represents one column of the original data matrices.

The model involving the terms $\hat{I}(Y_e/x_{ij})$ yielded some improvement over the linear model for the criterion Quantity with $R^2 = .4756$. However, the multiple R^2 for Adaptability dropped to .2958. In the fictitious cases, the model with the $\hat{H}(Y_e/x_{ij})$ terms was fairly adequate for Quantity as compared to regression analysis in the cue values, while the one with the term $\hat{H}(Y_e, x_{ij})$ resulted in a slight improvement for Adaptability and Rater 2.

Further alternatives tested were models that consisted of linear combinations employing all three information measures and models that in addition employed the cue values. The number of variables in the regression was limited to six in each case. The fit was found to improve markedly (cf. Table 2, dependent variable = Quantity).

A model alternative using logarithmic functions of the criterion variable gave a slightly better fit than the linear model when the $\hat{H}(Y_e, x_{ij})$ terms were employed. These results are summarized in Table 2.

```
*
*W
C-8K FOCAL ©1969

01.03 C FMC: DEPENDENT VARIABLE: YE10=X17, TOTAL
01.05 S N=42
01.10 S M1=5; S M2=1; S M3=18; S M4=5; S M5=14
01.15 A !!"ENTER NI",NI,!
01.20 A "ENTER CORRESP. NKI"!,I1,I2,I3,I4,I5,!
01.25 S X=FLOG(2)
01.27 S A=I1*FLOG(I1)/X
01.30 S B=I2*FLOG(I2)/X
01.35 S C=I3*FLOG(I3)/X
01.40 S D=I4*FLOG(I4)/X
01.45 S E=I5*FLOG(I5)/X
01.47 S G=I1*FLOG(M1)/X
01.50 S H=I2*FLOG(M2)/X
01.55 S I=I3*FLOG(M3)/X
01.60 S J=I4*FLOG(M4)/X
01.65 S K=I5*FLOG(M5)/X
01.70 S L=FLOG(N)/X
01.75 S M=FLOG(NI)/X
01.80 S Q=(A+B+C+D+E)/NI
01.85 S O=(A+B+C+D+E)/N
01.90 S P=(G+H+I+J+K)/NI
01.95 S IY=L-M+Q-P

02.05 S HY=M-Q
02.10 S HX=NI*L/N-O
02.15 T !!"I(YE/XIJ)",IY
02.20 T !"H(YE/XIJ)",HY
02.25 T !"H(YE,XIJ)",HX
02.50
02.55
*
```

Figure 2. FOCAL Program for Computation of Information Measures

Table 1. Firm A, Summary of Regression Runs,

Empirical Cases

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
1	$\hat{Y}_{e[n]}=b_o+\sum_i b_i x_{in}$	Indust	68	4	.0566
2	"	Quant	68	6	.1156
3	"	Adapt	68	6	.1402
4	"	J Know	68	5	.0421
5	"	Qual	68	6	.1290
6	"	Indust	38	10	.2546
7	"	Quant	38	10	.3147
8	"	Adapt	38	9	.3482
9	"	J Know	38	9	.1643
10	"	Qual	38	9	.3117
11	"	Indust	32	10	.3405
12	"	Quant	32	10	.5298
13	"	Adapt	32	9	.6442
14	"	J Know	32	10	.3394
15	"	Qual	32	10	.5154
18	"	Quant	32	6	.2731
19	"	Adapt	32	5	.3900
20	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Quant	32	6	.4756
21	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Quant	32	6	.3607
22	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Quant	32	5	.3697
23	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Adapt	32	5	.2958
24	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Adapt	32	6	.1545
25	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Adapt	32	6	.2698

Table 2. Firm A, Summary of Regression Runs,

Fictitious Cases

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
26	$\hat{Y}_{s[n]}=b_o+\Sigma b_i x_{in}$	Indust R_1*	30	5	.3584
27	"	Quant R_1	30	6	.4544
28	"	Adapt R_1	30	6	.4863
29	"	J Know R_1	30	6	.5757
30	"	Qual R_1	30	6	.4781
31	"	Indust R_2	30	6	.7737
32	"	Quant R_2	30	6	.8807
33	"	Adapt R_2	30	6	.3586
34	"	J Know R_2	30	6	.7988
35	"	Qual R_2	30	6	.4136
36	"	Total R_1	30	6	.3472
37	"	Total R_2	30	6	.6823
38	$\hat{X}_{12,n}=b_o+\Sigma b_i x_{in}$ $(i=7,\ldots,11)$**	Total R_1	20	5	.9164
39	$\hat{X}_{18,n}=b_o+\Sigma b_i x_{in}$ $(i=13,\ldots,17)$**	Total R_2	30	5	.8467
40	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Quant R_1	30	5	.3188
41	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Quant R_1	30	6	.4195
42	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Quant R_1	30	6	.2487
43	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Quant R_2	30	5	.1733
44	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Quant R_2	30	4	.7050
45	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Quant R_2	30	6	.1588

Table 2 (Cont'd)

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
46	$\hat{Y}_{s[n]}=b_o+\Sigma b_i x_{in}+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$ $+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$ $+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Quant R_1	30	6	.5601
47	"	Quant R_2	30	6	.9350
48	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$ $+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$ $+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Quant R_1	30	5	.4779
49	"	Quant R_2	30	6	.8772
50	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Adapt R_1	30	5	.2432
51	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Adapt R_1	30	6	.3519
52	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Adapt R_1	30	6	.4766
53	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Adapt R_2	30	6	.2616
54	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Adapt R_2	30	5	.1437
55	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Adapt R_2	30	6	.4431
56	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Adapt R_1	30	6	.2423
57	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Adapt R_1	30	6	.3939
58	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Adapt R_1	30	6	.5320
59	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Adapt R_2	30	6	.2658
60	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Adapt R_2	30	5	.1491
61	$\log\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Adapt R_2	30	4	.4467
62	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \log\hat{I}(Y_e/x_{i[n]})$	Adapt R_1	30	5	.2889
63	"	Adapt R_2	30	6	.2063

Table 2 (Cont'd)

Run No.	Model	Dep. Variable	Sample Size	No.of Var. Ent.	Mult. R^2
64	$\log\hat{Y}_{s[n]}=b_o$				
	$+\Sigma b_i \log\hat{I}(Y_e/x_{i[n]})$	Adapt R_1	30	6	.2850
65	"	Adapt R_2	30	6	.2271

*R_1 and R_2 refers to Rater 1 and 2 respectively.

**$\hat{X}_{12,n}$ and $\hat{X}_{18,n}$ are the Total ratings of Rater 1 and 2 respectively, while the x_{in} (i=7, ..., 11 for Rater 1, and i=13, ..., 17 for Rater 2) refer to the individual performance criteria as defined in Chapter V.

The computer program BMD05D General Plot - Including Histogram - Version of August 18, 1964, Health Sciences Computing Facility, UCLA, was utilized to prepare a number of graphic illustrations pertaining to the research findings. Appendix B contains frequency histograms of the independent variables and plots of dependent against independent variables.

Tables 3 through 17 depict in detail the results of selected regression runs. Cumulative R^2 and the coefficient at the final step were obtained directly from the computer printouts. The t-statistic was taken as the square root of the F value on the printout. To obtain a normalized partial coefficient of multiple determination, the partial coefficient of multiple determination R_i^2 was first computed:

$$R_i^2 = \frac{(b_i/S_{b_i})^2}{(b_i/S_{b_i})^2 + N - I - 1}$$

S_{b_i} is the standard error of the coefficient b_i, N is the number of cases, and I is the number of variables entered. Normalizing thus obtained values was done with the formula:

$$R_i{}^{*2} = R_i^2 \, R^2 \, (100\%) \Big/ \sum_{j=1}^{I} R_j^2 \quad .$$

Thus $R_i{}^{*2}$ value gives a direct indication of the importance of the independent variable under consideration in explaining the dependent variable Y_e or Y_s. As shown by the $R_i{}^{*2}$, values of tables 3 through 17, the different models did not agree in terms of importance assigned to the cues with respect to particular criterion variables. As an example, typing was found to be most important in explaining Quantity in Firm A when a linear regression model was employed. However, age was assigned far more importance when a model using the terms $\hat{I}(Y_e/x_{ij})$ was tested. Similar observations could be made throughout.

Table 3. Results from Firm A; Run 12,

Empirical Cases N=32, Dep. Variable=Quantity

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		-2.295)		
1	Add Educ	.1819	.144	.584	.923
2	Mental	.2925	.044	3.057	17.804
3	Numeric	.3469	- .109	-2.268	11.376
4	Yrs/Job	.3958	- .125	-1.373	4.764
5	Typing	.4319	.030	1.446	5.236
6	Verbal	.4860	.010	1.596	6.245
7	Visual	.5012	.005	.768	1.575
8	Marit St	.5121	- .127	- .811	1.758
9	Job Exp	.5190	.041	.866	1.995
10	Age	.5298	- .013	- .696	1.302

Table 4. Results from Firm A; Run 18,

Empirical Cases N=32, Dep. Variable=Quantity

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		2.090)		
1	Add Educ	.1819	.169	.605	.024
2	Typing	.2251	.029	1.335	11.331
3	Marit St	.2421	- .155	- .906	5.403
4	Yrs/Job	.2564	- .074	- .746	3.702
5	Job Exp	.2724	.036	.687	3.148
6	Age	.2731	- .003	- .160	3.702

Table 5. Results from Firm A; Run 20,

Empirical Cases N=32, Dep. Variable=Quantity

Step Number	Var. Ent. $=\hat{I}(Y_e/x_{ij})$ of:	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		3.928)		
1	Yrs/Job	.1700	1.177	1.948	9.906
2	Age	.3383	-1.219	-3.307	22.873
3	Marit St	.4461	-2.631	-2.047	10.788
4	Typing	.4589	.241	.643	1.222
5	Job Exp	.4691	.272	.794	1.847
6	Add Educ	.4756	.750	.557	.922

Table 6. Results from Firm A; Run 27,

Fictitious Cases N=31, Dep. Variable=Quantity,

Rater 1

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		1.817)		
1	Yrs/Job	.2617	.065	1.080	5.340
2	Add Educ	.3944	.235	2.371	24.557
3	Marit St	.4346	.216	1.436	10.294
4	Job Exp	.4472	.052	.797	3.364
5	Age	.4524	.005	.373	.749
6	Typing	.4544	- .003	- .285	.440

Table 7. Results from Firm A; Run 41,

Fictitious Cases N=30, Dep. Variable=Quantity,

Rater 1

Step Number	Var. Ent. $=\hat{H}(Y_e/x_{ij})$ of:	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		2.004)		
1	Job Exp	.1650	- .210	-1.461	7.057
2	Marit St	.2934	.221	2.433	17.007
3	Age	.3560	.082	1.809	10.344
4	Add Educ	.4137	.093	1.421	6.708
5	Yrs/Job	.4190	.013	.459	.754
6	Typing	.4195	.006	.141	.071

Table 8. Results from Firm A; Run 32,

Fictitious Cases N=30, Dep. Variable=Quantity,

Rater 2

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		-3.331)		
1	Typing	.8726	.110	12.073	79.969
2	Add Educ	.8768	.081	.935	3.388
3	Job Exp	.8789	.040	.715	2.014
4	Yrs/Job	.8792	- .033	- .629	1.564
5	Age	.8805	.006	.477	.908
6	Marit St	.8807	.022	.168	.113

Table 9. Results from Firm A; Run 44,

Fictitious Cases N=30, Dep. Variable=Quantity,

Rater 2

Step Number	Var. Ent. $=\hat{H}(Y_e/x_{ij})$of:	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		2.447)		
1	Typing	.6863	.385	7.672	64.224
2	Add Educ	.6943	- .076	- .948	3.176
3	Yrs/Job	.7012	.027	.738	1.950
4	Marit St	.7050	.064	.564	1.149

Table 10. Results from Firm A; Run 46,

Fictitious Cases N=30, Dep. Variable=Quantity

Rater 1

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		24.056)		
1	Yrs/Jor	.2617	.212	.386	.466
2	Add Educ	.3944	2.539	2.771	18.063
3	$\hat{H}(Y_e/x_{ij})$, $X_i \equiv$ Age	.4412	.906	2.264	13.154
4	$\hat{I}(Y_e/x_{ij})$, $X_i \equiv$ AddEduc	.5036	.886	1.876	9.578
5	$\hat{H}(Y_e, x_{ij})$, $X_i \equiv$ JobExp	.5391	- .956	-1.714	8.171
6	$\hat{H}(Y_e, x_{ij})$, $X_i \equiv$ Age	.5601	- .322	-1.048	3.289

Table 11. Results from Firm A; Run 47,

Fictitious Cases N=30, Dep. Variable=Quantity,

Rater 2

Step Number	Variable Entered	Cumul. R^2	Final Step* Coefficient	t	$R_i{*}^2$
	(Constant		-2.569)		
1	Typing	.8725	.096	8.276	57.531
2	$\hat{I}(Y_e/x_{ij})$ $X_i \equiv$ Age	.8915	- .140	-1.840	9.603
3	$\hat{H}(Y_e/x_{ij})$ $X_i \equiv$ Typing	.9063	.082	1.847	9.672
4	$\hat{H}(Y_e/x_{ij})$ $X_i \equiv$MaritSt	.9118	.100	1.624	7.690
5	$\hat{H}(Y_e/x_{ij})$ $X_i \equiv$ Age	.9204	.048	1.607	7.545
6	$\hat{H}(Y_e/x_{ij})$ $X_i \equiv$MaritSt	.9350	-	-	-

*Due to flaw in machine procedure no complete printout for step (6).

Table 12. Results from Firm A; Run 19,

Empirical Cases N=32, Dep. Variable=Adaptability

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		5.010)		
1	Yrs/Job	.1760	- .160	-1.892	8.914
2	Age	.2452	- .045	-2.764	16.734
3	Job Exp	.3845	.089	2.333	12.752
4	Marit St	.3883	.052	.374	.394
5	Typing	.3900	- .004	- .027	.206

Table 13. Results from Firm A; Run 23,

Empirical Cases N=32, Dep. Variable=Adaptability

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		3.484)		
1	Yrs/Job	.2068	- .626	-2.233	18.209
2	Age	.2594	- .246	-1.151	5.486
3	Add Educ	.2824	3.083	1.031	4.449
4	Marit St	.2947	3.122	.541	1.259
5	Job Exp	.2958	.138	.202	.177

Table 14. Results from Firm A; Run 28,

Fictitious Cases N=30, Dep. Variable=Adaptability

Rater 1

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	R_i^{*2}
	(Constant		2.054)		
1	Yrs/Job	.3138	.095	1.361	8.644
2	Add Educ	.4154	.259	2.240	20.768
3	Marit St	.4519	.275	1.564	11.149
4	Job Exp	.4813	.089	1.188	6.700
5	Typing	.4847	- .005	- .451	1.017
6	Age	.4863	- .004	- .265	.352

Table 15. Results from Firm A; Run 52,

Fictitious Cases N=30, Dep. Variable=Adaptability

Rater 1

Step Number	Var. Ent. $=\hat{H}(Y_e,x_{ij})$of:	Cumul. R^2	Final Step Coefficient	t	R_i^{*2}
	(Constant		.662)		
1	Marit St	.1721	.268	2.645	20.258
2	Add Educ	.2910	.083	1.436	7.145
3	Job Exp	.3719	.101	.905	2.984
4	Typing	.4185	.043	1.110	4.413
5	Yrs/Job	.4427	-.053	-1.483	7.579
6	Age	.4766	-.043	-1.220	5.281

Table 16. Results from Firm A; Run 33,

Fictitious Cases N=30, Dep. Variable=Adaptability

Rater 2

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		1.936)		
1	Add Educ	.1089	.258	2.459	14.255
2	Marit St	.1838	.317	1.993	10.085
3	Yrs/Job	.2993	- .106	-1.667	7.383
4	Typing	.3403	.010	.886	2.259
5	Age	.3550	- .011	.716	1.493
6	Job Exp	.3586	.025	.361	.385

Table 17. Results from Firm A; Run 55

Fictitious Cases N=30, Dep. Variable=Adaptability

Rater 2

Step Number	Var. Ent. $=\hat{H}(Y_e, x_{ij})$ of:	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		3.449)		
1	Typing	.2016	.086	2.662	20.709
2	Age	.3506	- .061	-2.042	13.498
3	Job Exp	.4351	- .153	-1.630	9.101
4	Add Educ	.4403	.019	.395	.593
5	Marit St	.4419	.020	.237	.214
6	Yrs/Job	.4431	.007	.227	.195

Correlation of $R_i{*}^2$ and $\hat{I}(Y_e/X_i)$

It would seem reasonable to postulate that the decision-maker in multiple cue decision tasks ought to attach more significance to or place more weight on those cues that convey the most information about the ecological variable. Some logical measure of performance would thus be the degree of association between the partial coefficient of multiple determination ($R_i{*}^2$) and the corresponding information gains $\hat{I}(Y_e/X_i)$.

By definition (cf. Chapter IV):

$$\hat{I}(Y_e/X_i) = \sum_{j=1}^{J} p(x_{ij})\ \hat{I}(Y_e/x_{ij})$$

The probabilities of (x_{ij}) were estimated by their corresponding relative frequencies

$$\hat{p}(x_{ij}) = \frac{n_{ij.}}{n_{i..}}$$

where $n_{ij.}$ was the sum of occurrences over all values of the dependent variable with respect to the j-th interval of the i-th independent variable, and $n_{i..}$ was equivalent to the total sample size N.

The pairs of $R_i{*}^2$ and $\hat{I}(Y_e/X_i)$ were ranked in order of decreasing $R_i{*}^2$ values. This was done in the following table displaying the $R_i{*}^2$ that resulted from the regression runs of the subjective ratings using the cue values.

Table 18. Firm A, Pairs of $R_i{*}^2$ and $\hat{I}(Y_e/X_i)$

Rater	Dependent Variable	Independent Variable	$R_i{*}^2$	$\hat{I}(Y_e/X_i)$
1	Quantity	Add Educ	24.55	1.578
	(Run 27)	Marit St	10.29	1.932
		Yrs/Job	5.34	1.981
		Job Exp	3.36	1.101
		Age	.75	1.749
		Typing	.44	1.018
2	Quantity	Typing	79.97	1.018
	(Run 32)	Add Educ	3.39	1.578
		Job Exp	2.01	1.101
		Yrs/Job	1.56	1.981
		Age	.91	1.749
		Marit St	.11	1.932
1	Adaptability	Add Educ	20.77	.913
	(Run 28)	Marit St	11.15	1.147
		Yrs/Job	8.64	4.160
		Job Exp	6.70	2.261
		Typing	1.02	1.018
		Age	.35	2.758
2	Adaptability	Add Educ	14.25	.913
	(Run 33)	Marit St	10.08	1.147
		Yrs/Job	7.38	4.160
		Typing	2.26	1.018
		Age	1.49	2.758
		Job Exp	.38	2.261

For the purpose of statistical comparison, correlation coefficients between $R_i{*}^2$ and $\hat{I}(Y_e/X_i)$ were computed. This was done separately for the two Raters, with the values for Quantity and Adaptability pooled in each case. The results were -.1051 for Rater 1 and -.2878 for Rater 2. The points on which these computations were based are plotted in Figure 3 for Rater 1 and in Figure 4 for Rater 2.

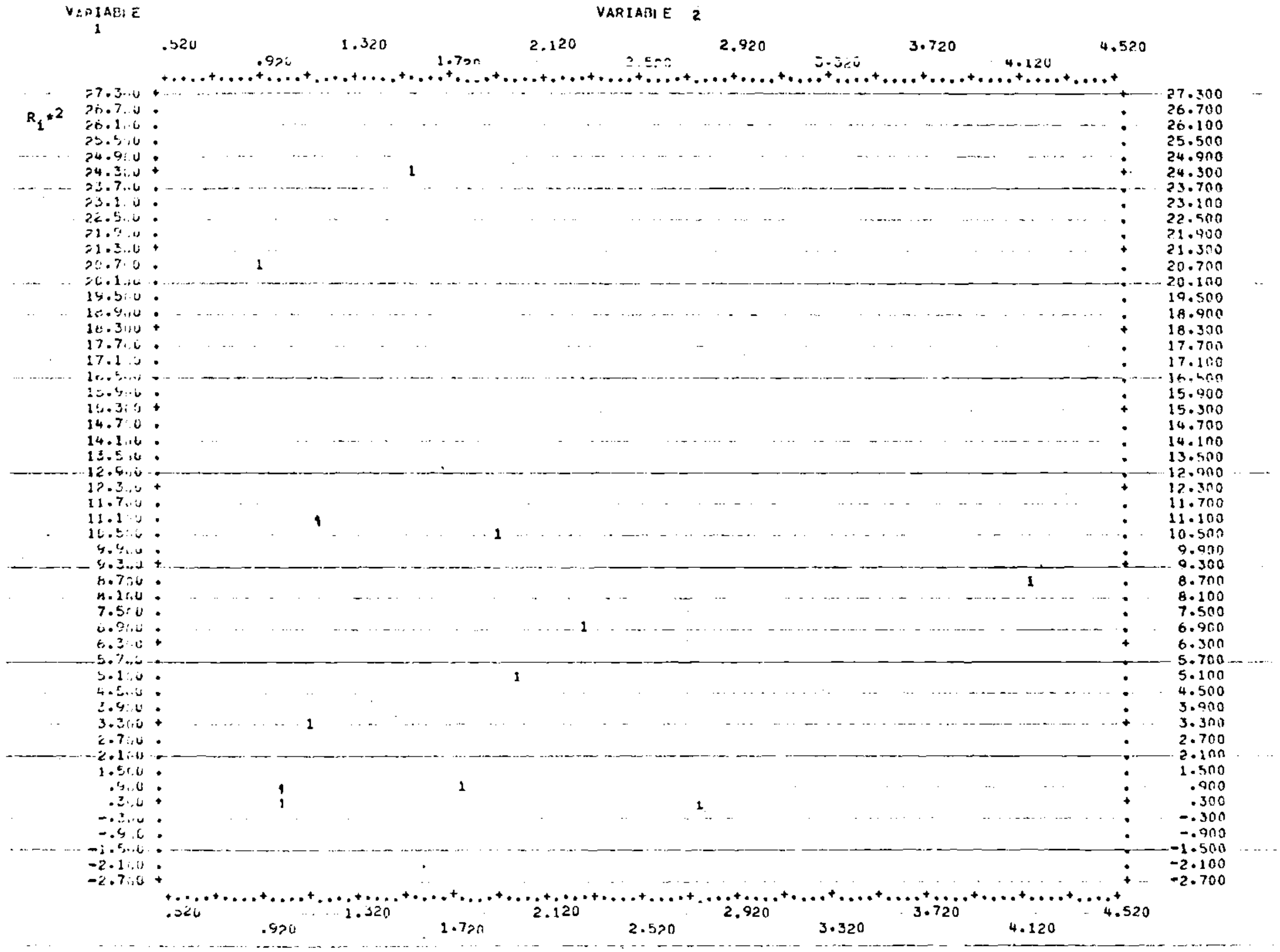

Figure 3. Firm A, $R_i{*}^2$ vs. $\hat{I}(Y_e/X_i)$, Rater 1

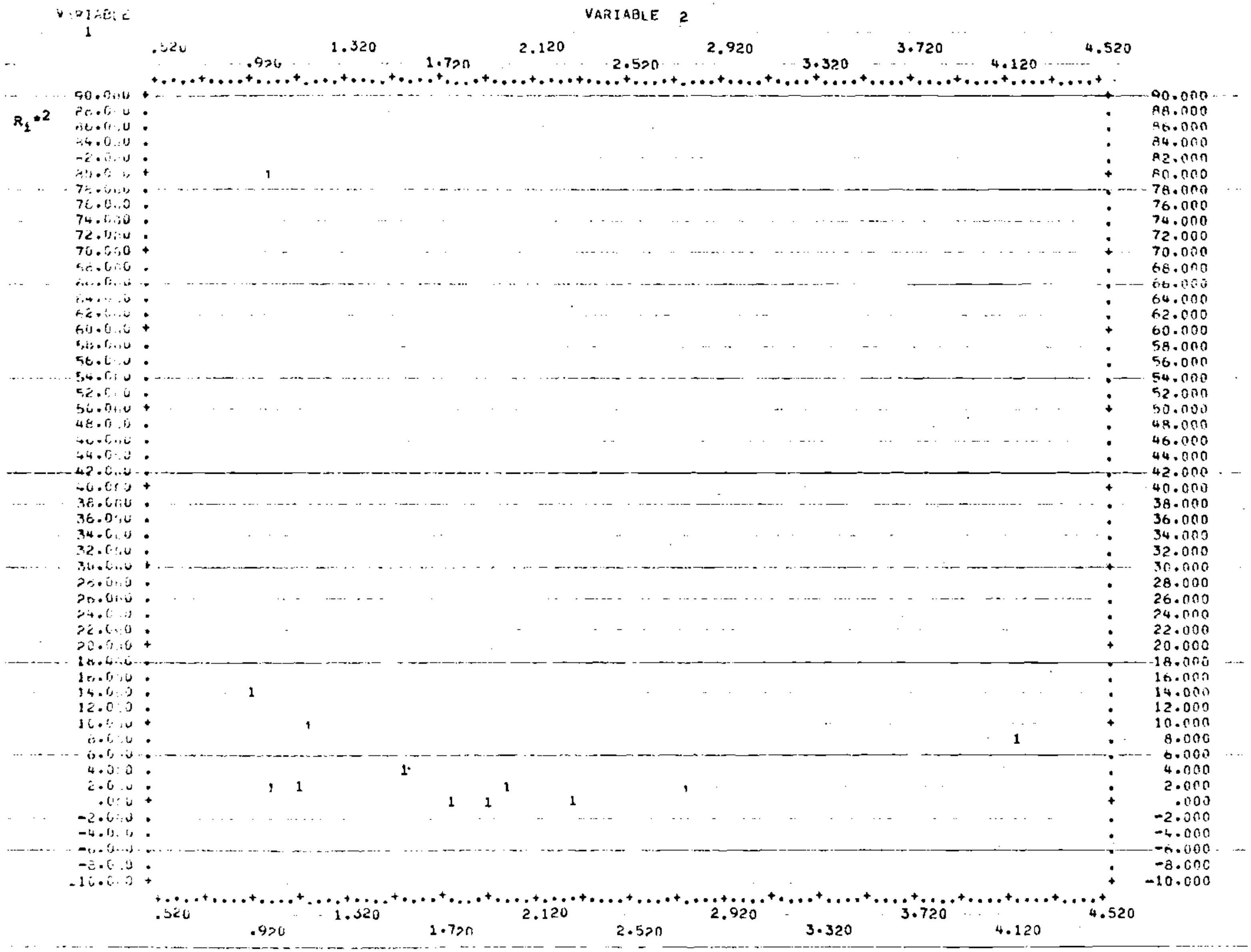

Figure 4. Firm A, $R_i{*}^2$ vs. $\hat{I}(Y_e/X_i)$, Rater 2

Lens Model Coefficients

The lens model coefficients were first computed by means of utilizing the results of regression runs 18 - empirical cases and 32 - fictitious cases, the summaries of which are given in Tables 4 and 8. The criterion variable was Quantity and the ratings of the fictitious cases were those obtained from Rater 2. This choice was made because the responses of Rater 2 provided for a better fit than Rater 1 in the linear model. The discussion of the various indices computed refers to Figure 1.

The ecological validities r_{ei} were described as the correlations between the i-th predictor and the criterion. Table 19, an excerpt of Table 42 (Appendix D) summarizes these values:

Table 19. Firm A, Ecological Validities, Criterion = Quantity

Predictor	Correlation
1. Age	.026
2. Marital Status	-.199
3. Typing Speed	.410
4. Additional Education	.427
5. Job Experience	.277
6. Years per Job	-.107

Thus, Typing Speed and Additional Education were most highly correlated with Quantity.

The utilization coefficients r_{si} were used to describe the correlations between the cues and the judgment of Rater 2. These values are reflected in Table 20 (cf. Table 43):

Table 20. Firm A, Utilization Coefficients,
Criterion = Quantity, Rater 2

Predictor	Correlation
1. Age	-.186
2. Marital Status	.187
3. Typing Speed	.934
4. Additional Education	.016
5. Job Experience	.175
6. Years per Job	.070

A comparison between utilization coefficients and ecological validities shows that Rater 2 did recognize fairly well the importance of typing skills, however, the weight that he assigned to Additional Education was significantly less than indicated by the corresponding ecological validity.

The values for the cues' redundancies are interdependent with the ecological validities. They were presented in Table 42. For comparison, the values assumed by the subject can be found in Table 43 (Appendix D).

The environmental side of the lens model can be expressed by a multiple regression equation that utilizes optimal weights determined by the validity of each predictor. For the 32 cases under consideration it amounted to (cf. Table 4):

$$\hat{Y}_{eq} = 2.09 - .01\ X_1 - .15\ X_2 + .03\ X_3 + .17\ X_4 + .04\ X_5 - .07\ X_6$$

The decision-makers judgment could be expressed in a similar equation (cf. Table 8):

$$\hat{Y}_{sq2} = 3.33 + .01\ X_1 + .02\ X_2 + .11\ X_3 + .08\ X_4 + .04\ X_5 - .03\ X_6$$

The environmental predictability R_e, which is $r_{Y_e\hat{Y}_e}$, was low with .27. On the other hand, the rater's response linearity reached a value of $R_s = .88$.

Further lens model coefficients are presented as follows: Regression run 18 again provided for the values on the environmental side of the lens. This time they were paired with run 27 - fictitious cases, the summary of which is given in Table 6. The criterion variable was again Quantity and the ratings of the fictitious cases refers to those obtained from Rater 1.

The utilization coefficients r_{si}, describing the correlations between the cues and the judgment of Rater 1 can be obtained directly from Table 43 in Appendix D.

The judgment of Rater R_1 could be expressed in a multiple regression equation (cf. Table 6):

$$\hat{Y}_{sq1} = 1.817 + .005\ X_1 + .216\ X_2 + .235\ X_3 + .052\ X_4 + .062\ X_5 - .003\ X_6$$

The response linearity of Rater 1 was $R_s = .6711$.

A further set of lens model coefficients was determined for the criterion variable Adaptability. It was based on run 19 (Table 12) - empirical cases, run 28 (Table 14) and run 33 (Table 16) - fictitious cases for Raters 1 and 2 respectively.

The ecological validities are again presented in Table 42 (Appendix D). The utilization coefficients for both Rater 1 and 2 are depicted in Table 43.

The multiple regression equation modeling the environmental side of the lens was (cf. Table 12):

$$\hat{Y}_{ea} = 5.01 - .045\ X_1 + .052\ X_2 - .004\ X_3 + .089\ X_5 - .16\ X_6$$

The judgment of Rater 1 could be expressed as (cf. Table 14):

$$\hat{Y}_{sa1} = 2.054 - .004\ X_1 + .275\ X_2 + .259\ X_3 + .089\ X_4 + .095\ X_5 - .005\ X_6$$

The decision process of Rater 2 was modeled in the following equation (cf. Table 16):

$$\hat{Y}_{sa2} = 1.936 - .011\ X_1 + .317\ X_2 + .258\ X_3 + .025\ X_4 - .106\ X_5 + .010\ X_6$$

The environmental predictability reached a value of .36, which was higher than for the criterion Quantity. The response linearity of Rater 1 was .70, and for Rater 2 it amounted to .58.

A comparison of the various results indicates the following: In contrast to the ecological validity, Rater 1 underestimated significantly the weight to be attached to typing in explaining the criterion Quantity. He assigned high importance to additional education, which was in agreement with the corresponding ecological validity, but he overestimated the effect of job tenure. The latter was found to have a negative effect on the value of the criterion Quantity. A similar observation was made for the criterion Adaptability, which was also negatively related to age and somewhat positively to additional education. Rater 2 recognized these relationships fairly well, while the utilization coefficients of Rater 1 appeared more randomly related to the ecological validities.

