



---

The Judicial Reception of Multiple Regression Studies in Race and Sex Discrimination Cases

Author(s): Michael O. Finkelstein

Source: *Columbia Law Review*, Vol. 80, No. 4 (May, 1980), pp. 737-754

Published by: Columbia Law Review Association, Inc.

Stable URL: <https://www.jstor.org/stable/1122138>

Accessed: 30-08-2019 20:14 UTC

## REFERENCES

Linked references are available on JSTOR for this article:

[https://www.jstor.org/stable/1122138?seq=1&cid=pdf-reference#references\\_tab\\_contents](https://www.jstor.org/stable/1122138?seq=1&cid=pdf-reference#references_tab_contents)

You may need to log in to JSTOR to access the linked references.

---

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <https://about.jstor.org/terms>



JSTOR

*Columbia Law Review Association, Inc.* is collaborating with JSTOR to digitize, preserve and extend access to *Columbia Law Review*

## Exhibit P-453

This content downloaded from 130.91.93.179 on Fri, 30 Aug 2019 20:14:38 UTC  
All use subject to <https://about.jstor.org/terms>

## The Judicial Reception of Multiple Regression Studies in Race and Sex Discrimination Cases

Michael O. Finkelstein \*

The use of multiple regression models<sup>1</sup> in employment discrimination cases apparently was first suggested in print in a 1975 student note.<sup>2</sup> The idea caught on with remarkable rapidity. Following publication of the note, plaintiffs began introducing regression studies in many class-action discrimination cases, with the defendants usually responding with counterstudies. An obfuscating statistical war spread rapidly. By 1979, federal District Judge Fred M. Winner could complain, with only a touch of hyperbole, that title VII class actions had become "contests between college professor statisticians who revel in discoursing about advanced statistical theory."<sup>3</sup> In a number of complex cases the judges were spared opinion writing by settlements;<sup>4</sup> in others they spared themselves by ignoring regression findings and relying on simple inspection of the data.<sup>5</sup> As of this writing, however, in a number of important cases they have dealt with at least some of the issues raised in the statistical debate. I will examine the teaching of some of these opinions by focusing on problems that have arisen repeatedly and on some that are likely to arise in future cases.<sup>6</sup> In a final section I propose that pretrial proceedings be used to define the data base in order to narrow the issues arising from multiple regression analysis that are explored at trial.

---

\* Member of the New York Bar. Lecturer in Law, Columbia University. A.B., 1955, J.D., 1958, Harvard University. This article is adapted from a speech given at the Annual Meeting of the American Statistical Association in Washington, D.C., on August 14, 1979. I am grateful to Stephan Michelson and Harry Roberts for helpful comments and corrections.

1. This Article assumes a general familiarity with multiple regression technique. For an explanation see Fisher, *Multiple Regression In Legal Proceedings*, 80 *Colum. L. Rev.* 702 (1980). See also Finkelstein, *Regression Models In Administrative Proceedings*, 86 *Harv. L. Rev.* 1442 (1973), reprinted in Finkelstein, *Quantitative Methods In Law*, ch. 7 (1978).

2. Note, *Beyond the Prima Facie Case in Employment Discrimination Law: Statistical Proof and Rebuttal*, 89 *Harv. L. Rev.* 387 (1975).

3. *Otero v. Mesa County Valley School Dist.*, 470 F. Supp. 326, 331 (D. Colo. 1979). He added in a footnote the common refrain that "[j]udges are quite handicapped in trying to understand this testimony." *Id.* at 331 n.2. Later in his opinion he described his approach to these difficulties: "[A]ll a trial judge whose statistics course dates back 45 years can do is to try to use his limited knowledge of this quasi-mathematical approach to a problem and then temper the argued for results with a pinch of common sense." *Id.* at 335.

4. See, e.g., *Boylan v. The New York Times Co.*, 74 Civ. 4891 (S.D.N.Y., filed Nov. 7, 1974); *Smith v. Readers Digest*, 73 Civ. 4883 (S.D.N.Y., filed Nov. 14, 1973); *EEOC v. United Airlines*, 73 Civ. 972 (N.D. Ill., filed April 10, 1973).

5. See, e.g., *Wade v. Mississippi Coop. Extension Serv.*, 528 F.2d 508, 516-17 (5th Cir. 1976).

6. In several actions charging that at-large, area-wide voting was instituted to neutralize black voting strength, multiple regression was used to show that the race of the candidates and of the electorate rather than socioeconomic factors were the determinants in voting. *Kirksey v. City of Jackson*, 461 F. Supp. 1282, 1289-90 (S.D. Miss. 1978); *Brown v. Moore*, 428 F. Supp. 1123, 1128-29 (S.D. Ala. 1976); *Bolden v. City of Mobile*, 423 F. Supp. 384, 388-89 (S.D. Ala. 1976), *aff'd*, 571 F.2d 238 (5th Cir.), *prob. juris. noted*, 439 U.S. 815 (1978) (No. 77-1844). Since the regression findings apparently were not seriously disputed in those cases and since they did not involve employment discrimination, which is the central concern of this Article, they are not further discussed here.

## I. PLACEMENT AND PROMOTION

In cases involving charges of discrimination in initial placement and promotion, multiple regression characteristically arises in the following context. The statistics show that a minority group or women have a lower average wage than Caucasian men. The employer tenders the explanation that the lower wages of the minority or female workers reflect an absence of education, experience, or other factors relating to productivity. The plaintiff introduces a multiple regression study based on employee personnel records in which salary is the dependent variable and education, work experience, other productivity factors, and race or sex (depending on the claimed discrimination) are explanatory variables. The equation is usually in linear form in the sense that the expected value of the dependent variable salary is expressed as the weighted sum of the productivity factors.<sup>7</sup> These studies show a coefficient for minority group status or sex that is significantly different from zero; the interpretation is that after allowing for differences in education and experience the victims still receive less than they would have received if they had been Caucasian men.

The defendant answers with a competing regression study in similar form but using different cohorts of employees or different explanatory variables. In the defendant's regression the coefficient for race or sex is not statistically significant, thus purporting to show that differences in salary are fully explained by the factors included in the equation. The court must then determine which of the conflicting models is more correct. Although this task would seem highly technical—and there are nontrivial technical questions involved—the cases indicate that the more important issues are legal rather than statistical. In this section, I look at three sets of legal issues relating to the choice of explanatory variables, and then at the important technical problem raised by data “errors.”

