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SAMPLE DATA AS EVIDENCE:
MEETING THE REQUIREMENTS OF DAUBERT
AND THE RECENTLY AMENDED FEDERAL
RULES OF EVIDENCE

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INTRODUCTION

"You don’t have to eat the whole ox to know the hide is tough."¹ As the complexity of business litigation grows, it has become increasingly clear that accounting for all of the persons or things considered relevant in a particular dispute, or "eating the whole ox," if you will, is an unnecessarily onerous, nearly impossible task. Instead, litigants and the courts have often turned to statistical sampling, which involves collecting samples from a given population—a small subset of the relevant persons or things—deriving statistics from this sample data, and arriving at conclusions regarding the population based upon these sample statistics. This has not always been the case. In James S. Kirk & Co. v. Federal Trade Commission,² a case involving a dispute over a manufacturer’s claim

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1. JOHN W. STRONG, MCCORMICK ON EVIDENCE § 208 (5th ed. 1999) (citing DAVID S. MOORE, STATISTICS: CONCEPTS AND CONTROVERSIES 3 (2d ed. 1985)).
2. 59 F.2d 179 (7th Cir. 1932).
that its soap was made from olive oil, an administrative law judge refused to admit sampling evidence and instead heard testimony from seven hundred women regarding their understanding of the manufacturer’s claim.3

However, with the development and expanding deployment of scientific survey and sampling methods, courts have gradually become more willing to admit evidence based upon sample data.4 The Federal Rules of Evidence now specifically provide a basis for ruling favorably on the admissibility of sampling data in the form of public opinion poll evidence.5 Further, the Federal Judicial Center’s Manual for Complex Litigation supports the use of sampling, noting:

Statistical methods may often be useful to estimate, to specified levels of accuracy, the characteristics of a “population” or “universe” of events, transactions, attitudes, or opinions by observing those characteristics in a relatively small segment or “sample” of the population. The use of acceptable sampling techniques, in lieu of discovery and presentation of voluminous data from the entire population, may produce substantial savings in time and expense. In some cases, sampling techniques may provide the only practicable means to collect and present relevant data.6

3. Id. at 181; HANS ZEISEL & DAVID KAYE, PROVE IT WITH FIGURES: EMPIRICAL METHODS IN LAW AND LITIGATION 101 (1997) (citing Hans Zeisel, The Uniqueness of Survey Evidence, 45 CORNELL L.Q. 322, 326 (1960)).


5. See FED. R. EVID. 703 advisory committee notes. For additional information on the use of survey evidence in particular, see ZIPPO MFG. CO. v. ROGERS IMP., INC., 216 F. SUPP. 670, 686 (S.D.N.Y. 1963); Hans Zeisel, The Uniqueness of Survey Evidence, 45 CORNELL L.Q. 322, 326 (1960).

Indeed, statistical sample analysis has been undertaken in many different types of litigation, including motions for change in venue, trademark and advertising cases, pornography prosecutions, drug trafficking prosecutions, copyright infringement and software piracy.

7. See United States v. Tokars, 839 F. Supp. 1578, 1583 (N.D. Ga. 1993) (using a random poll of 998 individuals concerning pre-trial publicity as evidence weighing in favor of defendant's motion for change of venue); State v. Hickman, 337 N.W.2d 512, 515 (Iowa 1983) (upholding the trial court's refusal to change venue and noting that in a public survey, of those people polled who knew the victim or of the murder, 68% indicated they had formed no opinion regarding the defendant's fate). But see United States v. Collins, 972 F.2d 1385, 1398 (5th Cir. 1992) (noting that the trial court, after concluding that a telephone survey commissioned by the prosecution concerning the upcoming trial did not compromise the integrity of jury selection, ordered the defendants to refrain from taking their own poll); United States v. Haldeman, 559 F.2d 31 (D.C. Cir. 1976).


9. See United States v. Coenen, 135 F.3d 938 (5th Cir. 1998) (using samples of personal histories and characteristics to draw a statistical conclusion about future risk to the community); United States v. Hall, 142 F.3d 988 (7th Cir. 1998) (determining the volume of pornographic material stored on a personal computer using a sample of that material extrapolated to the total number of files); United States v. Black, 116 F.3d 198 (7th Cir. 1997) (describing a procedure whereby a board certified pediatrician examined a sample of pornographic photographs to determine that the defendant was trafficking in child pornography); see also United States v. Drew, 131 F.3d 1269 (8th Cir. 1997); United States v. Ownby, 131 F.3d 138 (4th Cir. 1997); United States v. Thomas, 74 F.3d 701 (6th Cir. 1996). For a discussion of statistical polls utilized to ascertain community standards with regard to pornography, see United States v. Pryba, 900 F.2d 748, 757 (4th Cir. 1990); People v. Nelson, 410 N.E.2d 476, 478 (Ill. App. Ct. 1980); Saliba v. State, 475 N.E.2d 1181, 1185 (Ind. Ct. App. 1985); Commonwealth v. Trainor, 374 N.E.2d 1216, 1220 (Mass. 1978); Carlock v. State, 609 S.W.2d 787, 789 (Tex. Crim. App. 1980); County of Kenosha v. C & S Mgmt., Inc., 588 N.W.2d 236, 252-53 (Wis. 1999).