Results from Firm B

Based on the previous discussion, the results obtained with the data of Firm B become largely self-explanatory. They are given in Tables 21 through 27 and in the appendices. For the computation of the information measures, the interval widths selected for the variables needed to be defined. Since the dependent variables attained values along a scale from 0 to 100, 10 intervals with width 10 were chosen. The cue values were broken down as follows:

1. Age: lower limit = 21, width = 1
2. Marital Status: lower limit = 1, width = 1
3. Dependents: lower limit = 0, width = 1
4. GPA: lower limit = 2.0, width = .5
5. Scholastic Activities: lower limit = 1, width = 1
6. Professional Organizations: lower limit = 1, width = 1
7. Interview Rating:

   Interval 1 = 3
   $4 \leq$ Interval 2 ≤ 5

Table 21. Firm B, Summary of Regression Runs, Empirical Cases

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
66	$\hat{Y}_{e[n]}=b_o+\Sigma b_i x_{in}$	Total	51	6	.3139
67	"	Total	43	6	.5848
68	$\hat{X}_{17,n}=b_o+\Sigma b_i x_{in}$				
	$(i=8,\ldots,16)$*	Total	29	4	.9204
69	$\hat{Y}_{e[n]}=b_o+\Sigma b_i x_{in}$	Accur	29	6	.3297
70	"	Volume	29	6	.2895
71	"	Tch Kn	29	7	.3555
72	"	Creativ	29	7	.3399
73	"	Decisn	29	6	.3759
74	"	Respon	29	7	.3278
75	"	Reliab	29	7	.3818
76	"	Harmon	29	7	.3530
77	"	Plan	29	5	.1392
78	"	Total	29	7	.3740
79	$\hat{X}_{17,n}=b_o+\Sigma b_i x_{in}$				
	$(i=8,\ldots,16)$*	Total	29	9	.9266
80	$\hat{Y}_{e[n]}=\Sigma b_i x_{in}$	Total	51	6	.9791
81	$\hat{X}_{17,n}=b_o+\Sigma b_i x_{in}$				
	$(i=8,\ldots,16)$*	Total	29	8	.9980
82	$\hat{X}_{17,n}=b_1 X_{15,n}$*	Total	29	1	.9909
83	$\hat{Y}_{e[n]}=b_o+\Sigma b_i x_{in}$	Total	30	6	.5840
84	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Total	30	5	.2014

Table 21 (Cont'd)

Run No.	Model	Dep. Variable	Sample Size	No.of Var. Ent.	Mult. R^2
85	$\hat{Y}_{e[n]}=b_o+\Sigma b_i\hat{H}(Y_e/x_{i[n]})$	Total	30	6	.1820
86	$\hat{Y}_{e[n]}=b_o+\Sigma b_i\hat{H}(Y_e,x_{i[n]})$	Total	30	6	.2642

*$\hat{X}_{17,n}$ is the Total rating, and the x_{in} (i=8, ..., 16) refer to the individual performance criteria as defined in Chapter V.

Table 22. Firm B, Summary of Regression Runs, Fictitious Cases

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
87	$\hat{Y}_{s[n]}=b_o+\Sigma b_i x_{in}$	Total R_1	30	6	.8705
88	"	Total R_1	30	7	.8049
89	"	Total R_2	30	6	.6798
90	"	Total R_2	30	7	.7091
91	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Total R_1	30	6	.3637
92	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Total R_1	30	5	.5168
93	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Total R_1	30	5	.4453
94	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Total R_2	30	5	.3487
95	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Total R_2	30	6	.5125
96	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Total R_2	30	6	.4209
107	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Total R_1	30	7	.51193
108	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Total R_1	30	7	.57476
109	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Total R_1	30	7	.60562
110	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	Total R_2	30	7	.45393
111	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	Total R_2	30	7	.51236
112	$\hat{Y}_{s[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	Total R_2	30	7	.51414
113	$\hat{Y}_{s[n]}=b_o+\Sigma b_i [\hat{I}(Y_e/x_i$	Total R_1	30	6	.3854
114	"	Total R_1	30		
115	"	Total R_2	30	4	.3419
116	"	Total R_2	30		
117	$\log\hat{Y}_{s[n]}=b_o$ $+\Sigma b_i [\hat{I}(Y_e/x_{i[n]})]^{-1}$	Total R_1	30	6	.3770

Table 22 (Cont'd)

Run No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
118	$\log\hat{Y}_{s[n]}=b_o$ $+\Sigma b_i[\hat{I}(Y_e/x_{i[n]})]^{-1}$	Total R_1	30	3	.3937
119	"	Total R_2	30	4	.3268
120	"	Total R_2	30		
121	$\hat{Y}_{s[n]}=b_o+\Sigma b_i x_{in}$	Total R_1, R_2	30	6	.8105

Table 23. Results from Firm B; Run 67,

Empirical Cases N=43, Dep. Variable=Total

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		66.318)		
1	GPA	.2532	11.427	3.213	13.475
2	Age	.3347	-1.579	-3.070	12.550
3	Dependts	.4717	9.563	4.191	19.834
4	Marit St	.5407	5.711	2.190	7.111
5	Schol Act	.5847	3.553	1.899	5.504
6	Prof Org	.5848	.272	.112	.021

Table 24. Results from Firm B; Run 87,

Fictitious Cases N=30, Dep. Variable=Total,

Rater 1

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{}^{*2}$
	(Constant		50.481)		
1	Prof Org	.4726	4.493	6.594	30.730
2	GPA	.7986	7.184	6.025	28.761
3	Schol Act	.8434	2.071	2.871	12.395
4	Age	.8507	- .413	-1.777	5.672
5	Marit St	.8575	1.406	1.696	5.223
6	Dependts	.8705	1.065	1.516	4.268

Table 25. Results from Firm B; Run 89,

Fictitious Cases N=30, Dep. Variable=Total,

Rater 2

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		56.439)		
1	Schol Act	.3732	3.272	2.589	14.642
2	GPA	.5352	8.083	3.870	25.587
3	Prof Org	.6212	2.228	1.867	8.537
4	Age	.6340	- .737	-1.812	8.107
5	Dependts	.6638	2.215	1.800	8.013
6	Marit St	.6798	1.559	1.073	3.094

Table 26. Results from Firm B, Run 121,

Fictitious Cases N=30, Dep. Variable=Total,

Average of Rater 1 and Rater 2

Step Number	Variable Entered	Cumul. R^2	Final Step Coefficient	t	$R_i{*}^2$
	(Constant		53.460)		
1	Schol Act	.4081	2.672	3.015	14.284
2	GPA	.5735	7.633	5.212	27.310
3	Prof Org	.7668	3.361	4.015	20.783
4	Age	.7776	- .575	-2.016	7.571
5	Dependts	.7930	1.640	1.901	6.846
6	Marit St	.8105	1.482	1.456	4.255

Table 27. Firm B, $R_i{*}^2$ and $\hat{I}(Y_e/X_i)$

Rater	Dependent Variable	Independent Variable	$R_i{*}^2$	$\hat{I}(Y_e/x_{ij})$
1	Total	Prof Org	30.73	2.013
	(Run 87)	GPA	28.76	4.598
		Schol Act	12.39	2.537
		Age	5.67	3.611
		Marit St	5.67	2.287
		Dependts	5.22	1.220
2	Total	GPA	25.59	4.598
	(Run 89)	Schol Act	14.64	2.537
		Prof Org	8.54	2.013
		Age	8.11	3.611
		Dependts	8.01	1.220
		Marit St	3.09	2.287

Results from Firm C

The usefulness of the data from Firm C was limited since subjective ratings could not be obtained. However, they offered some opportunity to compare the behavior of the various models tested for large variations in the sample size. Results of a summary nature are depicted in Table 28.

Table 28. Firm C, Summary of Regression Runs, Empirical Cases

No.	Model	Dep. Variable	Sample Size	No. of Var. Ent.	Mult. R^2
97	$\hat{Y}_{e[n]}=b_o+\Sigma b_i x_{in}$	14	95	11	.4580
98	"	15	95	12	.4820
99	"	16	95	11	.0610
100	"	14	88	13	.5711
101	"	15	88	12	.6117
102	"	15	80	12	.5760
103	"	8	30	7	.5298
104	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{I}(Y_e/x_{i[n]})$	8	30	6	.2796
105	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e/x_{i[n]})$	8	30	7	.3973
106	$\hat{Y}_{e[n]}=b_o+\Sigma b_i \hat{H}(Y_e,x_{i[n]})$	8	30	6	.3851

CHAPTER VII

DISCUSSION AND RECOMMENDATIONS

The need to assign meaning to the various results of this research poses a requirement to reduce the unmanageable conglomerate of outputs into an orderly array of causes. The main aspects that need to be taken into account when analyzing the results regard the adequacy of the data base. In conjunction with the problem thus defined, the applicability of the model hypotheses will have to be discussed, which in turn is largely dependent upon the types and quality of results presented in the previous chapter. This sort of analysis will then lend itself to the presentation of specific conclusions and recommendations.

Analysis of the Results

The data collected can be examined in accordance to quantitative and qualitative factors. Each individual factor can be assumed to have some bearing on the overall usefulness of the data.

One major quantitative aspect of the data base was the number of cases versus the number of predictor variables. From the viewpoint of reliability, the sample size should be as large as possible. It was suggested

(Kerlinger and Pedhazur, 1973) that any multiple regression analysis, and especially those with many independent variables, should have at least 100 subjects. Relatively small sample sizes yield high bias in the two most important regression statistics, R^2 and b. To realize the effect of decreased sample size, the R^2 can be adjusted (cf. Johnston, 1972):

$$\bar{R}^2 = R^2 - \frac{I}{N - I - 1} (1 - R^2)$$

As a representative example, $\bar{R}^2$ was computed for run 89, where R^2 turned out to be .68 (n = 30, I = 6). Then,

$$\bar{R}^2 = .68 - \frac{6}{30 - 6 - 1} (1 - .68) \approx .60,$$

a noticeable difference, but R^2 was concluded to be sufficiently close to an adjusted value $\bar{R}^2$, even for a sample size of 30 and six independent variables.

The least squares estimates of the model parameters may well be over- or underestimated which essentially does not interfere with the objectives of this research, as they were not limited to validate a regression model, but to test the relative performance of model alternatives.

When assessing the reliability of multiple regression, significant emphasis is generally placed on replication (op.cit.). This research employed three replications (the collection of empirical data in Firms A, B, and C) with varying statistical properties in terms of sample size, numbers and types of independent variables, dependent variables, and types of jobs under consideration. Thus, a comparison across the replications can allow certain conclusions as to possible general superiority of specific model alternatives.

Problems and deficiencies in the data base due to qualitative aspects are probably difficult to assess. A main question concerns certainly the types of cues that were selected to predict job performance. The choice had to be based on the availability and quantifiability of the total possible number of variables. The compromises that had to be made did not leave representativeness and reliability of the results unaffected. As an example, some personality traits, such as alertness, drive, and likeability might be significant cues to success of design engineers, but of course they were not available from the information on the application blanks.

A potentially severe source of error regarding the assumption of a linear regression model could have resulted from arbitrary coding of variables that do not lend themselves to unique quantification. Intuitively, it could be assumed, e.g. that the extent of involvement in extra-curricular activities would be somewhat directly related to performance measures such as adaptability. Thus, a larger numerical score for a greater number of activities and responsibilities seemed to be warranted. But in the case of the variable Marital Status, the quantification was at best related to some kind of subjective value scheme. As indicated by Figure 22 in Appendix B, this choice resulted in a clearly nonlinear relationship with the subjective Total of Rater 2 in Firm B. This could have been avoided, had the numerical values been arranged in different order.

Finally, in the case of some variables, arbitrary interval limits and unequal widths had to be decided on in order to facilitate the computation of the information-metric terms. These groupings were based on assumed increments of equal effect on the dependent variable. Therefore, if any contamination did result from this type of imperfection, it is assumed to be fairly insignificant.

On the whole, the choice of predictors is probably fairly adequate, if one considers the findings by Ghiselli and Berthol (1953; cf. Chapter II) who emphasized the relatively high reliability in terms of R^2 of biographical items compared to predictors such as intelligence, aptitude, interest, and personality.

Multiple regression analysis under some circumstances has a serious weakness in terms of unreliability of the regression weights (Kerlinger and Pedhazur, 1973). This becomes severe in particular when the sample size is small and the independent variables are highly correlated. In case of Firm A, e.g., Job Experience was significantly correlated with Age and Additional Education (.55 and .47), and Additional Education was correlated with Typing Speed (.56). If there had been more predictors involved, factor analysis might have been used to create orthogonal independent variables.

Besides these weaknesses, that are of major concern only when the regression weights are of prime importance, multiple regression analysis has obvious advantages over the other model alternatives discussed in Chapter III. It is suited to almost any nonexperimental research in which there are several independent variables and one dependent variable at a time (ibid.).

In this research the R^2 values were used to measure the accuracy of the estimates of performance that could be generated by means of the model alternatives. R^2 is an estimate of the proportion of variance accounted for by all the variables in the regression. As pointed out, this value was traditionally low for models predicting job performance. Raubenheimer and Tiffin (1971; cf. Chapter II) reported a multiple R of .50 for a regression model using test scores and biographical items to predict job success. With only one fourth of the variance accounted for by the predictors, a model can certainly not be considered useful for personnel selection and job assignment.

It can be shown that in personnel research the relationships between the predictors and job performance are more complex than assumed by the simple configuration of the lens model. For the purpose of illustration one might look at a clearcut case where the lens model is directly applicable. Diagnosis of a medical condition, e.g., is based on the symptoms that the patient shows. These symptoms are the immediate consequence of the condition, thus each of the cues is directly related to the ecological variable and serves the physician to arrive at his subjective estimate thereof.

In terms of job performance, the analog would be a situation where the personnel administrator assesses job performance of, say, a typist, based on his knowledge of her typing speed, motivation, idle time, emotional condition, job knowledge, etc. With the exception of typing speed, none of the predictors of performance available from the data of Firm A appears to be a direct indicator of Quantity or Adaptability as criterion. Rather, the independent variables are linked in lens model fashion to the proximal variables which in turn form a lens model construct together with the distal variable. Then, one could imagine a set of regression models with the cues (number of dependents, additional education, related job experience, etc.) as independent variables and the proximal traits, e.g. motivation or job knowledge being the dependent variables. Subsequently, the resulting values of the proximal traits, being the characteristics of actual performance, could be related in a multiple regression equation to the criterion.

An additional factor potentially contaminating the validity of estimates results from the time lag between occurrence of certain cue values, such as additional education (up to 17 years in Firm A), college activities, or grade point average (up to eight years in Firm B), and utilization of such information. Perhaps the cue values ought to be weighted with a factor inverse to the time lag, in order to account for the "wear off" effect that presumably decreases its relevance.

Dunnette (1963) suggested to discriminate between different combinations of predictors, applicants, job behaviors and situations. In his new model for selection research he indicated the need for many different groupings of tests for different groups of persons, depending upon the patterns of job behavior to be predicted. Thus, his prediction model called attention to the likelihood of complex interactions between predictor groupings, groups or types of individuals, job behavior patterns, and broadly defined organizational consequences. As an example, he found that a test of perceptual speed and accuracy for the selection of bottle inspectors may predict accurately only for non-high school graduates. For male high school graduates he found no useful prediction from the test at all, whereas all female high school graduates were found to perform well, so that a test was unnecessary.

From the preceding discussion it has become clear that relatively high multiple R^2 values could hardly be expected. Thus, values between .27 and .58 as found for the empirical cases of Firms A and B (for the major dependent variables) have to be considered satisfactory, as far as the comparison with related studies in the literature is concerned.

The expected meager result mentioned above appeared to warrant an attempt to propose a conceptually different model, which might ultimately aid reducing the significant cost involved in matching men and jobs less than optimally.

For a model to be representative, it should generate a criterion value in a fashion analogous to the functioning of the real system. As it has become apparent, the simple lens model cannot serve this purpose. The information-theoretic model hypotheses, however, are based on the notion of the decision-maker reducing his uncertainty about the criterion value when he obtains information about a cue. Thus, these models do represent some of the aspects of the decision maker's strategy, which is illustrated by the right side of the lens model.

This intuitive reasoning leads to the assumption that the model alternatives, using the information measures might yield appreciable improvements over the linear model for the subjective ratings. However, with the exception of run 55, this was not the case. But a comparison of the $R_i{*}^2$ values sheds light on this result. Two main reasons were assumed to be responsible for this outcome. The raters used in some instances completely different weights for the cues compared to the results from the empirical cases. Rater 2 of Firm A notably based his judgment almost exclusively on one cue - typing speed - when assessing the criterion value for Quantity. Although models using any combination of the information measures yielded a significant increase in R^2 (Runs 46-49), these alternatives probably ought to be considered a result of chance that would not hold under cross-validation.

On the other hand, some encouraging results were found for the empirical cases. For the data of Firm A, R^2 increased for Quantity from .27 for a linear regression model to .47 for a multiple regression model using $\hat{I}(Y_e, x_{ij})$ terms. In other cases, models based on information measures performed approximately as well as the model in the cue values.

Not much interpretation could be provided for the logarithmic model alternatives that were tested, although some gave a slightly better fit than the linear model. A conceptual framework was not developed for these results.

Conclusions

The results of this research can be summarized in the following statements:

1. Tests, interviews and personal history information, as pertaining to assessing job Adaptability, found extensive treatment in the research literature. It was generally agreed that:

    (a) tests are useful but often difficult to validate;

    (b) interviews, with the exception of structured versions, are given more than due weight;

    (c) personal history items are most consistently related to certain performance measures.

2. Since performance criteria are generally independent of each other, most researchers argue against a unidimensional measure of overall job performance. Exceptions considered are those measures that are based on a dollar criterion, or that are derived from individual criteria by means of statistical methods.

3. Performance appraisal systems are described in literature to be used by over three-fourths of U. S. companies for reasons such as to provide feedback to employees and as a management tool.

4. Strategies and formal models for personnel decisions, that are described in numerous studies, attempted

to

(a) provide optimal man-job match or to minimize the overall cost by means of optimization techniques,

(b) propose statistical prediction models that were based on empirical data.

5. In the present study, multiple linear regression statistics employed in Brunswik's lens model were found applicable in representing the probabilistic interrelations between predictors and criteria of job performance.

6. Three model alternatives were proposed that expressed the relevance of the predictors to the criterion in forms of certain information theory measures.

7. For the purpose of comparing the information-metric model with the simple linear cue model, empirical data were collected from three large employers representing the service and the manufacturing industries.

8. In order to compare the predictive power of the model alternatives, subjective ratings on 30 fictitious cases were obtained from each of two firms.

9. A total of 121 regression runs were prepared for both the empirical and the fictitious cases of Firms A, B, and C. These employed besides the linear model eight different information-theoretic ones, and combinations of the above.

10. The proposed information-theoretic model formulations were found to be competitive alternatives that, in six instances, yielded higher R^2 values than the linear cue models.

11. The multiple R^2 ranged for selected runs employing empirical cases from .30 to .58, for the fictitious cases from .17 to .87.

12. No significant relationships were found to exist between the information gains given cue values and the weight attached to the cues by the Raters.

13. A major limitation of this research was the relatively small sample size that could be obtained for specific combinations of jobs and persons.

Recommendations

This research did not establish either the multiple linear regression model or the proposed information-theoretic model as clearly more relevant to assessment for the purpose of making selection and placement decisions. However, there are many areas where refinement or revision of the approach taken might allow for more precise and far-reaching conclusions.

For the data used in this research, one might review the method used for coding of the variable marital status. Furthermore, one might try to account for the time lag between occurrence of a cue such as grade point average or college activities and its being considered for assessment purposes. This could be achieved by means of weighting the cue value by a factor which is reciprocal to the time lag.

Using linear relationships or a model in the information measures, one ought to consider a multiple-lens model construct, relating cues and distal variable via a set of proximal traits (Beach, 1967). It should also be considered how the dynamic nature of job performance could be taken into account since the contribution of the individual over the total time of his employment is what counts for the firm.

For increased reliability of the results, a significantly larger data base should be generated. This appears to be important especially for the accuracy of the information measures derived, as the various probabilities involved are derived from frequencies.

In contrast to the approach taken here, data might be collected in a completely different area of multiple cue decision tasks. Until further hypotheses about information-theoretic decision models have been established, research in this field should center around simple lens model concepts.

APPENDICES

NOTE TO THE FOLLOWING ILLUSTRATIONS

In the histograms the frequencies are indicated by numbers on the vertical axis level with the horizontal bars in the graphs. The horizontal axis indicates the values of the variables.

In the plots, the letters J, K, L, M, N, O, P are employed to refer to individual observations. Several observations per point are indicated by a corresponding number. Ten or more observations are identified by the following letters: 10=A, 11=B, 12=C, 13=D, 14=E, 15=F.

APPENDIX A

RAW DATA

Table 29. Firm A, Empirical Cases

DATA MATRIX

VARIABLE NUMBER

ITEM * NUMBER *	1 AGE	2 MARIT ST	3 TYPING	4 ADD ED	5 JOB EX	6 YRS/JB	7 VERBAL	8 NUMER	9 VISUAL	10 MENT AB	11 INDUST	12 QUANT	13 ADAPT	14 J KNWL	15 QUALITY
SCALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	37.	1.	50.	0.	6.	1.	21.	7.	110.	115.	5.	5.	4.	4.	5.
2	32.	1.	55.	0.	1.	1.	9.	5.	47.	92.	3.	2.	3.	3.	3.
3	19.	2.	60.	1.	0.	3.	10.	9.	130.	101.	4.	3.	2.	4.	2.
4	38.	2.	55.	1.	15.	3.	10.	4.	97.	92.	4.	3.	4.	3.	2.
5	18.	2.	52.	0.	0.	3.	17.	9.	78.	113.	3.	4.	4.	2.	3.
6	38.	3.	50.	0.	6.	4.	22.	7.	117.	117.	3.	3.	3.	2.	3.
7	34.	1.	50.	0.	2.	5.	22.	13.	82.	129.	4.	3.	3.	2.	2.
8	44.	3.	50.	0.	1.	3.	14.	9.	80.	108.	4.	2.	2.	4.	2.
9	25.	1.	65.	1.	2.	2.	17.	10.	99.	115.	5.	4.	4.	5.	4.
10	20.	3.	55.	0.	5.	1.	20.	8.	93.	116.	4.	5.	4.	3.	3.
11	41.	3.	65.	0.	6.	2.	19.	9.	104.	114.	4.	4.	3.	4.	3.
12	23.	2.	55.	1.	3.	1.	9.	4.	107.	90.	3.	3.	3.	2.	2.
13	46.	1.	55.	0.	3.	4.	96.	10.	35.	106.	4.	3.	2.	2.	3.
14	26.	1.	50.	1.	5.	2.	61.	6.	85.	105.	5.	4.	4.	4.	5.
15	31.	1.	55.	1.	4.	1.	15.	8.	103.	108.	4.	3.	4.	3.	3.
16	19.	1.	55.	0.	1.	1.	10.	10.	107.	103.	3.	3.	3.	2.	1.
17	23.	2.	65.	1.	4.	4.	9.	4.	95.	90.	4.	3.	3.	4.	3.
18	29.	1.	65.	1.	6.	1.	18.	7.	64.	111.	5.	4.	4.	5.	4.
19	25.	1.	52.	1.	5.	5.	19.	4.	56.	107.	4.	3.	3.	3.	3.
20	18.	2.	55.	0.	0.	3.	11.	13.	92.	111.	4.	3.	4.	3.	4.
21	35.	1.	50.	0.	2.	5.	22.	13.	82.	129.	4.	3.	3.	2.	2.
22	25.	2.	50.	1.	1.	1.	18.	6.	90.	109.	3.	3.	4.	3.	3.
23	27.	2.	50.	1.	1.	2.	18.	3.	67.	104.	5.	4.	5.	4.	4.
24	26.	1.	48.	0.	3.	2.	20.	4.	106.	109.	4.	3.	3.	4.	5.
25	20.	2.	45.	0.	0.	1.	91.	15.	84.	106.	3.	3.	4.	2.	3.
26	24.	3.	50.	0.	0.	3.	22.	5.	96.	115.	4.	4.	4.	4.	4.
27	17.	2.	60.	0.	0.	3.	25.	11.	99.	131.	3.	3.	4.	2.	4.
28	23.	3.	65.	0.	.5.	3.	14.	8.	133.	106.	3.	3.	4.	3.	3.
29	43.	1.	40.	2.	9.	5.	24.	14.	122.	135.	4.	5.	3.	2.	3.
30	28.	3.	60.	2.	14.	3.	17.	14.	107.	123.	4.	4.	4.	4.	4.
31	21.	1.	60.	1.	3.	1.	16.	7.	117.	107.	4.	5.	4.	4.	5.
32	21.	1.	65.	2.	3.	1.	21.	18.	149.	137.	4.	4.	4.	3.	4.

Table 30. Firm A, Fictitious Cases

DATA MATRIX

VARIABLE NUMBER

ITEM * NUMBER *	1 AGE	2 MARIT ST	3 ADD ED	4 JOB EX	5 YRS/JB	6 TYPING	7 INDUST	8 QUANT	9 ADAPT	10 JOB KNWL	11 QUALI	12 TOT R1	13 INDUST	14 QUANT	15 ADAPT	16 JOB KNWL	17 QUALI	18 TOT R2
SCALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	35.	1.	0.	1.	1.	55.	30.	30.	20.	20.	20.	30.	3.	4.	3.	2.	3.	3.
2	20.	2.	0.	0.	2.	60.	30.	30.	30.	30.	30.	35.	3.	4.	3.	3.	4.	4.
3	32.	1.	1.	2.	4.	45.	40.	30.	40.	30.	35.	40.	4.	2.	3.	4.	3.	3.
4	25.	1.	3.	4.	3.	70.	40.	30.	30.	40.	30.	40.	5.	5.	3.	4.	4.	5.
5	19.	2.	0.	0.	2.	65.	30.	20.	20.	20.	20.	25.	2.	4.	3.	3.	3.	3.
6	39.	2.	2.	1.	4.	45.	30.	30.	30.	20.	30.	30.	4.	2.	2.	4.	4.	4.
7	40.	3.	1.	2.	5.	60.	30.	35.	30.	30.	30.	30.	4.	3.	3.	5.	4.	4.
8	18.	2.	0.	0.	1.	70.	30.	30.	35.	35.	35.	35.	3.	5.	3.	2.	3.	3.
9	23.	1.	2.	3.	3.	65.	20.	20.	25.	25.	25.	25.	4.	4.	3.	4.	3.	4.
10	31.	2.	1.	3.	9.	55.	30.	30.	35.	30.	35.	35.	3.	3.	2.	5.	3.	3.
11	23.	1.	0.	5.	5.	50.	20.	20.	20.	20.	20.	20.	2.	2.	2.	5.	3.	2.
12	27.	2.	2.	2.	7.	60.	30.	35.	35.	35.	30.	30.	4.	4.	2.	5.	4.	4.
13	41.	2.	0.	7.	8.	70.	35.	30.	35.	35.	30.	35.	2.	5.	2.	5.	4.	4.
14	25.	3.	1.	1.	4.	80.	20.	20.	20.	25.	20.	20.	3.	5.	3.	5.	4.	4.
15	30.	1.	0.	0.	2.	75.	30.	20.	20.	20.	20.	25.	2.	5.	2.	3.	3.	4.
16	18.	2.	0.	0.	1.	60.	15.	15.	20.	15.	15.	15.	2.	3.	2.	2.	3.	3.
17	28.	2.	3.	2.	5.	45.	35.	35.	35.	40.	35.	35.	4.	2.	3.	5.	4.	4.
18	26.	1.	2.	1.	4.	65.	30.	30.	30.	35.	30.	30.	4.	4.	3.	5.	4.	4.
19	19.	1.	0.	1.	2.	60.	20.	20.	20.	25.	20.	20.	2.	3.	3.	4.	3.	3.
20	23.	1.	1.	0.	1.	50.	25.	25.	20.	20.	20.	20.	3.	2.	3.	2.	2.	2.
21	29.	2.	1.	3.	3.	55.	30.	30.	35.	35.	35.	35.	3.	3.	3.	4.	3.	3.
22	34.	3.	1.	1.	5.	65.	35.	30.	30.	30.	35.	35.	3.	4.	3.	5.	3.	4.
23	24.	2.	2.	2.	4.	70.	30.	30.	30.	30.	30.	30.	4.	5.	4.	4.	4.	5.
24	38.	2.	3.	0.	2.	55.	35.	30.	35.	30.	30.	30.	4.	3.	3.	3.	3.	3.
25	43.	1.	0.	0.	1.	50.	20.	15.	15.	10.	15.	15.	2.	2.	2.	2.	3.	2.
26	21.	2.	0.	2.	1.	45.	20.	20.	20.	20.	20.	20.	2.	2.	2.	2.	3.	2.
27	24.	1.	0.	4.	2.	60.	20.	25.	25.	30.	25.	25.	2.	3.	2.	3.	3.	3.
28	22.	1.	1.	4.	4.	75.	30.	30.	30.	30.	30.	30.	3.	5.	2.	4.	3.	4.
29	26.	3.	1.	5.	3.	70.	30.	35.	40.	40.	35.	40.	3.	5.	4.	4.	4.	4.
30	27.	2.	1.	3.	7.	60.	30.	35.	40.	40.	35.	40.	3.	3.	3.	5.	3.	3.

Table 31. Firm B, Empirical Cases

DATA MATRIX

VARIABLE NUMBER

ITEM NUMBER	1 AGE	2 MARIT ST	3 DEPEND	4 GPA	5 SCHOL ACT	6 PROF O	7 INERV	8 ACCUR	9 VOLUME	10 TECH KN	11 IDEAS	12 DECIS	13 RESPONS	14 RELIAB	15 HARMON	16 PLAN	17 TOTAL
SCALE	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	0
1	25.	2.	0.	28.	1.	3.	40.	70.	60.	70.	70.	70.	70.	75.	75.	75.	70.
2	21.	2.	0.	26.	3.	2.	40.	80.	70.	99.	90.	80.	80.	90.	80.	90.	90.
3	24.	1.	2.	26.	2.	1.	35.	70.	95.	90.	90.	95.	95.	93.	93.	93.	93.
4	27.	1.	1.	27.	1.	1.	40.	85.	70.	70.	60.	70.	70.	70.	70.	70.	70.
5	21.	2.	0.	29.	2.	2.	25.	60.	50.	80.	80.	80.	80.	80.	80.	50.	80.
6	22.	2.	0.	22.	2.	1.	45.	90.	70.	75.	80.	70.	75.	70.	70.	70.	60.
7	26.	1.	1.	31.	1.	1.	32.	72.	72.	72.	70.	70.	65.	73.	88.	-0.	75.
8	30.	1.	1.	22.	2.	2.	45.	60.	60.	80.	80.	60.	80.	60.	60.	-0.	75.
9	24.	1.	0.	22.	2.	3.	40.	80.	60.	60.	60.	50.	80.	80.	60.	-0.	67.
10	26.	3.	0.	28.	3.	2.	40.	80.	80.	60.	60.	60.	60.	80.	80.	-0.	75.
11	25.	1.	0.	25.	1.	2.	-0.	80.	70.	70.	70.	50.	60.	80.	80.	-0.	70.
12	23.	1.	1.	21.	1.	1.	-0.	50.	70.	50.	50.	70.	70.	50.	80.	70.	70.
13	22.	2.	0.	31.	2.	2.	-0.	92.	90.	90.	90.	80.	80.	92.	95.	95.	90.
14	23.	2.	0.	30.	3.	3.	-0.	95.	90.	90.	95.	95.	95.	90.	95.	70.	90.
15	27.	1.	2.	35.	2.	1.	-0.	85.	85.	85.	95.	95.	95.	95.	95.	95.	95.
16	24.	1.	1.	34.	2.	2.	-0.	90.	93.	90.	88.	90.	95.	88.	95.	92.	92.
17	23.	2.	0.	27.	2.	1.	-0.	80.	95.	70.	70.	70.	90.	95.	95.	90.	85.
18	25.	2.	0.	29.	2.	2.	-0.	90.	85.	95.	90.	93.	90.	90.	95.	90.	90.
19	23.	2.	0.	30.	1.	2.	-0.	90.	90.	90.	90.	90.	90.	90.	90.	90.	90.
20	22.	1.	0.	32.	1.	2.	-0.	90.	92.	95.	95.	80.	95.	92.	92.	80.	92.
21	24.	2.	0.	32.	3.	2.	-0.	90.	85.	92.	95.	90.	90.	90.	95.	90.	90.
22	27.	2.	0.	32.	2.	2.	-0.	90.	70.	95.	65.	70.	40.	95.	95.	40.	65.
23	25.	2.	0.	29.	2.	2.	-0.	80.	50.	80.	30.	50.	80.	80.	80.	50.	70.
24	26.	3.	1.	22.	1.	2.	-0.	70.	90.	90.	70.	75.	93.	70.	93.	75.	90.
25	22.	1.	0.	30.	1.	2.	-0.	70.	70.	70.	70.	70.	70.	70.	90.	70.	70.
26	31.	2.	0.	24.	1.	2.	-0.	30.	30.	30.	30.	30.	30.	30.	70.	50.	50.
27	22.	1.	1.	27.	2.	2.	-0.	90.	90.	80.	90.	80.	90.	90.	75.	70.	90.
28	29.	1.	2.	23.	1.	2.	-0.	70.	80.	80.	80.	80.	50.	80.	30.	80.	80.
29	28.	1.	2.	30.	1.	2.	-0.	50.	70.	50.	50.	70.	90.	70.	60.	70.	70.
30	29.	1.	1.	24.	3.	2.	-0.	70.	80.	80.	70.	80.	80.	60.	80.	80.	75.
31	22.	2.	0.	26.	3.	2.	-0.	90.	90.	90.	90.	98.	98.	90.	98.	-0.	95.
32	24.	1.	2.	25.	1.	2.	-0.	99.	99.	99.	90.	99.	99.	99.	99.	-0.	95.
33	29.	1.	1.	22.	1.	2.	-0.	60.	60.	60.	60.	60.	80.	80.	60.	-0.	67.
34	23.	1.	0.	29.	2.	3.	-0.	60.	60.	80.	80.	80.	80.	80.	80.	-0.	75.
35	21.	2.	0.	25.	1.	1.	-0.	70.	50.	50.	70.	70.	70.	70.	70.	-0.	70.
36	26.	2.	0.	24.	1.	2.	-0.	60.	80.	80.	60.	60.	60.	80.	80.	-0.	75.
37	30.	1.	0.	21.	1.	2.	-0.	35.	35.	25.	20.	25.	40.	40.	60.	-0.	57.
38	22.	2.	0.	25.	1.	2.	-0.	60.	80.	60.	80.	80.	80.	60.	80.	-0.	75.
39	26.	1.	0.	20.	3.	2.	-0.	45.	35.	50.	40.	50.	30.	55.	55.	-0.	53.
40	24.	2.	0.	30.	1.	1.	-0.	60.	80.	80.	60.	80.	60.	60.	70.	-0.	65.
41	22.	2.	0.	32.	2.	2.	-0.	80.	60.	80.	60.	60.	80.	60.	90.	-0.	75.
42	30.	1.	0.	26.	1.	1.	-0.	80.	80.	70.	80.	50.	70.	50.	70.	-0.	70.
43	25.	1.	1.	23.	2.	1.	-0.	60.	60.	80.	50.	60.	60.	60.	80.	-0.	75.

