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THE NUMBERS GAME — THE USE AND MISUSE OF STATISTICS IN CIVIL RIGHTS LITIGATION

Marcy M. Hallock†

I. INTRODUCTION

"In the problem of racial discrimination, statistics often tell much, and Courts listen."

"We believe it evident that if the statistics in the instant matter represent less than a shout, they certainly constitute far more than a mere whisper."

THE PARTIES TO ACTIONS BROUGHT UNDER THE CIVIL RIGHTS LAWS have relied increasingly upon statistical analyses to establish or rebut cases of unlawful discrimination. Although statistical evidence has been considered significant in actions brought to redress racial discrimination in jury selection, it has been used most frequently in cases of allegedly discriminatory

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It shall be an unlawful employment practice for an employer . . . to fail or refuse to hire or to discharge any individual, or otherwise to discriminate against any individual with respect to his compensation, terms, conditions, or privileges of employment, because of such individual's race, color, religion, sex, or national origin . . . .


To prove a Title VII violation, the challenged employment practice must be demonstrated to be discriminatory on the basis of race, sex, religion, or national origin. Unlike discrimination suits under the equal protection clause of the United States Constitution, it is not necessary in Title VII actions to prove that an employer subjectively intended to discriminate. Statistical evidence of a discriminatory impact has been held by some courts to be sufficient to establish a prima facie violation of Title VII. According to one court, "[i]n many cases the only available avenue of proof is the use of racial statistics to uncover clandestine and covert discrimination by the employer or union involved." Another court concluded that


10. See, e.g., United States v. Hayes Int'l Corp., 456 F.2d 112, 120 (5th Cir. 1972). In Hayes, the government charged that the employer's hiring practices violated Title VII by excluding blacks from technical and clerical jobs. Id. at 119. Statistical evidence was introduced to show that only 20 of the 1223 employees in these positions were Negroes, while 30% of the general population of the surrounding area consisted of Negroes. Id. at 120. In determining that these figures were relevant to establishing a Title VII violation, the Fifth Circuit stated that "these lopsided ratios are not conclusive proof of past or present discriminatory hiring practices; however, they do represent a prima facie case." Id. (emphasis in original). The court noted that the high ratio of whites to blacks in clerical and technical jobs justified an inference of racially discriminatory hiring procedures. Id. See also United States v. Ironworkers Local 86, 443 F.2d 544, 551 & n.21 (9th Cir. 1971). But see Parham v. Southwestern Bell Tel. Co., 433 F.2d 421, 426 (8th Cir. 1970) (statistics, as a matter of law, established a violation of Title VII).

11. United States v. Ironworkers Local 86, 443 F.2d 544, 551 (9th Cir. 1971). In Ironworkers, the Ninth Circuit affirmed the district court's finding that five building construction unions and three joint apprenticeship and training committees were guilty of racially discriminatory conduct which deprived blacks of employment opportunities. Id. at 546. The evidence revealed the underrepresentation of blacks in the unions and committees, as well as many overt acts of unlawful discrimination. Id. at 548.
"[s]tatistical evidence is an important tool for placing seemingly inoffensive employment practices in their proper perspective."\(^{12}\)

Courts have formulated general guidelines for meeting the burden of proof in Title VII cases,\(^{13}\) despite the diversity of employment practices which have been litigated under the statute.\(^{14}\) To establish a prima facie case, in the absence of an exculatory explanation from the defendant-employer, the plaintiff-employee must present evidence of disparate treatment sufficient to support an inference of unlawful discrimination.\(^{15}\) For example, to establish a

\(^{12}\) Senter v. General Motors Corp., 532 F.2d 511, 527 (6th Cir. 1976). In Senter, the Sixth Circuit found that the gross statistical disparity between the percentage of blacks employed at hourly and supervisory positions helped to establish that the employer's promotional system violated Title VII. \(\text{Id. at } 527-28\). The court reasoned that "[a]n employee is at an inherent disadvantage in gathering hard evidence of employment discrimination, particularly when the discrimination is plant-wide in scope. It is for this reason that we generally acknowledge the value of statistical evidence in establishing a prima facie case of discrimination under Title VII." \(\text{Id. at } 527\) (citations omitted).

\(^{13}\) See, e.g., International Bhd. of Teamsters v. United States, 431 U.S. 324 (1977). In that case, the government claimed that the company was guilty of a "pattern or practice" of discrimination in violation of Title VII. \(\text{Id. at } 328-29\) (construing Civil Rights Act of 1964, Title VII, § 707, 42 U.S.C. § 2000e-6(a) (1970)). The Court stated:

> Because it alleged a systemwide pattern or practice of resistance to the full enjoyment of Title VII rights, the Government ultimately had to prove more than the mere occurrence of isolated or "accidental" or sporadic discriminatory acts. It had to establish by a preponderance of the evidence that racial discrimination was the company's standard operating procedure — the regular rather than the unusual practice.

\(^{14}\) See, e.g., International Bhd. of Teamsters v. United States, 431 U.S. 324, 329-30 (1977) (hiring, assignment, pay, promotion, transfer, and seniority practices); Senter v. General Motors Corp., 532 F.2d 511, 515 (6th Cir. 1976) (promotion system); Pettway v. American Cast Iron Pipe Co., 494 F.2d 211, 216 (5th Cir. 1974) (employees' governing boards, testing and employment qualifications, apprenticeship program, assignment to supervisory positions, and seniority system); Brown v. Gaston County Dyeing Mach. Co., 457 F.2d 1377, 1383 (4th Cir. 1972) (hiring and promotion practices, and failure to post notices of job vacancies); United States v. Hayes Int'l Corp., 456 F.2d 112, 119 (5th Cir. 1972) (relying on employment referral service for job applicants and maintaining different application procedure for friends and relatives of employees); United States v. Ironworkers Local 86, 443 F.2d 544, 548 (9th Cir. 1971) (admission requirements, applicant testing, active recruitment of white applicants, and preferential treatment for friends and relatives of employees or union members).

\(^{15}\) Ochoa v. Monsanto Co., 335 F. Supp. 53, 58 (S.D. Tex. 1971). In the words of the Ochoa court:

> At most, the demonstration of gross statistical disparity amounts to a prima facie showing of discrimination, thus shifting to the opposing party the burden of going forward, with exculatory evidence. . . . Under Title VII, such data has been viewed in this Circuit as establishing a "preliminary showing" of a violation. . . . This is taken to mean that plaintiff, although still bearing the risk of nonpersuasion, can by the use of persuasive statistics cast upon defendant the duty of producing at least equally persuasive controverting evidence if he can.

\(\text{Id. at } 58\) (citations omitted).
prima facie case of racial discrimination under Title VII, the Supreme Court has held that the plaintiff must show:

(i) that he belongs to a racial minority; (ii) that he applied and was qualified for a job for which the employer was seeking applicants; (iii) that, despite his qualifications, he was rejected; and (iv) that, after his rejection, the position remained open and the employer continued to seek applicants from persons of complainant's qualifications.\(^{16}\)

In an effort to rebut the plaintiff's prima facie case, the defendant-employer may offer a business reason for the challenged practice.\(^{17}\) However, the inference of illegality will be dispelled only if the evidence proves that the business purpose is legitimate and nondiscriminatory.\(^{18}\)

Although statistics may be considered probative and supportive of an individual Title VII claim, they have been held to be "determinative" in class actions.\(^{19}\) The magnitude of class actions,\(^{20}\)

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16. McDonnell Douglas Corp. v. Green, 411 U.S. 792, 802 (1973) (footnote omitted). Subsequent cases have held that the plaintiff-employee need not have applied for employment if the employer's conduct indicates that plaintiff's application would have been futile. See, e.g., Rodriguez v. East Tex. Motor Freight System Inc., 505 F.2d 40, 55 (5th Cir. 1974), rev'd in part on other grounds, 431 U.S. 395 (1977).