10. Sampling has been widely utilized to determine the quantity of illegal drugs involved in drug trafficking prosecutions. For examples of such extrapolation, see United States v. Whiting, 28 F.3d 1296, 1304-06 (1st Cir. 1994) (statistically extrapolating based upon the quantity of drugs found, evidence of volume in distribution, and an estimate of time period engaged in the distribution); United States v. Hilton, 894 F.2d 485 (1st Cir. 1990); United States v. Sklar, 920 F.2d 107, 112-14 (1st Cir. 1990) (weighing the illegal drugs contained in some postal envelopes and extrapolating the volume that would likely have been contained by many more received by the defendant); United States v. Walton,
litigation,\textsuperscript{11} the auditing of waste, fraud, and abuse of welfare programs,\textsuperscript{12} labor and employment litigation,\textsuperscript{13} and a wide variety of other contexts.\textsuperscript{14} In fact, some courts have conducted sampling


studies *sua sponte.* In 1993, the Supreme Court articulated new standards for judicial admissibility of scientific expert testimony. In *Daubert v. Merrell Dow Pharmaceuticals,* the Court ruled that the Federal Rules of Evidence superceded the seventy-year-old standard for the admissibility of scientific evidence originally articulated in *Frye v. United States.* The Court explicitly rejected *Frye*'s general acceptance requirement, relegating general acceptance to merely one of many factors, including examination of error rates and the testing of expert theories, to be weighed in determining admissibility. Under *Daubert,* the courts are “gatekeepers” that function to insure expert evidence is “good science.”

In December 2000, an amendment to Federal Rule of Evidence 702 (FRE 702) took effect. Many observers believe the new rule does little more than codify *Daubert* and its progeny.

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16. See *Daubert v. Merrell Dow Pharm., Inc.,* 509 U.S. 579, 593-95 (1993). Although there was some debate as to what constituted “scientific” expert testimony, the Supreme Court, in *Kumho Tire Co. v. Carmichael,* made it clear that the *Daubert* holding applied to all expert testimony—not simply so-called “scientific” testimony. See *Kumho Tire Co., Ltd. v. Carmichael,* 526 U.S. 137, 147-53 (1999).


18. See id. at 579.

19. 293 F. 1013 (D.C. Cir. 1923). *Frye* imposed a requirement for scientific evidence that the methods employed be generally accepted in the scientific community. Id. at 1014.


21. See *Daubert,* 509 U.S. at 593.

22. FED. R. EVID. 702.

23. See Brixen & Meis, supra note 20, at 527-29. The “trilogy” that is often referred to as “progeny” include *Daubert,* *Kumho Tire,* and *General Electric Co. v. Joiner,* 522 U.S. 136 (1997). See id. at 527-33, 535. *Joiner*’s importance vests mainly in the finding that abuse of discretion is the proper standard of review for *Daubert* inquiries and the guidance suggesting that evaluation of methodologies and resulting conclusions could not be conducted in isolation from one another. See *Joiner,* 522 U.S. at 146. The Court stated:

[N]othing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.

*Id.* Further, the Court held that experts must explain the manner by which they reached their conclusions, noting that particular methodologies may be appropriate in some circumstances and
Prior to the amendment, FRE 702 read in its entirety:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.24

The December 2000 amendment added language that qualifies the nature of the data upon which experts may base their testimony:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.25

This new rule creates a mishmash of sometimes overlapping guidelines that focus on the expert’s qualifications, the sufficiency of the expert’s facts or data, the reliability of the principles and methods employed, and the reliability of applying these principles and methods to the specific facts of a given case.26


24. FED. R. EVID. 702 (1999). Prior to the enactment of FRE 702, expert testimony was admissible only if the expert knowledge lay "beyond the range of . . . the average juror." See Brien & Meis, supra note 20, at 527 (quoting 1 MODERN SCIENTIFIC EVIDENCE: THE LAW AND SCIENCE OF EXPERT TESTIMONY § 1-1.0, at 1 (David Faigman et al. eds., 1997)).

25. FED. R. EVID. 702 (emphasis added).

26. Courts have characterized this facet of reliability as "fit." See, e.g., United States v. Downing, 753 F.2d 1224, 1242 (3d Cir. 1985) ("An additional consideration under Rule 702—and another aspect of relevancy—is whether expert testimony proffered in the case is sufficiently tied to the facts of the
Most often, courts allow statistical sampling evidence as the basis for expert opinion testimony subject to FRE 703.\textsuperscript{27} And like any other expert testimony, this testimony must satisfy the restrictions of \textit{Daubert} and FRE 702. This Article explores the relationship between these restrictions and testimony related to statistical sampling evidence. Part I briefly describes the development of statistical sampling as an acceptable type of evidence. Part II explores the history of the \textit{Daubert} rule and the subsequent amendment to FRE 702, examining the manner in which various courts have applied the new rule. This examination is organized according to the primary requirements of \textit{Daubert} and FRE 702. First, Part II considers expert qualification, which forms a threshold requirement for the admissibility of expert evidence preceding any analysis based upon the factors delineated in \textit{Daubert} and FRE 702. Second, Part II examines the three prongs of the \textit{Daubert} test, arguably codified in the newly amended version of FRE 702, namely: 1) the requirement of sufficient facts or data; 2) the requirement of reliable principles and methods; and 3) the requirement that these principles and methods be reliably applied. Finally, Part II contemplates two procedural issues brought to bear under a \textit{Daubert} analysis—the mandated analysis of the burden of proof with regard to reliability and the question concerning when to employ the new FRE 702. Part III outlines statistical sampling principles that speak to the sufficiency

\textsuperscript{27} \textit{FED. R. EVID.} 703. Rule 703 states in relevant part:

The facts or data in the particular case upon which an expert bases an opinion or inference may be those perceived by or made known to the expert at or before the hearing. If of a type reasonably relied upon by experts in a particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence in order for the opinion or inference to be admitted.