Table 32. Firm B, Fictitious Cases

DATA MATRIX

VARIABLE NUMBER

ITEM * NUMBER *	1 AGE	2 MARIT ST	3 DEPEND	4 GPA	5 SCHOL ACT	6 PROF O	7 INTERV	R 1: 8 V 1-6	R 1: 9 V 1-7	R 2: 10 V 1-6	R 2: 11 V 1-7
SCALE	0	0	0	-1	0	0	0	0	0	0	0
1	24.	1.	1.	32.	1.	1.	3.	70.	70.	70.	75.
2	29.	1.	2.	31.	1.	2.	4.	75.	75.	75.	80.
3	22.	2.	0.	35.	2.	1.	3.	80.	75.	80.	80.
4	28.	1.	3.	25.	1.	1.	2.	65.	65.	65.	65.
5	26.	3.	1.	22.	2.	3.	3.	80.	75.	80.	75.
6	22.	2.	0.	28.	3.	2.	2.	80.	70.	80.	80.
7	29.	1.	3.	27.	2.	1.	2.	75.	75.	75.	70.
8	25.	1.	2.	26.	1.	2.	4.	75.	80.	80.	75.
9	23.	2.	0.	25.	1.	1.	3.	65.	70.	60.	60.
10	25.	2.	0.	30.	2.	1.	5.	70.	80.	75.	75.
11	24.	1.	2.	20.	1.	2.	2.	70.	65.	65.	65.
12	27.	3.	1.	24.	1.	2.	1.	70.	50.	65.	60.
13	23.	2.	2.	29.	3.	3.	3.	85.	80.	90.	85.
14	30.	1.	1.	32.	2.	1.	4.	75.	80.	75.	85.
15	22.	2.	0.	34.	1.	2.	3.	85.	80.	80.	80.
16	21.	1.	0.	26.	3.	2.	4.	80.	85.	80.	80.
17	23.	1.	0.	37.	2.	1.	3.	75.	80.	80.	80.
18	28.	3.	0.	31.	2.	1.	2.	75.	75.	80.	75.
19	23.	1.	1.	27.	2.	3.	3.	80.	80.	80.	80.
20	24.	1.	1.	29.	1.	2.	2.	75.	70.	75.	75.
21	28.	2.	2.	30.	2.	3.	4.	85.	85.	80.	80.
22	22.	2.	1.	25.	1.	1.	2.	70.	70.	70.	70.
23	24.	1.	0.	24.	1.	2.	3.	70.	75.	70.	70.
24	26.	2.	0.	28.	2.	3.	3.	80.	80.	75.	75.
25	27.	1.	1.	21.	2.	1.	1.	65.	65.	65.	65.
26	25.	1.	2.	32.	3.	2.	3.	80.	80.	85.	85.
27	24.	2.	0.	33.	3.	3.	3.	85.	80.	75.	75.
28	21.	2.	0.	28.	1.	1.	2.	75.	70.	80.	80.
29	22.	2.	0.	35.	2.	3.	3.	85.	85.	65.	65.
30	23.	1.	1.	37.	3.	2.	5.	85.	90.	85.	85.

Table 33. Firm C, Empirical Cases

DATA MATRIX

VARIABLE NUMBER

INDEPENDENT VARIABLES — DEPENDENT VARIABLES

ITEM NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SCALE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2.	24.	3.	298.	293.	300.	23.	8.	21.	35.	14.	19.	18.	1.	1.	92.
2	2.	27.	2.	289.	275.	284.	22.	9.	5.	6.	11.	15.	16.	1.	1.	69.
3	2.	23.	2.	287.	287.	285.	27.	10.	5.	31.	10.	14.	18.	4.	2.	82.
4	1.	18.	2.	282.	285.	279.	44.	36.	73.	35.	11.	22.	26.	4.	3.	139.
5	1.	19.	2.	288.	298.	260.	46.	39.	50.	31.	0.	22.	27.	4.	3.	125.
6	1.	21.	1.	286.	295.	279.	33.	23.	64.	38.	11.	24.	23.	5.	3.	108.
7	2.	25.	2.	280.	276.	281.	36.	25.	0.	29.	17.	24.	24.	5.	4.	91.
8	2.	23.	3.	287.	278.	292.	24.	15.	1.	29.	20.	18.	24.	2.	2.	69.
9	1.	19.	2.	285.	285.	283.	29.	14.	23.	29.	12.	23.	24.	4.	4.	127.
10	1.	18.	2.	288.	295.	283.	36.	30.	18.	29.	13.	25.	29.	4.	3.	159.
11	1.	19.	2.	298.	297.	281.	51.	47.	35.	31.	35.	28.	30.	6.	5.	96.
12	1.	19.	1.	335.	291.	332.	37.	26.	52.	38.	0.	22.	27.	6.	5.	155.
13	1.	19.	3.	282.	298.	269.	38.	33.	39.	34.	9.	18.	27.	6.	6.	141.
14	2.	23.	2.	287.	298.	279.	36.	24.	84.	23.	2.	23.	23.	4.	4.	120.
15	1.	20.	3.	307.	312.	312.	35.	23.	31.	42.	8.	20.	24.	4.	4.	108.
16	1.	18.	2.	278.	295.	271.	38.	27.	51.	30.	2.	22.	34.	4.	3.	141.
17	2.	21.	2.	287.	278.	284.	35.	20.	10.	23.	12.	19.	26.	5.	1.	120.
18	2.	19.	2.	285.	287.	283.	28.	12.	27.	35.	3.	21.	21.	2.	2.	82.
19	2.	21.	2.	282.	295.	272.	33.	20.	2.	38.	3.	24.	25.	2.	2.	77.
20	1.	22.	2.	287.	283.	280.	45.	38.	47.	42.	10.	20.	31.	4.	3.	108.
21	1.	18.	2.	295.	287.	281.	33.	18.	24.	28.	0.	22.	20.	1.	1.	56.
22	1.	18.	2.	285.	288.	282.	35.	13.	69.	32.	8.	22.	25.	4.	3.	145.
23	2.	18.	2.	308.	300.	321.	40.	23.	47.	35.	3.	18.	18.	4.	3.	142.
24	2.	23.	2.	275.	275.	274.	25.	8.	2.	0.	13.	15.	12.	1.	1.	90.
25	1.	19.	3.	273.	282.	263.	32.	19.	18.	24.	6.	18.	25.	1.	1.	53.
26	2.	15.	2.	278.	290.	275.	32.	20.	23.	33.	8.	13.	21.	1.	1.	43.
27	1.	21.	2.	272.	295.	248.	28.	12.	72.	34.	9.	17.	19.	5.	4.	141.
28	1.	24.	1.	270.	262.	271.	27.	31.	41.	41.	13.	25.	31.	1.	1.	74.
29	1.	18.	2.	298.	315.	287.	36.	24.	70.	38.	8.	28.	36.	4.	3.	152.
30	1.	23.	2.	286.	287.	284.	35.	23.	31.	27.	6.	24.	28.	3.	2.	84.
31	1.	15.	2.	299.	317.	287.	37.	26.	76.	40.	8.	24.	31.	5.	2.	92.
32	1.	19.	1.	286.	284.	285.	31.	17.	41.	39.	10.	25.	30.	1.	1.	79.
33	1.	22.	2.	274.	277.	269.	33.	20.	5.	32.	8.	24.	29.	1.	1.	90.
34	2.	24.	3.	307.	315.	301.	32.	21.	46.	43.	8.	25.	27.	7.	5.	107.
35	2.	22.	2.	290.	288.	289.	34.	23.	16.	32.	0.	20.	28.	5.	3.	109.
36	2.	25.	3.	293.	315.	279.	37.	26.	21.	31.	10.	26.	35.	5.	2.	126.
37	2.	18.	2.	293.	275.	302.	33.	20.	17.	31.	13.	24.	21.	1.	1.	86.
38	2.	27.	2.	288.	277.	292.	31.	26.	18.	23.	3.	21.	21.	4.	2.	65.
39	2.	22.	2.	317.	291.	288.	37.	27.	72.	36.	2.	26.	29.	6.	5.	98.
40	2.	23.	2.	292.	277.	303.	32.	18.	10.	44.	0.	25.	29.	4.	3.	135.
41	2.	20.	2.	296.	297.	295.	35.	23.	29.	36.	1.	16.	22.	1.	1.	52.
42	1.	23.	3.	308.	301.	319.	33.	20.	52.	47.	4.	26.	14.	4.	4.	26.
43	2.	23.	2.	290.	291.	268.	28.	13.	23.	35.	12.	22.	29.	4.	4.	149.
44	2.	23.	2.	291.	299.	285.	37.	26.	45.	34.	0.	20.	36.	5.	5.	73.
45	3.	20.	3.	315.	317.	316.	48.	42.	38.	44.	19.	30.	31.	5.	5.	111.
46	2.	28.	2.	309.	317.	302.	36.	9.	35.	42.	0.	23.	30.	5.	3.	70.
47	3.	19.	2.	282.	297.	271.	28.	14.	12.	34.	17.	27.	36.	4.	3.	160.
48	1.	19.	2.	312.	325.	301.	53.	50.	33.	40.	23.	25.	33.	6.	6.	89.
49	2.	20.	3.	293.	303.	286.	37.	26.	70.	37.	9.	22.	23.	4.	3.	128.
50	1.	20.	2.	311.	328.	298.	38.	27.	92.	45.	8.	26.	33.	5.	5.	66.
51	2.	18.	2.	287.	273.	293.	38.	28.	23.	37.	0.	21.	32.	5.	5.	99.
52	1.	18.	2.	305.	310.	309.	36.	24.	74.	43.	5.	14.	29.	6.	5.	109.
53	1.	22.	3.	295.	282.	317.	39.	29.	0.	37.	7.	17.	27.	5.	4.	104.
54	2.	18.	2.	282.	294.	279.	25.	8.	10.	29.	7.	25.	25.	1.	1.	83.
55	2.	18.	2.	293.	285.	295.	30.	15.	21.	20.	13.	23.	28.	3.	2.	76.
56	2.	18.	2.	277.	279.	273.	18.	0.	3.	7.	9.	18.	24.	1.	1.	91.
57	2.	24.	2.	260.	294.	279.	25.	32.	2.	11.	14.	19.	20.	1.	1.	89.
58	2.	18.	2.	266.	270.	260.	31.	17.	8.	17.	15.	25.	15.	2.	1.	86.
59	2.	23.	2.	292.	282.	296.	29.	14.	34.	24.	9.	15.	18.	3.	3.	83.
60	1.	18.	3.	290.	288.	289.	28.	29.	5.	26.	14.	22.	25.	4.	3.	137.
61	1.	18.	2.	234.	294.	297.	40.	20.	80.	37.	9.	22.	8.	7.	5.	156.
62	2.	33.	2.	254.	260.	244.	35.	23.	14.	25.	12.	25.	29.	4.	4.	139.
63	1.	18.	1.	305.	331.	299.	55.	53.	67.	41.	33.	28.	36.	7.	7.	67.
64	2.	25.	2.	293.	285.	297.	35.	27.	10.	25.	2.	21.	27.	4.	3.	102.
65	2.	22.	2.	271.	255.	277.	24.	9.	48.	18.	0.	17.	22.	1.	1.	76.
66	1.	25.	2.	304.	303.	304.	48.	44.	34.	33.	3.	23.	21.	6.	5.	108.
67	1.	22.	2.	289.	290.	287.	28.	12.	54.	44.	2.	22.	24.	5.	4.	57.
68	1.	18.	1.	297.	305.	291.	36.	24.	51.	42.	14.	15.	35.	4.	2.	67.
69	1.	26.	2.	290.	290.	288.	29.	14.	14.	46.	0.	20.	24.	5.	5.	159.
70	1.	24.	1.	276.	284.	267.	32.	18.	6.	23.	14.	20.	23.	4.	3.	166.
71	2.	18.	2.	282.	280.	283.	33.	21.	10.	39.	0.	13.	22.	4.	2.	88.
72	2.	23.	3.	320.	326.	317.	33.	20.	81.	40.	14.	14.	31.	6.	6.	122.
73	2.	26.	2.	289.	300.	294.	28.	12.	43.	35.	0.	19.	20.	4.	3.	40.
74	1.	14.	2.	315.	335.	301.	51.	47.	69.	44.	37.	29.	32.	7.	7.	65.
75	2.	17.	2.	313.	317.	289.	32.	28.	25.	42.	14.	19.	19.	3.	2.	79.
76	2.	28.	2.	296.	297.	303.	41.	29.	20.	34.	17.	22.	22.	2.	2.	69.
77	1.	18.	2.	308.	313.	304.	45.	35.	39.	39.	9.	24.	33.	6.	5.	86.
78	1.	21.	2.	278.	278.	277.	44.	39.	23.	38.	0.	25.	22.	4.	3.	113.
79	2.	22.	2.	302.	315.	294.	19.	29.	42.	37.	0.	19.	29.	4.	2.	139.
80	2.	18.	2.	300.	298.	300.	22.	3.	44.	37.	0.	20.	29.	3.	1.	59.

Table 34. Firm C, Empirical Cases
(Nos. 1-30)

DATA MATRIX

VARIABLE NUMBER

ITEM * NUMBER *	1 INDEPENDENT VARIABLES	2	3	4	5	6	7	8 DEP VAR
SCALE	0	0	0	0	0	0	0	0
1	298.	293.	300.	23.	8.	21.	35.	1.
2	283.	295.	284.	22.	9.	5.	8.	1.
3	237.	287.	285.	27.	10.	5.	31.	2.
4	282.	285.	279.	44.	36.	23.	35.	3.
5	[illegible]	293.	280.	46.	39.	50.	31.	3.
6	286.	295.	279.	33.	23.	64.	38.	3.
7	280.	276.	281.	36.	25.	0.	29.	4.
8	287.	278.	292.	24.	15.	1.	29.	2.
9	285.	285.	293.	29.	14.	23.	29.	4.
10	283.	295.	283.	36.	30.	18.	29.	3.
11	298.	297.	291.	51.	47.	35.	31.	5.
12	305.	291.	332.	37.	26.	52.	38.	5.
13	282.	298.	269.	38.	33.	39.	34.	6.
14	287.	293.	279.	36.	24.	84.	23.	4.
15	307.	312.	302.	35.	23.	31.	42.	4.
16	273.	285.	271.	33.	27.	51.	30.	3.
17	262.	276.	284.	35.	20.	10.	23.	1.
18	285.	287.	283.	28.	12.	27.	35.	2.
19	282.	295.	272.	33.	20.	2.	38.	2.
20	282.	293.	280.	45.	38.	47.	42.	3.
21	285.	297.	281.	33.	18.	24.	29.	1.
22	235.	283.	237.	35.	13.	69.	32.	3.
23	308.	300.	321.	40.	23.	47.	35.	3.
24	275.	275.	274.	25.	8.	2.	0.	1.
25	273.	282.	253.	32.	19.	18.	24.	1.
26	273.	280.	275.	32.	20.	23.	33.	1.
27	292.	295.	238.	23.	12.	72.	34.	4.
28	270.	252.	271.	27.	11.	41.	41.	1.
29	293.	315.	287.	36.	24.	70.	33.	3.
30	283.	287.	284.	35.	23.	31.	27.	2.