A. *Inappropriate Variables*

Explanatory variables have been found inappropriate for inclusion in multiple regression analyses for various reasons. First, a variable may reflect a position or status bestowed by the employer, in which case if there is discrimination the award of position or status may be “tainted.” Second, a variable may reflect factors unrelated to productivity, in which case its inclusion might conceal salary discrimination against a group if the variable correlates with group status. Third, a variable may be related to productivity so that it might otherwise be appropriate for inclusion in the analysis, but may nevertheless reflect a qualification that had been denied to an employee group by the employer's discrimination. Fourth, the data reflecting the

---

7. Sometimes transformations of the variables are used. For example, the salary dependent variable may be expressed in logarithmic form or independent variables may be expressed in squared terms. See generally Fisher, *supra* note 1, at 711-12 & n.20.

variable may be unreliable. The cases discussed in this and the next section illustrate these situations.

The tainted variable objection was the key reason that the defendant's regression study was rejected in *James v. Stockham Valves & Fittings Co.*<sup>8</sup> In *Stockham Valves*, the defendant employer presented a regression study by Dr. James Gwartney, an economist, to refute an implication of discrimination from the fact that blacks earned an average of \$0.37 less per hour than whites. Seeking to explain the difference on the basis of "productivity factors," Gwartney regressed earnings on years of schooling, achievement, seniority, skill level, outside craft experience, outside operative experience, absenteeism, and merit ratings.

The court found this objectionable because the critical factors of "skill level" and "merit rating" were defined in such a way as to incorporate discrimination. "Skill level" was derived from the employee's job class; he had skill if he worked in a job with a sufficiently high rating. But since exclusion of blacks from higher-level jobs was the alleged discrimination, the regression was worse than useless for the defendant: "A regression analysis defining 'skill level' in that way thus may confirm the existence of employment discrimination practices that result in higher earnings for whites."<sup>9</sup> As for merit ratings, Gwartney used the evaluations of Stockham supervisors who were overwhelmingly white and who rated merit on a subjective basis. The court commented: "If there is racial bias in the subjective evaluations of white supervisors [which was charged by the plaintiffs] then that bias will be injected into Dr. Gwartney's earnings analysis."<sup>10</sup> The defendant's regression was rejected and the plaintiffs' claims of discrimination were sustained.

In *Stastny v. Southern Bell Telephone & Telegraph Co.*,<sup>11</sup> the court found the defendant's regression study suspect because of the inclusion of variables that were deemed to be inappropriate for all of the first three reasons cited above. In that case women in management and non-management positions charged discrimination by Southern Bell. Experts for both sides estimated separate regression equations for men and women to explain promotion and pay decisions.<sup>12</sup> At the outset, Judge MacMillan swept away

8. 559 F.2d 310 (5th Cir. 1977), cert. denied, 434 U.S. 1034 (1978).

9. *Id.* at 332.

10. *Id.* In an article written after the decision, Gwartney apparently accepted this judgment as correct. Gwartney, Asher, Haworth & Haworth, *Statistics, the Law, and Title VII: An Economist's View*, 54 *Notre Dame Law.* 633, 656 n.66 (1979). In the same vein, a district court held in a recent title VII case that plaintiff was correct to omit from its regression study "company-related variables" such as initial position, subsequent promotions or transfers, and prior salary, on the ground that these variables were "subject to, and evidence of, an employer's discriminatory behavior." *Greenspan v. Automobile Club of Michigan*, 22 *Fair Empl. Prac. Cas.* 184, 219 (E.D. Mich. 1980).

11. 458 F. Supp. 314 (W.D.N.C. 1978).

12. Regression studies in discrimination cases have been performed either by estimating a single equation with an indicator variable for the victim group or by estimating two separate equations for the victim and favored groups. Discrimination is inferred in the first case if the coefficient for the victim group indicates a lower mean salary for its members and is statistically significant. Discrimination is inferred in the second case if the coefficients of

both regressions with a broadside: "Regression analysis begins with the assumption that certain independent variables in fact determine the outcome of decisions to raise pay and promote. Such assumptions are intellectually questionable and not grounded in any solid evidence."<sup>13</sup>

Of more immediate interest here is a footnote in which the court observed that the defendant's regressions (again prepared by Dr. Gwartney) used certain independent variables that were tainted.<sup>14</sup> The first such variable was "marital status," since "there is no evidence that an unmarried woman is less likely to be a productive worker than a married man." This somewhat cryptic comment merits further examination. The usual reason for including a marital status variable (and sometimes a variable for children) is that married men are believed to be more attached to the workforce than married women; the lower mean salary of women is to be at least partially explained by the lower productivity of married women. To test this proposition in a single regression equation, a marriage variable would have to be included for each sex. If married men are in fact more productive, and this productivity is recognized, at least some of the difference in salary attributable to the gender variable would be shifted to the marriage variable.

On the other hand, a shift of this sort could conceal discrimination if managers rewarded marriage for men and not for women, mistakenly assuming that married men are more productive than married women, or believing that married men "deserve" greater earnings because they provide the sole or principal support for a family. These are not implausible explanations; indeed, one investigator has concluded that a principal source of disparity in wages between men and women in a large metropolitan publishing firm was the belief of the managers that married men deserved higher earnings than married women.<sup>15</sup> Since inclusion of the marriage variable may well conceal discrimination, attachment to the workforce should be tested more directly with proxies such as absences or gaps in service.<sup>16</sup>

---

the productivity factors are significantly smaller for the victims than for the favored group, thus indicating that victims receive less salary "credit" for productivity than the favored group. As it is usually presented (in linear form and without interactive terms), the single equation approach displays only the difference in average salaries between the groups that is not accounted for by productivity factors; this difference may not be an equally good estimate at both ends of the productivity scale, since discrimination may not be uniform for lower and higher echelon employees. The two-equation approach is more informative in that the unaccounted-for differences are estimated separately at each level of productivity by comparing the regression estimates of salary given by the two equations, and the source of the discriminatory effect may be pinpointed by comparing the coefficients of the various productivity factors in the two equations. On the other hand, if the data are sparse a single equation with interactive terms may be more useful since the inclusion of all subgroups in the analysis lends strength to the estimates made for each subgroup.