20. See FED. R. Civ. P. 23(a)(1). For a discussion of the numerosity requirement of Rule 23, see Hopper, Propriety of Class Actions Under Title VII and Determination of
and the virtual impossibility of comparing each member of the class,\textsuperscript{21} have forced the courts to allow parties to introduce statistical data as evidence of employment practices.\textsuperscript{22} According to the Supreme Court, statistical proof of a significant disparity in treatment can constitute a prima facie case in class actions, and shift the burden of going forward with evidence to the opposing party.\textsuperscript{23}

In ratifying the use of statistical evidence, courts have recognized that there are certain inherent limitations in its probative value.\textsuperscript{24} The Ninth Circuit has warned: "[A]s is the case with all statistics, their use is conditioned by the existence of proper supportive facts and the absence of variables which would undermine the reasonableness of the inference of discrimination which is drawn."\textsuperscript{25} In the recent Supreme Court case of \textit{International Brotherhood of Teamsters v. United States},\textsuperscript{26} the Court reaffirmed the importance of statistical proof, but cautioned "that statistics are not irrefutable; they come in infinite variety and, like any other kind of evidence, they may be rebutted. In short, their usefulness depends on all of the surrounding facts and circumstances."\textsuperscript{27}

Appellate courts have articulated guidelines for the use of statistics in order to minimize the inherent limitations of statistical proof. In \textit{Taylor v. Safeway Stores, Inc.},\textsuperscript{28} the Tenth Circuit ruled that the statistical data must be closely related to the specific issue for which it is submitted.\textsuperscript{29} The Fourth Circuit, in \textit{Logan v. General


21. The United States Supreme Court has recently indicated that it may be lenient in certifying class actions in employment discrimination suits. East Tex. Motor Freight System, Inc. v. Rodriguez, 431 U.S. 395 (1977). In that case, the Court asserted that "suits alleging racial or ethnic discrimination are often by their very nature class suits, involving classwide wrongs. Common questions of law or fact are typically present. But careful attention to the requirements of Fed. Rule Civ. Proc. 23 remains nonetheless indispensable." \textit{Id.} at 405.


24. \textit{E.g., Harper v. Trans World Airlines, Inc.}, 525 F.2d 409, 412 (8th Cir. 1975) (size of sample population represented by statistics too small to have predictive or persuasive value). \textit{See} note 107 and accompanying text \textit{infra}.

25. \textit{United States v. Ironworkers Local 86}, 443 F.2d 544, 551 (9th Cir. 1971) (footnote omitted).


28. 524 F.2d 263 (10th Cir. 1975).

29. \textit{Id.} at 272. In \textit{Taylor}, a discharged employee had brought a class action on behalf of himself and all other Negro employees of Safeway Stores in Colorado. \textit{Id.} at 266. The district court, however, limited the size of the class to employees of the store's Denver warehouse. \textit{See id.} at 266–67. As a result, Safeway's employment statistics
Fireproofing Co., refusal to infer the existence of discriminatory hiring practices from a disproportionate representation of minorities in the employer's work force because there was no finding that qualified applicants had been refused employment. In the words of the court, "where such statistics are 'based on community racial proportions,' which is the situation in this case, they are often 'ambiguous' and 'ought to be listened to with a critical ear.'" The United States' Supreme Court echoed these warnings in Hazelwood School District v. United States and International Brotherhood of Teamsters v. United States. Although both decisions noted that gross statistical disparities between a work force and the general population may constitute prima facie proof of a Title VII violation, the Court in each case emphasized the importance of carefully scrutinizing the relevance of the statistical data offered as evidence. For example, in Hazelwood, the statistics in the record failed to differentiate between hiring practices before and after the school district became subject to Title VII. Qualifying the use of statistical proof, the Supreme Court ruled that "once a prima facie case has been established by statistical work force disparities, the employer must be given an opportunity to show 'that the claimed discriminatory pattern is a product of pre-Act [Title VII] hiring rather than unlawful post-Act discrimination.'"
Basic problems inherent in statistical analysis still have not been resolved by the courts, notwithstanding the increased use of statistics to establish prima facie cases under Title VII and the manifold limitations and restrictions on statistical proof that have been prescribed in the case law. This article addresses basic issues in statistical analyses and suggests various methods of statistical proof which may be useful in employment discrimination cases. Section II includes a discussion of statistical significance which advocates the adoption of the .05 level of significance in Title VII cases. Section III compares the use of applicant flow and demographic statistical analyses. Multiple regression and chi-square test are considered in Section IV. Finally, Section V presents a hypothetical example in which a cell model analysis is utilized to rebut a prima facie case of discrimination.

II. THE STATISTICAL CONCEPT OF SIGNIFICANCE

One of the fundamental concepts in the use of statistical analysis to demonstrate or rebut evidence of employment discrimination cases is that of significance. If the data presented by the plaintiff shows a “significant” disparity on the basis of race, sex, religion, national origin, or age, a prima facie case of the violation of Title VII or the Age Discrimination in Employment Act (ADEA) is established. The defendant-employer then must justify each “significant” disparity. Despite its importance, the courts have not specifically addressed the concept of significance, and have not established the proper precedent for sophisticated statistical techniques.

In the study of statistics, the term “significance” is used in connection with the examination of a hypothesis’ validity, and its meaning depends upon the hypothesis tested. Consider the following hypothetical example: Did employer X practice age discrimination when he hired 400 employees from 1000 applicants? To test this hypothesis, the 1000 applicants are assigned a number.

39. See note 6 supra.
40. See notes 87-120 and accompanying text infra.
42. 29 U.S.C. §§ 630–634 (1970 & Supp. V 1975) (protects individuals between the ages of forty and sixty-five years). The first appellate court to apply the Title VII prima facie case standards to the ADEA was the Fifth Circuit. United States v. Hayes Int'l Corp., 456 F.2d 112, 120 (5th Cir. 1972); Hodgson v. First Fed. Sav. & Loan Ass'n, 455 F.2d 818, 823 (5th Cir. 1972) (dictum).
from 1 to 1000 and are subdivided into two groups. One group consists of those individuals who are under forty or over sixty-five years old and, therefore, unprotected by the ADEA. The second group includes all applicants who are between the ages of forty and sixty-five, and thus entitled to protection against age discrimination under the statute. The ratio of applicants covered by the ADEA to those not covered by the statute may then be compared to the ratio of hired applicants covered by the ADEA to those not covered by the statute. If the employer has not discriminated on the basis of age, the proportion of covered individuals who applied for jobs will be similar to the proportion of covered individuals who were hired. If age has been a factor in the employer's hiring practices, the difference between the ratios will be greater than the slight deviation that can be attributed to chance.

Statisticians can calculate the probability that the difference in proportions will not exceed the difference that would be produced by a random selection of the job applicants. In the hypotheses stated above, the disparity between the ratios would be statistically significant at the .05 level if the probability were less than one chance out of twenty that a random selection of job applicants would produce a difference equivalent to the disparity. Although the .01 level of significance is a more stringent standard, it is conceptually the same as the .05 level. A difference is statistically significant at the .01 level if the probability were less than .01 that a random procedure theoretically would produce a difference of that amount. Thus, a "significant" difference is evidence of nonrandomness; in other words, that factors other than chance — such as age — are at work in the hypothesis.

Statistical significance must be distinguished from "legal significance," which is the extent of statistical disparity that the

50. See Statistical Proof and Rebuttal, supra note 6, at 398–99 n.49.
51. See Elementary Statistics, supra note 47, at 94. Theoretically, to rebut a prima facie case of discrimination which is supported by valid statistical evidence, significant at the .01 level, the defendant would also have to present evidence significant at the .01 level. See Statistical Proof and Rebuttal, supra note 6, at 398 n.49.
courts will consider to constitute a prima facie case. Although the concept of significance is essential to the implementation of statistical analysis in discrimination cases, it has rarely been addressed by the courts. Those cases which have addressed the question have employed statistical theory as a guide for interpreting the statistical data. Courts have endorsed the position of professional statisticians who generally treat as significant those deviations that can be expected to occur randomly no more than 5% of the time — the .05 level of significance.