\textit{Id.} In fact, the advisory committee notes to FRE 703 suggest that, with regard to public opinion polls, this is the preferred approach. \textit{FED. R. EVID.} 703 advisory committee notes. “The rule... offers a more satisfactory basis for ruling upon the admissibility of public opinion poll evidence. Attention is directed to the validity of the techniques employed rather than to relatively fruitless inquiries whether hearsay is involved.” \textit{Id.}
procedural issues brought to bear under a *Daubert* analysis—the mandated analysis of the burden of proof with regard to reliability and the question concerning when to employ the new FRE 702. Part III outlines statistical sampling principles that speak to the sufficiency and reliability questions raised by *Daubert* and FRE 702. Part III also offers practical guidance to assist in shoring up statistical sampling evidence to prevent its exclusion, providing a checklist that may be employed to assail similar evidence offered by adversaries.

I. THE WAXING OF SAMPLING EVIDENCE

Despite a long tradition illustrating practical and reliable use of statistical samples in other social science disciplines, courts have not historically warmed up to the idea that such samples are appropriately admissible evidence.28 Ironically, a case where the court refused to admit sample evidence became a watershed in the changing attitudes toward such evidence. In *Sears, Roebuck & Co. v. City of Inglewood*,29 Sears sued the city of Inglewood, California, seeking a sales tax refund Sears mistakenly paid.30 To substantiate its $27,000 claim, Sears hired experts to audit a probability sample of sales slips from 33 out of the 286 days in question.31 The experts estimated the overpaid taxes to be $28,250 with a standard error of $1150, but this was unacceptable to the judge who demanded they audit the entire inventory of 950,000 sales slips.32 This arduous tabulation resulted in a figure of $26,750.22.33

As early as 1953, however, the court in *United States v. United Shoe Machinery Corp.*34 directly endorsed sampling. *United Shoe* was

28. *See, e.g., supra* note 10 and accompanying text.
29. Described in *ZEISEL & KAYE*, * supra* note 3, at 101 (citing R. Clay Sprouls, *The Admissibility of Sample Data Into a Court of Laws: A Case History*, 4 UCLA L. REV. 222 (1957)).
30. *Id.*
31. *Id.*
32. *Id.*
33. *Id.*
an antitrust case in which the United States government charged the defendant with violations of the Sherman Act. 35 In its defense, United Shoe intended to call a large number of their customers as witnesses. The presiding judge, Charles Wyzanski, chose instead to utilize a sample of customers selected at “random” by means of a scheme of his own design. 36 In his opinion, Judge Wyzanski wrote: “If antitrust trials are to be kept manageable, samples must be used.” 37 In later writings, he offered more detailed viewpoints:

[T]he judge can perform a useful function if he, through pre-trial conferences or at a later stage of the litigation when he is more aware of its dimensions, provides for appropriate samplings of the conduct and the effects. If the judge is fortunate, the parties may agree on the sampling. But where they do not, it seems to me to be the judge’s responsibility first to elicit from witnesses on the stand the criteria necessary to determine what are fair samples and then to direct the parties to prepare such samples for examination and cross-examination. Sampling will make the record not merely more informative but shorter. 38

Litigants often use sampling evidence in today’s courtrooms with the explicit support of the Federal Rules of Evidence and the Federal Judicial Center’s Manual for Complex Litigation. 39 “The burden of proof rests upon the [proponent] to show, through testimony of an appropriate expert, that the sample was selected in accordance with these principles so that its results can be projected to the

35. Id. at 298.
36. Wyzanski selected a sample of forty-five customers for depositions by referencing a standard directory of the trade and including the first fifteen names from the 1st, 11th, and 21st letters of the alphabet. See Zeisel & Kaye, supra note 3, at 102.
37. United Shoe, 110 F. Supp. at 305.
39. See supra notes 5-6 and accompanying text.
II. DAUBERT AND FRE 702

The admissibility of expert testimony, including that of experts seeking to testify regarding conclusions reached through the application of statistical sampling methods, can be outcome determinative in modern day litigation. Further, the difficulties faced by litigators are not confined to the federal courts, which are bound by Daubert and FRE 702. In fact, many states have adopted Daubert either by direct reference or by relying upon state rules with similar factors.

40. ZEISEL & KAYE, supra note 3, at 102 (citing FEDERAL JUDICIAL CENTER, MANUAL FOR COMPLEX LITIGATION § 2.712, at 118 (3d ed. 1982) [hereinafter 1982 MANUAL]).
41. Id. (quoting 1982 MANUAL § 2.712, at 118).
A. Qualification of the Expert

The original version of FRE 702 and the recently amended version both explicitly require qualification of experts: "[A] witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto. . . ."\textsuperscript{44} The burden of establishing a witness' qualifications lies with the proponent of the evidence.\textsuperscript{45} There are no definite guidelines for determining the knowledge, skill or experience required of a witness.\textsuperscript{46} However, a witness' qualifications as an expert must be measured with respect to the opinions the witness seeks to offer.\textsuperscript{47} In Jones v. Lincoln Electric Co.,\textsuperscript{48} the court held that the trial court properly allowed a witness with expertise in material science and metallurgy to testify about the chemical composition of welding fumes, but that the lower court abused its discretion when it allowed the witness to testify about the medical effects of the welding fumes.\textsuperscript{49} Likewise, in Pan American World Airways, Inc. v. Port Authority of New York and New Jersey,\textsuperscript{50} a case alleging negligence in runway maintenance, the court refused to qualify the plaintiff's proposed witness as an expert, finding he had little experience with large airports and was entirely unfamiliar with ground procedures at


44. Fed. R. Evid. 702 (emphasis added).
48. 188 F.3d 709 (7th Cir. 1999).
49. Id. at 723-24.
50. 995 F.2d 5 (2d Cir. 1993).
JFK. The lesson here is that experts employed to testify about statistical evidence should have substantive experience as well as technical, methodological experience. For example, an expert testifying as to statistical evidence of employment discrimination should have substantive knowledge and experience related to employment matters and should have conducted independent investigations to become familiar with the defendant’s decision-making procedures regarding the issues under consideration.