13. 458 F. Supp. at 323. Despite this statement, the court subsequently used the defendant's regressions against it by observing that they supported the conclusion that education differences explained little of the discrepancy in treatment between men and women. *Id.*

14. *Id.* at 323-24 n.3.

15. Osterman, *Sex Discrimination In Professional Employment: A Case Study*, 32 *Ind. & Lab. Rel. Rev.* 451, 464 (1979).

16. These were in fact used in the regression studies prepared by the plaintiffs in *Agarwal v. McKee & Co.*, 16 *Empl. Prac. Dec.* ¶8301 (N.D. Cal. 1977), discussed at text accompanying notes 30-33 *infra*, and in *Boylan v. The New York Times Co.*, 74 *Civ.* 4891

The court's other objections to the regression study are clearer and appear to be correct. Judge MacMillan found that "salary class" was not properly a productivity factor but rather a result that, theoretically, productivity factors would explain. "Months in salary class" was subject to the same defect as salary class. "Years of schooling" was male-biased since the defendant until recently had purposely discriminated by refusing to hire women with college degrees.<sup>17</sup>

The cases conflict on whether academic rank should be included as a variable in testing for salary discrimination against women teachers. In *Mecklenburg v. Montana Board of Regents of Higher Education*,<sup>18</sup> Montana State University defended a charge of discrimination against women with a multiple regression study of faculty salaries prepared by Dr. Kenneth Tiahrt of the university. The Tiahrt analysis is not described very clearly in the court's opinion, but evidently included explanatory variables relating to promotion and tenure. The court objected to the analysis since it had already found discrimination against women in promotions and tenure decisions, based on other evidence. "Because the Tiahrt salary study was done within each rank, it was impossible to 'catch' any discriminatory salary treatment resulting from inequities in promotions."<sup>19</sup>

A contrary position on this issue appears in *Presseisen v. Swarthmore College*,<sup>20</sup> a class action against Swarthmore alleging discrimination against women in hiring, promotion, and salary. As part of their proof of salary discrimination, the plaintiffs introduced a multiple regression study by Professor John DeCani, in which the salary of full-time faculty in each of the years 1971-1972 through 1975-1976 was regressed on sex, age, degree, years since highest degree, years at Swarthmore, and division of the college. Separate regressions were computed for each of the five years in question, and the coefficient for sex was significant in each of these years.

As the court saw it, the key problem with this study (but not the only problem explored in the lengthy opinion) was that DeCani had excluded academic rank as an explanatory variable. DeCani testified that he did so because women at Swarthmore took longer on the average to reach a given rank than men. However, the court had previously found that the plaintiffs' claim of discrimination in promotions at Swarthmore had not been sustained;

---

(S.D.N.Y., filed Nov. 7, 1974). In *EEOC v. United Airlines*, 73 Civ. 972 (N.D. Ill., filed April 16, 1973), the defendant's regression study for certain years used maternity leaves as the only measure of gaps in service. The inclusion of this variable might have concealed an improper differential in the treatment by the employer of male and female absences in that sex discrimination case.

17. 458 F. Supp. at 323 n.3. Note that the court refused to allow years of schooling to explain promotion decisions because there had been discrimination in hiring with respect to this factor. This approach would be questionable if hiring discrimination were not charged or if the statute of limitations had barred any such claim.

18. 13 Empl. Prac. Dec. ¶ 11,438 (D. Mont. 1976).

19. Id. at p. 6496.

20. 442 F. Supp. 593 (E.D. Pa. 1977), aff'd mem., 582 F.2d 1275 (1978).

it thus concluded that the awards of rank were not tainted by discrimination. DeCani's regression and plaintiffs' claims of discrimination were rejected.<sup>21</sup>

The court's reasoning that led to this conclusion is not persuasive. After the dust had settled over the conflicting promotion studies in *Presseisen*, the survivor was a DeCani rebuttal study (prepared to meet objections to the initial study) which showed a difference between men and women for the time of promotion from assistant to associate professor and from associate to full professor. The court refused to accept the study as sufficient proof of discrimination because the differences lacked statistical significance.<sup>22</sup> But an absence of statistically significant differences is not equivalent to affirmative evidence that promotions were made neutrally so that rank could properly be used as an explanatory variable. Moreover, if there were no statistical disparities between men and women respecting awards of rank, excluding rank as an explanatory variable would not create a false finding of discrimination. On the other hand, including rank as an explanatory variable could incorrectly explain away discrimination in salary even if the differences between men and women with respect to awards of rank were not statistically significant.<sup>23</sup> Thus, in the normal case, rank should be included as an explanatory variable only when there is clear evidence of neutral and objective standards that have consistently been followed in granting rank, so that there is no chance for discrimination. Most academic institutions have not yet developed such standards, although it may be possible to do so.

### B. *Qualitative Factors*

In almost every case it is argued by those opposing regression findings that the results would have been changed significantly if additional explanatory variables had been used. Usually the argument is made with respect to qualitative factors that either cannot be reflected in quantitative terms, or can be reflected only by dubious or even obviously imperfect quantitative surrogates. The courts are not consistent in their treatment of this type of objection, with the variation in judicial position seemingly best explained in each case by the consistency of regression results with the judge's view of the case as a whole.

In *Commonwealth v. Local 542, IUOE*,<sup>24</sup> a class action was brought by blacks in the operating engineer trade in Eastern Pennsylvania and Delaware. The defendants were Local 542 of the International Union of Operating Engineers, various construction contractors, employers, and certain trade associations. Central to the plaintiffs' complaint was a claim that blacks had been treated unfairly in referrals for work by union hiring halls.

---

21. *Id.* at 612-13.

22. *Id.* at 613.

23. This could occur because differences with respect to awards of rank, even though not statistically significant in themselves, may nevertheless "explain" enough of the difference in salary between men and women so that the remaining unexplained difference that is attributable to sex would not be statistically significant.

24. 469 F. Supp. 329 (E.D. Pa. 1978).