Although some statisticians have argued that the .05 level of significance is completely arbitrary and that the use of a higher or lower level could be more meaningful in some contexts, the use of the .05 level of significance in employment discrimination cases seems appropriate for two major reasons. First, the .05 level is generally used in all except the most rigid laboratory experiments because most people consider the one-out-of-twenty chance that a conclusion is wrong to be an acceptable degree of risk unless special circumstances require a higher or lower degree of certainty. There is no obvious reason why this common sense approach should not be adopted in employment litigation. The second reason which supports the use of the .05 level is that the Equal Employment Opportunity Commission expressly adopts it as the standard for examining the validity of the job relatedness of any test used by an employer to screen employees. Some courts have

53. See, e.g., United States v. Test, 550 F.2d 577, 584 (10th Cir. 1977). See also text accompanying note 68 infra.
54. See, e.g., United States v. Test, 550 F.2d 577, 584 (10th Cir. 1977).
56. Id.
57. E.g., Rozeboom, The Fallacy of the Null-Hypothesis Significance Test, in CONTEMPORARY PROBLEMS IN STATISTICS 122 (B. Lieberman ed. 1971).
58. E.g., Eysenck, The Concept of Statistical Significance and the Controversy about One-Tailed Tests, in CONTEMPORARY PROBLEMS IN STATISTICS 212-13 (B. Lieberman ed. 1971).
59. Rozeboom, supra note 57, at 118. Section 1607.5(c)(1) of the Equal Employment Opportunity Commission Guidelines on Employee Selection Procedure (EEOC Guidelines), 29 C.F.R. § 1607.5(c)(1) (1976), sets forth one circumstance where a degree of certainty higher than the .05 level of significance is required. Section 1607.5(c)(1) provides:
   (c) In assessing the utility of a test the following considerations will be applicable:
      (1) The relationship between the test and at least one relevant criterion must be statistically significant. This ordinarily means that the relationship should be sufficiently high as to have a probability of no more than 1 to 20 to have occurred by chance. However, the use of a single test as the sole selection device will be scrutinized closely when that test is valid against only one component of job performance.
56. See, e.g., United States v. Test, 550 F.2d 577, 584 (10th Cir. 1977).
utilized the .05 level of significance in this context, but have viewed it as “a desirable goal and not a prerequisite.” Given the judicial precedent for using this level of significance to provide at least a benchmark in evaluating employment practices, an inference of discrimination should thereby be dispelled when the disparity between the employer’s work force and the general population of applicants falls within the .05 level of significance.

In United States v. Test, one of the only discrimination cases that addressed the concept of legal significance, the Tenth Circuit ruled that legal and statistical significance are not necessarily equivalent. In that case, the defendants claimed that Colorado’s method of selecting potential members for federal grand and petit juries violated the fifth and sixth amendments of the United States Constitution and the federal Jury Selection and Service Act of 1968, because the selection process resulted in substantial underrepresentation of chicanos, blacks, and persons under forty years of age. The disparities between the proportion of chicanos and blacks in the general population and the voter registration lists from which the juror lists were derived were not large, but the court found them to be statistically significant. Nevertheless, in the words of the Tenth Circuit “[t]he mathematical conclusion that the disparity between these two figures is ‘statistically significant’ does not, however, require an a priori finding that these deviations are ‘legally significant’ . . . .” The Tenth Circuit relied on Swain v. Alabama, where the United States Supreme Court held that a claim of systematic exclusion of blacks from juries was not established, even though the defendant had shown that blacks comprised 26% of the male population in the country, but only 10-15% of the jury members. In its consideration of Swain, the Test court noted:

In the present [case] the maximum disparity demonstrated by defendants between the percentages of blacks and Chicanos in the voting-age community and on the master jury rolls was

61. United States v. Georgia Power Co., 474 F.2d 906, 915 (5th Cir. 1973). The Georgia Power court, in its discussion of § 1607.5(c)(1) of the EEOC Guidelines, noted that the section’s requirement of a .05 level of significance “must not be interpreted or applied so rigidly as to cease functioning as a guide and become an absolute mandate or proscription.” Id. For the text of § 1607.5(c)(1), see note 59 supra.
62. 550 F.2d 577 (10th Cir. 1977).
63. Id. at 584.
64. U.S. Const. amends, V, VI.
66. 550 F.2d at 581.
67. Id. at 583-84.
68. Id. at 584.
69. 380 U.S. 202 (1965); see 550 F.2d at 586-87.
70. 380 U.S. at 205 (1965).
approximately 4%. Since this figure is well below the 10-16% range of disparity approved in Swain, the district court properly concluded defendants had failed to establish a prima facie case of systematic exclusion and accepted the government's general explanations and asseverations of good faith in rebuttal.71

Unfortunately, the Tenth Circuit in Test did not specify the degree of disparity that would be legally substantial. The case does, however, provide a new ground for challenging a prima facie employment discrimination case or rebutting a defense to such a case, because the litigants can argue that a statistical analysis, although significant to a statistician, is not necessarily significant in a court of law.72

III. THE USE OF DATA IN APPLICANT FLOW AND DEMOGRAPHIC ANALYSES

The two most common types of statistical analyses in Title VII cases utilize what may be described as either applicant flow or demographic data.73 Analyzing applicant flow data entails a comparison of the applicant pool with hired employees, as demonstrated by the hypothetical example given in Section II.74 In contrast, the demographic method involves a comparison of minority group representation in the employer's work force with that of the general population in the geographical area.75 Through an examination of cases that have considered demographic and applicant flow data, it will be demonstrated that the selection of the appropriate analytical method depends upon the facts of each case.

A. Demographic Data Analysis

The demographic method of statistical analysis is intended to reveal evidence of purposeful discrimination. Although Title VII

71. 550 F.2d at 587.
72. See id. at 584.
73. For a treatment of the demographic technique, see Statistics and Preferences, supra note 6, at 465-72. For a discussion of applicant flow analysis, see B. Schlei & P. Grossman, supra note 18, at 1165-67.
74. See notes 44-50 and accompanying text supra. See also notes 121-133 and accompanying text infra.
75. On many occasions, federal courts have compared the composition of the company's work force with the composition of the labor force in the surrounding area. See, e.g., Crockett v. Green, 534 F.2d 715, 718 (7th Cir. 1976); Long v. Sapp, 502 F.2d 34, 40 (5th Cir. 1974); Erie Human Relations Comm'n v. Tuillo, 493 F.2d 371, 373 n.4 (3d Cir. 1974); Bridgeport Guardians v. Bridgeport Civil Serv. Comm'n, 482 F.2d 1333, 1335 (2d Cir. 1973); Castro v. Beecher, 459 F.2d 725 (1st Cir. 1972). See also note 79 infra.
does not require "an employer's work force to be racially bal-
anced," the use of demographic data to prove employment
discrimination has been endorsed by the Supreme Court. In
International Brotherhood of Teamsters v. United States, the
Supreme Court noted:

Statistics showing racial or ethnic imbalance are probative . . .
only because such imbalance is often a telltale sign of purposeful
discrimination; absent explanation, it is ordinarily to be
expected that nondiscriminatory hiring practices will in time
result in a work force more or less representative of the racial
and ethnic composition of the population in the community from
which employees are hired. Evidence of longlasting and gross
disparity between the composition of a work force and that of
the general population thus may be significant even though . . .
Title VII imposes no requirement that a work force mirror the
general population.