Further, the receptiveness of other courts to a potential expert’s testimony may factor into the admissibility equation. While it is true a court will determine all issues of admissibility before it, the court in *Blue Cross and Blue Shield of New Jersey, Inc. v. Philip Morris, Inc.*, found that a trial judge may consider the experience of other courts in determining an expert’s reliability under *Daubert*:

> After a witness has been repeatedly rejected by courts . . . it is appropriate to take judicial notice of lack of credibility to reject a witness on *Daubert* grounds. The courts need not repeatedly hold preliminary hearings to determine that the testimony of a particular witness is unacceptable. Repeated demonstration that the wheel is round or that a witness is a charlatan is not required in a sensible system of justice.

In sum, another court’s rejection of an expert’s analysis may weigh heavily against qualifying his testimony as an expert in future cases.

**B. Sufficiency of Facts or Data**

“In reviewing the sufficiency of the facts, the court’s role is to determine whether sufficient facts exist to support the witness’s conclusion, not whether one party’s version of the facts should be

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51. *Id.* at 10.
53. *Id.* at 325.
credited.”54 According to the advisory committee notes to FRE 702, “[t]he emphasis in the amendment on ‘sufficient facts or data’ is not intended to authorize a trial court to exclude an expert’s testimony on the ground that the court believes one version of the facts and not the other.”55 Arguably, “the weaknesses in the underpinnings of the [expert’s] opinion, go to the weight and not the admissibility of the testimony.”56 In fact, the Federal Judicial Center’s Manual for Complex Litigation explicitly makes this point.57 However, the court in Elswick v. Nichols58 noted, “‘[p]roposed testimony must be supported by appropriate validation. . . .’”59 The guidelines of the Manual for Complex Litigation require that in the case of “sampling for the purpose of generating data about a population to be offered for its truth . . . the reliability and validity of estimates about the population derived from sampling are critical. The methods used [including methods employed for data gathering] must conform to generally recognized statistical standards.”60

In order to avoid the danger of having statistical sampling evidence deemed inadmissible, proposed experts should engage in independent validation of available data rather than merely accepting counsel’s data at face value. Should opposition experts allege inconsistencies in the preparation of data for analysis, the proponents should address these inconsistencies immediately and where possible, offer

55. FED. R. EVID. 702 advisory committee notes.
57. MANUAL FOR COMPLEX LITIGATION § 21.493, at 102 (3d ed. 1995) (citing E. & J. Gallo Winery v. Gallo Cattle Co., 967 F.2d 1280, 1292 (9th Cir. 1992) and McNeilab, Inc. v. Am. Home Prods. Corp., 848 F.2d 34, 38 (2d Cir. 1988)). “Even if the court finds deficiencies in the proponent’s showing, the court may receive the evidence subject to argument going to its weight and probative value.” Id.
59. Id. at 766 (quoting Daubert v. Merrell Dow Pharm., Inc. 509 U.S. 579, 588 (1993)).
60. MANUAL FOR COMPLEX LITIGATION § 21.493, at 101-02 (3d ed. 1995). Note that the Manual for Complex Litigation distinguishes between “sampling for the purpose of generating data about a population to be offered for its truth” and sampling in the nature of polling to measure opinions, attitudes, and actions by a population. Id. The Manual for Complex Litigation also offers additional factors for assessing the admissibility of a survey. Id.
explanations. Most importantly, data preparation work should offer the transparency and reliability necessary for the court to be confident in its own determination of the sufficiency of utilized data. Otherwise, the court might exclude an expert’s testimony solely on data sufficiency grounds.

C. Reliable Principles and Methods

In Booth v. Black & Decker, Inc., the court excluded expert testimony after applying a Daubert analysis that turned on “whether the expert [was] qualified, and whether the testimony [met] the two requirements of [FRE] 702 . . . Daubert . . . and Kumho Tire . . . , [namely]: (1) that the methodology underlying the testimony is valid and (2) that the opinion will be helpful to the factfinder.” The court went on to describe how a district court would assess an expert’s methodology under FRE 702:

[The] district court must . . . be mindful of the following factors:
“(1) whether a method consists of a testable hypothesis; (2) whether the method has been subjected to peer review; (3) the known or potential rate of error; (4) the existence and maintenance of standards controlling the technique’s operation; (5) whether the method is generally accepted; (6) the relationship of the technique to methods which have been established to be reliable; (7) the qualifications of the expert witness testifying based on the methodology; and (8) the non-judicial uses to which the method has been put.”

In Booth, the court rejected expert testimony regarding a manufacturing defect in a toaster, because, among other reasons, the

62. Id. at *3.
63. Id. (quoting Oddi v. Ford Motor Co., 234 F.3d 136, 145 (3d Cir. 2000) and Elcock v. Kmart Corp., 233 F.3d 734, 745-46 (3d Cir. 2000)). These factors, along with those found in Daubert and in the Federal Judicial Center’s Manual for Complex Litigation, form the basis for the procedural and methodological reliability analysis considered in detail in Part III. See infra Part III.
expert failed to do independent testing to support his conclusions.\textsuperscript{64} Proposed experts should use caution not to take for granted that methodologies are clear and understandable. While the expert in \textit{Booth} observed that it "[did] not require any great mind to understand this thing,"\textsuperscript{65} the court found that he missed the point.\textsuperscript{66}

The requirements of \textit{Daubert} and \textit{Kumho Tire} do not rise and fall with the complexity of each case; whether the expert is testifying on quantum physics or car crashes, the expert must provide the Court with information sufficient to understand and assess the reliability of the methodology the expert applied in reaching her conclusions.\textsuperscript{67}

Failure to provide the court with a reasonable means of assessing statistical methodologies will likely result in a finding that the proposed evidence is unreliable and therefore inadmissible.