The plaintiffs introduced two multiple regression studies prepared by Dr. Bernard Siskin bearing on this question. In the first study, Siskin compiled hours worked by white and minority union members during 1969-1971, and used linear multiple regression to account for differences in age, geographical district, branch,<sup>25</sup> seniority, and list status.<sup>26</sup> The regression of hours worked on these factors showed that race was highly significant, with whites on the average working 109 hours more per year than blacks.<sup>27</sup> A second study showed similar results for 1972 data.<sup>28</sup>

The defendants' experts objected that this analysis omitted crucial factors, the most significant being skill. The court rejected this argument for three reasons. First, there was no evidence that skill varied by race, or that it was not fully accounted for by the age, seniority, work list, branch, and district factors. Second, Siskin had excluded skill because he believed that union data on skill were totally unreliable. The court apparently concurred, referring to evidence indicating that even union hiring hall agents did not consider the skills listed on work records as accurate. Finally, to the extent that skill might develop from experience, it would be an inappropriate explanatory factor since the plaintiffs had charged that they were unfairly deprived of the opportunity to gain experience.<sup>29</sup>

A contrary approach to the qualitative variable problem was evidenced in *Agarwal v. McKee & Co.*<sup>30</sup> In that case, a class of minorities (East Asians, blacks, Asians, Spanish-surnamed persons, and American Indians) brought suit for damages and for injunctive relief, claiming that the company's practices prevented them from reaching top salary levels. McKee employed some 3,000 persons in some 500 job classifications, which were distributed among 17 salary levels.

The plaintiffs introduced a regression study in which salary was regressed on (a) minority status, (b) total years of education, (c) number of years since receipt of highest degree, (d) age of employee, (e) age of employee squared, (f) type of professional registration held by the employee, (g) years of prior experience, (h) years of experience at McKee, (i) years of experience at McKee squared,<sup>31</sup> and (j) number of years of any break in service at McKee.

---

25. The branches were: the union parent body, consisting of experienced engineers; an "A" branch consisting of unskilled oilers; and a "B" branch consisting of operators of earth-moving equipment.

26. Union members were categorized by groups, and within each group were supposed to be called in order from lists prepared by date of the member's registration as available for work.

27. 469 F. Supp. at 354.

28. For this data, the raw difference for whites and minorities was 176 hours worked; the regression difference was 97.5 hours. *Id.* at 354-55.

29. *Id.* at 377-80. The last argument appears unobjectionable since denial of the opportunity to gain experience is the very discrimination charged. Compare the court's argument in *Stastny v. Southern Bell Tel. & Tel. Co.*, 458 F. Supp. 314, 323 n.3 (W.D.N.C. 1978), that years of schooling should not have been considered as an explanatory factor because it was male-biased.

30. 16 Empl. Prac. Dec. ¶ 8301 (N.D. Cal. 1977).

31. A squared term for years of experience is frequently included to allow for the

The court objected that the regression was not properly specified because it excluded information that "could have had some bearing on salary," such as job level at McKee, prior salary, and past overseas assignment.<sup>32</sup> Moreover, while the regression included years of experience and years of education, there was no coding of type or quality of either. Finally, "plaintiff did not attempt to determine whether particular individuals had special abilities or characteristics which might have had a bearing upon salary level."<sup>33</sup> The court concluded that plaintiffs had failed to meet their burden of proving discrimination.

For the most part, these objections do not seem valid. Job level could not properly be used as an explanatory variable because the assignment of levels may well have been tainted by discrimination. The failure to code type or quality of prior experience or education should more properly fall on the employer than on the plaintiff, since such coding would be relevant only to the extent the employer could demonstrate that differences in type of education or prior employment experience were validly related to the requirements of the job. For even more cogent reasons, it should be the employer's burden to prove, if it could, the improbable fact that salary differences among groups were attributable to the special characteristics of particular individuals.

In *Mecklenburg* and *Presseisen*, the two university discrimination cases discussed earlier, it is not surprising that the two courts differed in their assessment of qualitative variables, given their result-oriented approach to the problem. In *Mecklenburg*, the court noted that in plaintiffs' and defendants' statistical studies no account was taken of qualitative variables such as teaching ability, research contributions, and community contributions. From this the court found only that "no conclusions as to how such factors affect men and women dissimilarly can be drawn."<sup>34</sup> However, in *Presseisen*, the court rejected the regression studies introduced by both sides, in part because they did not include such factors as scholarship, publications, some assessment of teaching ability, quality of degree, career interruptions, quality of publications, administrative responsibilities, and some measure of committee work.<sup>35</sup>

Again it seems appropriate to question whether plaintiffs should bear the burden of presenting so refined an analysis in a promotion case. To justify requiring such variables in a regression, the employer would have to show that the necessary information was available and was in fact used in promotion decisions. From this perspective, it is perhaps significant that the defendant in *Presseisen* did not include such variables in its analysis of

---

fact that the contribution of a year of seniority to expected salary decreases as years of seniority increase.

32. The reference to overseas assignment probably was due to the fact that McKee had significant international operations.

33. *Id.* at p. 5574.

34. 13 *Empl. Prac. Dec.* at p. 6496.

35. 442 *F. Supp.* at 616.

its own promotion process. But instead of accepting the defendant's method as a tacit acknowledgement that the omitted variables were not significant, the *Presseisen* plaintiffs muddied the waters by eliciting testimony from their expert that the defendant's regressions were defective for failing to include such factors. The court cited this testimony in support of its rationale for rejecting both regressions as misspecified.<sup>36</sup>

### C. *Time-Barred Discrimination*

In title VII cases there is a stringent jurisdictional requirement: plaintiffs must file a charge within 180 days of the act of discrimination or, in a state having a fair employment practices agency, within 300 days of the act of discrimination.<sup>37</sup> This means that charges of discrimination in hiring and promotion must generally (with certain caveats discussed below) be confined to this short period with respect to proof of liability.<sup>38</sup> The effect of these limitations is illustrated by the fate of the regressions in *Dickerson v. United States Steel Corp.*<sup>39</sup>

In *Dickerson*, Dr. Samuel Litwin introduced for the plaintiffs statistical studies in which salaries were regressed on years of seniority and years of seniority squared. Unlike other studies, the regression curves were fitted separately for whites and blacks and the coefficients of the two curves were tested for statistically significant differences. The results showed that blacks earned less than whites, with the gap widening as seniority reached higher levels. The court accepted this evidence in support of the plaintiffs' claim that blacks were initially channeled into less desirable jobs and then "locked in" by the rule that any transfer would forfeit seniority. However, prior to the end of the trial, the Supreme Court decided *United Air Lines v. Evans*,<sup>40</sup> which the *Dickerson* court interpreted as holding that "acts not made the basis of timely charges cannot be the basis of any liability, even if the effects are continuing because of a racially neutral practice."<sup>41</sup> Reacting to *Evans*, the court struck the regressions, apparently on the theory that the lower salaries of blacks included in the data reflected the lock-in effect. The court felt "that inclusion of the earlier data would so severely influence the regression curves' shapes as to render the analyses irrelevant."<sup>42</sup>

---

36. *Id.*

37. 42 U.S.C. § 2000e-5(e) (1976). A 180-day limitations period applies to proceedings under Exec. Order No. 11,246. 41 C.F.R. § 60-1.21 (1979).