The preliminary task in the use of demographic data is to
determine the appropriate "general population" to compare with the
employer's work force. The relevant points of comparison may be
between the minority group representation among the employees
and the labor market in the surrounding city, county, or state. An
increasing number of jurisdictions have utilized Standard Metropoli-
tan Statistical Area (SMSA) data, which is taken from the national
census grouping in the area surrounding the employer's place of
business. After determining that SMSA data is relevant to the case,
some appellate tribunals have criticized trial courts because the size of the SMSA was inappropriate.\footnote{E.g., Patterson v. American Tobacco, 535 F.2d 257 (4th Cir. 1976).}

\textit{Taylor v. Safeway Stores, Inc.}\footnote{524 F.2d 263 (10th Cir. 1975).} demonstrated that both the size of the employer work force and the SMSA used in the statistical analysis must be appropriately chosen. In that case, the plaintiff-employee brought an individual claim and a class action, alleging that the defendant's hiring practices violated Title VII.\footnote{Id. at 266; see note 29 supra.} In denying the class action claim on the basis of a finding of no statistical disparity, the Tenth Circuit ratified the district court's comparison of the Denver SMSA data with the data collected from the Safeway warehouse involved in the suit.\footnote{524 F.2d at 272.} The circuit court reasoned:

The district court compared the percentage of blacks living in the Denver Standard Metropolitan Statistical Area, 4.1 percent, with the number of blacks hired by Safeway at the \textit{frozen food warehouse} between 1968 and 1972, an average of 18 percent each year . . . . Since the district court limited Taylor's class claim to the frozen food warehouse [instead of Denver Safeway Stores generally] its choice of data for comparison was proper . . . . \footnote{Id. (footnote and citation omitted) (emphasis in original).} We find no substantial statistical disparity in blacks employed at the warehouse to prove a prima facie case of past discrimination by Safeway in its hiring at the frozen food warehouse.\footnote{See id.}

Thus, the court demonstrated that once the appropriate size of the SMSA is chosen, it still must be compared to the relevant work force — the frozen food warehouse, instead of all the Safeway stores in the area.\footnote{See notes 90-95 and accompanying text infra.}

In the choice of the relevant surrounding labor market for demographic analyses, three types of problems have surfaced in the case law: 1) some courts have mistakenly compared the employer's work force to groups other than the local labor market;\footnote{See notes 96-114 and accompanying text infra.} 2) courts have noted that statistics of the general population do not always reflect the pool of qualified job applicants;\footnote{See notes 115-117 and accompanying text infra.} and 3) some courts have compared the representation of a single minority group on the employer's staff with the total minority population in the surrounding area.\footnote{81. \textit{E.g.}, Patterson v. American Tobacco, 535 F.2d 257 (4th Cir. 1976). 82. 524 F.2d 263 (10th Cir. 1975). 83. \textit{Id.} at 266; see note 29 supra. 84. 524 F.2d at 272. 85. \textit{Id.} (footnote and citation omitted) (emphasis in original). 86. See \textit{id.}. 87. \textit{See notes} 90-95 and accompanying text infra. 88. \textit{See notes} 96-114 and accompanying text infra. 89. \textit{See notes} 115-117 and accompanying text infra.
problems, others have provided rulings that should serve as a guide in the future.

The first type of problem was exemplified in *Hazelwood School District v. United States*, where the district court relied upon a comparison of the percentage of black teachers in the school district to the number of black pupils in the school. The trial court held for the school district, and the Eighth Circuit reversed on the basis of a sufficient statistical disparity in the record:

The district court erred in comparing the percentage of black teachers in Hazelwood with the percentage of black students in its schools rather than with the percentage of black teachers in the relevant labor market area. The law is well-settled that the relevant consideration in an employment discrimination case is the statistical disparity between the proportion of blacks in the employer's workforce and the proportion of blacks in the labor market . . . .

On appeal to the United States Supreme Court, the case was remanded to the trial court because the appellate court's finding of a statistical disparity in the record denied the employer an opportunity to rebut the prima facie case. The Supreme Court, however, affirmed the Eighth Circuit's criticism of the type of comparison admitted by the trial judge:

There can be no doubt . . . that the District Court's comparison of Hazelwood's teacher work force to its student population fundamentally misconceived the role of statistics in employment discrimination cases. The Court of Appeals was correct in the view that a proper comparison was between the racial composition of Hazelwood's teaching staff and the racial composition of the qualified public school teacher population in the relevant labor market.

90. *77 S. Ct. 2736 (1977).*
92. 392 F. Supp. at 1286.
93. *United States v. Hazelwood School Dist., 534 F.2d 805, 812 (8th Cir. 1976).* The Eighth Circuit further commented: "The level of black student enrollment in Hazelwood school sheds no light whatsoever upon the dispute before us, and the district court clearly erred in absolving Hazelwood of unlawful employment practices on the basis of the paucity of black students in the Hazelwood schools." *Id.*
94. *77 S. Ct. at 273-74. See notes 17-18 and accompanying text supra.*
95. *Id.* at 2742 (footnote and citation omitted).
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The second type of problem involving selection of the appropriate local work force is the comparison of qualified applicants for skilled positions with the general work force population. In *James v. Stockham Valves and Fittings Co.*, a district court properly directed:

When considering the number of blacks in jobs which require special skills and abilities, the relevant figure for comparison purposes is the percentage of blacks in the local labor market who are qualified for such jobs. The relevant labor pool cannot be assumed to be the same as the general population where the jobs demand skills and training possessed by relatively few individuals.

The Supreme Court of the United States was faced with a similar issue in *Mayor of Philadelphia v. Educational Equality League*, where Philadelphia civic leaders claimed that Mayor Tate violated the equal protection clause of the fourteenth amendment by discriminating against blacks in the appointment of the school board nominating panel. According to the City Charter, nine of the thirteen panel members were to consist of “the highest ranking officer of [each] one of nine categories of citywide organizations.”

The district court held that “differences between the percentage of Negroes in the city’s population (34%) or in the student body of the public school system (60%) and the percentages of Negroes on the 1971 Nominating Panel (15%) had no significance.” The Third Circuit reversed, finding racial discrimination by relying in part on the percentage comparisons that had been rejected by the district court.

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97. Id. at 496 (citations omitted).
99. Id. at 609.
100. Id. at 607.
102. Educational Equality League v. Tate, 472 F.2d 612, 618 (3d Cir. 1973). In finding a significant statistical disparity based on the data presented to the district court, the Third Circuit stated: “The small proportion of blacks on the Panel is significant in light of the racial composition of the public schools, which are about 60% black. Because one qualification for Panel membership is interest in the public school system and because the parents of school children are likely to have this interest, a colorblind method of selection might be expected to produce that many more black Panel members. Thus, properly considered, the small proportion of blacks on the Panel points toward the possibility of discrimination.”
Citing two statistical principles which the appellate court had neglected, the Supreme Court agreed with the district court that there was no reliable proof of discrimination in the record.\textsuperscript{103} The Court initially noted that the percentage comparisons between the racial composition of the panel and the city population failed to take into account the high qualifications required of panel members.\textsuperscript{104} The Court stated, "the relevant universe for comparison purposes consists of the highest ranking officers and the categories of organizations and institutions specified in the city charter, not the population at large."\textsuperscript{105} Second, since the only panel had thirteen members, and "the addition or subtraction of a single Negro meant an 8\% change in racial composition,"\textsuperscript{106} the Court concluded that the universe was too small to produce statistically significant comparisons.\textsuperscript{107}

In a similar case, \textit{James v. Wallace},\textsuperscript{108} the Fifth Circuit also rejected a demographic comparison. In that case, Governor George C. Wallace was charged with systematically discriminating against blacks in his appointments to state boards and commissions.\textsuperscript{109} The evidence showed that, although 23\% of the state's citizens were black, less than 1\% of the Governor's appointees were black.\textsuperscript{110} The court held that plaintiffs' demographic analysis had not made out a \textit{prima facie} case, finding that "not every black person in Alabama is qualified to serve on the boards and commissions named in this action. For many such bodies there are very specialized prerequisites . . . ."\textsuperscript{111}

Another example of demographic comparisons of qualified and unqualified individuals is \textit{Patterson v. American Tobacco Co.}\textsuperscript{112} The defendant company in that case argued that the district court had erroneously considered the number of blacks and women in the Richmond SMSA general workforce, rather than using only the blacks and women in the Richmond SMSA supervisory workforce, to
ascertain a ratio applicable to promotions. The Fourth Circuit agreed with the company and stated:

The record discloses that 6.8 percent of the blacks and 1.5 percent of the women in the Richmond SMSA are placed in a category that includes supervisory personnel. Those percentages furnish a more realistic measure of the company's conduct than the gross percentage of blacks and women in the whole workforce, including unskilled labor.