APPENDIX B

HISTOGRAMS OF CASE DISTRIBUTION AND PLOTS OF DEPENDENT VS. INDEPENDENT VARIABLES

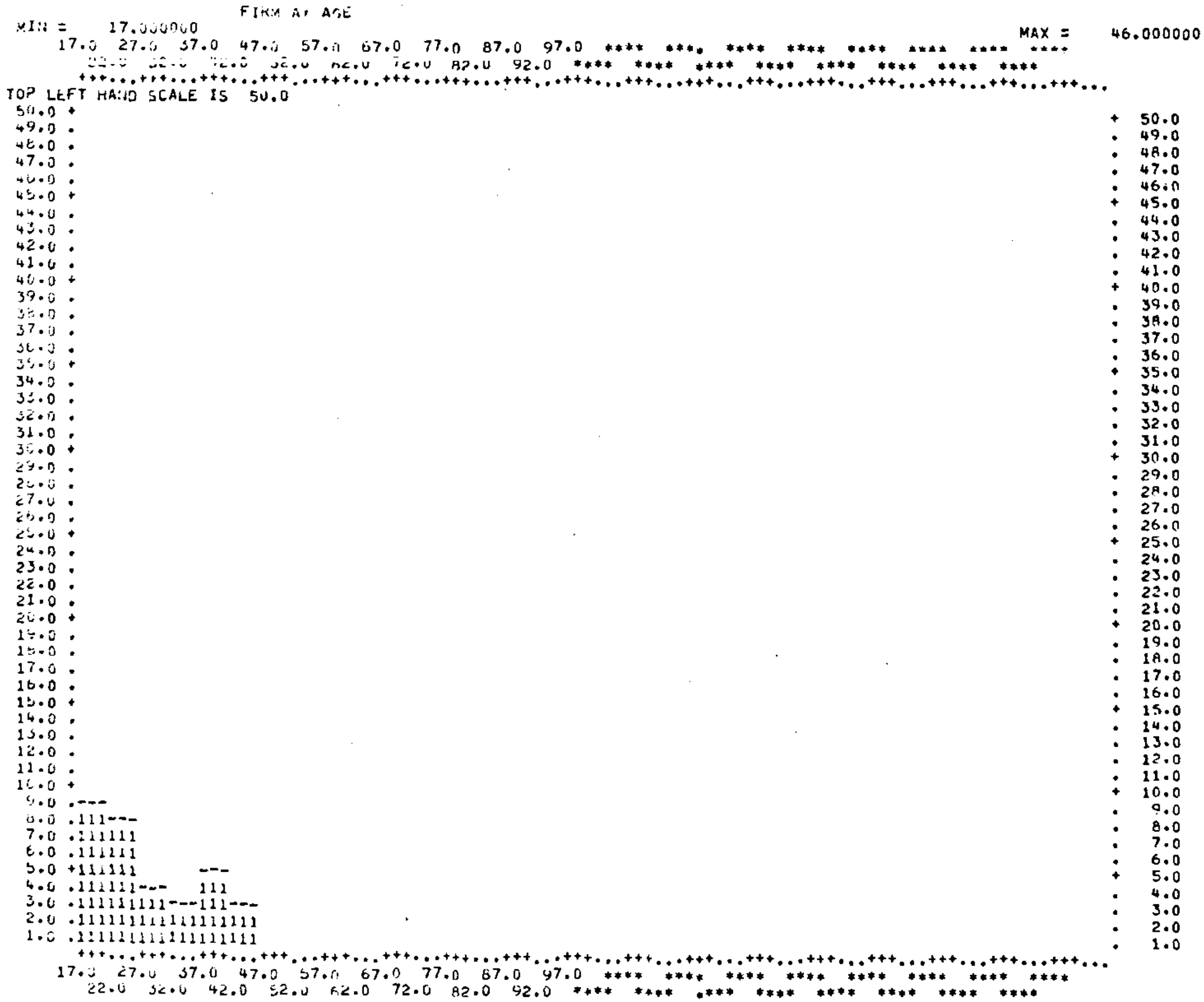

Figure 5. Firm A, Age Distribution

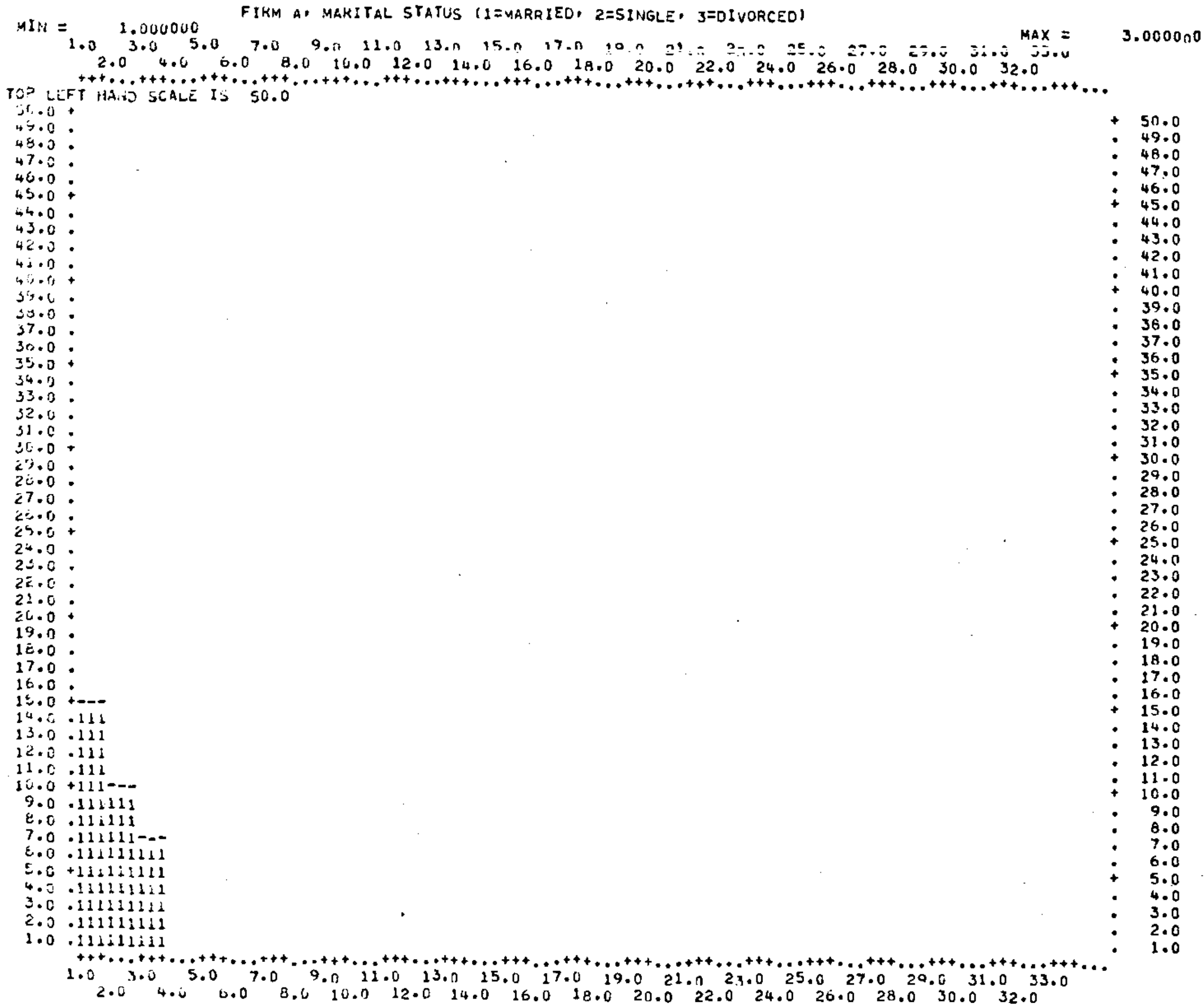

Figure 6. Firm A, Marital Status Distribution

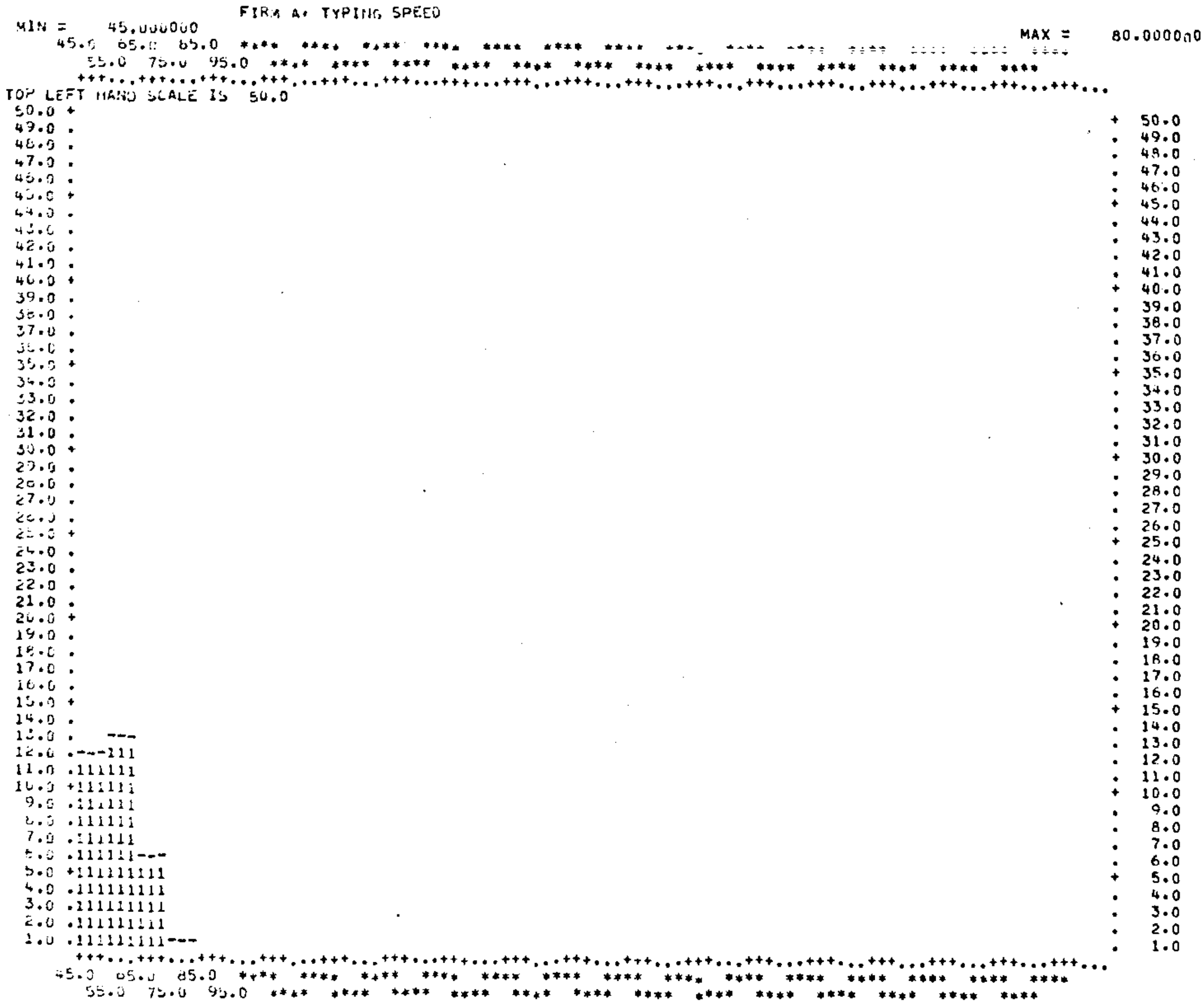

Figure 7. Firm A, Typing Speed Distribution

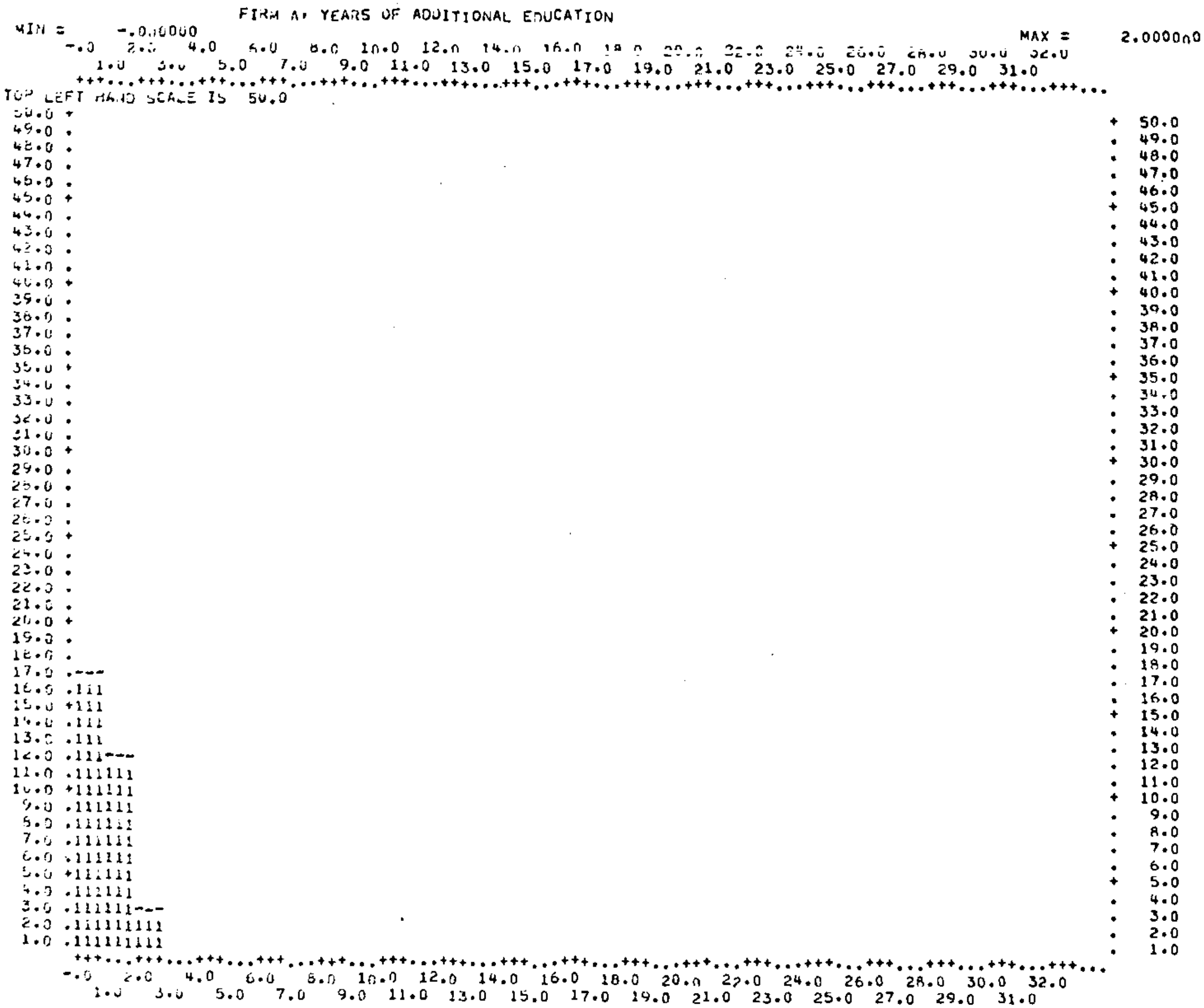

Figure 8. Firm A, Additional Education Distribution

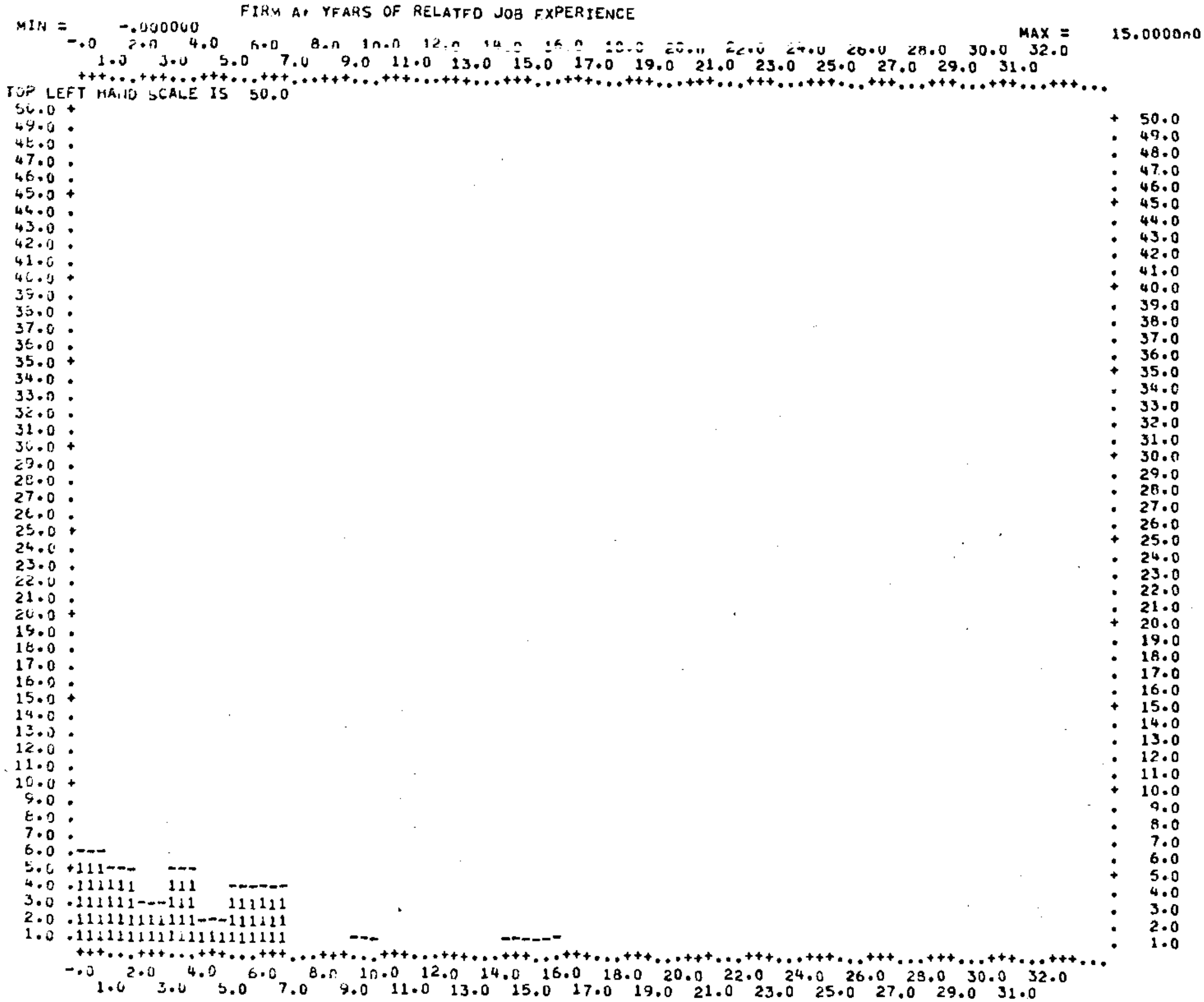

Figure 9. Firm A, Related Job Experience Distribution

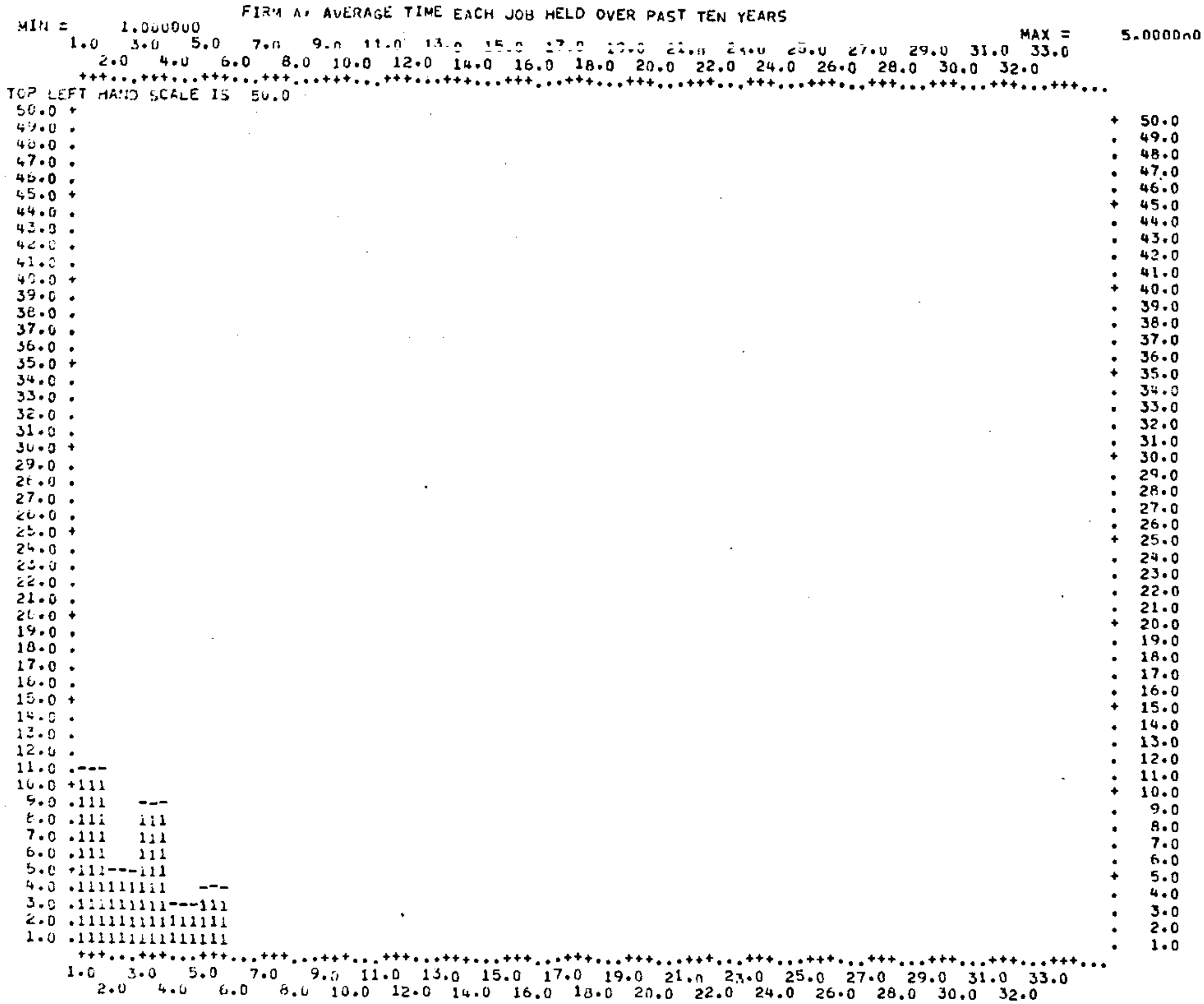

Figure 10. Firm A, Time Each Job Held Distribution

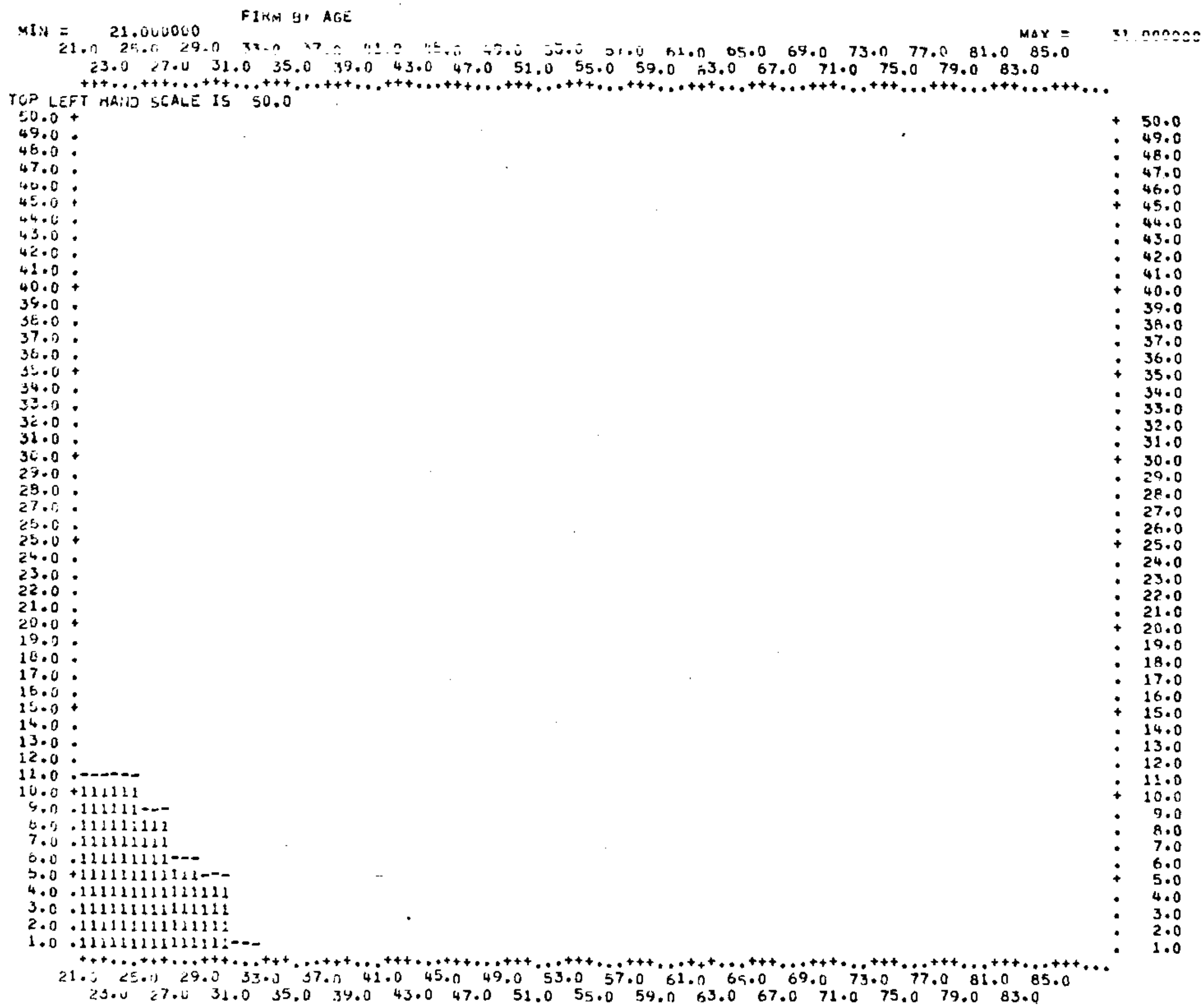

Figure 11. Firm B, Age Distribution

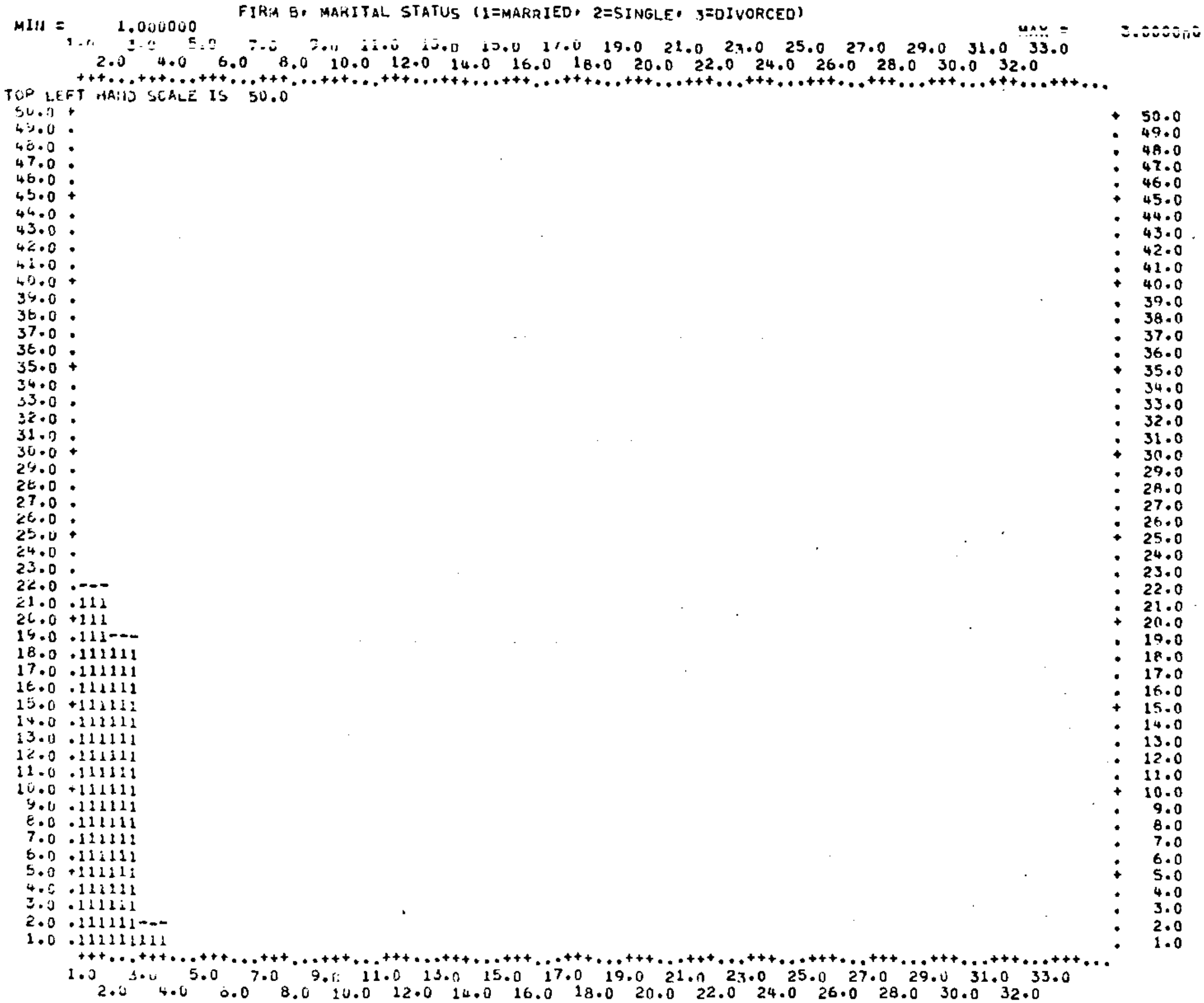

Figure 12. Firm B, Marital Status Distribution

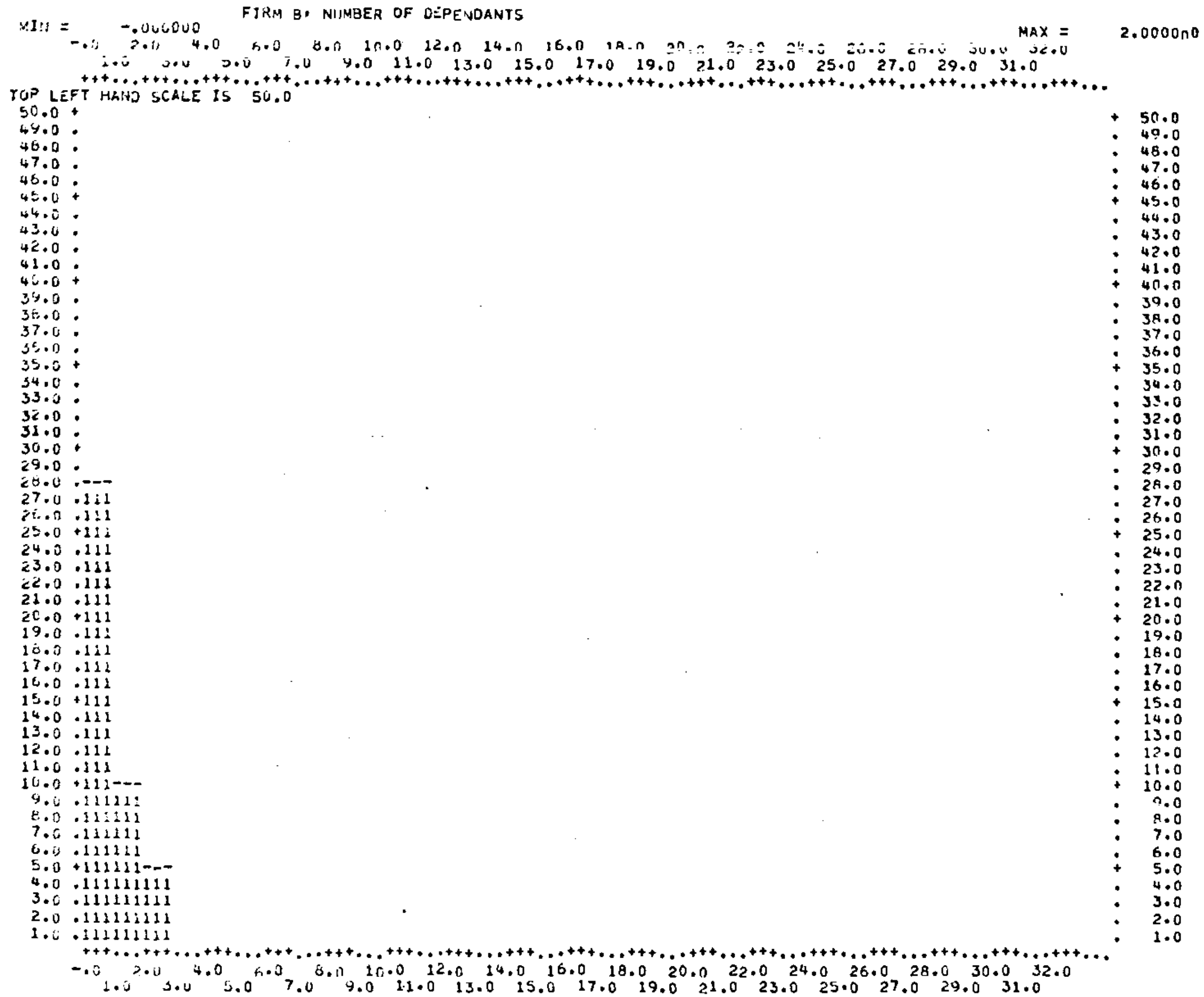

Figure 13. Firm B, Number of Dependents Distribution

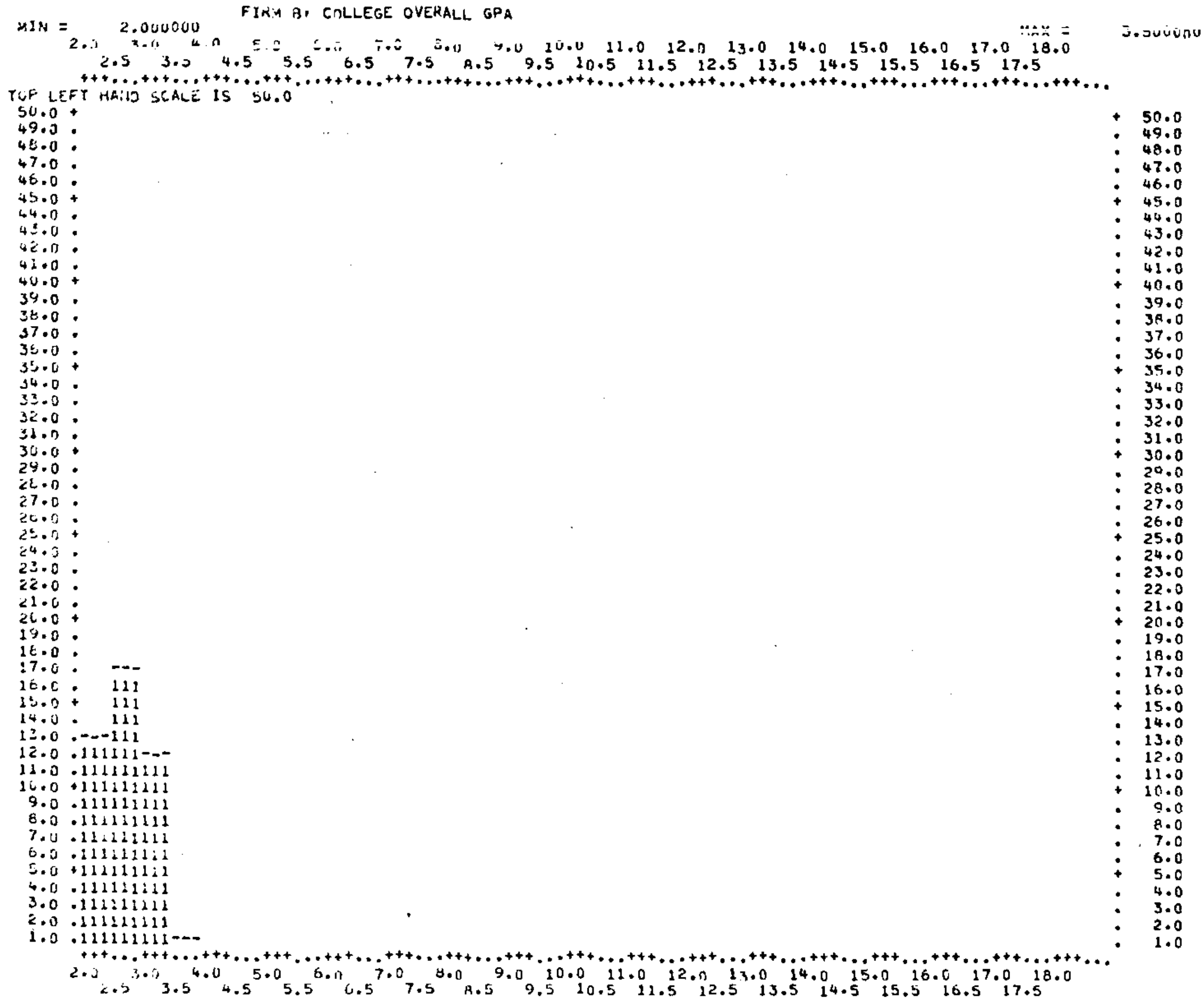

Figure 14. Firm B, College GPA Distribution

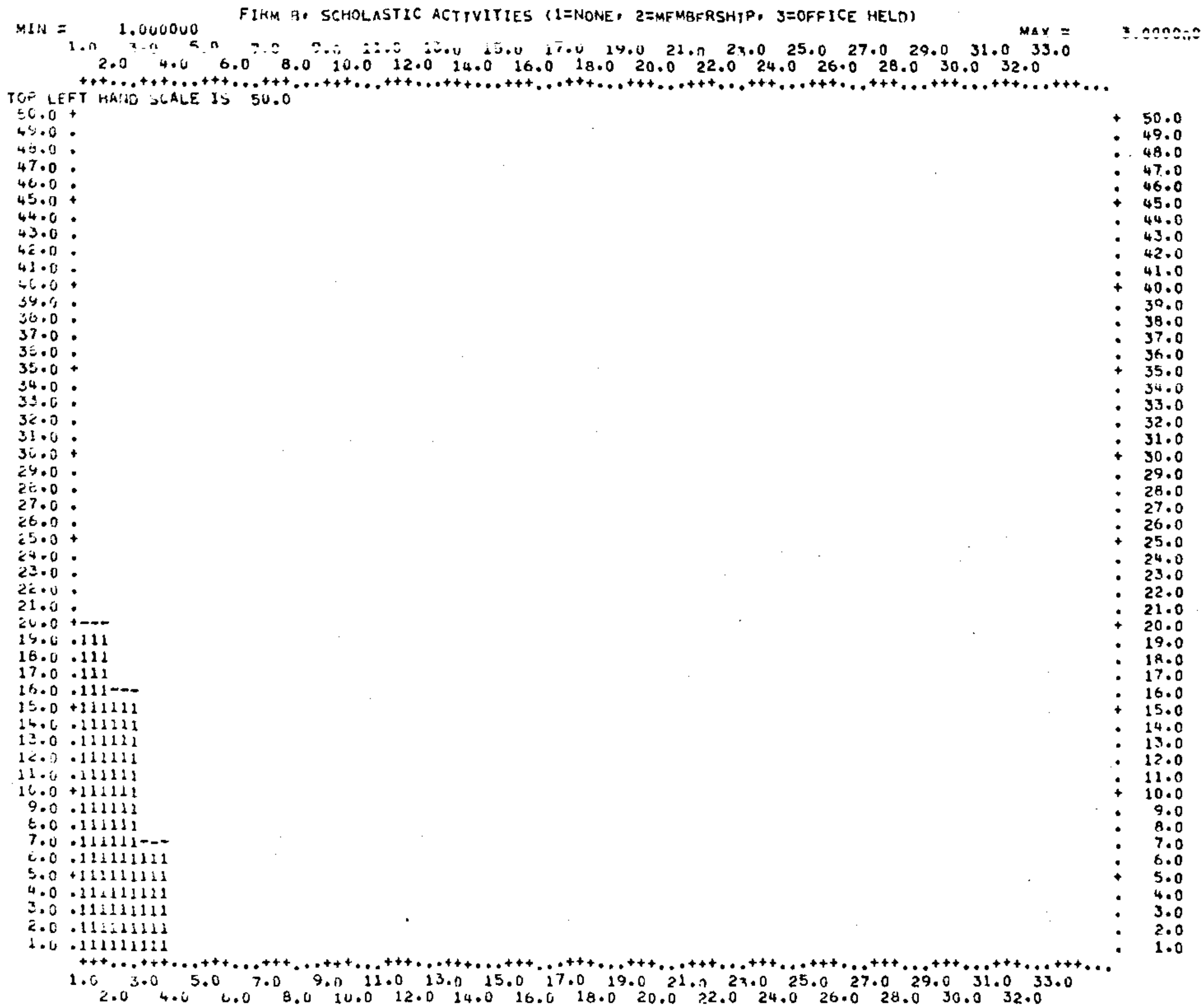

Figure 15. Firm B, Scholastic Activities Distribution

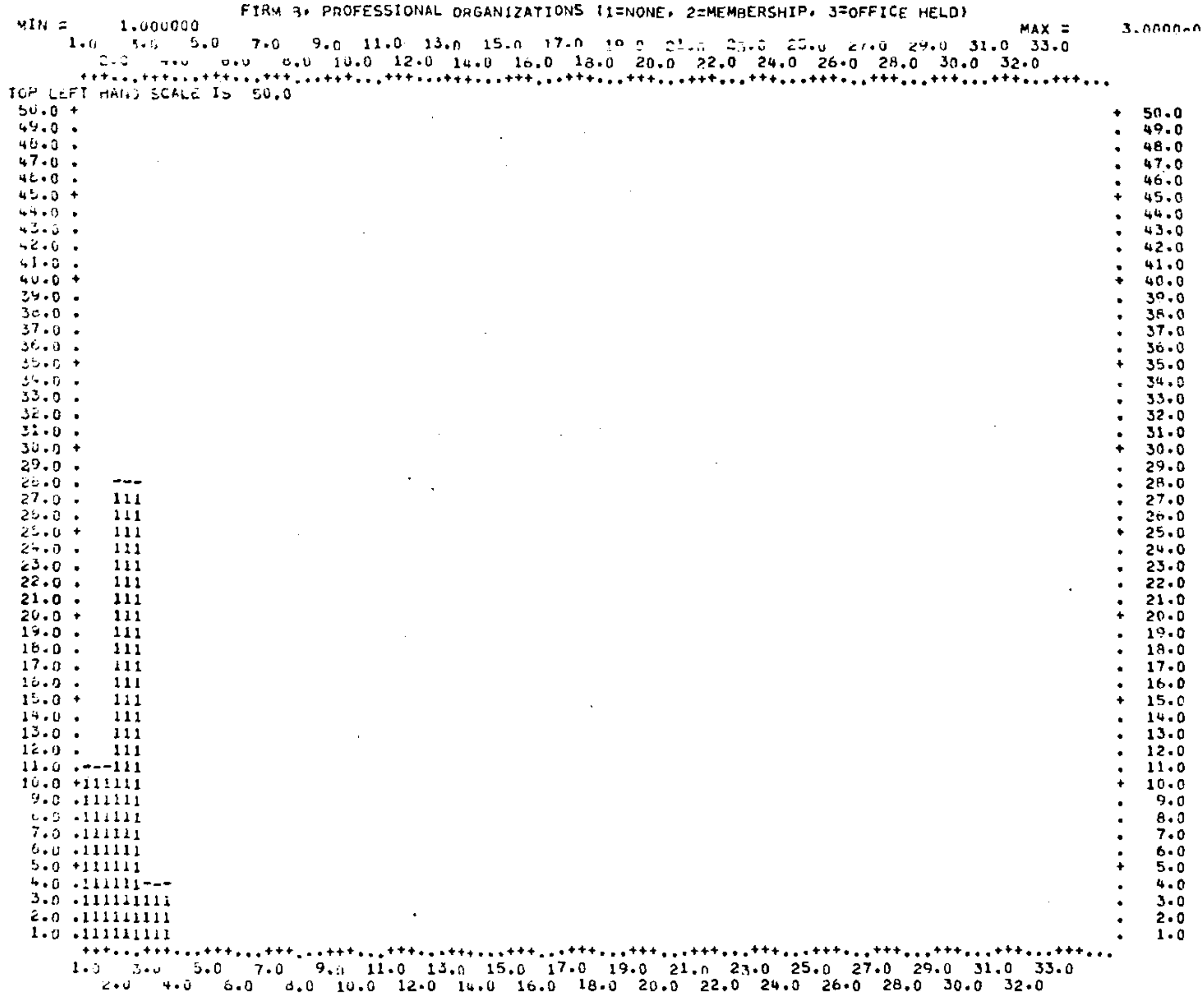

Figure 16. Firm B, Professional Organizations Distribution

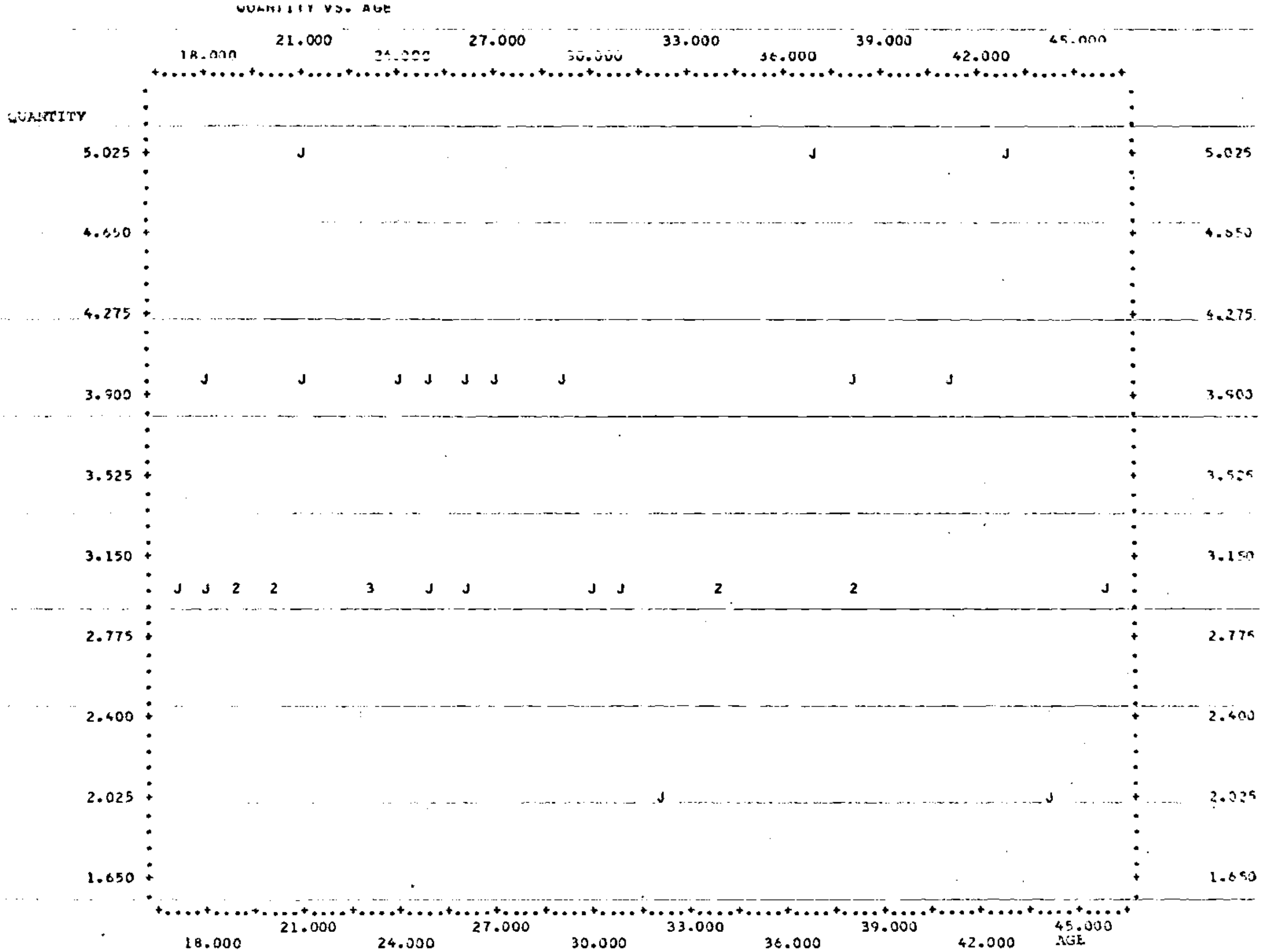

Figure 17. Firm A, Y_e vs. X = Age

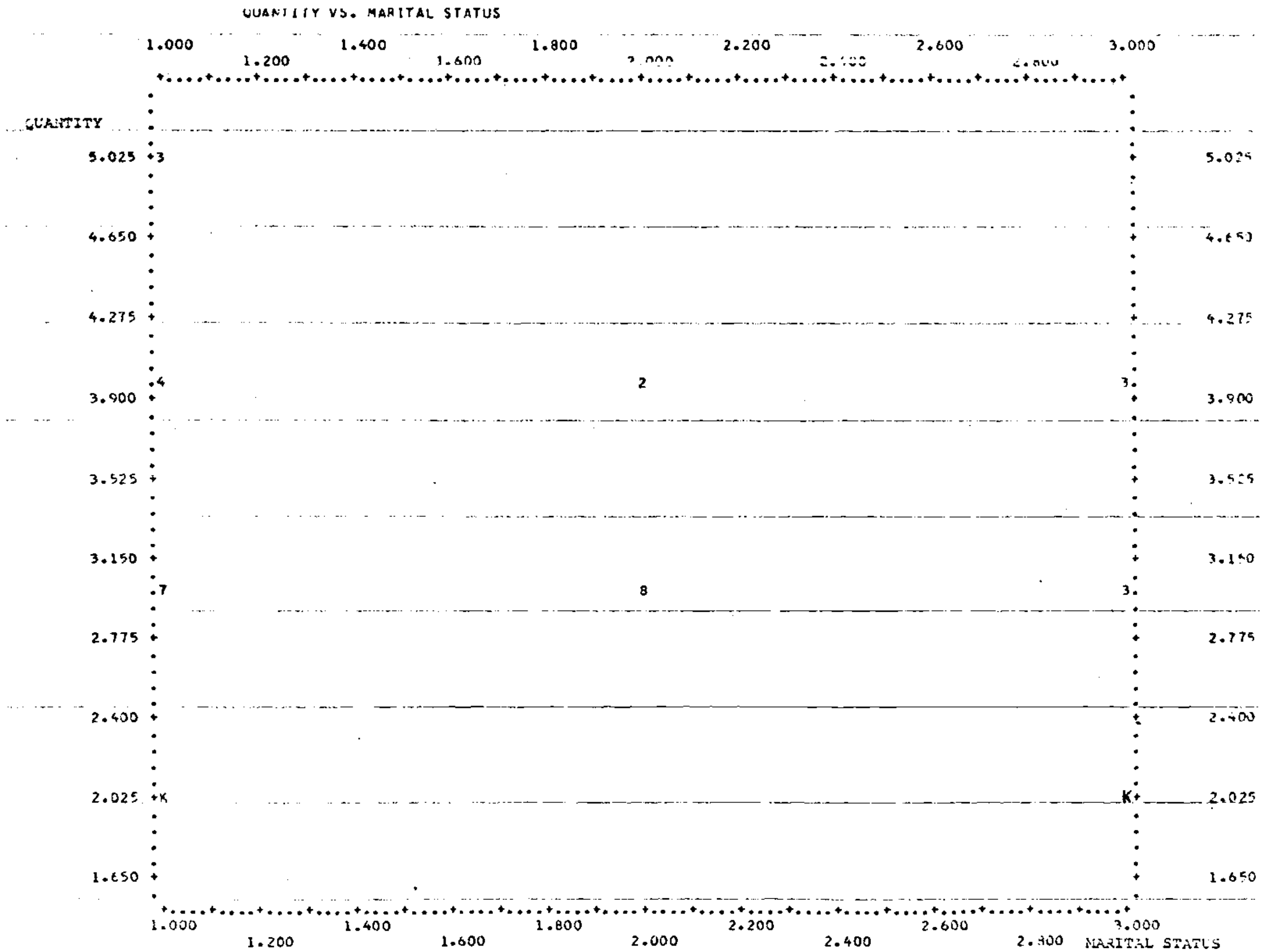

Figure 18. Firm A, Y_e vs. X = Marital Status

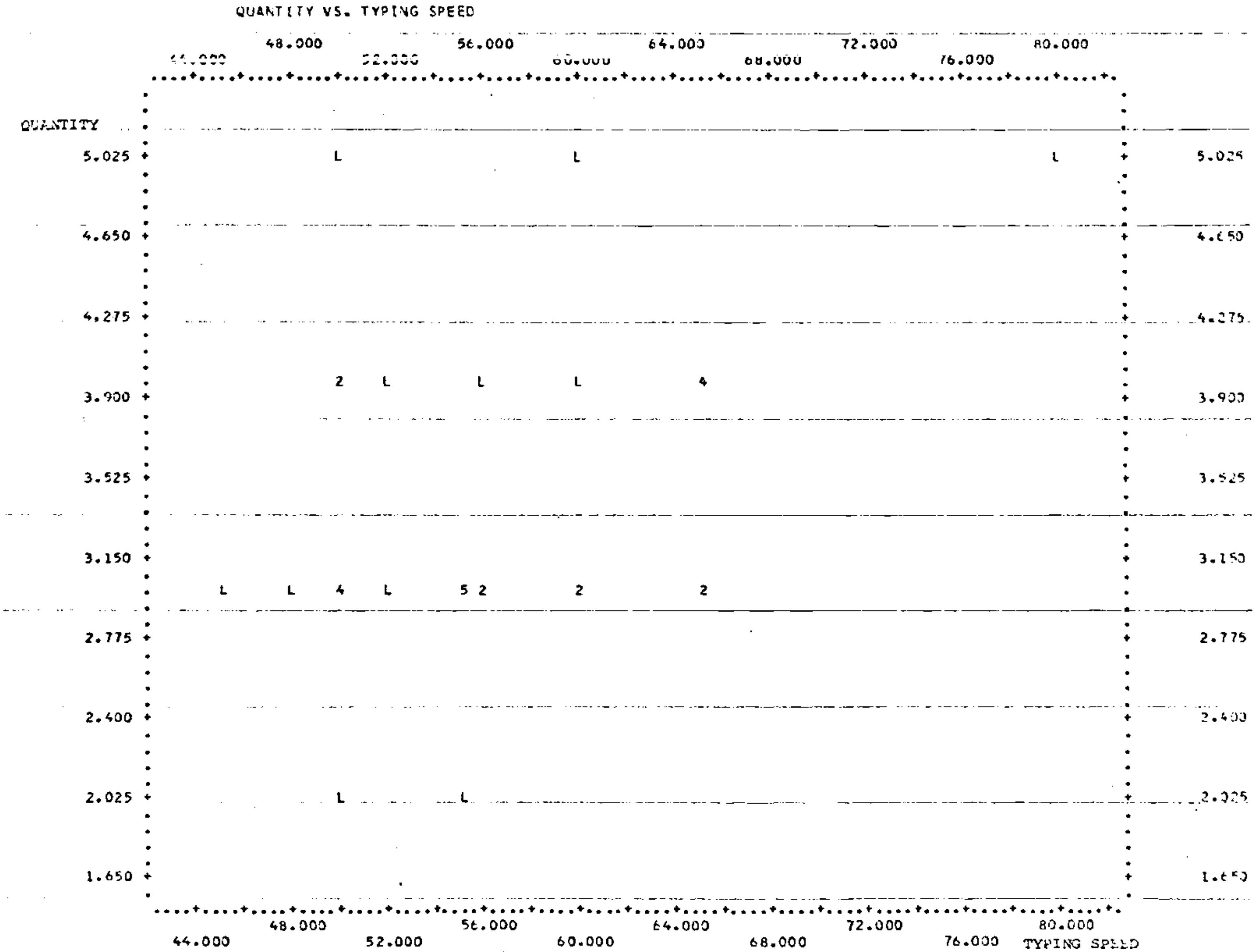

Figure 19. Firm A, Y_e vs. X = Typing Speed

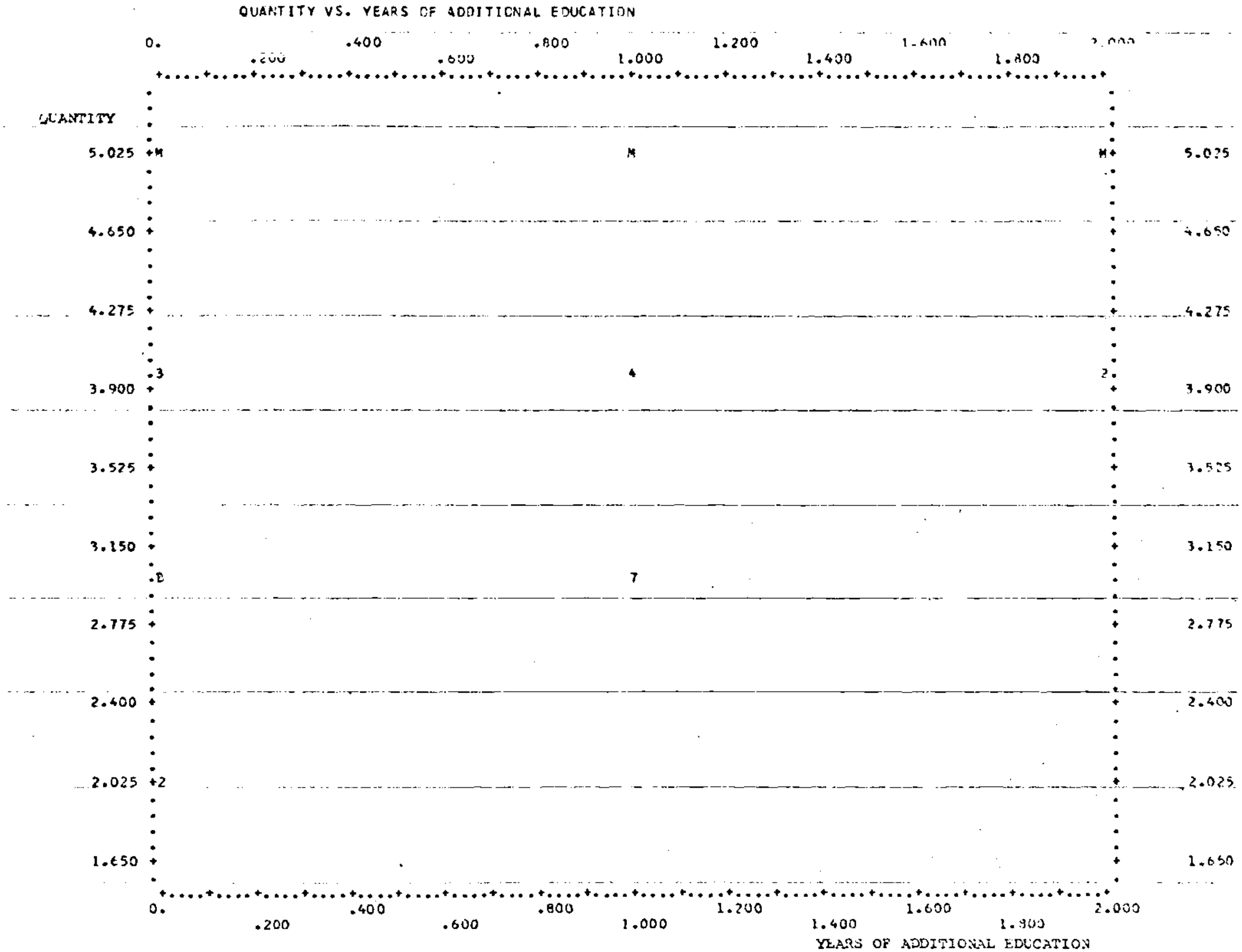

Figure 20. Firm A, Y_e vs. X = Additional Education

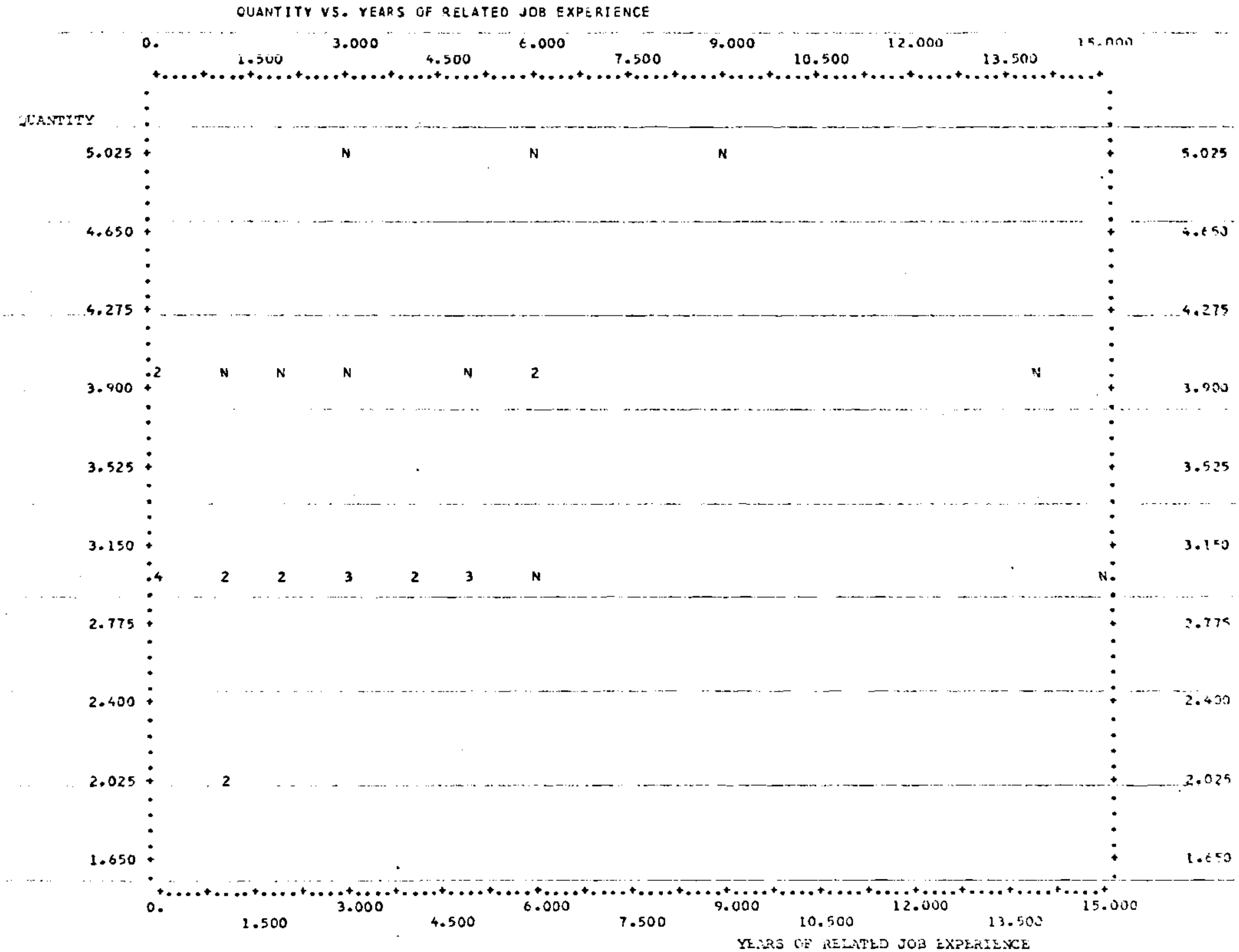

Figure 21. Firm A, Y_e vs. X = Related Job Experience

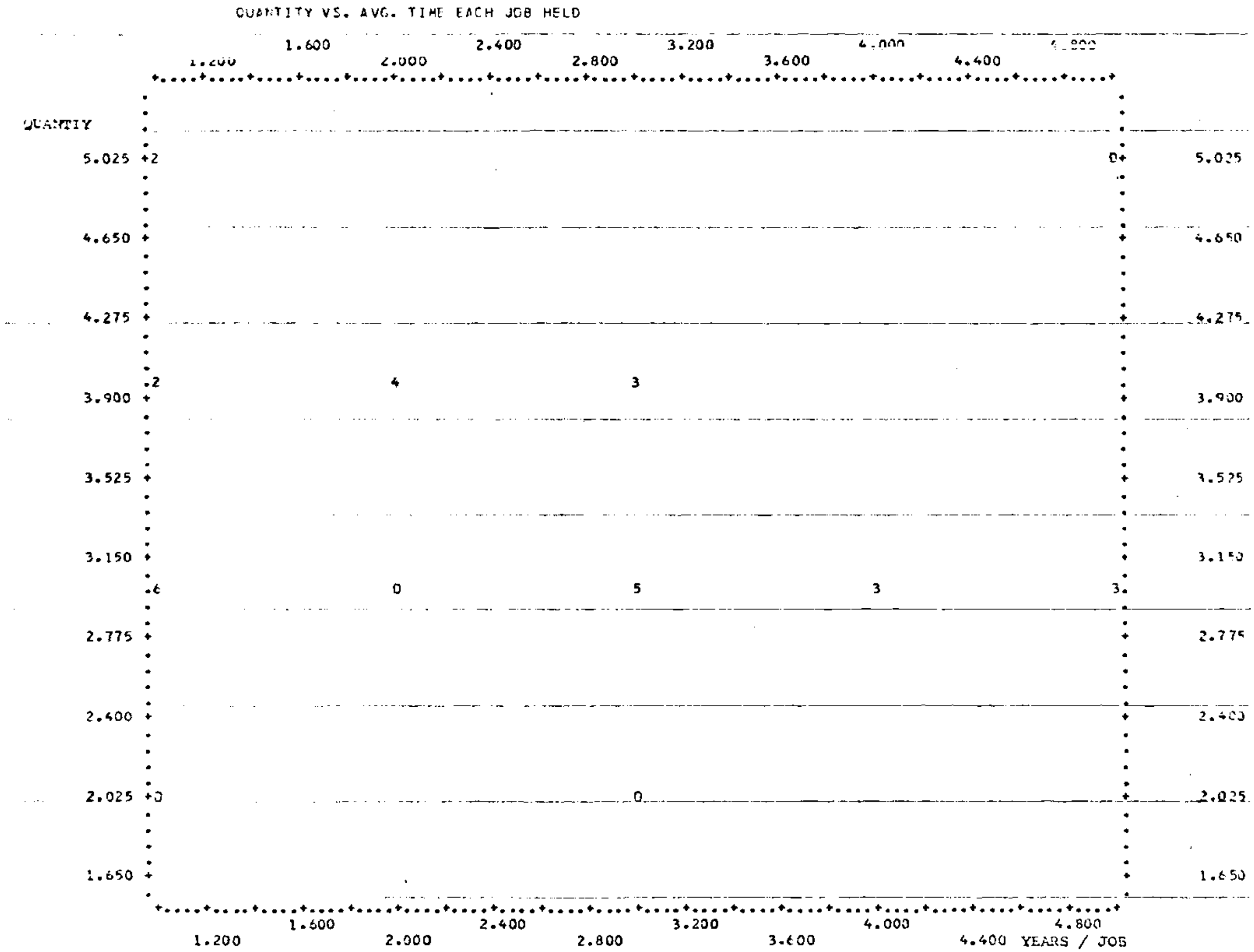

Figure 22. Firm A, Y_e vs. X = Time Each Job Held

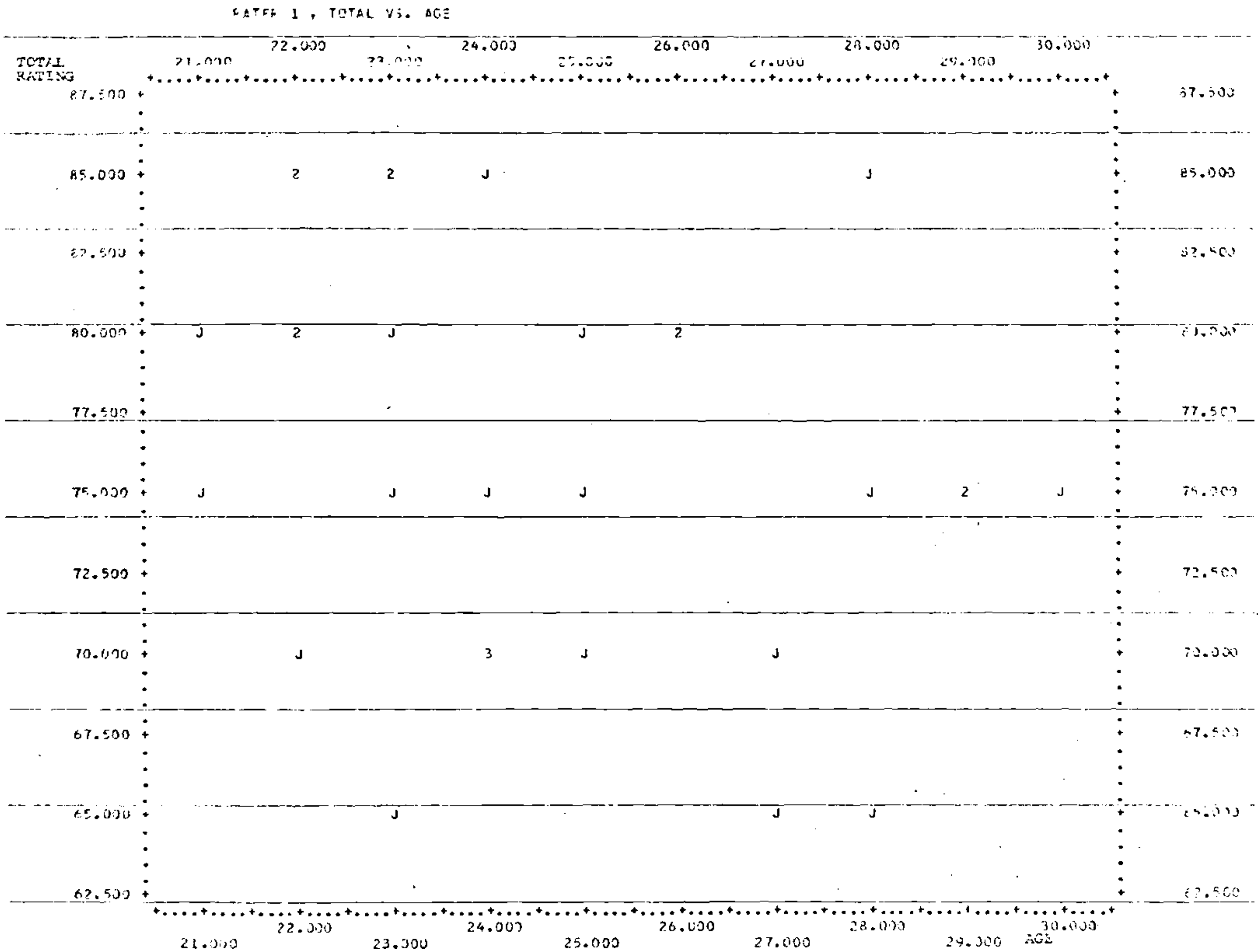

Figure 23. Firm B, Y_s vs. X = Age

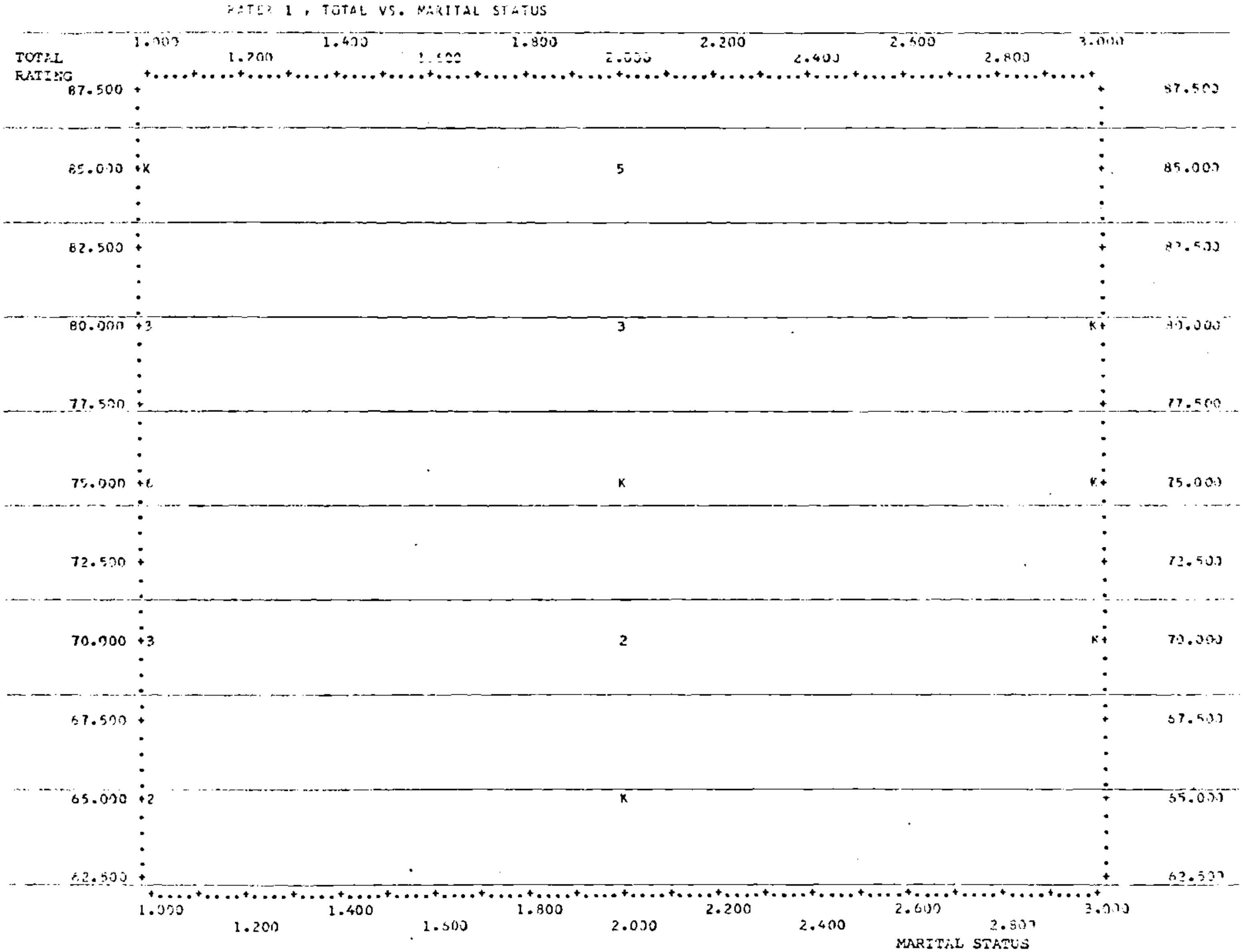

Figure 24. Firm B, Y_s vs. X = Marital Status

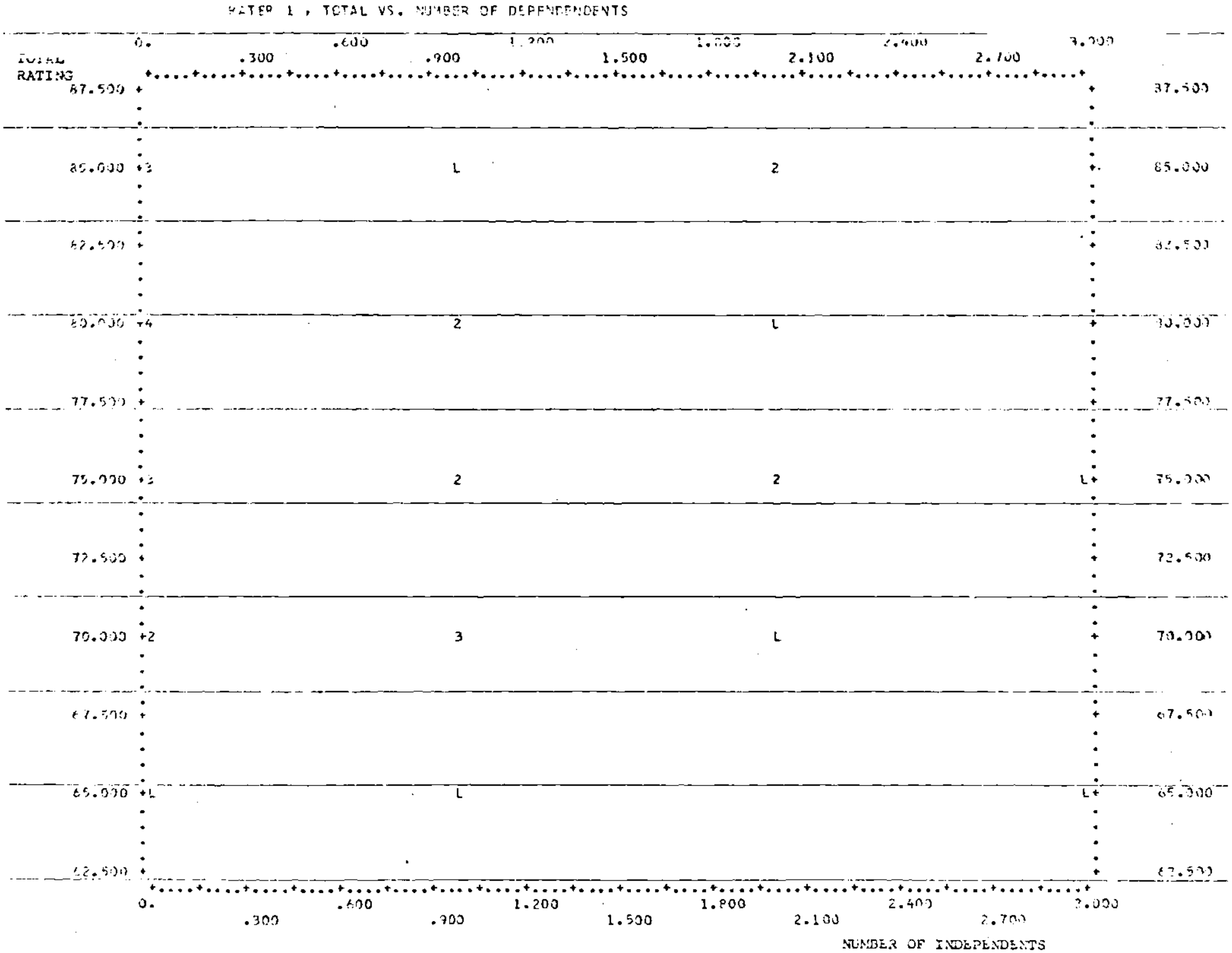

Figure 25. Firm B, Y_s vs. X = Number of Dependents

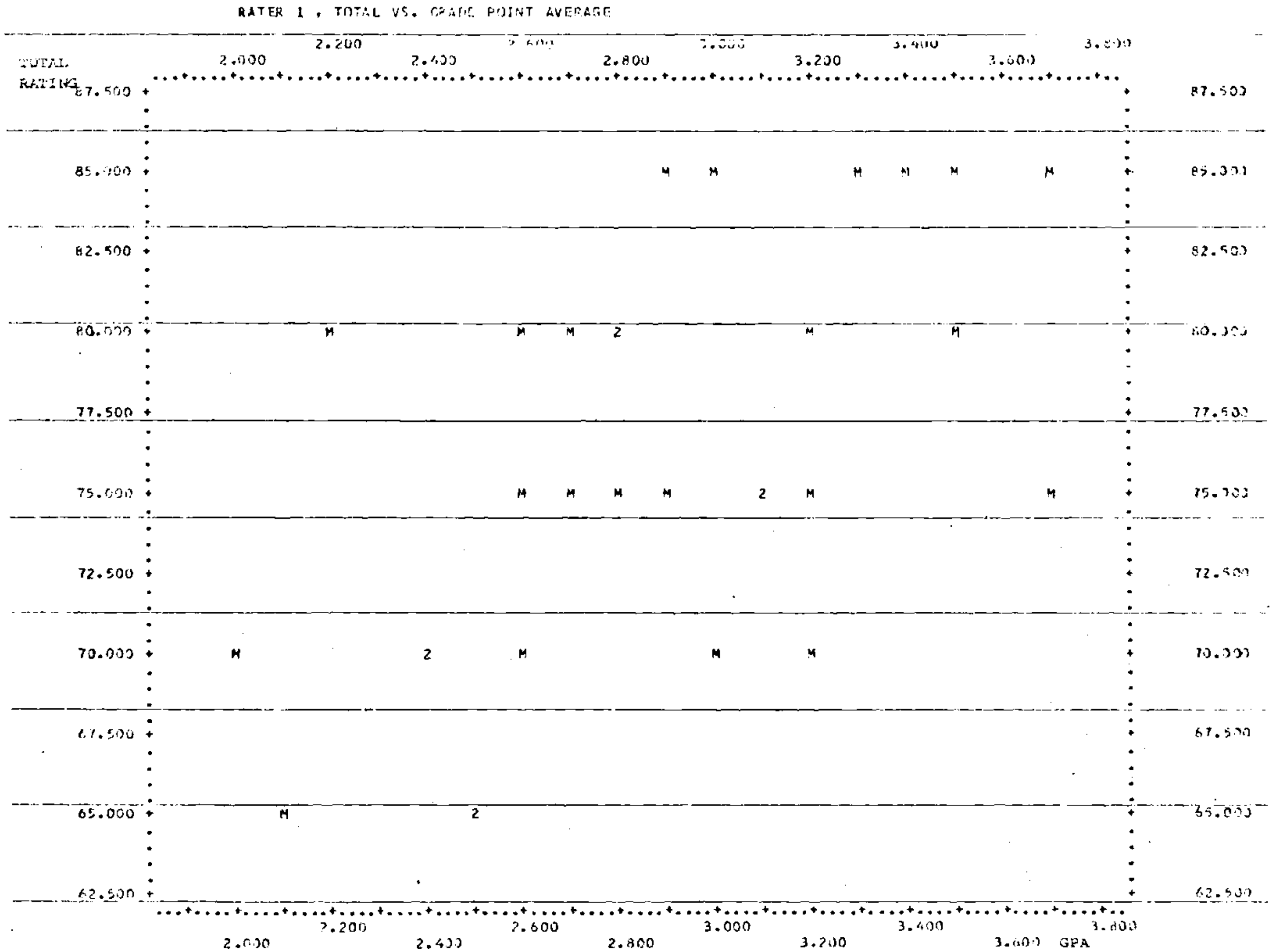

Figure 26. Firm B, Y_s vs. X - GPA

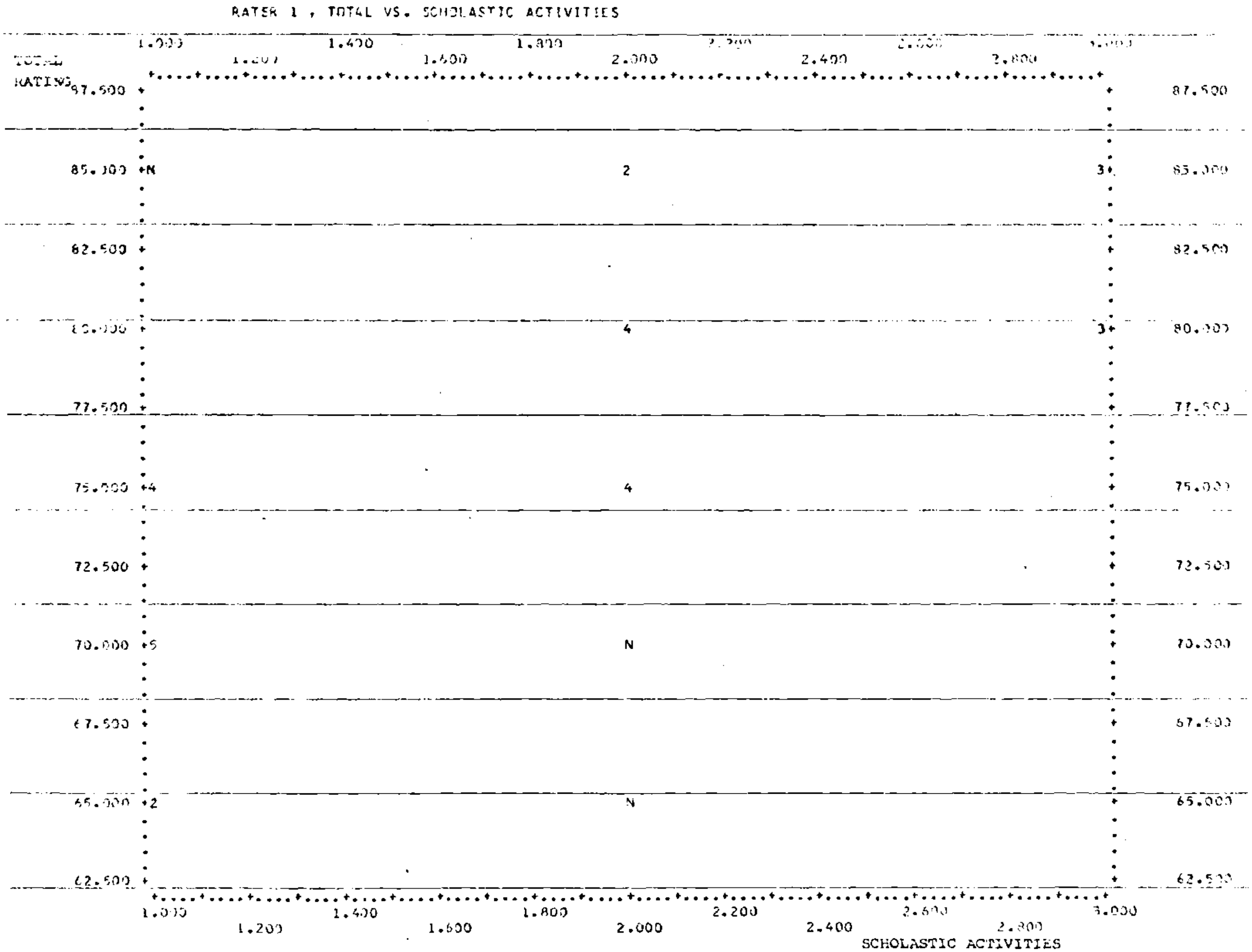

Figure 27. Firm B, Y_s vs. X = Scholastic Activities

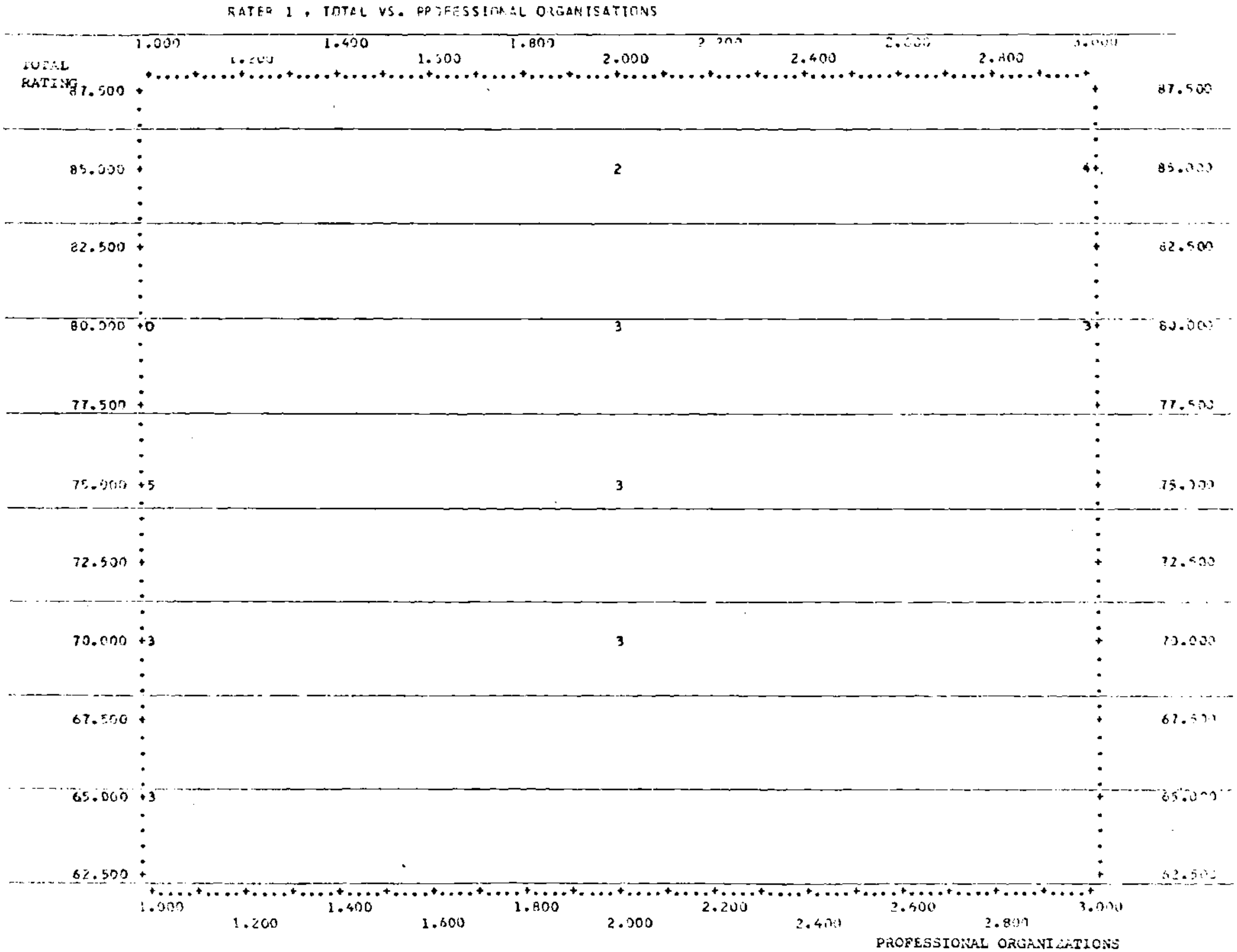

Figure 28. Firm B, Y_s vs. X = Professional Organizations

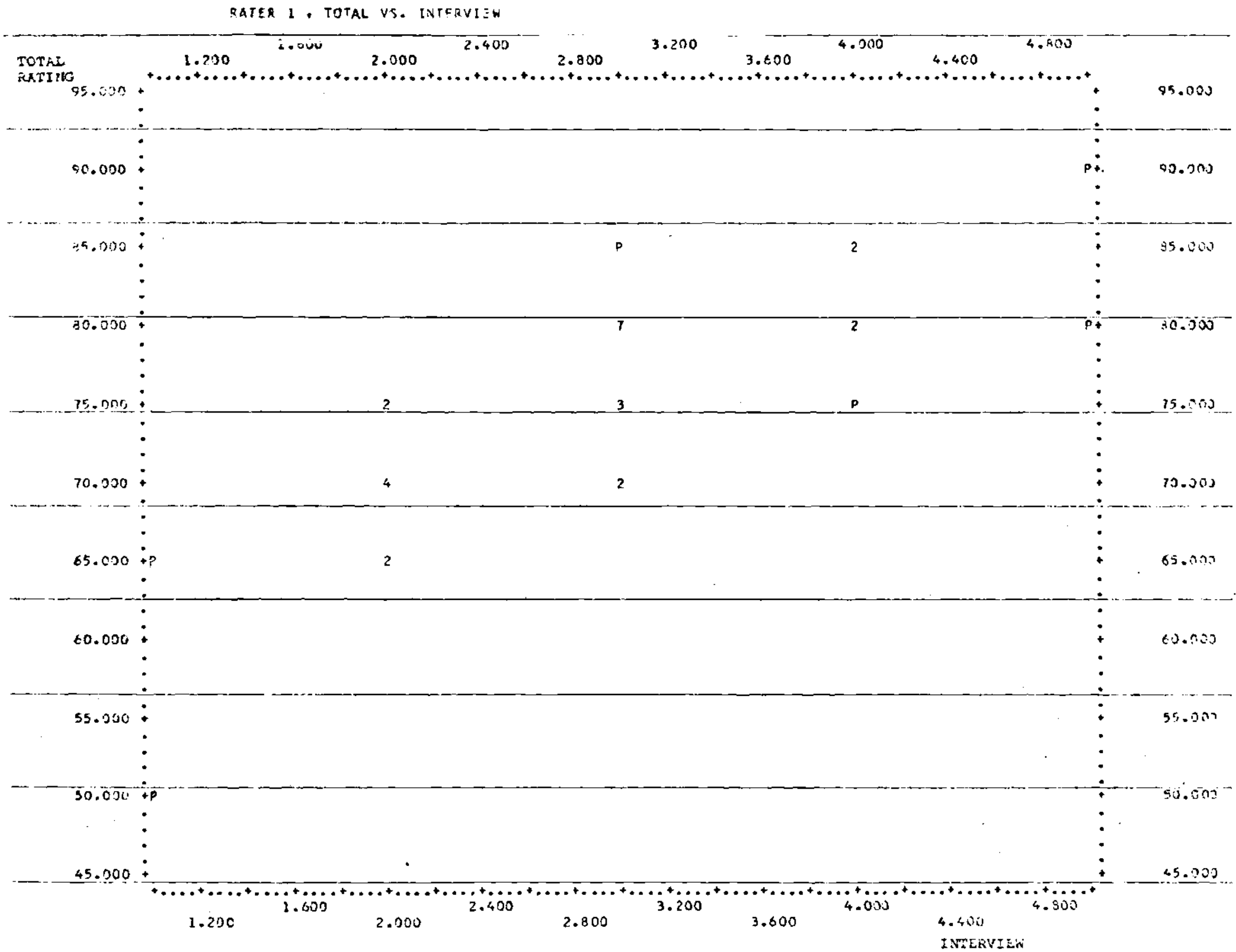

Figure 29. Firm B, Y_s vs. X - Interview

APPENDIX C

CONVERTED DATA MATRICES

EMPLOYING INFORMATION MEASURES

INCLUDING PLOTS

Table 35. Firm A, Empirical Cases

Converted Data Matrix, Y_e = Quantity

DATA MATRIX

ITEM NUMBER	I(Y/x1) 1 AGE x1	H(Y/x1) 2	H(Y,x1) 3	... 4 MARITAL STATUS x2	5	6	7 TYPING SPEED x3	8	9	10 ADDITIONAL EDUC x4	11	12	13 JOB	14 EXPERIENCE x5	15	16 YEARS PER JOB x6	17	18
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	23.	152.	66.	8.	175.	133.	8.	145.	126.	9.	130.	93.	8.	169.	111.	6.	132.	103.
2	97.	92.	41.	8.	175.	133.	8.	145.	126.	8.	167.	121.	8.	169.	111.	9.	167.	121.
3	12.	122.	86.	31.	72.	75.	10.	128.	101.	25.	92.	62.	16.	135.	89.	9.	167.	121.
4	23.	152.	66.	31.	72.	75.	10.	128.	101.	44.	158.	47.	15.	135.	89.	9.	167.	121.
5	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	16.	135.	89.	6.	132.	103.
6	23.	152.	66.	26.	145.	80.	8.	145.	126.	9.	130.	93.	83.	1.	32.	6.	132.	103.
7	97.	92.	41.	8.	175.	133.	8.	145.	126.	8.	167.	121.	66.	81.	49.	6.	132.	103.
8	116.	158.	47.	26.	145.	80.	8.	145.	126.	8.	167.	121.	16.	135.	89.	6.	132.	103.
9	25.	95.	74.	8.	175.	133.	10.	128.	101.	8.	167.	121.	91.	72.	53.	20.	92.	62.
10	33.	100.	50.	26.	145.	80.	8.	145.	126.	9.	130.	93.	8.	169.	111.	9.	167.	121.
11	23.	152.	66.	26.	145.	80.	8.	145.	126.	9.	130.	93.	91.	72.	53.	20.	92.	62.
12	25.	95.	74.	31.	72.	75.	10.	128.	101.	8.	167.	121.	8.	169.	111.	9.	167.	121.
13	116.	158.	47.	8.	175.	133.	8.	145.	126.	8.	167.	121.	83.	1.	32.	9.	167.	121.
14	25.	95.	74.	8.	175.	133.	10.	128.	101.	9.	130.	93.	91.	72.	53.	6.	132.	103.
15	33.	100.	50.	8.	175.	133.	10.	128.	101.	9.	130.	93.	8.	169.	111.	9.	167.	121.
16	12.	122.	86.	8.	175.	133.	8.	145.	126.	8.	167.	121.	8.	169.	111.	9.	167.	121.
17	25.	95.	74.	31.	72.	75.	10.	128.	101.	9.	130.	93.	83.	1.	32.	20.	92.	62.
18	33.	100.	50.	8.	175.	133.	10.	128.	101.	9.	130.	93.	8.	169.	111.	20.	97.	62.
19	25.	95.	74.	8.	175.	133.	10.	128.	101.	9.	130.	93.	66.	81.	48.	6.	132.	103.
20	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	16.	135.	89.	9.	167.	121.
21	97.	92.	41.	8.	175.	133.	8.	145.	126.	8.	167.	121.	66.	81.	48.	6.	132.	103.
22	12.	122.	86.	31.	72.	75.	10.	128.	101.	8.	167.	121.	8.	169.	111.	6.	132.	103.
23	33.	100.	50.	31.	72.	75.	10.	128.	101.	8.	167.	121.	91.	72.	53.	9.	167.	121.
24	25.	95.	74.	8.	175.	133.	8.	145.	126.	8.	167.	121.	91.	72.	53.	6.	132.	103.
25	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	8.	169.	111.	6.	132.	103.
26	25.	95.	74.	26.	145.	80.	8.	145.	126.	25.	92.	62.	16.	135.	89.	6.	132.	103.
27	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	16.	135.	89.	9.	167.	121.
28	25.	95.	74.	26.	145.	80.	8.	145.	126.	9.	130.	93.	16.	135.	89.	20.	92.	62.
29	116.	158.	47.	8.	175.	133.	144.	92.	41.	44.	158.	47.	66.	81.	49.	154.	1.	16.
30	23.	152.	66.	26.	72.	75.	144.	92.	41.	44.	158.	47.	16.	135.	89.	9.	167.	121.
31	12.	122.	86.	8.	175.	133.	10.	128.	101.	8.	167.	121.	8.	169.	111.	9.	167.	121.
32	12.	122.	86.	8.	175.	133.	144.	92.	41.	8.	167.	121.	8.	169.	111.	20.	92.	62.

Table 36. Firm A, Empirical Cases

Converted Data Matrix, Y_e = Adaptability

DATA MATRIX

VARIABLE NUMBER