38. If liability is established, back pay may be recovered for a two-year period prior to the charge. 42 U.S.C. § 2000e-5(g) (1976).

39. 439 F. Supp. 55 (E.D. Pa. 1977), rev'd on other grounds, 582 F.2d 827 (3d Cir. 1978).

40. 431 U.S. 553 (1977). The Court held that a female flight attendant who was discriminatorily discharged in 1968 and rehired in 1972 was not entitled to seniority back to the date of discharge because she had not filed a timely complaint at the time of her separation. The discharge had become "merely an unfortunate event in history which has no present legal consequences." 431 U.S. at 558.

41. 439 F. Supp. at 69.

42. *Id.* at 79 n.25.

In a promotion case, the way to avoid the *Dickerson* problem is to include as an explanatory variable the positions of the employees just prior to the start of the period of legal responsibility.<sup>43</sup> This could be done only on a showing that position was a relevant productivity factor. If it is, the remaining question is whether the nature of the employees' prior experience with the defendant employer should be excluded as a tainted variable. For example, if an employer has discriminated against women prior to the period of legal responsibility by promoting men to managerial positions, does he discriminate within the period by promoting men on the basis of their prior managerial experience? The answer, I think, should be no. If, as *Evans* says, prior discrimination is merely an "unfortunate event in history which has no present legal consequences," the employees' experience with the firm prior to the period of legal responsibility cannot be excluded as tainted if relevant to the promotion process.<sup>44</sup> The cure for the past is not a finding of present discrimination, but rather an affirmative action plan by which women or minorities are offered the chance to make up for opportunities lost by reason of conduct now beyond legal redress.

This conclusion does not imply that the employer's pre-statute of limitations conduct is irrelevant to proof of discrimination. The employer must recognize the experience gained by minorities or women prior to the period of legal responsibility in making promotions within that period. This means that variables reflecting such experience should be included in the regression. Moreover, the Supreme Court has noted that "[p]roof that an employer engaged in racial discrimination prior to the effective date of Title VII might in some circumstances support the inference that such discrimination continued, particularly where relevant aspects of the decisionmaking process had undergone little change."<sup>45</sup> As applied to data, that comment implies that if promotion decisions within the period of legal responsibility indicate an adverse impact on a protected group, but there are too few decisions within that period on which to base a finding of statistical significance, the data for earlier periods could be aggregated with them for purposes of testing for significance if relevant aspects of the decisionmaking process had been little changed.<sup>46</sup>

---

43. The period of legal responsibility, as used here, means the effective date of the legislation or executive order prohibiting discrimination, or the statute of limitations date, whichever is more recent.

44. One could also use salary prior to the start of the period of legal responsibility as an explanatory variable. But this probably would be objectionable because it would sanitize differentials in salary for persons performing comparable work, even though such discrimination could be immediately corrected without waiting for promotional opportunities.

45. *Hazelwood School Dist. v. United States*, 433 U.S. 299, 309 n.15 (1977). See also *Village of Arlington Heights v. Metropolitan Hous. Dev. Corp.*, 429 U.S. 252, 267 (1977).

46. For purposes of computing back pay, a discriminatory failure to promote occurring within the statute of limitations period may be viewed as a continuing violation from an earlier period when the promotion should have been granted, thus entitling the victims to recovery up to the full two-year period allowed for back pay. See, e.g., *Verzosa v. Merrill Lynch, Pierce, Fenner & Smith, Inc.*, 589 F.2d 974 (9th Cir. 1978) (per curiam).

#### D. Data "Errors" and Reverse Regression

The reason for including explanatory variables relating to productivity in the regression equation is to see whether differences in productivity among groups account for differences in their average salaries. The procedure assumes that if an employer ignores group membership and awards salary solely on the basis of productivity, the regression will tend to estimate a zero coefficient for group membership. It follows that a statistically significant group-membership coefficient is evidence of discrimination since not all differences in salary can be ascribed to differences in productivity.

But it has been pointed out by Professor Harry Roberts<sup>47</sup> and others<sup>48</sup> that this assumption, and the conclusion based on it, are not necessarily correct. Neither the true productivity of the employees nor the assessments made by the employer are known. All we have is a proxy that can be thought of as a measure of true productivity with a random error. The fact of error in the proxy raises a serious problem. If, for example, the proxy indicates that women are less productive than men (they may have less education and this is the proxy variable) the regression estimate of salary for women will be lower than that for men, for any given level of education, even if the employer is nondiscriminatory and makes error-free assessments of his employees' true productivity in fixing their salaries. In short, some of the explanation of salary differences that would be attributable to productivity if true productivity were used is instead attributed to gender because of random errors in the proxy.<sup>49</sup> This phenomenon is sometimes referred to as "underadjustment," since the proxies for productivity fail to account fully for the differences in salary attributable to differences in productivity.

Roberts demonstrated the extent of possible bias by performing a computer simulation in which hypothetical samples of 100 men and 100 women were drawn from a population in which the mean male salary was \$10,000 and the mean female salary was \$7,000. The standard deviation of

---

47. Defendant's Exhibit No. 114 at 7-14, *United States Dep't of Treasury v. Harris Trust & Sav. Bank, C.A. #78-OFCCP-2* (1978) (Roberts et al., *Statistical Study of Equal Economic Opportunity: Methodological Issues*) (hereinafter Roberts). The highlights of Roberts's studies have been published as H. Roberts, "Harris Trust and Savings Bank: An Analysis of Employee Compensation" (Report 7946, Center for Mathematical Studies in Business and Economics, Department of Economics and Graduate School of Business, University of Chicago) (1979).