The third type of error which is prominent in employment discrimination cases is the comparison of statistics for a single minority group with those for the entire minority population. In Rios v. Enterprise Association Steamfitters Local 638, the district court had ordered the defendant steamfitters union to achieve a 30% representation of black and Spanish surnamed individuals in the union's apprenticeship program as a remedy for past discrimination. The Second Circuit held that the representation goal was inaccurate noting that

[the trial judge's comments at one point during the proceedings indicate that the [30%] figure was prompted by regulations recently proposed by the Deputy Mayor-City Administrator of the City of New York, which set a goal of 28% “minority” steamfitters to be reached by June 30, 1977. However, this proposed figure (which is not part of the record below) was based on a definition of the term “minority” which includes not only Negroes and Spanish surnamed Americans but Orientals, American Indians and, where appropriate, females and other classes of individuals which have been the subject of past discriminatory practices.]

This type of problem was avoided in Kaplan v. International Alliance of Theatrical Employees by the selection of the proper minority comparison group. In Kaplan, SMSA data was used to compare female membership in the defendant-union to the female

113. Id. at 274. This objection was based on the district court's finding that the American Tobacco Co. had engaged in sex and race discrimination in the selection of supervisors. See id. at 272.
114. Id. at 275.
115. 501 F.2d 622 (2d Cir. 1974).
117. 501 F.2d at 632.
118. 525 F.2d 1354 (9th Cir. 1975).
population of the relevant labor force.\textsuperscript{119} In the words of the Ninth Circuit:

Upon showing disproportionate female membership in a union in comparison to the available female work force in a demographic area, an inference arises that the sex imbalance results from discrimination, and the burden of going forward and the burden of persuasion is shifted to the accused, for such a showing is sufficient to establish a prima facie case of sex discrimination.\textsuperscript{120}

The other method used for proving a prima facie case of discrimination is the utilization of applicant flow data.\textsuperscript{121} The applicant flow analysis is simply a comparison of the proportion of minority representation among the total applicants with the minority representation among the successful applicants — the employees.\textsuperscript{122} In \textit{United States v. Georgia Power Co.},\textsuperscript{123} evidence that only 7.2\% of the employer’s workforce was black, while 33\% of the applicants for employment at some of defendant’s plants were black,\textsuperscript{124} along with evidence of overtly discriminatory acts,\textsuperscript{125} presented a prima facie case of racial discrimination in hiring.\textsuperscript{126} In \textit{Johnson v. Goodyear Tire and Rubber Co.},\textsuperscript{127} the Fifth Circuit compared the percentage of newly hired blacks placed in the lowest job grade (40\%) with the percentage of new employees generally who were placed at that level (5\%).\textsuperscript{128} Thus, 95\% of the total applicants

\textsuperscript{119} Id. at 1358.
\textsuperscript{120} Id.
\textsuperscript{121} For a detailed analysis of applicant flow data, see B. SCHLEI & P. GROSSMAN supra note 18, at 1165–67. See also text accompanying notes 44–50 & 74 supra. A third method of analysis, “comparative” analysis, is related to the applicant flow method, because it involves the use of statistics to compare the treatment of minority employees of the company. \textit{Statistics and Preferences}, supra note 6, at 468–72. For applications of comparative analysis, see Bolton v. Murray Envelope Corp., 493 F.2d 191, 195 (5th Cir. 1974) (court relied on evidence that 34\% of black employees had janitorial positions, while less than 6\% of white employees held such positions, and that 100\% of higher-paid printers and office workers were white to establish prima facie employment discrimination case); United States v. Hayes Int'l Corp., 415 F.2d 1038, 1040 (5th Cir. 1969) (court relied on evidence that 96\% of white employees were positioned in seven highest pay grades, while 77\% of black employees held jobs at three lowest pay grades to establish prima facie case).
\textsuperscript{122} See, e.g., Hester v. Southern Ry., 497 F.2d 1374, 1379 (5th Cir. 1974).
\textsuperscript{123} 474 F.2d 906 (5th Cir. 1973).
\textsuperscript{124} Id. at 910 n.2.
\textsuperscript{125} Id. at 925–26. The Fifth Circuit concluded that word-of-mouth hiring practices and a policy of recruiting skilled applicants only from all-white institutions had a discriminatory effect on black employment. \textit{Id}.
\textsuperscript{126} Id. at 910 n.2.
\textsuperscript{127} 491 F.2d 1364 (5th Cir. 1974).
\textsuperscript{128} Id. at 1369 n.4. This exemplifies the “comparative” statistical technique. See note 121 supra.
hired were placed into higher job grades, while only 60% of the blacks hired were so placed. 129 This disparity was held by the district court to constitute a prima facie case. 130

Although applicant flow analysis often provides stark percentage comparisons, it can be misleading. The district court in Patterson v. Western Development Labs, 131 considered evidence of alleged discrimination in hiring based upon a pool of 5000 applications. 132 Concluding that the applicant pool had been incorrectly drawn, the court rejected the data:

These statistics on actual applicants . . . are incomplete, because they were taken from data which included only the 5,000 applicants who applied “in person” at defendant’s Palo Alto facility — a group that generally applies for lower skilled positions — and did not include the 8,000 additional applicants who applied “by mail” — a group from which defendant hires by far the greater number of its employees. . . .

It further appears from the evidence that plaintiffs, in comparing the percentages of blacks who applied for employment to the percentage of blacks actually hired, compared the percentage of black applicants only in the “in person” group (11.1%) with the percentage of blacks actually hired from both the “in person” and the “by mail” applicants group. 133

There is controversy over whether applicant flow or demographic data provide the most reliable evidence. 134 If the role of statistics in civil rights litigation expands in the future, continued conflict over this question can be anticipated. In Hester v. Southern Railway Co., 135 the Fifth Circuit concluded that the applicant flow analysis was superior: “The most direct route to proof of racial discrimination in hiring is proof of disparity between the percentage of blacks among those applying for a particular position and the percentage of blacks among those hired for the position.” 136 The same court, however, in Jones v. Tri-County Electric Cooperative, Inc., 137 emphatically endorsed the demographic method of analysis,

129. See 491 F.2d at 1369.
132. Id. at 774.
133. Id. (emphasis in original).
134. See B. SCHLEI & P. GROSSMAN, supra note 18, at 1165.
135. 497 F.2d 1374 (5th Cir. 1974).
136. Id. at 1379.
137. 512 F.2d 1 (5th Cir. 1975).
noting that "[t]he statistics which the courts have always considered is the racial composition of the employer's work force as compared to the percentage of the minority population the employer's service area." 138 A district court, in Robinson v. Union Carbide Corp.,139 carefully scrutinized the applicability of a demographic analysis in general and stated:

The implication of present decision law is that if industry employs blacks below the ratio of minority to majority in the area work force it is prima facie evidence of discrimination. As affecting the industry involved in this case, the evidence is that the hourly employees meet the quota as established by this ratio. However, the ratio of applicants more nearly approximates 50-50, which is considerably higher than the ratio of minority to majority in the work force, ergo, this industry discriminates. This is so because these statistics, as in other cases, show a prima facie case of discrimination and therefore the burden shifts to the industry to prove that it has some justifiable business purpose why the employment ratio ought not to be 50-50. Advancing the same argument to its ultimate conclusion, you can envision a situation where the number of applications were maneuvered to or legitimately filed so as to reflect 100 percent with the result [that] the industry employees would become all black or nearly so. This is a strange anomaly. An industry could never become all white without being discriminatory, but it could become all black without being discriminatory — (at all cost we must avoid situations that would require considerations of questions of reverse discrimination). Another glaring anomaly is that if such a theory is accepted and followed, what occurs when the ratio and applicants vary from day to day, week to week and year to year? Industry would never know when it was or was not in compliance, and can't you imagine the argument if the application ratio fell below the area work force ratio?140

The applicant flow and the demographic analysis are each useful in a variety of specific fact situations.141 A recent development will undoubtedly bolster the reliability of SMSA data in demographic analysis. On October 17, 1976, Congress mandated that a mid-decade census be undertaken in addition to the traditional decennial census.142 The updating of the population data through survey and

138. Id. at 2.
140. Id. at 736–37.
statistical techniques will clearly upgrade the relevancy and usefulness of SMSA data and, therefore, the demographic method of analysis in civil rights litigation.