ITEM NUMBER	I(Y/x_1) 1	H(Y/x_1) 2	H(Y,x_1) 3	... 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	AGE x_1			MARITAL STATUS x_2			TYPING SPEED x_3			ADDITIONAL EDUC x_4			JOB	EXPERIENCE x_5		YEARS PER JOB x_6		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	12.	97.	57.	9.	129.	112.	6.	140.	123.	19.	97.	83.	24.	85.	82.	6.	132.	103.
2	154.	1.	32.	9.	129.	112.	6.	140.	123.	16.	174.	123.	24.	85.	82.	9.	167.	121.
3	27.	99.	79.	13.	157.	102.	7.	155.	111.	68.	65.	57.	70.	76.	73.	9.	167.	121.
4	12.	97.	57.	13.	157.	102.	7.	155.	111.	20.	92.	41.	70.	76.	73.	9.	167.	121.
5	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	70.	76.	73.	6.	132.	103.
6	12.	97.	57.	7.	138.	78.	6.	140.	123.	19.	97.	83.	125.	92.	41.	6.	132.	103.
7	154.	1.	32.	9.	129.	112.	6.	140.	123.	16.	174.	123.	154.	1.	37.	6.	132.	103.
8	187.	92.	41.	7.	138.	78.	6.	140.	123.	16.	174.	123.	70.	76.	73.	6.	132.	103.
9	23.	100.	75.	9.	129.	112.	7.	155.	111.	16.	174.	123.	46.	152.	66.	20.	92.	62.
10	112.	81.	48.	7.	138.	78.	6.	140.	123.	19.	97.	83.	24.	85.	82.	9.	167.	121.
11	12.	97.	57.	7.	138.	78.	6.	140.	123.	19.	97.	83.	46.	152.	66.	20.	92.	62.
12	23.	100.	75.	13.	157.	102.	7.	155.	111.	16.	174.	123.	24.	85.	82.	9.	167.	121.
13	187.	92.	41.	9.	129.	112.	6.	140.	123.	16.	174.	123.	125.	92.	41.	9.	167.	121.
14	23.	100.	75.	9.	129.	112.	7.	155.	111.	19.	97.	83.	46.	152.	66.	6.	132.	103.
15	112.	81.	43.	9.	129.	112.	7.	155.	111.	19.	97.	83.	24.	85.	82.	9.	167.	121.
16	27.	99.	79.	9.	129.	112.	6.	140.	123.	16.	174.	123.	24.	85.	82.	9.	167.	121.
17	23.	100.	75.	13.	157.	102.	7.	155.	111.	19.	97.	83.	125.	92.	41.	20.	92.	62.
18	112.	81.	43.	9.	129.	112.	7.	155.	111.	19.	97.	83.	24.	85.	82.	20.	92.	62.
19	23.	100.	175.	9.	129.	112.	7.	155.	111.	19.	97.	83.	154.	1.	37.	6.	132.	103.
20	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	70.	76.	73.	9.	167.	121.
21	154.	1.	32.	9.	129.	112.	6.	140.	123.	16.	174.	123.	154.	1.	37.	6.	132.	103.
22	27.	99.	79.	13.	157.	102.	7.	155.	111.	16.	174.	123.	24.	85.	82.	6.	132.	103.
23	112.	81.	48.	13.	157.	102.	7.	155.	111.	16.	174.	123.	46.	152.	66.	9.	167.	121.
24	23.	100.	75.	9.	129.	112.	6.	140.	123.	16.	174.	123.	46.	152.	66.	6.	132.	103.
25	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	24.	85.	82.	6.	132.	103.
26	23.	100.	75.	7.	138.	78.	6.	140.	123.	68.	65.	57.	70.	76.	73.	6.	132.	103.
27	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	70.	76.	73.	9.	167.	121.
28	23.	100.	75.	7.	138.	78.	6.	140.	123.	19.	97.	83.	70.	76.	73.	20.	92.	62.
29	187.	92.	41.	9.	129.	112.	20.	92.	41.	20.	92.	41.	154.	1.	37.	154.	1.	16.
30	12.	97.	57.	7.	138.	78.	20.	92.	41.	20.	92.	41.	70.	76.	73.	9.	167.	121.
31	27.	99.	79.	9.	129.	112.	7.	155.	111.	16.	174.	123.	24.	85.	82.	9.	167.	121.
32	27.	99.	79.	9.	129.	112.	20.	92.	41.	16.	174.	123.	24.	85.	82.	20.	92.	62.

Table 37. Firm A, Fictitious Cases

Converted Data Matrix, Y_s = Quantity

DATA MATRIX

VARIABLE NUMBER

ITEM NUMBER	$I(Y/x_1)$ 1	$H(Y/x_1)$ 2	$H(Y,x_1)$ 3	... 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	AGE x_1			MARITAL STATUS x_2			ADDITIONAL EDUC x_3			JOB EXPERIENCE x_4			YEARS PER JOB x_5			TYPING SPEED x_6		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	97.	92.	41.	8.	175.	133.	8.	145.	126.	8.	167.	121.	8.	169.	111.	7.	135.	109.
2	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	91.	72.	53.	7.	135.	108.
3	97.	92.	41.	8.	175.	133.	10.	128.	101.	8.	167.	121.	83.	1.	32.	1.	155.	111.
4	25.	95.	74.	8.	175.	133.	144.	92.	41.	9.	130.	93.	16.	135.	89.	58.	92.	62.
5	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	91.	72.	53.	58.	92.	62.
6	23.	152.	66.	31.	72.	75.	144.	92.	41.	8.	167.	121.	83.	1.	32.	1.	155.	111.
7	23.	152.	66.	26.	145.	80.	10.	128.	101.	8.	167.	121.	66.	81.	48.	7.	135.	108.
8	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	8.	169.	111.	58.	92.	62.
9	25.	95.	74.	8.	175.	133.	144.	92.	41.	8.	167.	121.	16.	135.	89.	58.	92.	62.
10	33.	100.	50.	31.	72.	75.	10.	128.	101.	8.	167.	121.	66.	81.	48.	7.	135.	108.
11	25.	95.	74.	8.	175.	133.	8.	145.	126.	9.	130.	93.	66.	81.	48.	1.	155.	111.
12	33.	100.	50.	31.	72.	75.	144.	92.	41.	8.	167.	121.	66.	81.	48.	7.	135.	108.
13	23.	152.	66.	31.	72.	75.	8.	145.	126.	9.	130.	93.	66.	81.	48.	58.	92.	62.
14	25.	95.	74.	26.	145.	80.	10.	128.	101.	8.	167.	121.	83.	1.	32.	341.	1.	16.
15	33.	100.	50.	8.	175.	133.	8.	145.	126.	25.	92.	62.	91.	72.	53.	341.	1.	16.
16	12.	122.	86.	31.	72.	75.	8.	145.	126.	25.	92.	62.	8.	169.	111.	7.	135.	108.
17	33.	100.	50.	31.	72.	75.	144.	92.	41.	8.	167.	121.	66.	81.	48.	1.	155.	111.
18	25.	95.	74.	8.	175.	133.	144.	92.	41.	8.	167.	121.	83.	1.	32.	58.	92.	62.
19	12.	122.	86.	8.	175.	133.	8.	145.	126.	8.	167.	121.	91.	72.	53.	7.	135.	108.
20	25.	95.	74.	8.	175.	133.	10.	128.	101.	25.	92.	62.	8.	169.	111.	1.	155.	111.
21	33.	100.	50.	31.	72.	75.	10.	128.	101.	8.	167.	121.	16.	135.	89.	7.	135.	108.
22	97.	92.	41.	26.	145.	80.	10.	128.	101.	8.	167.	121.	66.	81.	48.	58.	92.	62.
23	25.	95.	74.	31.	72.	75.	144.	92.	41.	8.	167.	121.	83.	1.	32.	58.	92.	62.
24	23.	152.	66.	31.	72.	75.	144.	92.	41.	25.	92.	62.	91.	72.	53.	7.	135.	108.
25	116.	158.	47.	8.	175.	133.	8.	145.	126.	25.	92.	62.	8.	169.	111.	1.	155.	111.
26	12.	122.	86.	31.	72.	75.	8.	145.	126.	8.	167.	121.	8.	169.	111.	1.	155.	111.
27	25.	95.	74.	8.	175.	133.	8.	145.	126.	9.	130.	93.	91.	72.	53.	7.	135.	109.
28	25.	95.	74.	8.	175.	133.	10.	128.	101.	9.	130.	93.	83.	1.	32.	341.	1.	16.
29	25.	95.	74.	26.	145.	80.	10.	128.	101.	9.	130.	93.	16.	135.	89.	58.	92.	62.
30	33.	100.	50.	31.	72.	75.	10.	128.	101.	8.	167.	121.	66.	81.	48.	7.	135.	109.

Table 38. Firm A, Fictitious Cases

Converted Data Matrix, Y_S = Adaptability

DATA MATRIX

VARIABLE NUMBER