48. Wolins, *Sex Differentials in Salaries: Faults in Analysis of Covariance*, 200 *Science* 723 (1978).

49. This bias is an inherent consequence of probability theory and least squares estimation, the technique used in regression. The reason for it may be appreciated by considering an extreme case. Suppose that productivity correlates with gender, but the productivity proxy used in the regression is so defective that it is only slightly correlated with the nondiscriminatory employer's perfectly accurate assessments of productivity on which awards of salary are based. In that event, the variation in salary arising from productivity factors that correlate with gender would be attributed to gender, making the coefficient of gender statistically significant even though the employer did not discriminate. Conversely, the coefficient of the proxy would be insignificant since by hypothesis it did not substantially correlate with assessed productivity, which was the basis for salary determinations. In less extreme situations, the coefficient of gender will be overstated and that of the proxy understated, with both being statistically significant.

both male and female salaries was \$1,500. The difference in salaries was due entirely to the employer's assessments of productivity and not to discrimination since salary was fixed as 100 times the assessment. True productivity was taken to have a normal deviation about the employer's assessment with a standard deviation of 20. Errors in the proxy for the assessments were simulated by stipulating that for any true productivity the proxy had a normal deviation about true productivity with a standard deviation of 20. A regression of salary on gender and the proxy assigned a coefficient of \$2,439 to gender.<sup>50</sup> Thus, almost all of the \$3,000 difference in mean salary between men and women was attributed to gender, even though, by hypothesis, the employer made salary decisions on the basis of assessed productivity and the proxy used by the statistician to estimate true productivity was subject only to random errors.<sup>51</sup>

To avoid bias arising from errors in the explanatory variables, Roberts proposed to reverse the usual procedure and to regress productivity variables (condensed into a single variable) on salary and gender.<sup>52</sup> This avoids the problem identified by Roberts because random errors in the dependent variable do not bias the estimates of the coefficients of the explanatory variables.<sup>53</sup> Reverse regression asks whether persons earning the same salary are equally productive, as opposed to regression in the usual form, which asks whether equally productive persons earn the same salary. In reverse regression, for example, a statistically significant positive coefficient for gender tells us (if gender is coded 0 for men and 1 for women) that for any given salary women are more productive than men; this may suggest discrimination against women. If the coefficient for gender is not statistically significant, the reverse regression would show that men and women at the same salary level were equally productive.<sup>54</sup>

Unfortunately, however, reverse regression does not seem to be a satisfactory substitute for regression in the usual form. The basic difficulty is that reverse regression only describes the employment situation within

---

50. Roberts, *supra* note 47, at 14.

51. The understatement of the proxy coefficient is a function of the ratio of the variance of the proxy errors to the variance of the true productivity. For a discussion, see J. Johnston, *Econometric Methods* 150 (1963). As this ratio increases, the regression coefficient of the proxy becomes increasingly understated relative to the coefficient that would be assigned to the true productivity, if that were known.

52. Roberts, *supra* note 47, at 17. The reversal of dependent and independent variables to eliminate bias in the estimates of the regression coefficients is a recognized procedure. See, e.g., M. Ezekiel & K. Fox, *Methods of Correlation and Regression Analysis* 314 (3d ed. 1959).

53. The reason is that the regression curve passes through the mean values of the dependent variable at each point and the effect of random errors in the dependent variable is simply to enlarge the spread of values around the mean.

54. For example, in the *Harris Bank* case, *supra* note 47, Professor Roberts found in a traditional regression study of a cohort of employees entering the bank in 1965-1968 that women earned approximately 24% less than men after accounting for differences in basic productivity variables; this difference was statistically significant. Defendant's Offer of Proof Exhibit 83, ch. 5, § 7.0, at 33. However, reverse regression of the productivity factors on salary and sex showed no statistically significant difference in productivity per dollar of salary between men and women. *Id.*

salary levels, but since the manner in which employees reach those levels is an important aspect of the employer's behavior, the results of reverse regression can be quite misleading. If there has been discrimination in promotions, salary is likely to be a tainted variable, the effect of its inclusion being to conceal discrimination with respect to awards of salary. For example, an employer may discriminate by promoting larger proportions of men than women from each cohort of equally qualified employees. In that event, men and women could be equally qualified at each salary level, but women would be underrepresented at the higher levels and overrepresented at the lower levels. Regression in the usual form would reveal the discrimination because the average salary of women would be less than that of men at each qualification level, but reverse regression would show no discrimination because men and women would be equally qualified at each salary level.<sup>55</sup> Conversely, if an employer promoted equal proportions of men and women from each cohort of equally qualified employees, regression in the usual form would correctly find him innocent of discrimination, but reverse regression would find that he had discriminated against the group with the more highly qualified members since they would predominate at the higher levels.<sup>56</sup> Inaccuracies of this kind indicate that the problem of bias generally cannot be circumvented by using reverse regression.

## II. HIRING

Multiple regression studies have been little used to demonstrate discrimination in hiring. In one notable contest, however, District Judge Sam C. Pointer consulted elaborate statistical analyses apparently not

---

55. To illustrate this situation, suppose an employer has 45 high-paying jobs (\$20,000 annually) and 45 low-paying jobs (\$10,000 annually). All high-paying jobs are reached by promotion from low-paying jobs. Employees are divided into highly qualified and other groups. Of the 25 highly qualified men, 20 were promoted; of the 20 highly qualified women, 10 were promoted. Conversely, of the 20 other men, 10 were promoted; of the 25 other women, 5 were promoted. On these facts, the employer presumptively has discriminated against women by promoting larger proportions of highly qualified men (20 out of 25) than highly qualified women (10 out of 20) and larger proportions of other men (10 out of 20) than other women (5 out of 25). This discrimination would be revealed by regression in the usual form since the average salary for men is higher than that for women at each qualification level (e.g., \$18,000 for highly qualified men compared with \$15,000 for highly qualified women). By contrast, reverse regression would not reveal any discrimination since men and women have equal qualifications at each salary level: at the higher salary level two-thirds of each group are highly qualified; at the lower salary level one-third of each group is highly qualified. I am indebted to Professor Bruce Levin for this and the example in the next footnote.

56. To illustrate this situation, assume the employer described in the preceding footnote made the following promotions: Of 30 highly qualified men, 20 were promoted; of 15 highly qualified women, 10 were promoted. Of 15 other men, 5 were promoted; of 30 other women, 10 were promoted. Although equal proportions of men and women within the highly qualified group and within the other group were promoted (two-thirds in the first group, one-third in the second group), the higher-paying jobs have a larger proportion of highly qualified men (20 out of 25) than highly qualified women (10 out of 20). On these facts, the employer seems to be innocent of wrongdoing, but reverse regression would nevertheless indicate that he had discriminated against *men* since their average qualifications in the high-paying jobs are above those of women.

presented by counsel, using regression to determine whether employment tests that disqualified disproportionate numbers of blacks had been adequately validated.