IV. THE USE OF SOPHISTICATED STATISTICAL ANALYSES

The vast study of statistics offers litigants a variety of analytical approaches for presenting and rebutting arguments in discrimination suits. Two of the more sophisticated statistical methods, multiple regression\(^\text{143}\) and the chi-square test,\(^\text{144}\) however, by and large remain untapped. The technique of multiple regression, which can determine the degree of influence that one variable — age — has over another variable — salary — is easily adaptable to defend against a prima facie case of discrimination.\(^\text{145}\) Regression analysis can best be explained by presenting an example of simple linear regression, where there is only a single explanatory variable.\(^\text{146}\) The example is depicted by a graph with the characteristic to be explained — salary — represented on the vertical axis and the explaining factor — age — represented on the horizontal. Each employee is illustrated by a point on the graph. Linear regression estimates the line that is the closest to this conglomeration of points.\(^\text{147}\) If the effect of factors not considered in the analysis (merit, seniority, etc.) is negligible, the points will form a relatively straight line.\(^\text{148}\) If there are substantial unexplained influences, the points will not line up. Regression analysis finds the line that best depicts the relationship between the variables examined.\(^\text{149}\) Multiple regression is simply an extension of simple linear regression to the use of several explanatory variables, each of which has a separate axis.\(^\text{150}\)

In the context of an employment discrimination case, assume that an employer is charged with giving discriminatory raises.

\(^{143}\) For a discussion of the use of multiple regression analysis and variance analysis to prove employment discrimination cases, see Statistical Proof and Rebuttal, supra note 6, at 395–405. According to the commentary, “[t]he term ‘regression’ is a carryover from the first use of this statistical method, Karl Pearson’s study of height of fathers and sons to prove the law of ‘regression to the mean.’” Id. at 395 n.35, quoting G. SneCDECOR & W. COCHRAN, STATISTICAL METHODS 164 (6th ed. 1967).

\(^{144}\) For a detailed discussion of the chi-square test, see N. DOWNIE & R. HEATH, BASIC STATISTICAL METHODS ch. 14 (1959); A. HUGHES & D. GRAWOIG, STATISTICS: A FOUNDATION FOR ANALYSIS ch. 11 (1971).

\(^{145}\) See Statistical Proof and Rebuttal, supra note 6, at 409–15.

\(^{146}\) Id. at 398 n.48.

\(^{147}\) Id.

\(^{148}\) See A. Hughes & D. Grawoig supra note 144, at 316.

\(^{149}\) Id.

\(^{150}\) Statistical Proof and Rebuttal, supra note 6, at 398 n.48.
Suppose each employee’s last annual raise is the dependent variable — $Y$ — and the following factors represent the independent variables: age $X_1$, years of education $X_2$, years of seniority in the particular company $X_3$, and race $X_4$. A numerical value could be assigned for each of the five variables for every employee. Since the $X_1$, $X_2$, and $X_3$ variables are “continuous” i.e., they exist to different degrees, they are directly quantifiable. However, the $X_4$ variable — race — is “binary” i.e., there are only two race classifications in the hypothetical. Numerical values for $X_4$ must be assigned by membership in a group — 0 for nonwhite and 1 for white, or vice versa.

The equation for this hypothetical would be of the form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$$

where $b_0$ is a constant; $b_1$ measures the marginal change in the annual salary raise, $Y$, which is associated with an additional year of age, all other things being equal; $b_2$ measures the change in $Y$ which is associated with an additional year of education, all other things being equal; and $b_3$ measures the change in $Y$ which accompanies one additional year of seniority. The $b_4$ figure represents the change in $Y$ that is attributable to the fact that the employee is white — a change in $X_4$ from 0 to 1. If the defendant company has not discriminated on the basis of race, $b_4$ will not differ significantly from 0.

Regression analysis offers evidence in a relatively simple and easily comprehensible format. It can be applied to charges of discrimination at almost any stage of the employment process, and an equation can easily be expanded to fit the data by adding other independent variables. However, despite its appeal, a regres-

151. According to one commentator:

In order to use . . . [multiple regression analysis], the measurement of the observed characteristic whose variance is to be explained must be in numeric form. If the quantity actually being explained, for example salary, were available only in the form of levels, such as three tiers (apprentice, journeyman, and craftsman), quantitative analysis . . . would then be difficult. 

Id. at 396 n.43, citing M. EZEKIEL & K. Fox, METHODS OF CORRELATION AND REGRESSION ANALYSIS 378-87 (3d ed. 1959).

152. For a discussion of discrete (including binary) and continuous variables, see A. HUGHES & D. GRAWOIG, supra note 144, at 42-43.

153. Statistical evidence can be applied to cases of discriminatory hiring, promoting, or discharging of employees, in addition to certain inequitable work conditions, such as salary differentials. For the most part, however, “[a]llegations of discrimination in work conditions are not susceptible to proof by statistics . . . .” James v. Stockham Valves & Fittings Co., 394 F. Supp. 434, 456 (N.D. Ala. 1975). See note 151 supra.
sion analysis has been utilized in only one case. In Wade v. Mississippi Cooperative Extension Service, the trial court relied partially upon plaintiffs' regression analysis to hold that the plaintiffs had established a prima facie case of discrimination in hiring and promotion. In its brief to the Fifth Circuit, defendants attempted to discredit the foundation of the regression analysis. Relying on expert witness' testimony, defendants alleged that the application of regression analysis to the field of social science violated sound statistical procedures.

The Fifth Circuit rejected defendants' contentions on two grounds. First, it found that the district court had relied upon both the regression analysis and evidence that although eighty-seven vacancies existed, no black was ever promoted to such a position. Secondly, the court held that the regression analysis was valid in this context:

Although multi-variate regression analysis is indeed a sophisticated and difficult method of proof in an employment discrimination case, there was additional evidence of specific instances of black and white workers with essentially similar experience and qualifications receiving disparate salaries. Thus, we find that while in some instances the statistical facts spoke for themselves, as in the absence of promotions of black professional workers, in other cases, there was evidence beyond the statistical facts and analysis that would support an inference of discrimination, as in the case of salaries.

This use of a sophisticated analysis by litigants graphically demonstrates the courts' hesitancy to deal with statistics. Instead of squarely addressing multiple regression, the court "hung its hat" on evidence with which it was more familiar — testimony of specific instances of discrimination. In acknowledging the use of multiple regression in a social statistics setting, however, the court implicitly opened the door for its future use.