ITEM NUMBER	$I(Y/x_1)$ 1	$H(Y/x_1)$ 2	$H(Y,x_1)$ 3	... 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	AGE x_1			MARITAL STATUS x_2			ADDITIONAL EDUC x_3			JOB EXPERIENCE x_4			YEARS PER JOB x_5			TYPING SPEED x_6		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	154.	1.	32.	9.	129.	112.	6.	140.	123.	16.	174.	123.	24.	85.	82.	9.	167.	121.
2	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	46.	152.	66.	9.	67.	121.
3	154.	1.	32.	9.	129.	112.	7.	155.	111.	16.	174.	123.	125.	92.	41.	6.	132.	103.
4	23.	100.	75.	9.	129.	112.	20.	92.	41.	19.	97.	83.	70.	76.	73.	20.	92.	52.
5	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	46.	152.	66.	20.	92.	62.
6	12.	97.	57.	13.	157.	102.	20.	92.	41.	16.	174.	123.	125.	92.	41.	6.	132.	103.
7	12.	97.	57.	7.	138.	78.	7.	155.	111.	16.	174.	123.	154.	0.	37.	7.	167.	121.
8	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	24.	85.	82.	20.	92.	52.
9	23.	100.	75.	9.	129.	112.	20.	92.	41.	16.	174.	123.	70.	76.	73.	20.	92.	62.
10	112.	81.	48.	13.	157.	102.	7.	155.	111.	16.	174.	123.	154.	1.	37.	9.	167.	121.
11	27.	99.	79.	9.	129.	112.	6.	140.	123.	19.	97.	83.	154.	0.	37.	6.	132.	103.
12	112.	81.	48.	13.	157.	102.	20.	92.	41.	16.	174.	123.	154.	1.	37.	9.	167.	121.
13	12.	97.	57.	13.	157.	102.	6.	140.	123.	19.	97.	83.	154.	1.	37.	20.	92.	62.
14	23.	100.	75.	7.	138.	78.	7.	155.	111.	16.	174.	123.	125.	92.	41.	154.	1.	16.
15	112.	81.	48.	9.	129.	112.	6.	140.	123.	68.	65.	57.	46.	152.	66.	154.	1.	16.
16	27.	99.	79.	13.	157.	102.	6.	140.	123.	68.	65.	57.	24.	85.	82.	9.	167.	121.
17	112.	81.	48.	13.	157.	102.	20.	92.	41.	16.	174.	123.	154.	1.	37.	6.	132.	103.
18	23.	100.	75.	9.	129.	112.	20.	92.	41.	16.	174.	123.	125.	92.	41.	20.	92.	62.
19	27.	99.	79.	9.	129.	112.	6.	140.	123.	16.	174.	123.	46.	152.	66.	9.	167.	121.
20	23.	100.	75.	9.	129.	112.	7.	155.	111.	68.	65.	57.	24.	85.	82.	6.	132.	103.
21	112.	81.	48.	13.	157.	102.	7.	155.	111.	16.	174.	123.	70.	76.	73.	9.	167.	121.
22	154.	1.	32.	7.	138.	78.	7.	155.	111.	16.	174.	123.	154.	1.	37.	20.	92.	62.
23	23.	100.	75.	13.	157.	102.	20.	92.	41.	16.	174.	123.	125.	92.	41.	20.	92.	62.
24	12.	97.	57.	13.	157.	102.	20.	92.	41.	68.	65.	57.	46.	152.	66.	9.	167.	121.
25	187.	92.	41.	9.	129.	112.	6.	140.	123.	68.	65.	57.	24.	85.	82.	6.	132.	103.
26	27.	99.	79.	13.	157.	102.	6.	140.	123.	16.	174.	123.	24.	85.	82.	6.	132.	103.
27	23.	100.	75.	9.	129.	112.	6.	140.	123.	19.	97.	83.	46.	152.	66.	9.	167.	121.
28	23.	100.	75.	13.	157.	102.	7.	155.	111.	19.	97.	83.	125.	92.	41.	154.	1.	15.
29	23.	100.	75.	7.	138.	78.	7.	155.	111.	19.	97.	83.	70.	76.	73.	20.	92.	62.
30	112.	81.	48.	13.	157.	102.	7.	155.	111.	16.	174.	123.	154.	1.	37.	9.	167.	121.

Table 39. Firm B, Empirical Cases

Converted Data Matrix, Y_e = Total

DATA MATRIX

VARIABLE NUMBER

ITEM *	$I(Y/x_1)$	$H(Y/x_1)$	$H(Y,x_1)$	...														
NUMBER *	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	AGE x_1			MARITAL STATUS x_2			DEPENDENTS x_3			GPA x_4			SCHOL	ACTIVITIES x_5		PROF ORGANIZ x_6		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	52.	99.	68.	12.	198.	139.	2.	202.	172.	22.	138.	107.	13.	178.	134.	31.	150.	46.
2	26.	149.	89.	12.	198.	139.	2.	202.	172.	22.	138.	107.	35.	138.	65.	5.	181.	158.
3	30.	187.	98.	11.	166.	134.	47.	137.	52.	22.	138.	107.	16.	180.	120.	35.	169.	93.
4	41.	158.	62.	11.	166.	134.	25.	130.	79.	22.	138.	107.	13.	176.	134.	35.	169.	93.
5	26.	149.	89.	12.	198.	139.	2.	202.	172.	22.	138.	107.	16.	180.	120.	5.	181.	155.
6	26.	147.	89.	12.	198.	139.	2.	202.	172.	52.	176.	105.	16.	180.	120.	35.	169.	93.
7	52.	99.	68.	11.	166.	134.	25.	130.	79.	31.	163.	97.	13.	178.	134.	35.	169.	93.
8	118.	100.	54.	11.	166.	134.	25.	130.	79.	52.	176.	105.	16.	130.	120.	5.	181.	156.
9	30.	187.	98.	11.	166.	134.	2.	202.	172.	52.	176.	105.	16.	150.	120.	31.	150.	46.
10	52.	99.	68.	44.	100.	25.	2.	202.	172.	22.	138.	107.	35.	138.	65.	5.	181.	158.
11	52.	99.	68.	11.	166.	134.	2.	202.	172.	22.	138.	107.	13.	178.	134.	5.	191.	158.
12	30.	187.	93.	11.	166.	134.	25.	130.	79.	52.	176.	105.	13.	178.	134.	35.	169.	93.
13	26.	149.	89.	12.	198.	139.	2.	202.	172.	31.	163.	97.	16.	180.	120.	5.	131.	158.
14	30.	167.	98.	12.	198.	139.	2.	202.	172.	31.	163.	97.	35.	138.	65.	31.	150.	46.
15	41.	158.	62.	11.	166.	134.	47.	137.	52.	162.	1.	13.	16.	180.	120.	35.	169.	93.
16	30.	187.	98.	11.	166.	134.	25.	130.	79.	31.	163.	97.	16.	180.	120.	5.	181.	158.
17	30.	147.	98.	12.	198.	139.	2.	202.	172.	22.	138.	107.	16.	180.	120.	35.	169.	93.
18	41.	158.	62.	12.	198.	139.	2.	202.	172.	22.	138.	107.	16.	180.	120.	5.	181.	156.
19	30.	187.	98.	12.	198.	139.	2.	202.	172.	31.	163.	97.	13.	178.	134.	5.	131.	158.
20	26.	149.	89.	11.	166.	134.	2.	202.	172.	31.	163.	97.	13.	176.	134.	5.	161.	159.
21	30.	187.	98.	12.	198.	139.	2.	202.	172.	31.	163.	97.	35.	138.	65.	5.	181.	158.
22	41.	158.	62.	12.	198.	139.	2.	202.	172.	31.	163.	97.	16.	180.	120.	5.	181.	156.
23	52.	99.	68.	12.	198.	139.	2.	202.	172.	22.	138.	107.	16.	180.	120.	5.	191.	156.
24	52.	99.	68.	44.	100.	25.	25.	130.	79.	52.	176.	105.	13.	178.	134.	5.	181.	158.
25	26.	149.	89.	11.	166.	134.	2.	202.	172.	31.	163.	97.	13.	178.	134.	5.	161.	155.
26	118.	100.	54.	12.	198.	139.	2.	202.	172.	52.	176.	105.	13.	178.	134.	5.	181.	158.
27	26.	149.	89.	11.	166.	134.	25.	130.	79.	22.	138.	107.	16.	180.	120.	5.	191.	158.
28	41.	158.	62.	11.	166.	134.	47.	137.	52.	52.	176.	105.	13.	178.	134.	5.	181.	158.
29	41.	158.	62.	11.	166.	134.	47.	137.	52.	31.	163.	97.	13.	178.	134.	5.	181.	158.
30	118.	100.	54.	11.	166.	134.	25.	130.	79.	52.	176.	105.	35.	138.	65.	5.	181.	158.