\textbf{D. Reliable Application of Principles and Methods}

The court in \textit{Rudd v. General Motors Corp.}\textsuperscript{68} extracted a recipe for the reliable application of principles and methods from the advisory committee notes on the 2000 amendments to FRE 702:

\begin{quote}
[The expert's] testimony is reliable because he provides a step-by-step and transparent account of the explanations he has considered, the physical indicia he associates with each possible alternative cause, and his reasons for excluding each of the alternative causes. At no point does he attempt to rest simply on his authority as an expert; rather, each time [the expert] relies upon his experience, he "explain[s] how that experience leads to...
\end{quote}

\textsuperscript{64} \textit{Booth}, 2001 WL 366631, at *2.
\textsuperscript{65} \textit{Id.} at *3.
\textsuperscript{66} \textit{Id.}
\textsuperscript{67} \textit{Id.}
\textsuperscript{68} 127 F. Supp. 2d 1330 (M.D. Ala. 2001).
the conclusion reached, why that experience is a sufficient basis for the opinion, and how that experience is reliably applied to the facts.”

The court found the expert’s testimony was “ultimately reliable” because he “made his reasoning processes and data sources sufficiently transparent so that, if there [were] counter-arguments and counter-evidence available to suggest” that the expert had failed “to consider a possible cause or [was] wrong to rely so conclusively on the physical indicia he [] specified, the adversary system [would] be competent to make this evident through ‘vigorous cross-examination’ and ‘presentation of contrary evidence.’” The guidance offered by Ambrosini and Rudd underscores the importance of independent validation of facts and data. Blind faith in the representations of counsel, along with a lack of substantive experience, can easily lead to a failure to consider any alternative explanations. Data coding and methods of data manipulation must be clear enough to allow replication and to permit the adversary system the opportunity to function in the manner suggested by the court in Rudd. “Hiding the ball” can result in a court finding the expert’s application of principles and methods unreliable and lead to the exclusion of related testimony.

E. Procedural Considerations

1. A Mandated Analysis of the Burden of Proof?

As the court noted in Rudd, “[t]he burden is traditionally placed on the proponent of expert testimony to establish that such admissibility requirements have been met by a 'preponderance of the evidence.'”

69. Id. at 1344 (quoting FED. R. EVID. 702 advisory committee notes).

70. Id. (quoting FED. R. EVID. 702 advisory committee notes and Ambrosini v. Labarraque, 101 F.3d 129, 140 (D.C. Cir. 1996)).

71. Rudd, 127 F. Supp. 2d at 1334; see also Bourjaily v. United States, 483 U.S. 171, 175 (1987) (finding that while Rule of Evidence 104(a) assigns the court the task of determining preliminary admissibility questions without specifying any particular standard of proof of reliability, courts have
In determining reliability, the trial judge is guided by a list of factors set forth by the Supreme Court in *Daubert*: whether a theory or technique can be or has been tested; “whether [a] theory or technique has been subjected to peer review and publication”; whether a theory or technique has gained widespread acceptance within a relevant community of experts, or, rather, has been unable to garner more than minimal support; and “the known or potential rate of error [of a technique], and the existence and maintenance of standards controlling the technique’s operation.”

The Court in *Daubert* emphasized that these factors are not to be used as a “definitive checklist,” but rather should be thought of as non-exclusive, non-dispositive considerations that may shape the trial judge’s “flexible inquiry” under FRE 702. In *Kumho*, the Court suggested that the trial judge should consider the specific factors identified in *Daubert* where they are reasonable measures of reliability. Finally, the advisory committee notes for the 2000 amendments to FRE 702 go further by providing “some general standards that the trial court must use to assess the reliability and helpfulness of proffered expert testimony.”

While the inquiry into “reliable principles and methods” has been a familiar feature of admissibility analysis under *Daubert*, the new Rule 702 appears to require a trial judge to make an evaluation that delves more into the facts than was recommended in *Daubert*, including as the rule does an inquiry traditionally proposed a preponderance-of-proof standard regardless of the burden of proof on the substantive issues; Allison v. McGhan Med. Corp., 184 F.3d 1300, 1312 (11th Cir. 1999) (“[T]he proponent of the testimony does not have the burden of proving that it is scientifically correct, but that by a preponderance of the evidence, it is reliable.”); Allstate Ins. Co. v. Hugh Cole Builder, Inc., 137 F. Supp. 2d 1283, 1286 (M.D. Ala. 2001) (“The proponent of the expert testimony has the burden to establish by a preponderance of the evidence that the admissibility requirements of Rule 702 are satisfied.”) (citing Rudd v. Gen. Motors Corp., 127 F. Supp. 2d 1330, 1334 (M.D. Ala. 2001))); Fed. R. Evid. 702 advisory committee notes.