154. 372 F. Supp. 126 (N.D. Miss. 1974); aff'd, 528 F.2d 508 (5th Cir. 1976).
155. 372 F. Supp. at 140.
157. 528 F.2d at 517.
158. Id.
159. Id.
160. Id. (footnote omitted).
161. Id. The Fifth Circuit has been the most consistent to rule that statistical proof alone creates a presumption, or a prima facie case, of discrimination, without the need to show evidence of specific acts of discrimination. See, e.g., Resendis v. Lee Way Motor Freight, Inc., 505 F.2d 69, 70-71 (5th Cir. 1974); Rodriguez v. East Tex. Motor Freight Systems, Inc., 505 F.2d 40, 53 (5th Cir. 1974), rev'd in part, 431 U.S. 395 (1977);
Another sophisticated statistical technique that has been utilized by litigants is the chi-square test.\textsuperscript{162} Chi-square is a test for significance which utilizes contingency tables to determine whether observed differences in any sample are greater than those which can be expected on the basis of chance.\textsuperscript{163} Frequencies are first calculated from the data with the aid of a standard contingency table on the theory that the data are distributed in a particular curve by chance.\textsuperscript{164} If the distribution is nonrandom and an assignable cause is involved, the resulting differences will be higher than the differences that are likely to be observed in a random situation.\textsuperscript{165} Then the values of the chi-square statistic can be analyzed to ascertain whether or not there is a significant disparity.\textsuperscript{166}

Unlike the district court in \textit{Wade},\textsuperscript{167} the trial court in \textit{Chance v. Board of Examiners}\textsuperscript{168} presented an in-depth analysis of the litigants' use of the chi-square test based upon the testimony of opposing statisticians.\textsuperscript{169} The plaintiffs alleged that examinations prepared and administered by defendants for the licensing of supervisory personnel had the effect of discriminating against blacks and Puerto Ricans.\textsuperscript{170} Plaintiffs' expert testified that the sample was large, and thus formed a sound basis for drawing statistical conclusions.\textsuperscript{171} In analyzing the aggregate data by means

\begin{quote}
Pettway v. American Cast Iron Pipe Co., 494 F.2d 211, 225 (5th Cir.), rehearing denied \textit{en banc}, 494 F.2d 1296 (5th Cir. 1974); United States v. Hayes Int'l Corp., 456 F.2d 112, 120 (5th Cir. 1972); Hodgson v. First Fed. Sav. & Loan Ass'n, 455 F.2d 818, 822-23 (5th Cir. 1972) (dictum in age discrimination case).

However, in other cases, the Fifth Circuit has qualified its broad ruling that employment discrimination suits can be proved without evidence of an overt discriminatory act. In the words of the court, "[s]ometimes statistical evidence alone will suffice; on other occasions live testimony or additional exhibits may be necessary." United States v. United States Steel Corp., 520 F.2d 1043, 1053 (5th Cir. 1975), rehearing denied \textit{en banc}, 525 F.2d 1214 (5th Cir. 1976). Accord, United States v. Ironworkers Local 86, 443 F.2d 544, 551 (9th Cir. 1971), \textit{cert. denied}, 404 U.S. 984 (1971). Both of these cases, however, may be distinguished because they were actions brought by the Attorney General against a "pattern or practice" of discrimination, pursuant to § 707 of Title VII, 42 U.S.C. § 2000e-6 (1970). \textit{See} note 13 \textit{supra}.


164. N. Downie & R. Heath, \textit{supra} note 144, at 149.

165. A. Hughes & D. Grawoig, \textit{supra} note 144, at 236.


167. \textit{See} notes 154-161 and accompanying text \textit{supra}.


169. 330 F. Supp. at 211.

170. \textit{Id.} at 205.

171. \textit{Id.} at 211. In the period in question, the evidence showed that the examinations had been administered to 6,201 candidates for supervisory positions. \textit{Id.} at 210. Of the 6,201 candidates, 5,910 were identified by their race; thus, the sample consisted of those 5,910 candidates. \textit{Id.} The gross aggregate pass-fail statistics revealed that the overall pass rate was 44.3% for white candidates and 31.4% for nonwhite candidates. \textit{Id.}
of the chi-square test, the witness found that "the probability of the
difference being a chance result not related to the factor of race is
determined as less than one in one billion." 172

In rebuttal, defendants' statistician challenged the use of
aggregate data based upon the possibility of overlap — that the
same persons may have taken more than one examination. 173 The
court rejected the overlap argument for three reasons. First, it held
that although defendants had the data from which to adduce how
many overlaps existed, it failed to restructure the sample accord-
ingly. 174 Second, the defendants' expert conceded that a random
overlap would not have substantially affected the probabilities; in
fact, he testified that even an overlap of 50% would not have
substantially affected the significance of the observed difference
between the white and nonwhite pass rates. 175 Third, testimony of
plaintiff's statistician revealed that the aggregate pass-fail rates
were too high to be a mere matter of chance, even if the probability
were reduced somewhat because of the overlap. 176

The plaintiffs presented another sample which consisted of the
fifty examinations that formed the raw material for the aggregate
pass-fail data. 177 The court criticized the sample because it was too
small:

41 of the 50 examinations were taken by only 83 (or 10.1%) of the
total number of Black and Puerto Rican candidates. Because of
the smallness of the sample in each instance the resulting
figures for each examination, when analyzed individually,
cannot be accorded much weight or significance for our
purposes. Although statisticians can analyze very small samples
through use of a method called the Fisher Exact Probability Test
in conjunction with the Chi-Square (Yates-corrected) Test, in our
opinion such a sample is less reliable than analyses based on
larger samples, even after making allowances for greater
margins of error in use of the small sample. Use of the small
sample involves more extrapolation and theory superimposed on
less fact. We prefer the greater fact content found in the larger
sample. For the reasons explained by . . . [the plaintiff's expert] —
principally the risk of spurious differences based on
insufficient evidence — we do not believe that meaningful
conclusions as to differences can be drawn from the meager data
derived from any one of these 41 examinations. 178

172. Id. at 212 (emphasis in original).
173. Id.
174. Id.
175. Id.
176. Id.
177. Id.; see note 171 supra.
178. 330 F. Supp. at 212.
It is submitted that the court's analysis failed to consider that in probability theory, the size of a sample does not necessarily have an impact on its reliability. By making a mathematical adjustment involving the "degrees of freedom," which compensates for the smallness of the sample, it will provide data that is equally reliable to that from much larger samples.\textsuperscript{179}

The Second Circuit affirmed the district court's findings and analysis.\textsuperscript{180} The defendants argued that other reasons could be inferred for the underrepresentation of blacks and Puerto Ricans in the supervisory positions.\textsuperscript{181} While acknowledging the possibility of these influences,\textsuperscript{182} the court held that the district court's findings were not clearly erroneous.\textsuperscript{183}

Thus, litigants can find support for the utilization of sophisticated statistical techniques presented to courts by expert witnesses. Virtually scores of analyses are available to fit the specific data in any employment situation. With the aid of a creative statistician and computer programmer, no data in employment discrimination cases is too complex for the application of statistical analysis.

V. BETTER USE OF STATISTICS — A PRACTICAL APPLICATION

The question arises whether or not a judge, who is generally skeptical of numbers and unfamiliar with the language of mathematics, will be receptive to this form of proof. As the following hypothetical example illustrates,\textsuperscript{184} it is possible to combine sophisticated statistical techniques with the common sense realities of the employment situation to produce a persuasive defense to allegations of employment discrimination.