Table 40. Firm B, Fictitious Cases

Converted Data Matrix, Y_e = Total

DATA MATRIX

ITEM NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
VARIABLE NUMBER	I(Y/x_1)	H(Y/x_1)	H(Y,x_1)	...																	
	AGE x_1			MARITAL STATUS x_2			DEPENDENTS x_3			GPA x_4			SCHOL	ACTIVITIES x_5		PROF ORG x_6			INTERVIEW x_7		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	30.	187.	98.	11.	166.	134.	25.	130.	79.	31.	163.	97.	13.	178.	134.	35.	169.	93.	66.	100.	66.
2	118.	100.	54.	11.	166.	134.	47.	137.	52.	31.	163.	97.	13.	178.	134.	5.	181.	159.	37.	146.	132.
3	26.	149.	89.	12.	198.	139.	2.	202.	172.	162.	1.	13.	16.	180.	120.	35.	169.	93.	66.	100.	66.
4	41.	158.	62.	11.	166.	134.	47.	137.	52.	22.	138.	107.	13.	178.	134.	35.	169.	93.	66.	100.	66.
5	52.	99.	68.	44.	100.	25.	25.	130.	79.	52.	176.	105.	16.	180.	120.	31.	150.	46.	66.	100.	66.
6	26.	149.	89.	12.	198.	139.	2.	202.	172.	22.	138.	107.	35.	139.	65.	5.	181.	158.	66.	100.	66.
7	118.	100.	54.	11.	166.	134.	47.	137.	52.	22.	138.	107.	16.	180.	120.	35.	169.	93.	66.	100.	66.
8	52.	99.	68.	11.	166.	134.	47.	137.	52.	22.	138.	107.	13.	178.	134.	5.	181.	158.	37.	146.	132.
9	30.	187.	98.	12.	198.	139.	2.	202.	172.	22.	138.	107.	13.	178.	134.	35.	169.	93.	66.	100.	66.
10	52.	99.	68.	12.	198.	139.	2.	202.	172.	31.	163.	97.	16.	180.	120.	35.	169.	93.	66.	100.	66.
11	30.	187.	98.	11.	166.	134.	47.	137.	52.	52.	176.	105.	13.	178.	134.	5.	181.	158.	66.	100.	66.
12	41.	158.	62.	44.	100.	25.	25.	130.	79.	52.	176.	105.	13.	178.	134.	5.	181.	158.	66.	100.	66.
13	30.	187.	98.	12.	198.	139.	47.	137.	52.	22.	138.	107.	35.	139.	65.	31.	150.	46.	66.	100.	66.
14	118.	100.	54.	11.	166.	134.	25.	130.	79.	31.	163.	97.	16.	180.	120.	35.	169.	93.	37.	146.	132.
15	26.	149.	89.	12.	198.	139.	2.	202.	172.	31.	163.	97.	13.	178.	134.	5.	181.	158.	66.	100.	66.
16	26.	149.	89.	11.	166.	134.	2.	202.	172.	22.	138.	107.	35.	138.	65.	5.	181.	158.	37.	146.	132.
17	30.	187.	98.	11.	166.	134.	2.	202.	172.	162.	1.	13.	16.	180.	120.	35.	169.	93.	66.	100.	66.
18	41.	158.	62.	44.	100.	25.	2.	202.	172.	31.	163.	97.	16.	180.	120.	35.	169.	93.	66.	100.	66.
19	30.	187.	98.	11.	166.	134.	25.	130.	79.	22.	138.	107.	16.	180.	120.	31.	150.	46.	66.	100.	66.
20	30.	187.	98.	11.	166.	134.	25.	130.	79.	22.	138.	107.	13.	178.	134.	5.	181.	158.	66.	100.	66.
21	41.	158.	62.	12.	198.	139.	47.	137.	52.	31.	163.	97.	16.	180.	120.	31.	150.	46.	37.	146.	132.
22	26.	149.	89.	12.	198.	139.	25.	130.	79.	22.	138.	107.	13.	178.	134.	35.	169.	93.	66.	100.	66.
23	30.	187.	98.	11.	166.	134.	2.	202.	172.	52.	176.	105.	13.	178.	134.	5.	181.	158.	66.	100.	66.
24	52.	99.	68.	12.	198.	139.	2.	202.	172.	22.	138.	107.	16.	180.	120.	31.	150.	46.	66.	100.	66.
25	41.	158.	62.	11.	166.	134.	25.	130.	79.	52.	176.	105.	16.	180.	120.	35.	169.	93.	66.	100.	66.
26	52.	99.	68.	11.	166.	134.	25.	130.	79.	31.	163.	97.	35.	138.	65.	5.	181.	158.	66.	100.	66.
27	30.	187.	98.	12.	198.	139.	2.	202.	172.	31.	163.	97.	35.	138.	65.	31.	150.	46.	66.	100.	66.
28	26.	149.	89.	12.	198.	139.	2.	202.	172.	22.	138.	107.	13.	178.	134.	35.	169.	93.	66.	100.	66.
29	26.	149.	89.	12.	198.	139.	2.	202.	172.	162.	1.	13.	16.	180.	120.	31.	150.	46.	66.	100.	66.
30	30.	187.	98.	11.	166.	134.	25.	130.	79.	162.	1.	13.	35.	139.	65.	5.	181.	158.	66.	100.	66.

Table 41. Firm C, Empirical Cases

Converted Data Matrix, Y_e = Total

DATA MATRIX

VARIABLE NUMBER

ITEM * NUMBER *	I(Y/x_j) 1	H(Y/x_j) 2	R(Y,x_j) 3	... 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	VARIABLE 1			VARIABLE 2			VARIABLE 3			VARIABLE 4			VARIABLE 5			VARIABLE 6			VARIABLE 7		
SCALE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
1	13.	255.	129.	13.	221.	158.	5.	253.	182.	116.	104.	57.	159.	54.	39.	13.	251.	127.	8.	232.	161.
2	10.	228.	177.	11.	239.	127.	5.	253.	182.	116.	104.	57.	159.	54.	39.	26.	204.	119.	215.	1.	13.
3	10.	228.	177.	13.	221.	158.	5.	253.	182.	116.	104.	57.	21.	217.	104.	26.	204.	119.	8.	232.	161.
4	10.	228.	177.	13.	221.	158.	19.	217.	126.	53.	199.	79.	89.	155.	49.	13.	251.	127.	8.	232.	161.
5	10.	228.	177.	11.	239.	127.	19.	217.	126.	53.	199.	79.	89.	155.	49.	12.	223.	91.	8.	232.	161.
6	10.	228.	177.	11.	239.	127.	19.	217.	126.	8.	238.	187.	12.	240.	165.	62.	206.	59.	8.	232.	161.
7	10.	228.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	12.	240.	165.	26.	204.	119.	40.	199.	90.
8	10.	228.	177.	13.	221.	158.	5.	253.	182.	116.	104.	57.	21.	217.	104.	26.	204.	119.	40.	199.	90.
9	10.	228.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	21.	217.	104.	13.	251.	127.	40.	199.	90.
10	10.	228.	177.	11.	239.	127.	19.	217.	126.	8.	238.	187.	89.	155.	49.	26.	204.	119.	40.	199.	90.
11	10.	228.	177.	11.	239.	127.	19.	217.	126.	242.	146.	39.	249.	81.	26.	13.	251.	127.	8.	232.	161.
12	13.	255.	129.	13.	221.	158.	262.	1.	8.	8.	238.	187.	12.	240.	165.	12.	223.	91.	8.	232.	151.
13	10.	228.	177.	11.	239.	127.	19.	217.	126.	53.	199.	79.	89.	155.	49.	13.	251.	127.	8.	232.	151.
14	10.	228.	177.	11.	239.	127.	19.	217.	126.	8.	238.	187.	12.	240.	165.	174.	192.	37.	40.	199.	93.
15	13.	255.	129.	11.	239.	127.	5.	253.	182.	8.	238.	187.	12.	240.	165.	11.	251.	127.	37.	264.	113.
16	10.	228.	177.	13.	221.	158.	19.	217.	126.	53.	199.	79.	12.	240.	165.	12.	223.	91.	8.	232.	161.
17	10.	229.	177.	13.	221.	158.	5.	253.	182.	8.	238.	187.	12.	240.	165.	26.	204.	119.	40.	199.	90.
18	10.	229.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	21.	217.	104.	13.	251.	127.	8.	232.	161.
19	10.	228.	177.	11.	239.	127.	19.	217.	126.	8.	238.	187.	12.	240.	165.	26.	204.	119.	8.	232.	161.
20	10.	228.	177.	13.	221.	158.	19.	217.	126.	53.	199.	79.	89.	155.	49.	12.	223.	91.	37.	268.	113.
21	10.	228.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	21.	217.	104.	13.	251.	127.	40.	199.	90.
22	10.	228.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	21.	217.	104.	62.	206.	59.	8.	232.	161.
23	13.	255.	129.	11.	239.	127.	110.	184.	47.	53.	199.	79.	12.	240.	165.	12.	223.	91.	8.	232.	161.
24	10.	228.	177.	13.	221.	158.	19.	217.	126.	116.	104.	57.	159.	54.	39.	26.	204.	119.	215.	1.	13.
25	164.	65.	33.	13.	221.	158.	152.	92.	21.	8.	238.	187.	21.	217.	104.	26.	204.	119.	40.	199.	90.
26	10.	228.	177.	13.	221.	158.	19.	217.	126.	8.	238.	187.	12.	240.	165.	13.	251.	127.	8.	232.	161.
27	10.	228.	177.	11.	239.	127.	5.	253.	182.	8.	238.	187.	21.	217.	104.	62.	206.	59.	8.	232.	161.
28	164.	65.	33.	104.	137.	34.	19.	217.	126.	116.	104.	57.	21.	217.	104.	12.	223.	91.	37.	263.	113.
29	13.	255.	129.	92.	25.	66.	5.	253.	182.	8.	238.	187.	12.	240.	165.	62.	206.	59.	8.	232.	161.
30	10.	228.	177.	13.	221.	158.	5.	253.	182.	8.	238.	187.	12.	240.	165.	13.	251.	127.	40.	199.	90.

Variable Numbers Refer to Table 24.

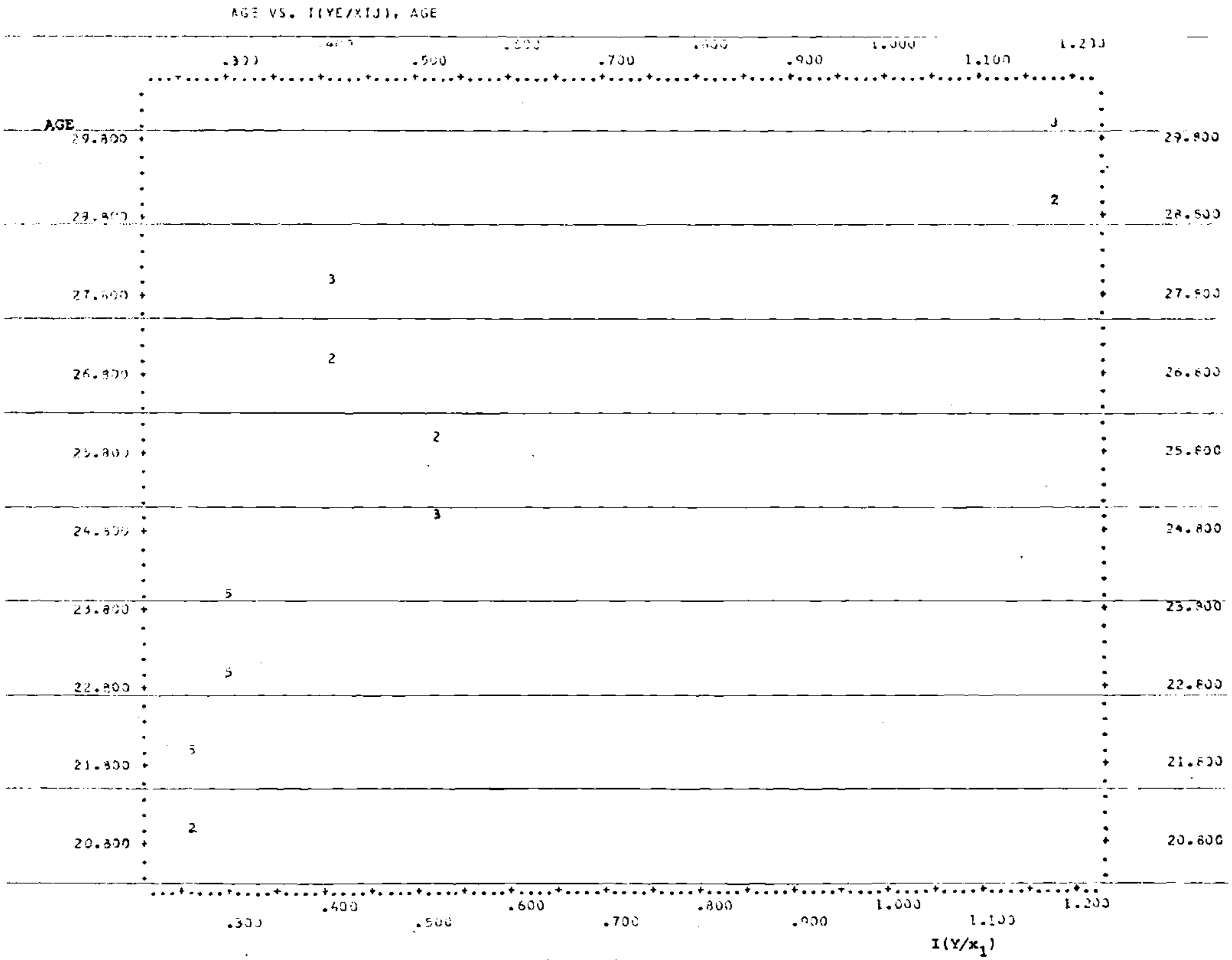

Figure 30. Firm B, X_{Age} vs. $I(Y_e/x_{Age})$

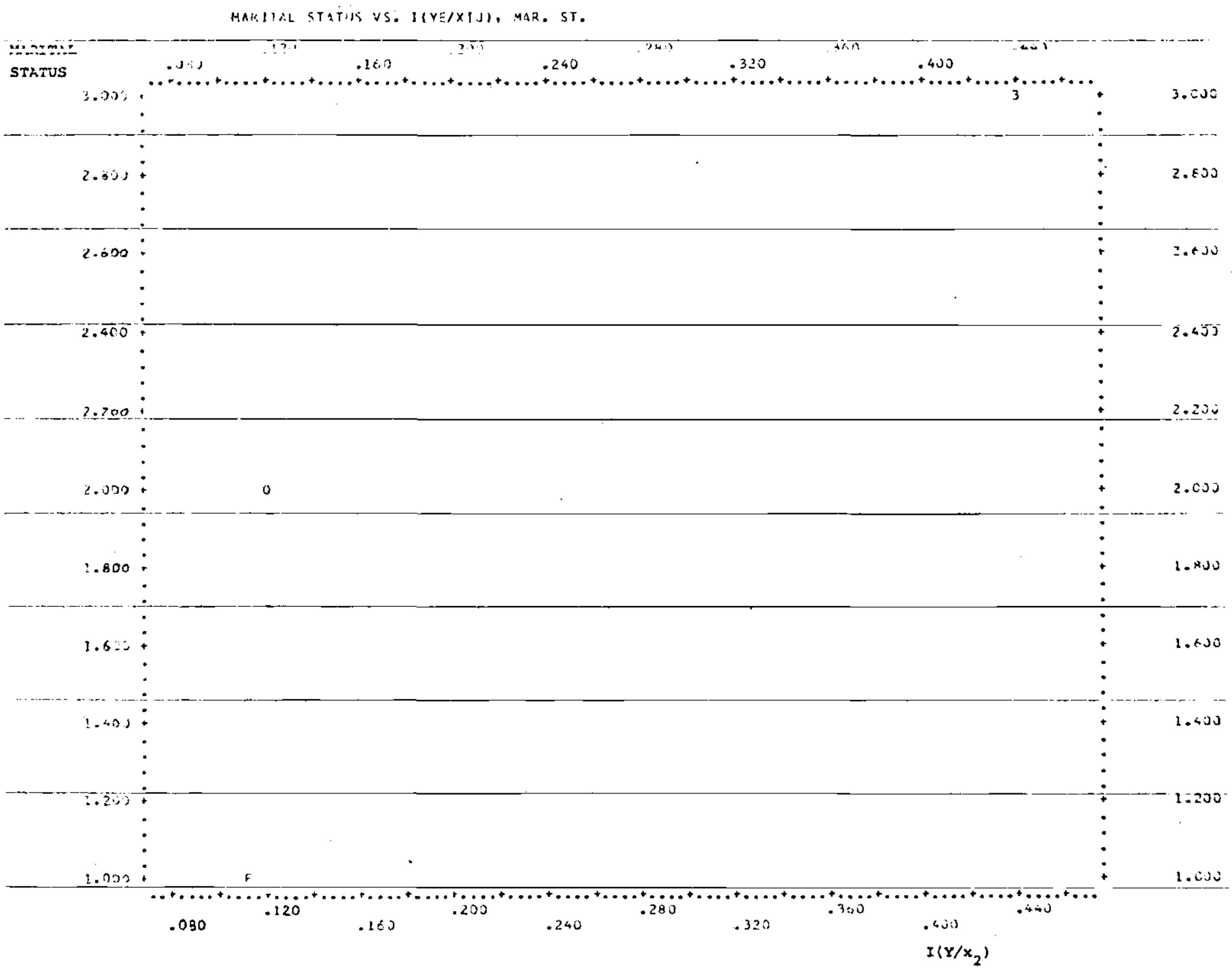

Figure 31. Firm B, X_{MarSt} vs. $I(Y_e/x_{MarSt})$

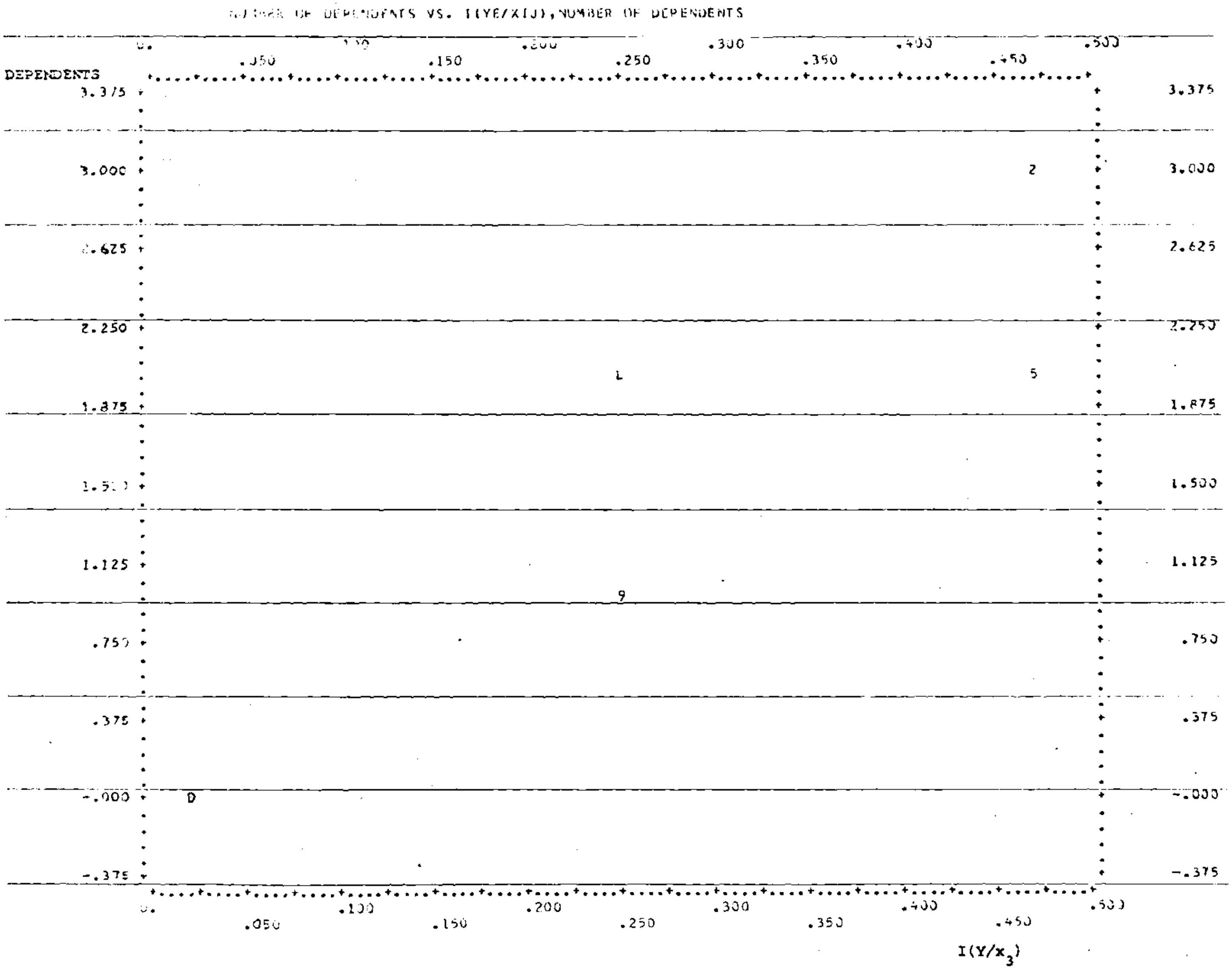

Figure 32. Firm B, X_{Dep} vs. $I(Y_e/x_{Dep})$

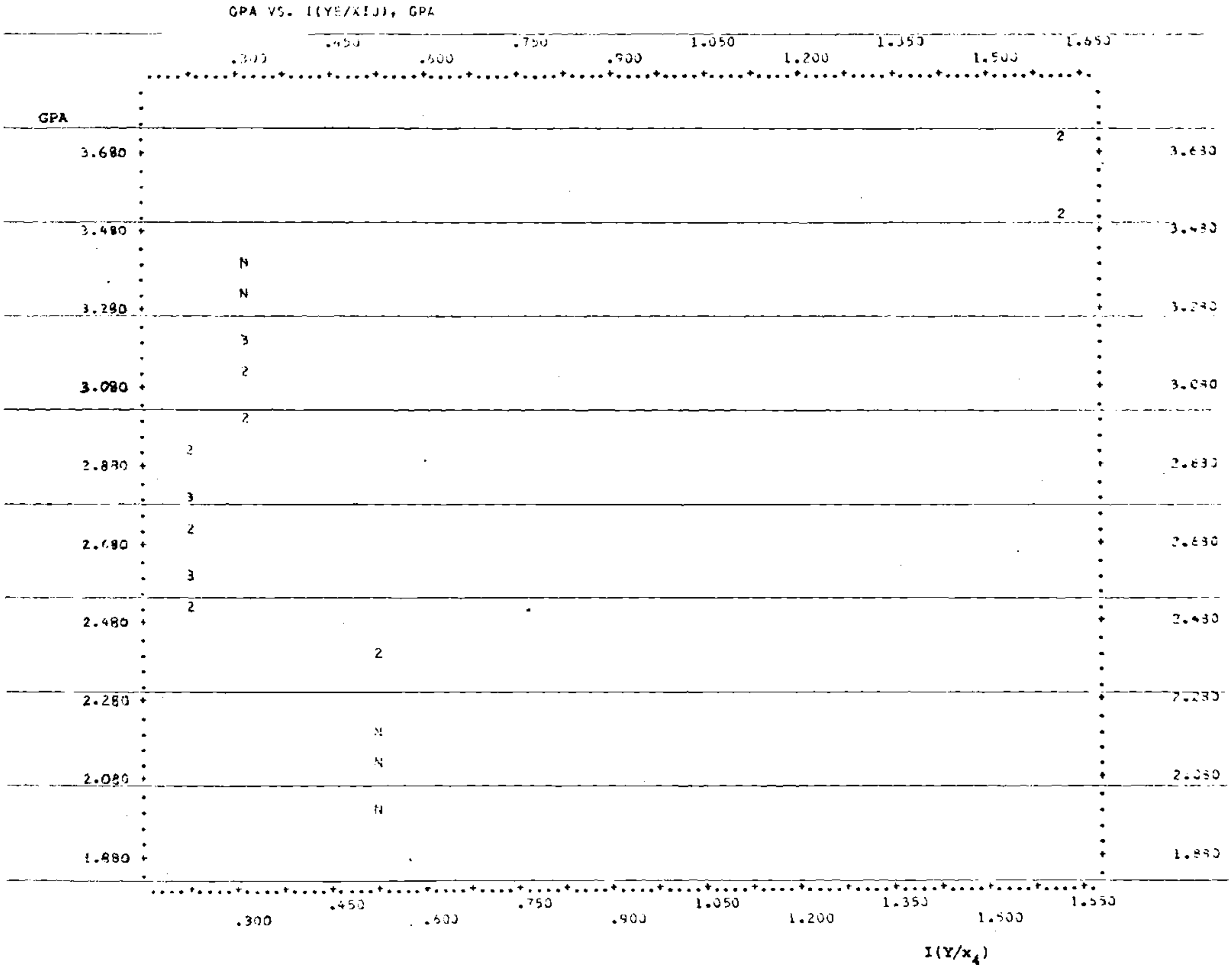

Figure 33. Firm B, X_{GPA} vs. $I(Y_e/x_{GPA})$

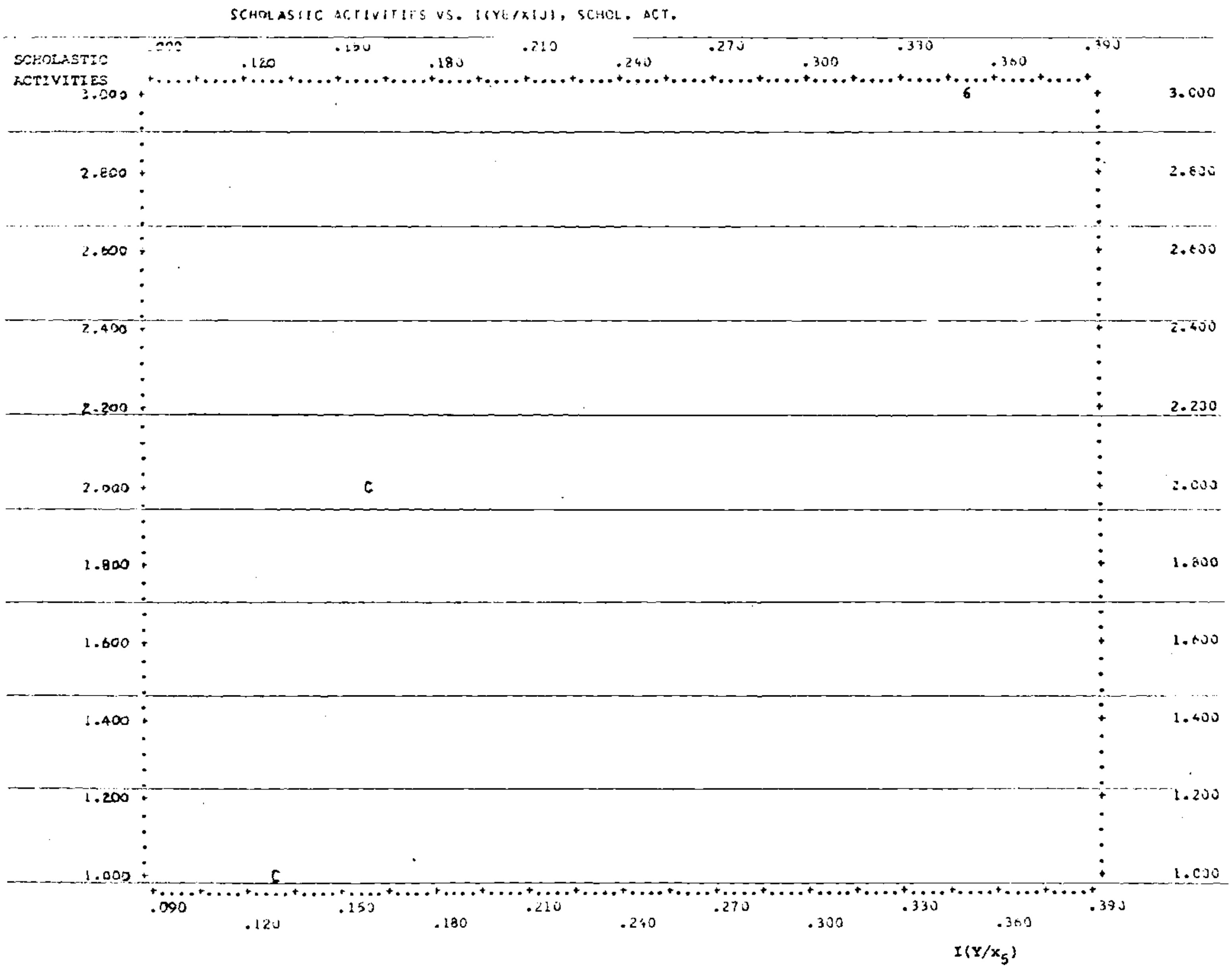

Figure 34. Firm B, X_{SchAct} vs. $I(Y_e/x_{SchAct})$

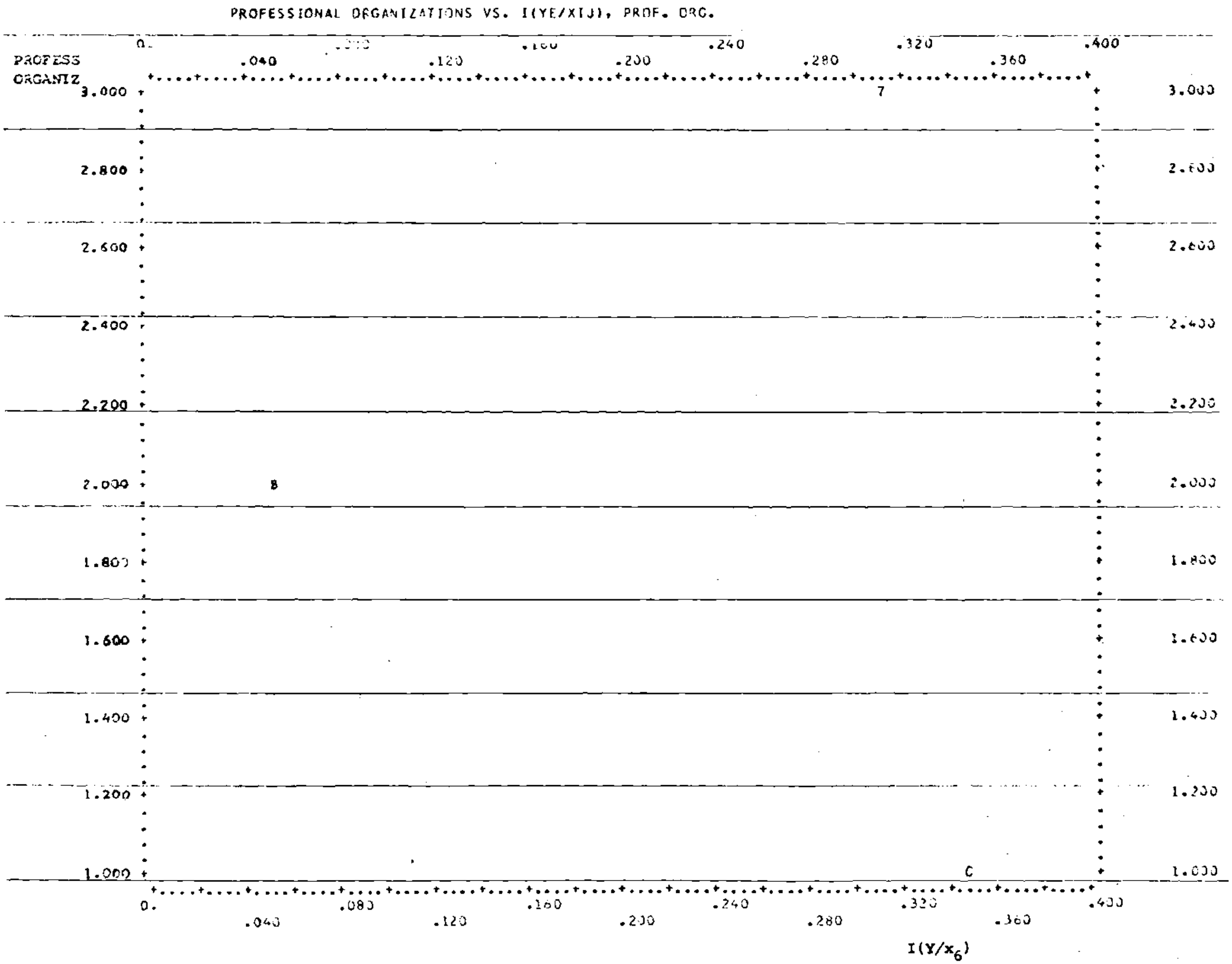

Figure 35. Firm B, $X_{ProfOrg}$ vs. $I(Y_e/x_{ProfOrg})$

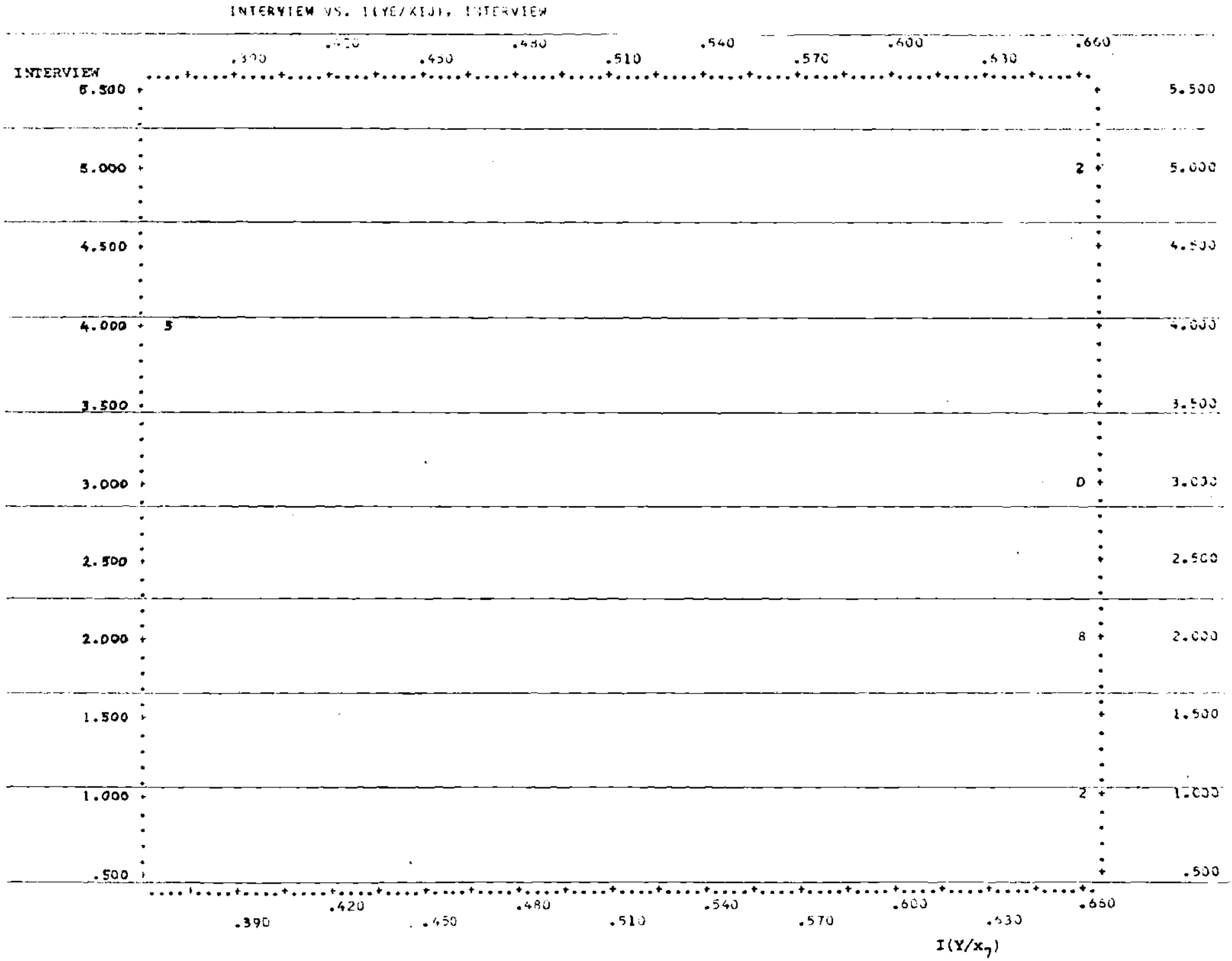

Figure 36. Firm B, X_{Int} vs. $I(Y_e/x_{Int})$

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Table 42. Ecological Validities and Intercue Redundancies