73. Id.
into the sufficiency of the testimony’s basis ("the testimony is based upon sufficient facts or data") and an inquiry into the application of a methodology to the facts ("the witness has applied the principles and methods reliably to the facts of the case"). Neither of these two latter questions that are now mandatory under the new rule—the inquiries into the sufficiency of the testimony’s basis and the reliability of the methodology’s application—were expressly part of the formal admissibility analysis under Daubert.76

The court in Rudd went even further, noting that the revised version of FRE 702 "incorporates a conscious rejection of Daubert’s sharply-drawn conclusions-versus-methodology distinction."77

Going beyond the permissive language of Joiner, the plain language of new Rule 702, as well as the advisory committee notes to the new Rule, makes it clear that this court is now obliged to screen expert testimony to ensure it stems from, not just a reliable methodology, but also a sufficient factual basis and reliable application of the methodology to the facts.78

Under Daubert, Joiner, and the old Rule 702, whether a factual sufficiency-of-basis inquiry should even be part of a trial judge's gatekeeping decision was a "close question."79 The newly amended Rule 702, however, not only permits but expressly mandates a quantitative inquiry into whether "the testimony is based upon sufficient facts or data."80

76. Id. at 1336-37 (citations omitted) (emphasis added).
77. Id. at 1337 (citing Fed. R. Evid. 702 advisory committee notes).
78. Id.
79. Rudd, 127 F. Supp. 2d at 1339.
80. Fed. R. Evid. 702; see Rudd, 127 F. Supp. 2d at 1339; see also Allstate Ins. Co. v. Hugh Cole Builder, Inc., 137 F. Supp. 2d 1283, 1285 (M.D. Ala. 2001) ("Under the amended Rule 702, a trial judge has an obligation to screen expert testimony to ensure it stems from, not just a reliable methodology, but also a sufficient factual basis and reliable application of the methodology to the facts." (citing Rudd, 127 F. Supp. 2d at 1337)).
2. Application of the New Rule

Given the immediately preceding discussion, it is apparent that admissibility analysis in a given case might depend upon whether the court should apply the new rule, or should instead rely upon the old FRE 702. The effective date of the new amendments was December 2000. However, “the new Rule 702 ‘shall govern all proceedings in civil cases’ pending December 1, 2000, ‘insofar as just and practicable.’”81

With new Rule 702 in play, [an opponent to expert testimony] gets a judicial-gatekeeping inquiry governed by a rule that contains all of the language of the old rule plus new language expressly authorizing [a possible] sufficiency-of-basis objection, that is, a line of inquiry that might not even have been available under old Rule 702.82

III. PRINCIPLES AND METHODS OF STATISTICAL SAMPLING

The science of statistics—the systematic study of mass phenomena and repetitive events—was not fully established as such until about 1919.83 It has been a much more recent phenomenon that this science has found its way into the legal domain as evidence.84 There are many outstanding texts that may be relied upon to establish a foundation of the fundamental principles of probability and statistics.85 This Part,

82. Id.
83. RICHARD VON MISES, PROBABILITY, STATISTICS AND TRUTH, at vii (2d English ed. 1957).
85. Indeed, far too many to cite here. Some favorites include: WILLIAM MENDENHALL, INTRODUCTION TO PROBABILITY AND STATISTICS (6th ed. 1979); GEORGE W. SNEDECOR & WILLIAM G. COCHRAN, STATISTICAL METHODS (1989); and COLLIN J. WATSON ET AL., STATISTICS FOR MANAGEMENT AND ECONOMICS (1993). To facilitate understanding of inferential analysis, see JOSEPH F. HAIR, JR. ET AL., MULTIVARIATE DATA ANALYSIS (1995) and JOHN NETER, WILLIAM WASSERMAN, & MICHAEL H. KUTNER, APPLIED LINEAR STATISTICAL MODELS (1990). For specific treatment of
however, will adopt a significantly narrower focus; that is, constructing statistical sampling evidence and delivering this evidence via expert testimony in a manner that not only comports with statistical practice, but also meets the requirements of rules of evidence promulgated through the newly amended Federal Rules and various judicial opinions, including *Daubert*.

Modern statistics is a theory of information with inference as its objective. The target of our curiosity is a set of measurements, a *population*, that exists in fact or may be generated by repeated experimentation. The medium of inference is the *sample*, which is a subset of measurements selected from the population. We wish to make an inference about the population on the basis of characteristics of the sample—or, equivalently, the information contained in the sample. 86

Of course, when one eschews the alternative of examining the entire population—an option insisted upon by the administrative judge in sampling techniques, see WILLIAM G. COCHRAN, SAMPLING TECHNIQUES (3d ed. 1977) and RICHARD L. SCHEAFFER ET AL., ELEMENTARY SURVEY SAMPLING (1990). For an introduction to the application of statistical methods to the law, see STEVEN M. CRAFTON & MARGARET F. BRINIG, QUANTITATIVE METHODS FOR LAWYERS (1994); STATISTICS AND THE LAW (Morris DeGroot et al. eds., 1994); STATISTICAL SCIENCE IN THE COURTROOM (Joseph L. Gastwirth ed., 2000); HANS ZEISEL & DAVID KAYE, PROVE IT WITH FIGURES: EMPIRICAL METHODS IN LAW AND LITIGATION (1997). A variety of loose-leaf publications deal to some extent with the application of statistical procedures to particular practice areas. For example, in the area of employment discrimination, see WALTER B. CONNOLLY, JR., ET AL., USE OF STATISTICS IN EQUAL EMPLOYMENT OPPORTUNITY LITIGATION (2000) and PAUL COX, EMPLOYMENT DISCRIMINATION (3d ed. 2000). Finally, for an excellent introduction to the treatment of statistical samples as evidence, see MANUAL FOR COMPLEX LITIGATION, supra note 6.