In this title VII case, *Ensley Branch of the NAACP v. Seibels*,<sup>57</sup> plaintiffs brought suit to enjoin the use of tests to screen applicants for positions as police officers, deputy sheriffs, and firefighters in Birmingham, Alabama. The widely used tests, developed by the Public Personnel Association, disqualified larger proportions of blacks than whites. Having found adverse impact, the court inquired whether the tests had been "validated and evidence[d] a high degree of utility."<sup>58</sup>

The court first established that there was a statistically significant correlation between an acceptable criterion measure of job performance (the so-called "experimental ratings")<sup>59</sup> and test scores. It then inquired whether there was sufficient correlation for "practical significance." The method used was to regress experimental ratings on test scores and to compare variations in ratings and scores. After correcting for a certain weighting factor, the court first found that a large variation in test scores produced only a small change in predicted ratings—e.g., a 40-point raw score difference on the test produced less than an 8 point difference on the rating score.<sup>60</sup> The court then used the standard error of the regression estimate to show that a difference in test scores of more than 86 points would be required before it could be said with .95 confidence that the higher-scoring person would receive the higher experimental rating. This difference exceeded the actual range in scores which all fell between 48 (passing) and a perfect 120 (which was never attained).<sup>61</sup> Finally, the court computed separate regressions for each of the twelve components of the experimental ratings and found that a test score of 48 would predict a rating of at least "adequate" on each component.

The court then computed the experimental ratings that would be predicted for test scores *below* 48. Since there were no experimental ratings for persons with such scores (because they were rejected), the court said it recognized the risk of extrapolation, but justified its procedure by noting that it had "little else available for comparable analysis."<sup>62</sup> Even with a test score of zero, the predicted rating was "adequate" or above for the rating as a whole; for five of the twelve components for which the predicted ratings would be less than adequate, the shortfall was not significant at the .05 level.<sup>63</sup>

On the basis of these and other arguments, the court concluded that

---

57. 13 Empl. Prac. Dec. ¶11,504 (N.D. Ala. 1977).

58. *Id.* at 6797 (citing EEOC guidelines).

59. *Id.* at 6803. These ratings were a weighted composite of twelve scored items that were specifically developed by professionals to validate the tests.

60. *Id.* at 6805.

61. *Id.*

62. *Id.*

63. *Id.*

there was no practically significant correlation between ratings and scores. The conclusion seems reasonable on the basis of the performance of those who passed the test. Of course, this is only an indication of the test's fairness. The absence of performance data for those who failed the test is a critical and inevitable omission in this type of case. It is better, however, to recognize the limits of statistical methods and do without this sort of information than to attempt to fill the gap with a probably inaccurate extrapolation.<sup>64</sup>

### III. BACK PAY

If an employer is found guilty of discrimination, he will ordinarily be compelled to make the victims whole with back pay. There are no cases of which I am aware in which a regression model has been used to compute the amount of a back pay award. However, a sensible suggestion to that effect was recently made in a pending case.

In *Kyriazi v. Western Electric Co.*,<sup>65</sup> Western Electric was found guilty of discrimination against women in hiring, initial assignment, and promotion; the case was remanded to special masters for determination of back pay. The court ordered the masters to compare each member of the class of women who were the victims of discrimination with a male employee with comparable skills upon hiring and comparable seniority between her salary and that received by the male counterpart.

In complying with this direction, the *Kyriazi* plaintiffs proposed to construct hypothetical male counterparts by multiple regression in which the dependent variable is male salary and the explanatory variables are male qualifications at hire and male seniority. The comparable salary for the hypothetical male would then have been estimated by inserting the values of the qualification and seniority variables of the female and reading the resulting salary estimates from the regression equation. This is an appropriate use of multiple regression, since it allows one to interpolate a comparable male for each female (even though a precisely comparable male may not exist) and it avoids variations in back pay awards arising from the choice of particular male counterparts. Unfortunately, in *Kyriazi* the masters rejected the regression approach without explanation, possibly due to their unfamiliarity with the methodology.

If promotional salary benefits are limited, they must be allocated among the victims. The judicially preferred method involves individual determinations as to which class member would have received each benefit.<sup>66</sup> When

---

64. In a footnote, the court correctly acknowledged that "[r]egression lines should not generally be used for prediction . . . beyond the range of predictor scores found in the sample, for beyond such known scores the relationship may cease to be significant, may cease to be linear, or may have a slope change." *Id.* at 6810 n.31.

65. 19 Empl. Prac. Dec. ¶ 8997 (D.N.J. 1979).

66. *United States v. United States Steel Corp.*, 520 F.2d 1043, 1055-56 (5th Cir. 1975), cert. denied, 429 U.S. 817 (1976).

individual determinations cannot be made, three different solutions have been proposed by the courts: (i) a division of the total award among the victims pro rata to the loss of each victim;<sup>67</sup> (ii) a division of the total award among the victims per capita;<sup>68</sup> and (iii) an award to each victim of the benefit received by a comparable member or members of the favored class.<sup>69</sup>

None of these methods is completely satisfactory. The first and second methods assume that there are no relevant differences in qualifications among the victims. By contrast, the regression method takes individual qualifications of the victims into account. If the lowest-paid victims also have below-average qualifications relative to other victims, the regression approach would award them less on the theory that they would have received below-average salaries if there had been no discrimination. Recognizing the effect of individual qualifications is in accord with the Supreme Court's direction to the lower courts to "balance the equities of each minority employee's situation in allocating the limited number of vacancies that were discriminatorily refused to class members."<sup>70</sup>

The third method assumes that if there had been no discrimination the victims would have received at least all the promotional benefits that favored group members received.<sup>71</sup> Calculation on this basis is clearly appropriate to remedy differentials in pay for comparable work, since the victims of such violations are entitled to the salaries earned by the favored group performing comparable work.<sup>72</sup> But when the charge involves denial of promotional benefits, back pay calculation based on the benefits received by the favored group will overcompensate the victims if the supply of such benefits is limited, since in the absence of discrimination they should have received not all these benefits but only their proportionate share. The

67. *Id.* at 1056-57. Inexplicably, the court used the single largest loss suffered by any victim as the measure of the total award to be divided among all victims. The court described the computation it would recommend as follows: "For example, if during a given period white A, with less plant seniority, occupied a job at which he earned \$15,000, but blacks B, C, D, E and F, with respective earnings in lower jobs of \$10,000, \$11,000 \$12,000, \$13,000 and \$14,000, each were equally capable and substantially equal in superior [sic] plant seniority, than [sic] their pro rata recoveries for the period could be computed as follows:  $5x + 4x + 3x + 2x + x = \$5,000$ . The variable,  $x$ , comes to roughly \$333. Thus B, whose hypothetical loss is five times greater than F's, recovers about \$1,665; C recovers \$1,332; D takes \$999; E recovers \$666; while F, who suffered the least economic injury, recovers \$333." *Id.* at 1056.