The hypothetical P. Miller Inc., an industrial employer, has several satellite manufacturing plants throughout the United States. Each plant is autonomous as to hiring and personnel policies. The

\textsuperscript{179} Mayo, \textit{Towards Strengthening the Contingency Table as a Statistical Method}, in \textit{Contemporary Problems in Statistics} 339 (B. Lieberman ed. 1971).
\textsuperscript{180} Chance v. Board of Examiners, 458 F.2d 1167 (2d Cir. 1972).
\textsuperscript{181} \textit{Id.} at 1173.
\textsuperscript{182} \textit{Id.}
\textsuperscript{183} \textit{Id.} The Second Circuit noted:
The question before us is whether the trial judge on the record before him was required to accept those inferences, and it is quite clear that he was not. In sum, while not all of us might have made the same factual inferences of racially discriminatory effect from the statistical evidence, both documentary and oral, before the court, none of us can say with the firm conviction required that those factual findings were mistaken.
\textsuperscript{184} The facts of this hypothetical are loosely based upon, and the statistics drawn from, the court's findings in United States v. Georgia Power Co., 474 F.2d 906, 925 (5th Cir. 1973). \textit{See} notes 123-126 and accompanying text \textit{supra}. 

http://digitalcommons.law.villanova.edu/vlr/vol23/iss1/2
Harper City plant (P. Miller — Harper City) has no formula for hiring. Assume that it leaves the actual decision to the personnel director, Sam Jones, who screens all completed applications after a job opening has been advertised in the community. Following a large recruitment of employees, charges of race discrimination in hiring were filed by several black men against P. Miller-Harper City. Suit was filed and plaintiffs presented statistics showing that only 7.2% of the employer's workforce was black despite the fact that 33% of the applicants for employment were black.\(^{185}\)

In rebutting the prima facie case made out above, the employer has two alternatives: Show that plaintiffs' data are wrong, or indicate how it fails to reveal any significant statistical disparities to the disadvantage of a minority group. This hypothetical example will illustrate the first approach, with reliance on the second where the data do not sufficiently prove the hypothesis.

Assume that P. Miller-Harper City was convinced that the percentage of black applicants — 33% — did not accurately reflect the number of qualified applicants. A statistician was hired, and a cell theory constructed which accounted for the testimony and input of Sam Jones.

The basic premise of the application of a cell theory to the hiring process is that the employment decision is subjective, but that it is also based upon certain definable and nondiscriminatory criteria.\(^{186}\)

In many hiring situations two sets of criteria must be met before an individual is hired. The first set is based upon employment data, which is readily apparent on the face of the application and tends to "self-disqualify" the applicant. Having discarded these individuals from the available sample, Sam Jones would then apply the second set of criteria — those qualifications that the applicant must possess in order to be hired. The applicants who do not self-disqualify, but who meet the hiring criteria, theoretically should be hired without regard to any other variables such as race and sex. Each applicant can be assigned to a particular statistical cell, and if a similar distribution occurs within the cells, it may be assumed that there was no discrimination in the hiring.\(^{187}\)

\(^{185}\) See 474 F.2d at 910 & n.2 (7.2% of company's employees were black, while 33% of applicants at two plants were black).

\(^{186}\) Only with discrete categories may the data be grouped in a finite number of separate cells. In the words of one author, "[e]xpected cell frequencies are computed according to the rules of probability. If two random variables are statistically independent, their joint probability is the product of the two marginal probabilities." A. Hughes & D. Grawoig, supra note 144, at 236. See also Elementary Statistics, supra note 47, at 199.

\(^{187}\) A. Hughes & D. Grawoig, supra note 144, at 236-37.
The instant cell analysis is a three-way classification: 1) whether hired or not hired, 2) race of applicant, and 3) whether the applicant has certain employability characteristics. The resultant grid is $2 \times 2 \times r$, where $r$ is the number of applicant categories established by the personnel director. Since there are four criteria which each applicant must satisfy, there are sixteen possible categories of applicants.\(^{188}\)

Thus, the contingency table is $2 \times 2 \times 16$, resulting in sixty-four mutually exclusive cells. If race were a factor in the employment decision, number two in the three-way classification above would be statistically independent from the other classifications in the equation. There is the danger that the hypothesis might be rejected for the wrong reason — not because race is a factor despite equivalent qualifications, but because one race may in general be better qualified, and thus, that a larger proportion of applicants of a particular race might fall into the categories where a higher proportion are hired, even though race is not explicitly considered by the employer. In order to avoid this outcome, statistical techniques can be applied to test for significant differences between proportions within the cells where applicants have similar qualifications.\(^{189}\)

The first step in constructing the cell model in this case would be to meet with Sam Jones and ascertain the criteria he used to evaluate the applicants.\(^{190}\) Jones, with the aid of counsel, arrived at seven self-disqualification criteria:\(^{191}\)

1. Inability to contact — no mailing address or phone number supplied.
2. Request for part-time or temporary (summer) only — P. Miller-Harper City was recruiting only for full-time employees.
3. Salary requirement too high where presently employed.
4. Applied for specific job not available or never available at the Harper City facility.
6. Failure to sign application attesting to truth of the information stated therein.
7. Subsequently withdrew application or accepted employment elsewhere.

\(^{188}\) See Figure 1 infra. See also text accompanying note 192 infra. Since each applicant must meet or fail to meet each of the four characteristics, the number of possible applicant categories is $2 \times 2 \times 4 = 16$. See A. Hughes & D. Grawoig, supra note 144, at 236.

\(^{189}\) See A. Hughes & D. Grawoig, supra note 144, at 236.

\(^{190}\) The number of criteria should be as small as possible to limit the number of cells, and thereby simplify the actual analysis. See id.

\(^{191}\) To be persuasive, the self-disqualification criteria should be supported and justified by testimony from Sam Jones for each individual to prove that no discrimination was practiced in this segment of the hiring process. See Statistical Proof and Rebuttal, supra note 6, at 409-10.
Jones then arrived at the four major criteria necessary for the hiring of an applicant:

1. Availability for necessary shift.
2. Immediate availability.
4. Skills.192

It can now be demonstrated how Jones would have evaluated each application. Those individuals who fell within the seven self-disqualifying criteria were removed from the sample, with comments noted for future testimony. The remaining applications were evaluated in terms of a cell structure established by the statistician.193 The grid on the following page was constructed:194

The grid depicts sixty-four separate and distinct cells, and each applicant can fall within only one of them. For example, if Jones had an applicant who was black, available for the proper shift, with good skills, and recommendations, but who was not hired because he was not available to begin work for a month, he would fall within cell number fifty-three. Or, if the applicant was white, possessed the requisite skills, was immediately available, but did not want to work on the night shift, and had bad recommendations, even though he was hired, that individual would fall within cell number eleven.

All of the applications were evaluated by Jones in the same fashion, and each was assigned a number. The remainder of the analysis would be completed by the statistician, who would use a computer program. The actual computations are not relevant here.

192. In defining the broad area of skills, he listed nine subtopics which he considered when determining if an applicant possessed the requisite skills:

1. Previous experience in job exactly like or very similar to openings available — dexterity and applicable transfer of skills.
2. Reason for leaving last employment — previous work record.
3. Length of time in previous position — stability.
4. Education attainment and proficiency — potential.
5. Adequate health for demands for job — physical abilities.
7. Distance away from Harper City plant and competition for the availability of work in that area — turnover potential.
9. Previous addresses match work experience and number of moves — job-hopping and stability.

These nine subtopics served two purposes: to aid Jones in the important decision as to whether or not an applicant possessed the requisite skills, and to serve as legally defensible criteria if the complex area of skills were challenged in court.

193. The cell structure should be founded upon statistical techniques which can be explained by expert testimony on the witness stand. See id. at 419 & n.152, construing Clark v. Universal Builders, Inc., 501 F.2d 324, 339 n.21 (7th Cir.), cert. denied, 419 U.S. 1070 (1974) (trial court ordered to admit testimony of econometrics expert).

194. The mathematical symbol for “not” is ~.
This hypothetical example is significant because it demonstrates that a cell analysis can be constructed which will combine logic and advanced statistics in a presentation that can easily be justified and explained to a judge. Ultimately, it should be successful in overturning a prima facie case of discrimination, because this analysis is an objective evaluation which precludes the subjectivity of personnel practices in which such characteristics as appearance, sex, race, national origin, age, and religion, can play a major role.

VI. Conclusion

Statistical analysis can be of substantial assistance in the proof or rebuttal of alleged employment discrimination. Such analysis, if used properly and creatively, can be synthesized for use in all phases of litigation and can provide objective criteria by which the court can evaluate the effects of certain employment practices. Litigators should work with statisticians to develop relevant statistical analyses founded upon sound methodology and legal logic so that courts will be better prepared to analyze data through the use of statistical tools.