86. RICHARD L. SCHEAFFER ET AL., ELEMENTARY SURVEY SAMPLING 1 (1990). The drawing of information from samples is commonplace. Important governmental policies are based on samples: in conducting the U.S. Census, only a small fraction of questions asked are asked of all households. See id. The vast majority of questions are asked of only small samples of households. See id. The Bureau of Labor Statistics uses a wide variety of survey samples to arrive at estimates of various statistics, including the consumer price index (CPI) and the monthly Current Population Survey. See id. Organizations such as Gallop, Harris, and Nielsen constantly sample public opinions, which they collect and extrapolate to the population. See id. Businesses of all sizes collect samples in order to manage the quality of manufacturing processes and make marketing decisions. See id. The Internet has had a dramatic effect in making this practice easy and ubiquitous. See id.
James S. Kirk & Co. v. Federal Trade Commission—there exists the possibility that the sample examined will not accurately reflect the characteristics of that population. Some amount of accuracy is traded for convenience and efficiency. It is the province of statistical science to maximize efficiency while minimizing the probability of error.

Error can creep into conclusions based upon statistical samples in two primary ways: sampling error and nonsampling error. Sampling error refers to error inherent in the process itself—error that derives from reaching conclusions based upon samples rather than populations. The careful design of sampling strategies and the reliable application of these strategies can control but cannot completely eliminate this error. Non-sampling errors are errors inherent in human interaction. Examples include non-response bias, inaccurate response or measurement error bias, and selection bias. These types of potential errors are much more difficult to control.

The reality is that courts must rely on sampling evidence in order to achieve a level of efficiency that allows them to accomplish their mission. However, courts are very concerned about the effects of excessive error on their decision-making processes and the consequences that this error may have for society. Remarkably, as

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87. 59 F.2d 179 (7th Cir. 1932).
88. In terms of generalizability, i.e., robustness, it can be even more important to quantify the likely size of the error.
89. See COCHRAN, supra note 85, at 359; SCHEAFFER et al., supra note 86, at 33.
90. Defined as: “Failure to measure some of the units in the chosen sample. This may occur by oversight or, with human populations, because of failure to locate some individuals or their refusal to answer the questions when located.” COCHRAN, supra note 85, at 359. For example, a survey sent out to potential class members is likely to result in a disproportionate response from members who are angry at the defendant and feel that they have been wronged in some way. This will tend to overstate the extent of harm and exaggerate the extent to which the class members are similarly situated.
91. “Errors of measurement on a unit. The measuring device may be biased or imprecise. With human populations the respondents may not possess accurate information or they may give biased answers.” COCHRAN, supra note 85, at 359.
92. If a judge asks a defense attorney to select a sample of twenty customers for deposition testimony in a fraud dispute, would this sample likely be different than a sample selected by a plaintiff’s attorney or prosecutor?
93. See SCHEAFFER, supra note 86. Sampling error is typically controllable given a large enough sample size, whereas non-sampling error cannot be controlled in this manner.
evidentiary standards have evolved over time, courts have fashioned elements that effectively address both sampling error and non-sampling error. This Part will now examine the manner in which these standards address potential error and offer some suggestions how such error may be avoided and, in the process, how to meet these standards.

A. Qualification of the Expert

While the qualification of an expert\textsuperscript{94} is not precisely a matter involving reliable methods of statistical sampling, the importance of the expert cannot be overestimated and is worth reiterating. Often, as a practical matter, a highly credentialed expert can "carry the day" by convincing a court to accept scientific evidence. Further, the expert's qualifications with regard to the substantive application area are of critical importance.\textsuperscript{95} A lack of substantive experience may result in a failure to consider alternative causation, leaving a court to find that the expert's application of principles and methods was unreliable.

Litigants should select statistical experts carefully, with particular attention to experience in the application area. Independent research and peer-reviewed publication can often overcome a lack of direct experience.\textsuperscript{96}

B. Sufficiency of Facts or Data

Recall that a review of sufficiency is not about believing the witness, but about ascertaining a minimum level of support for the witness' conclusion.\textsuperscript{97} In matters related to statistical sampling evidence, this review virtually always comes down to a question of adequacy of sample size. Appropriate sample sizes will depend upon

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\textsuperscript{94} See supra Part II.A.
\textsuperscript{97} See supra Part II.B.
the sampling methodology employed. However, in general, there is an inverse relationship between the sample size chosen and the potential error of conclusions based on this sample. At the extremes, one can literally “sample” the entire population, known as a *census*, and eliminate any possible deviation between the characteristics of the sample and the characteristics of the population of interest. Of course, this would defeat the objectives of efficiency and cost-effectiveness. On the other hand, common sense tells us that conclusions generalized to a population by virtue of examining a single member of that population are not likely to be very reliable. Experts often determine sample sizes in the sample design process as a function of the acceptable level of statistical error. What is most important is to realize that sample size significantly affects the reliability of proffered results. Experts should explicitly treat the issue in their analysis and be prepared to address it and provide justifications for their decisions in the course of their testimony.

C. Reliable Principles and Methods

When drawing conclusions about populations based upon statistical samples, hypothesis testing provides the means of presenting hypotheses and arriving at statistical confidence levels in their confirmation or rejection. Many courts have considered whether a method employed by a statistical expert contains a testable hypothesis. This may be a powerful tool to use against opposition experts. In a deposition, ask an opposition statistical expert to state the hypothesis that he is purporting to test. It is astounding how often “experts” are unable to do so.

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98. See generally Scheaffer, supra note 86; Cochran, supra note 85. A complete treatment of this subject is beyond the scope of this Article.

99. “[A] statistical procedure that involves collecting evidence and then making a decision as to whether a particular hypothesis should be accepted or rejected.” Douglas Downing & Jeffrey Clark, *Business Statistics* 448 (1985). As an example, one might sample a company’s employment records to test the hypothesis that employment discrimination was at play within the entire population.