68. *Head v. Timkin Roller Bearing Co.*, 7 Empl. Prac. Dec. ¶9,420 (S.D. Ohio 1974).

69. See, e.g., *Sabala v. Western Gillette, Inc.*, 516 F.2d 1251, 1265 (5th Cir. 1975), vacated and remanded in light of *International Bhd. of Teamsters v. United States*, 431 U.S. 951 (1977) (mem.); *United States v. Wood, Wire & Metal Lathers, Local Union 46*, 3 Empl. Prac. Dec. ¶8249 (S.D.N.Y. 1971). One court has gone further and has held that if the employer cannot demonstrate which of several victims would have received a particular promotion in the absence of discrimination, the full benefit of the promotion can be awarded to each. *Kyriazi v. Western Elec. Co.*, 19 Empl. Prac. Dec. ¶8997 (D.N.J. 1979).

70. *International Bhd. of Teamsters v. United States*, 431 U.S. 324, 372 (1977).

71. See, e.g., *Sabala v. Western Gillette, Inc.*, 516 F.2d 1251, 1265 (5th Cir. 1975), vacated and remanded in light of *International Bhd. of Teamsters v. United States*, 431 U.S. 951 (1977) (mem.); *United States v. Wood, Wire & Metal Lathers, Local Union 46*, 3 Empl. Prac. Dec. ¶8249 (S.D.N.Y. 1971).

72. *Love v. Pullman Co.*, 15 Empl. Prac. Dec. ¶8089 (10th Cir. 1978). *Brennan v. City Stores, Inc.*, 5 Empl. Prac. Dec. ¶8634 (5th Cir. 1973).

regression approach can be adapted to reflect this situation by estimating a single equation from data for all employees; the regression salary estimate is then the average salary for all employees with comparable qualifications, which is what the average salary for each would have been if the promotional benefits had been spread without discrimination among them all.<sup>73</sup> The proportionate share of benefits approach (without regression) has been used in at least one case.<sup>74</sup>

#### IV. A TWO-STAGE APPROACH

The emerging pattern in important class actions involving claims of discrimination is for both sides to introduce regression analyses. When that happens, the courts are confronted with complex choices: the employees included in the data base, the information coded for them, and even the functional form of the equations may differ. For example, in *Boylan v. The New York Times Company*,<sup>75</sup> a sex discrimination class action against the newspaper, the plaintiffs introduced a multiple regression study based on data for some 1,800 newspaper guild employees and used some 99 explanatory variables. The defendants responded with a regression study based on (among other things) an additional 5,000 Times employees, and which also used different and smaller sets of explanatory variables. In the plaintiffs' study, the coefficient for sex was statistically significant; in the defendants' study, it was not.

In traditional adversary proceedings, each side presents its studies, criticizes the opposing studies, and the court makes its choice on the basis of the completed projects. But that pattern, in the type of litigation discussed in this Article, is both wasteful and unsatisfactory. The major cost of computerized analysis based on employee records arises from the need to "clean" the data of errors and omissions. Under the current procedures, a party may spend an enormous amount of time and money in preparing a data set, only to find its study rejected because the court concluded that a different set of employees should have been covered. Moreover, since the parties' studies will differ in various respects, the court may prefer a blend of both approaches; yet there would be no "composite" model to reflect this mixed viewpoint. The court in the *Times* case might have wanted to include non-guild employees (as the defendant did), but have their salaries "explained" with plaintiffs' variables. The court might hesitate

---

73. The use of separate regression equations for protected and favored groups is equivalent to the favored-group counterpart approach, and would share its defect if used to compute back pay. However, when used to determine whether there has been discrimination, the problem of overcompensation noted in the text does not arise: if there was no discrimination, the coefficients of the equations would not be significantly different since each group would have received its fair share of promotions, regardless of the supply.

74. See, e.g., *Head v. Timken Roller Bearing Co.*, 7 Empl. Prac. Dec. ¶9420 (S.D. Ohio 1974).

75. 74 Civ. 4891 (S.D.N.Y., filed Nov. 7, 1974).

to direct new regression studies reflecting its view, since this could be time consuming and would require reopening the proceedings.

To deal with cognate problems in the context of administrative proceedings, I have elsewhere suggested that the decisionmaker should make a preliminary determination of the data to be subjected to analysis so that the parties and the court could focus their analytic efforts on that data.<sup>76</sup> This approach would seem particularly appropriate in the employment discrimination context. The matter can be approached in two stages because disputes over the scope of the data are quite separable from the analysis of them. Thus, in the *Times* case, the court could have determined prior to trial whether non-guild employees should be included with guild employees, and might also have designated appropriate productivity factors for the equation. The parties would then have been analyzing data for a common set of employees based on a common set of factors. Nothing would prevent a party from introducing analyses based on other information, but if a party failed to present an analysis of the information of primary interest, it would run the risk that the opposing party's results would be accepted.<sup>77</sup> In addition, by focusing the parties' efforts on the central data of the case the court would receive the benefit of contrasting analyses of that data, which should help to sharpen and simplify the issues for trial. This is a consideration of no small importance given the complexity of the problems that arise in applications of multiple regression analysis.

---

76. See Finkelstein, *supra* note 1, at 1442, 1461, reprinted in M. Finkelstein, *Quantitative Methods in Law*, ch. 7, at 226-34 (1978).

77. In particular, the parties should be free to demonstrate that the explanatory factors previously designated by the court produce a misspecified regression equation.