CORRELATION MATRIX

VARIABLE NUMBER	1 AGE	2 MARIT STATUS	3 TYPING	4 ADD EDUC	5 JOB EXPER	6 YEARS/JOB	QUANTITY	ADAPTABILITY
1	1.000	.077	.092	-.005	.548	.333	.026	-.388
2		1.000	-.048	-.210	.120	.058	-.199	.056
3			1.000	.556	.329	.104	.410	.022
4				1.000	.469	-.035	.427	.201
5					1.000	.151	.277	.110
6						1.000	-.107	-.420

Table 43. Utilization Coefficients and Intercue Redundancies

CORRELATION MATRIX

VARIABLE NUMBER	1 AGE	2 MARIT STATUS	3 ADD EDUC	4 JOB EXPER	5 YEARS/JOB	6 TYPING	RATER 1 8 QUANTITY	RATER 1 9 ADAPTABILITY	RATER 2 14 QUANTITY	RATER 2 15 ADAPTABILITY
1	1.000	.146	.176	.096	.317	-.240	.266	.184	-.186	-.156
2		1.000	.085	-.007	.298	.193	.345	.351	.187	.301
3			1.000	.056	.277	-.052	.492	.462	.016	.330
4				1.000	.550	.146	.300	.381	.175	-.104
5					1.000	.065	.512	.560	.070	-.145
6						1.000	.002	.020	.934	.2[illegible]6

APPENDIX E

EMPLOYMENT FORMS OF FIRMS A AND B

Type or print (in ink)

SHADED COLUMN LOCKHEED USE ONLY

APPLICANT'S NAME — Last — First — Middle | DATE PREPARED

HOME ADDRESS – No. and Street | HOME PHONE (Area Code)

City, State and Zip Code | BUSINESS PHONE (Area Code) | EXT.

PERMANENT MESSAGE CONTACT | PHONE (Area Code)

Name, Street Address, City and State of someone (other than spouse) where you may always be contacted

REQ. NO.

DEPT./ORGN. NO.

OCCUPATIONAL TO. [illegible]

EDUCATION

High School and College or University (Include City and State)	Attendance From (MO – YR)	To (MO – YR)	Units Completed	Major Field	Grade Point Average (Grade – Scale)	Degree Awarded	Date Awarded

List other education or training of significance

CHRONOLOGICAL EMPLOYMENT HISTORY – Account for all time for at least the past ten years, including U.S. Military Service and National Guard. If employed in your own business, give firm name and complete address of a business reference who can verify your activities during this period. If unemployed during any part of this period, list name and complete address of one person, not a relative, who can verify the unemployment period. You may refer to resume if attached; however, all information must be given, including salary breakdown. If professional history extends beyond ten years, please include. Your present employer will not be contacted without your specific permission.

INCOMPLETE APPLICATIONS WILL NOT BE CONSIDERED

SALARY — PER HOUR, WEEK (40 HOURS), MONTH OR YEAR (DO NOT INCLUDE OVERTIME) — START — FINAL — PER

1 — PRESENT OR LAST POSITION

COMPANY | FROM (MONTH YEAR) | TO (MONTH YEAR) | BASE

ADDRESS (No., Street, City, State and Zip Code) | BONUS

POSITION OR TITLE | AVAILABILITY DATE | FIELD PAY

BRIEFLY DESCRIBE YOUR DUTIES | OTHER (EXPLAIN)

NAME OF IMMEDIATE SUPERVISOR | REASON FOR LEAVING OR WANTING TO LEAVE | TOTAL

2

COMPANY | FROM (MONTH YEAR) | TO (MONTH YEAR) | BASE

ADDRESS (No., Street, City, State and Zip Code) | BONUS

POSITION AND DUTIES | FIELD PAY

OTHER (EXPLAIN)

NAME OF IMMEDIATE SUPERVISOR | REASON FOR LEAVING | TOTAL

3

COMPANY	FROM (MONTH/YEAR)	TO (MONTH/YEAR)	BASE
ADDRESS (No. Street, City, State and Zip Code)			BONUS
POSITION AND DUTIES			FIELD PAY
			OTHER (EXPLAIN)
NAME OF IMMEDIATE SUPERVISOR / REASON FOR LEAVING			TOTAL

4

COMPANY	FROM (MONTH/YEAR)	TO (MONTH/YEAR)	BASE
ADDRESS (No., Street, City, State and Zip Code)			BONUS
POSITION AND DUTIES			FIELD PAY
			OTHER (EXPLAIN)
NAME OF IMMEDIATE SUPERVISOR / REASON FOR LEAVING			TOTAL

List additional positions necessary to make this employment record cover ten (10) years or more (continue on separate page if necessary)

5

FROM MO.	FROM YR.	TO MO.	TO YR.	COMPANY	ADDRESS	YOUR POSITION	BASE SALARY	PER

PROFESSIONAL REFERENCES: Name five (5) persons in your field whom you know, and whom WE HAVE YOUR PERMISSION TO CONTACT, preferably professional and technical persons with whom you have worked

NAME	HOME ADDRESS	COMPANY OR AFFILIATION	BUSINESS PHONE

LIST OR BRIEFLY DESCRIBE any significant projects, thesis subjects, patent applications or publications to which you have given major effort or for which awards have been granted

BRIEFLY DESCRIBE the type of work for which you are best fitted by virtue of your aptitude, interests, education and experience

LOCKHEED USE ONLY

FORM LAC 200

NOTE – Complete reverse side

The Age Discrimination Act of 1967 prohibits discrimination on the basis of age with respect to individuals who are at least 40 but less than 65 years of age

PERSONAL DATA

BIRTHDATE	SOCIAL SECURITY NUMBER		
HEIGHT	WEIGHT	MARITAL STATUS	NO. OF DEPENDENT CHILDREN

If female and married or previously married, give maiden name

Do you have or have you had in the past any physical, visual or mental limitations or defects? Include even those that were temporarily disabling.

☐ Yes ► Describe

☐ No

EMERGENCY CONTACT – Spouse or other person who can be contacted in emergency

NAME | TELEPHONE (Incl. Area Code)

ADDRESS (No., Street, City, State and Zip Code)

U.S. MILITARY SERVICE (Include National Guard)

BRANCH OF SERVICE	RANK	DISCHARGE DATE	TYPE OF DISCHARGE	PRESENT DRAFT STATUS
				ARE YOU SUBJECT TO CALL TO ACTIVE DUTY?

PROFESSIONAL ORGANIZATIONS OR ASSOCIATIONS

List all to which you belong, excluding Trade Unions and any other the names or character of which indicate the race, religious creed, color, national origin, ancestry or political affiliation of its members

RELATIVES OR ACQUAINTANCES EMPLOYED BY LOCKHEED (Please list below)

NAME	POSITION	DEPT.	RELATIONSHIP

CITIZENSHIP

Are you a United States Citizen? NO ☐ YES ☐

If employed can you submit a Birth Certificate or other proof of United States Citizenship? ☐ Yes ☐ No

SECURITY CLEARANCE

Have you ever been granted a Security Clearance? NO ☐ YES ☐

Indicate level of most recent clearance, date granted and where employed at that time

Have you ever had a Security Clearance suspended, denied or revoked? NO ☐ YES ☐

Indicate level of clearance, date when action occurred, by whom and where employed at that time

HAVE YOU

Ever worked or applied for work at a Lockheed Company? NO ☐ YES ☐ ► ☐ Worked ☐ Applied

Where and when (Employee No. if applicable)

Ever worked for Lockheed under a different name? NO ☐ YES ☐

Give name used, where used and explain

Are you, or have you ever been a member of any communist organization or political party or organization which advocates or advocated the overthrow of our constitutional form of government in the United States, or do you have or have you had membership in or affiliation with any group, association or organization which advocated or advocates or lent or lends support to any organization or movement advocating the overthrow of our constitutional form of government in the United States.

WRITE ANSWER DO NOT TYPE OR PRINT ► Yes or No ________ If yes, name the organization and give complete details below or on separate page

Have you ever been convicted of an offense against the law, or forfeited collateral, or are you now under charges for any offense against the law? Include any convictions by general courts-martial while in military service. (You may omit: (a) traffic violations for which you paid a fine of $25.00 or less; and (b) any offense committed before your 18th birthday which was finally adjudicated in a juvenile court or under a youth offender law.) Include all instances where nolo contendere was plead, where bail was forfeited, and where a fine was paid.

Write Yes or No ________ If yes, give date, place, charge and disposition below or on separate page

Have you ever been convicted of a crime under another name? ☐ Yes ► ☐ No

Give name used, where used and explain

USE THE FOLLOWING SPACE AS REQUIRED

How did you learn of employment opportunities at Lockheed?

☐ Magazine Ad ☐ Lockheed Employee
☐ Newspaper * ☐ Other Means
Please name b

I hereby certify that the answers given by me to the foregoing questions and statements made are true and correct without consequential omissions of any kind whatsoever. I agree that the companies shall not be liable in any respect if my employment is terminated because of the falsity of statements, answers or omissions made by me in this questionnaire. I agree to submit to physical examination. If employment is obtained under this application I will comply with all orders, rules and regulations of this Company. I also authorize the companies, schools or persons named above to give any information regarding my employment or education, together with any information they may have regarding me whether or not it is on their records. I hereby release said companies, schools or persons from all liability for any damages whatsoever for issuing this information.

PLEASE SIGN ► READ THE ABOVE STATEMENT AND SIGN APPLICATION HERE: ____________

LOCKHEED MISSILES & SPACE COMPANY
TECHNICAL AND OFFICE JOB DESCRIPTION

LG 2 686-3

GENERAL CLERK - TYPIST

OCCUPATIONAL SUMMARY:

Must operate a typewriter at a net speed of 50 words per minute and perform the general clerical duties of a simple routine nature. Occasionally operate and use office machines incidental to the performance of assignments.

WORK PERFORMED:

Must operate a typewriter at a net speed of 50 words per minute.

Copy data on kardexes, inventory cards, ledgers or similar records.

Copy certain information from one document to another, match parts or code numbers, quantities, nomenclature, etc.; compare documents by copying or checking numbers or codes from standardized lists.

Type simple tabular data to predetermined forms as required.

Prepare simple reports where information and forms are provided and wherein the calculations are limited to addition, subtraction, multiplication and division.

Maintain routine office records following definite written and/or verbal instructions.

Furnish or relay information, upon request, which can be obtained by consulting folders, kardex, index files, ledgers or similar records.

Operate such office machines as adding machine and transfer posting machine. May maintain index files of addressing plates, mailing plates, mailing lists, and other materials and documents.

May requisition and maintain adequate stocks of office supplies such as forms, pencils, paper, folders, envelopes, etc.

Perform simple calculations, such as addition, subtraction, multiplication and division.

KNOWLEDGE AND ABILITY REQUIRED:

Have a working knowledge of routine office methods. Use arithmetic to make simple calculations. Working knowledge of details of assigned clerical documents and/or records. Ability to use the above assigned office machines, and to operate a typewriter at a net speed of 50 words per minute.

Released by Wage Administration
December 13, 1971 Agreement

LOCKHEED MISSILES & SPACE COMPANY
TECHNICAL AND OFFICE JOB DESCRIPTION

LG 5 708-3

TECHNICAL TYPIST

OCCUPATIONAL SUMMARY:

Layout and type for reproduction purposes, technical manuals, reports and publications requiring typing of various formulae, and preparation of charts, graphs and schedules and forms.

WORK PERFORMED:

Layout material to provide for proper area, margin, column arrangements, and line space, location of illustrations, footnotes, headings and formulae; prepare and type charts, graphs, schedules and forms. Type final drafts on multilith plates, stencils, vellum, bond paper and similar materials for reproduction purposes.

May use templates, light tables, and simple drafting instruments to insert mathematical symbols, equations and similar characters and for drawing lines.

Perform clerical functions incidental to above duties.

KNOWLEDGE AND ABILITY REQUIRED:

Ability to operate a typewriter at a net speed of 50 words per minute. Knowledge of layout and typing requirements for technical material. May use templates and simple drafting instruments and to make calculations necessary to layout manual pages, graphs, charts, schedules and forms.

Released by Wage Administration
December 13, 1971 Agreement

Hourly Employee Performance Review • • •

• *INSTRUCTIONS TO SUPERVISION. This review is intended to reflect your opinion of the employee's performance during the Review period. Please make your evaluation as complete as possible—do not omit any entries. The second (yellow) copy of this Review may be detached and used as a worksheet. Be sure to return original and pink copies ... of the completed Review to your Personnel Unit no later than* ____________

• • • EMPLOYEE NO. | NAME | CLASS CODE | SENIORITY DATE | ORGN. | FACILITY

JOB DUTIES - ... in your own words the specific work performed by the employee during the review period. If employee held more than one classification, describe duties performed in the most recent classification employee has held for 30 days or more.

RATING - Rate each factor by checking (✓) or typing (x) in the box that most closely reflects your judgement of the employee's performance for each factor.

• INDUSTRIOUSNESS-Degree to which employee makes effective use of working time.

• QUANTITY-Output-Speed

• ADAPTABILITY-Versatility-Adjustment to job or changed conditions. Ease with which new duties are learned.

• JOB KNOWLEDGE-Extent of knowledge as it applies to the job.

• QUALITY-Accuracy in work. Freedom from errors.

ATTENDANCE COMMENTS - Enter comments if attendance had an effect on the employee's contribution. IMPORTANT: if attendance infractions committed by the employee are ... preprinted at the top of the review form, enter these in the appropriate spaces provided.

COMMENTS REFLECTING NOTEWORTHY ACCOMPLISHMENTS OR QUALITIES

COMMENTS PERTAINING TO SKILLS AND TRAITS NEEDING IMPROVEMENT

RATED BY ____________ ENDORSED BY ____________ REVIEWED BY ____________

Hourly Employee Performance Review • • •

● *INSTRUCTIONS TO SUPERVISION: This review is intended to reflect your opinion of the employee's performance during the Review period. Please make your evaluation as complete as possible--do not omit any entries. The second (yellow) copy of this Review may be detached and used as a worksheet. Be sure to return original and pink copies (carbon intact) of the completed Review to your Personnel Unit no later than* ______

EMPLOYEE NO.	NAME	CLASS. CODE	SENIORITY DATE	ORGN	FACILITY		ATTENDANCE (DAYS) ABSENT	TARDY	SHORT TIME	REVIEW DATE

JOB DUTIES - Record in your own words the specific work performed by the employee during the review period. If employee held more than one classification, describe duties performed in the most recent classification employee has held for 30 days or more.

RATING - Rate each factor by checking (✓) or typing (x) in the box that most closely reflects your judgement of the employee's performance for each factor.

● **INDUSTRIOUSNESS-Degree to which employee makes effective use of working time.**

☐ Poor Wastes time ☐ Needs More Initiative ☐ Generally Keeps Busy ☐ Self starter Sustains Effort ☐ Exceptionally Diligent

● **QUANTITY-Output-Speed**

☐ Slow not productive ☐ Marginal Output ☐ Acceptable ☐ Exceeds Requirements ☐ Exceptionally Fast

● **ADAPTABILITY-Versatility-Adjustment to job or changed conditions. Ease with which new duties are learned.**

☐ Poor Learns Slowly ☐ Needs Some Improvement ☐ Meets Acceptable Standards ☐ Learns Quickly ☐ Excellent Versatility

● **JOB KNOWLEDGE-Extent of knowledge as it applies to the job.**

☐ Limited ☐ Fair Understanding ☐ Knows Job ☐ Well Informed ☐ Excellent Knowledge

● **QUALITY-Accuracy in work. Freedom from errors.**

☐ Poor Workmanship ☐ Marginal Accuracy ☐ Acceptable ☐ Good Workmanship ☐ Extremely Accurate

ATTENDANCE COMMENTS - Enter comments if attendance had an effect on the employees contribution. IMPORTANT: If attendance infractions committed by the employee are not preprinted at the top of the review form, enter these in the appropriate spaces provided.

COMMENTS REFLECTING NOTEWORTHY ACCOMPLISHMENTS OR QUALITIES

COMMENTS PERTAINING TO SKILLS AND TRAITS NEEDING IMPROVEMENT

RATED BY ______
SIGNATURE OF IMMEDIATE SUPERVISOR

ENDORSED BY ______
SIGNATURE OF ORGN MANAGER | ORGN NO

REVIEWED BY ______
PERSONNEL UNIT | UNIT NO

INTERVIEW - The most important part of the performance review is the interview held with the employee rated. Whether constructive suggestion, praise or actual criticism is warranted, this is an opportunity to:

1) Counsel employee in some detail as to where he stands on total performance.
2) Encourage ever better performance
3) Build productive supervisor-employee relations

EMPLOYEE COPY OF PERFORMANCE REVIEW SHOULD BE DISTRIBUTED ON THE FRIDAY PRECEDING THE REVIEW DATE

FORM LMSC 836 4

LOCKHEED MISSILES & SPACE COMPANY

Education and training

Education

Name of school	Location	Dates attended From	Dates attended To	Years credit	Year grad	Degree	Course or major subject
High school							
Business or trade school							
College or university							
Graduate study							
Other							

Note: A copy of your college transcript should accompany this application if you graduated from college within last 5 years

High school and undergraduate record

	High school	College (undergraduate)	
Scholastic standing (estimate if not known)	Average grade, standing in class, etc	Average grade, gradepoint, standing, etc.	
Scholastic honors		Significant courses in major subject if attended within last 5 years	
Significant extracurricular activities if attended within last 5 years			
		Expenses earned (percent and how earned)	

Graduate study

Field of graduate study	Scholarships, fellowships, assistantships, etc.	Name of major professor

Courses in specialized fields	Research problems

Special training or qualifications

Languages spoken fluently	Languages read fluently	Factory or shop machines operated
Office machines operated		
Typing speed _____ wpm	Shorthand speed _____ wpm	

Describe any other special training or skills which are in any way related to the kind of work you want to do

Work experience

If additional space is needed, attach separate sheets

Present or la… employment

Name of present or last employer				Type of business		Address	
Starting date		Leaving date		Starting pay	Final pay	Reason for leaving	May we contact?
Month	Year	Month	Year				

Job title (present or last)	Name of supervisor	Supervisor's job title

Description of work and responsibilities

Previous employment

Name of next previous employer				Type of business		Address	
Starting date		Leaving date		Starting pay	Final pay	Reason for leaving	May we contact?
Month	Year	Month	Year				

Job title (last)	Name of supervisor	Supervisor's job title

Description of work and responsibilities

Name of next previous employer				Type of business		Address	
Starting date		Leaving date		Starting pay	Final pay	Reason for leaving	May we contact?
Month	Year	Month	Year				

Job title (last)	Name of supervisor	Supervisor's job title

Description of work and responsibilities

Additional experience

State what you did in any periods not already covered, including part time or self employment

Dates	

Unless otherwise indicated, state any prior work experience with FMC Corporation, its divisions or subsidiaries

Activities	Professional organizations, including offices (omit union organizations and organizations which would indicate race, creed, color or national origin)	Hobbies and leisure interests

Publications	Title (include patents)	Journal reference or patent number

Work preferences			
	Kind of work most wanted		
	Other kinds of work in which interested		
	Location preferences or limitations	Approx. salary range expected	Date available to start work

Previous address	List home address in U S for last 5 years Dates	Street and number	City	State	Zip

Remarks	
	Have you ever been convicted of, or entered a plea of guilty to, a felony or misdemeanor other than parking or minor traffic violation? ☐ Yes ☐ No If yes, explain fully
	List serious operations, accidents, illnesses, disabilities, and limitations (if none, so state)
	Have you ever received workman's compensation for an industrial illness/injury? ☐ Yes ☐ No If yes, explain

Signature		
	Are you aware of any reason why you might not be able to obtain a fiduciary bond or government security clearance, if required? ☐ Yes ☐ No It is understood and agreed that any misstatement made by me in this application will be sufficient cause for discharge from the company's service if I have been employed. It is also understood that this employment is subject to satisfactory physical examination by the company physician at the time of employment and thereafter at any time required by the company.	Date ____________________ Signature of applicant ____________________

Form 609 -- June 73

FMC CORPORATION

REQUIRES RUSH HANDLING ☐

INTERVIEW APPRAISAL SHEET

NAME (PRINT) LAST FIRST INITIAL

CANDIDATE FOR: REGULAR ☐ SUMMER ☐ FUTURE ☐

DO YOU RECOMMEND EMPLOYMENT? (IF NO, EXPLAIN IN COMMENTS) YES ____ NO ____

WHERE? (DIVISION OR PLANT) 1. ____________ 2. ____________

DATE AVAILABLE FOR EMPLOYMENT: ____________

LOCATION PREFERENCES ____________

LIMITATIONS ____________

BACHELOR'S DEGREE DATA

SCHOOL	MAJOR	DATE	GPA OVERALL / MAJOR

HIGHEST DEGREE DATA: MASTER'S ☐ DOCTOR'S ☐

SCHOOL	MAJOR	DATE	GPA OVERALL / MAJOR

PLANS GRAD. WORK: YES ☐ NO ☐ POSSIBLY ☐

WILLING TO TRAVEL? ____

SUGGESTED DATE(S) FOR PLANT VISIT ____________ 19____

APPLICANT'S DECISION DEADLINE ____________ 19____

CANDIDATE'S JOB INTEREST(S)

____ ACCOUNTING ____ PROCESS ____ TECH. SALES
____ DESIGN. ____ PRODUCTION ____ OTHER ____________
____ IND. ENGR. ____ RESEARCH ____________
____ MANUFACTURING ____ SALES ____________

INTERVIEWER COMMENTS

(USE REVERSE SIDE FOR FACULTY COMMENTS, ETC., IF NECESSARY)

OVERALL ATING

RATING SCALE –

5 – OUTSTANDING, ELIGIBLE FOR TOP OFFER
4 – EXCELLENT, SHOULD MAKE OFFER
3 – GOOD, PROSPECT WELL WORTH CONSIDERING
2 – AVERAGE, CONSIDER IF NEED IS GREAT
1 – NOT SUITABLE

INTERVIEWER: ____________ DIVISION: ____________ DATE INTERVIEWED: ____________

(SEE REVERSE FOR RATING ON APPEARANCE, ATTITUDE, ETC.)

Personal Appearance:			(Remarks)
Physique: ( ) Athletic ( ) Ordinary ( ) Slight	Appearance: ( ) Handsome ( ) Average ( ) Poor	Grooming: ( ) Neat ( ) Ordinary ( ) Untidy, Flashy	
Speech: Vocabulary: ( ) Excellent ( ) Average ( ) Limited ( ) Trite	Articulation: ( ) Distinct ( ) Average ( ) Indistinct ( ) Unnatural	Conversation: ( ) Talks Easily ( ) Acceptable ( ) Reticent ( ) Rambling	
General Behavior: Manner: ( ) Cocky ( ) Self-Confident ( ) Poised ( ) Retiring ( ) Self-Conscious ( ) Energetic ( ) Over-Agressive ( ) Ingratiating ( ) Nervous	Response: ( ) Direct ( ) Neutral ( ) Evasive ( ) Jumps to Concl. ( ) Mentally Alert ( ) Dull ( ) Has Common Sense ( ) Lacks Common Sense	Maturity: (Considering Age) ( ) High ( ) Average ( ) Low	

INTERVIEWER'S OPINIONS, FACULTY COMMENTS, ETC: ____________________

FMC CORPORATION
ORDNANCE DIVISION–SAN JOSE
SALARIED POSITION DESCRIPTION

POSITION TITLE Associate Design Engineer CODE 279
REPORTS TO: TITLE As assigned PREPARED BY (Rewritten) PRB DATE 10/23/64
SECTION As assigned APPROVED BY JCB, CAR DATE 3/17/65
DEPARTMENT Engineering APPROVED BY LCD, FMM DATE 3/18/65

PURPOSE OF POSITION:

To design, redesign, lay out, and detail component parts and assemblies under close supervision.

REGULAR DUTIES:

1. Performs design work of moderate difficulty under the close supervision and guidance of a design or project engineer, securing approval for completed work.

2. Prepares estimates, reports, stress analyses, and other technical calculations as required.

3. Follows up on fabrication of parts in the shop and their incorporation into the product or project, recommending design changes to supervisor.

4. Conducts engineering tests in the laboratory or in the field and prepares test reports.

OCCASIONAL DUTIES:

1. May direct the work of draftsmen assigned for layout and detail work.

2. May consult with customers, vendors, production employees, and others concerning the advisability of any contemplated design changes.

ORD-PERS-1017 (8/64)

POSITION EVALUATION

POSITION TITLE Associate Design Engineer CODE 279

FACTOR AND EXPLANATION OF RANKING	DEGREE	POINT VALUE	TOTAL
RESPONSIBILITY FOR PERSONNEL May direct the work of several draftsmen. Functionally responsible for fabrication follow-up in shop.			
RESPONSIBILITY FOR BUSINESS DEVELOPMENT Under close supervision contributes to the design and development of products involving considerations of material costs, production processes, adaptation to tooling, strength of material, appearance, and mechanical and functional excellence. Contact with vendors, technical societies, and potential customers in testing the product.			
RESPONSIBILITY FOR PHYSICAL RESOURCES Responsible for drafting equipment and drawings. Responsible for cost considerations inherent in design such as materials selection, manufacturing methods, and tooling.			
PLANNING Plans work of supporting personnel to best utilize their various levels of ability. Responsible for inherent planning in design such as most efficient components, materials, methods, etc.			
DECISION MAKING Decides when to rely on standard engineering practices and when to seek advice from supervisor.			
KNOWLEDGE–SKILLS–EXPERIENCE–QUALIFICATIONS REQUIRED BSME degree or its equivalent. Ability to perform technical calculations used in the field of mechanical engineering and use standard engineering manuals and materials catalogues. Select materials for various engineering purposes under supervision. No previous experience required. Direct and check the work of assigned draftsmen. Elementary knowledge of machine design including the design of precision machine parts, welded and fabricated sheet and plate metal assemblies, gearing and mechanical assemblies.			
	TOTAL		

EVALUATED BY: SJWSC - (Bench Mark Job) DATE 1953

APPROVED BY: ______ DATE ______ SALARY GRADE: ______

APPROVED BY: ______ DATE ______

Please return by: ______

FMC Corporation — ORDNANCE ENGINEERING DIVISION

ENGINEER PERFORMANCE RATING

Judge each characteristic separately or independently; that is, you should not let your evaluation of one trait unduly influence you on another. Rate the reviewee in relation to other engineers with approximately the same number of years' experience.

(NAME) ______ (YEARS EXPERIENCE) ______ (CLASSIFICATION) ______

(TIME IN PRESENT CLASSIFICATION) ______ (LAST REVIEW) ______ SCHEDULED (MONTH OF REVIEW) ______

(DESCRIBE GENERALLY PRESENT ASSIGNMENT) ______

CONSIDER ACCURACY, NEATNESS, & GENERAL EXCELLENCE OF WORK.

QUALITY OF WORK	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER VOLUME OF WORK COMPLETED.

QUANTITY OF WORK	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER DEMONSTRATED TECHNICAL KNOWLEDGE AND ABILITY.

TECHNICAL COMPETENCE	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER ABILITY TO GENERATE NEW IDEAS AND DEVELOP SOUND SOLUTIONS TO PROBLEMS.

CREATIVITY	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER ABILITY TO MAKE SOUND DECISIONS.

JUDGMENT	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER INCLINATION AND ABILITY TO ACT ON OWN RESPONSIBILITY.

INITIATIVE	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER RELIABILITY IN COMPLETING ASSIGNMENTS AS EXPECTED.

DEPENDABILITY	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

CONSIDER ATTITUDE AND WILLINGNESS TO WORK HARMONIOUSLY.

CO-OPERATION W/SUPERVISOR	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90
W/OTHERS						

CONSIDER ABILITY TO PLAN, LEAD, AND DELEGATE TOWARD SUCCESSFUL COMPLETION OF ASSIGNMENT.

LEADERSHIP & MANAGEMENT ABILITY	BELOW 10	10 – 30	AND PROGRESSING SATISFACTORILY	30 – 70	70 – 90	ABOVE 90

Does reviewee fit present classification? ______ If not, your recommendation ______

Comment on attendance and punctuality ______

When necessary does reviewee put in extra effort______; outside hours______?

Is reviewee taking any courses to improve his value to FMC? ______

Would you (prefer) (accept) (rather not have) reviewee in your group? (circle one)

080-713 (3/65) (OVER)

COMMENTS:
(Please describe and evaluate reviewee's overall performance, making recommendations for improvement and/or explaining strong points.)

OVERALL EVALUATION	BELOW 10	10 30	AND PROGRESSING SATISFACTORILY	30 70	70 90	ABOVE 90

(SIGNATURE OF REVIEWER) (DATE)

ADDITIONAL COMMENTS:
(To be made where more than two evaluations would be desirable)

OVERALL EVALUATION	BELOW 10	10 30	AND PROGRESSING SATISFACTORILY	30 70	70 90	ABOVE 90

(SIGNATURE OF REVIEWER) (DATE)

ADDITIONAL COMMENTS:
(To be made by next level of supervision)

OVERALL EVALUATION	BELOW 10	10 30	AND PROGRESSING SATISFACTORILY	30 70	70 90	ABOVE 90

(SIGNATURE OF REVIEWER) (DATE)

BIBLIOGRAPHY

BIBLIOGRAPHY

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