100. See supra notes 61-67 and accompanying text.
Again, experts should treat this issue explicitly; they should commit testable hypotheses to writing, and they should be prepared to discuss these hypotheses, both in the technical language of statistical hypotheses testing and the layman's language of common decision-making.

If testable hypotheses are properly constructed, then testing leads many courts to another concern that looms large when presented with sample evidence—the potential rate of error.\textsuperscript{101} This error rate is, to some extent, subject to manipulation. As noted previously, the selection of a particular sample size will influence the level of potential error.\textsuperscript{102} Further, design of hypothesis testing can also affect the rate of error.\textsuperscript{103} Careful analysis of precedent regarding particular substantive application areas in particular jurisdictions may reveal error rates that are considered acceptable. If so, the error rate will drive decision-making with respect to such issues as sample size and sampling methodology. In any event, experts should carefully determine the potential error rate associated with any given sample and be prepared to address the impact of this error rate on the conclusions reached.

Finally, when considering the reliability of principles and methods, courts often look for standards that may control the technique's operation.\textsuperscript{104} These standards often appear in the peer reviewed work of others applying statistical sampling to a particular substantive application area. In addition, as discussed above, statutes, court rules, and precedential case law may promulgate standards. Additionally, all statistical methods have a series of assumptions about underlying data

\textsuperscript{101} See \textit{supra} Part II.C.
\textsuperscript{102} See \textit{supra} Part III.B.
\textsuperscript{103} While a subject that warrants, at the very least, an entire Article of its own, the choice between one-tailed tests and two-tailed tests is a quite frequent area of disagreement. While statistical scientists understand that the nature of the evidence gathered appropriately determines the hypothesis test employed, this quite frequently becomes a partisan issue, with methodology selection based upon what offers the most favorable results for a given client. See \textbf{DOWNING} & \textbf{CLARK}, \textit{supra} note 99, at 240-71.
\textsuperscript{104} See \textit{supra} Part II.C.
that must be met for their appropriate use.\textsuperscript{105} Experts should test these assumptions and should be prepared to discuss how they met a particular method’s assumptions.\textsuperscript{106}

\textbf{D. Reliable Application of Principles and Methods}

In many ways, courts rely on the adversarial process of ““vigorous cross-examination”” and ““presentation of contrary evidence’” to determine whether an expert has dependably applied reliable principles and methods to a particular set of facts.\textsuperscript{107} While it is tempting to disguise principles and methods employed in hopes of making it more difficult for opposition experts to assail favorable outcomes and conclusions, doing so can lead the court to deem the expert’s application of principles and methods unreliable.\textsuperscript{108} In such circumstances, the court may exclude related testimony. The better strategy is to allow the adversarial system to function in the manner contemplated by the court in \textit{Rudd} by providing a “step-by-step and transparent account” of the analysis performed.\textsuperscript{109} In doing so, the court is more likely to afford credit to an expert’s testimony and his opinions are more likely to remain before the trier of fact.

\textbf{CONCLUSION}

Necessity is the mother of invention.\textsuperscript{110} Court dockets at all levels continue to grow exponentially.\textsuperscript{111} At the same time, individual cases

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\textsuperscript{105} \textit{See generally} JOSEPH F. HAIR, JR. \textit{ET AL.}, \textit{supra} note 85, at 60-75.
\textsuperscript{106} Remarkably, the authors’ personal experience suggests that experts rarely do this. There are many instances in which experts have employed linear methodologies without bothering to test the underlying data for linearity! In the interest of full disclosure, application of a linear methodology to a non-linear problem results in a first order approximation. Therefore, if you are able to conclude that a relationship exists between variables, the results are conservative.
\textsuperscript{107} \textit{Rudd} v. \textit{Gen. Motors Corp.}, 127 F. Supp. 2d 1330, 1344 (M.D. Ala. 2001) (quoting FED. R. EVID. 702 advisory committee notes); \textit{see also supra Part II.D.}
\textsuperscript{108} \textit{See id.}
\textsuperscript{109} \textit{Rudd}, 127 F. Supp. 2d at 1344.
\textsuperscript{110} \textit{Attributed to RICHARD FRANCK, Northern Memoirs} (written in 1658, printed in 1694).
\textsuperscript{111} For those mathematically minded readers who are troubled by the vernacular use of the adjective “exponential,” it is true that, strictly speaking, where \text{exp} \{X\} is used to determine future growth, and \text{X}
are increasing in complexity. A single case before a single court may have thousands of parties, even more potential witnesses, and millions of pieces of potential evidence. Seventy years ago, an administrative law judge in the Seventh Circuit may have had the time and the energy to hear testimony from seven hundred individual witnesses, but no court enjoys this luxury today. Judges are studying statistics texts, litigants are talking of “bellwether” trials, and federal court materials now suggest that statistical sampling may in some cases be the “only practicable means to collect and present relevant data.”

Litigants have presented statistical sampling evidence in virtually all-imaginable types of litigation. Such evidence is already imbedded in the lingua franca of litigators, particularly litigators who make their home in the realm of complex litigation. Trying a class action without explicitly considering the possibility of statistical sampling evidence is likely to be tantamount to malpractice. And these complexities are not limited to practice before the federal courts—many state courts have accepted the necessity of summary evidence in complex matters and have adopted federal standards for evaluating this evidence either by direct reference or by relying upon state rules with similar factors.

For various reasons, attorneys will serve themselves and their clients well by adding an understanding of statistical sampling evidence, and the standards for judging such evidence, to their litigation arsenal. Of course, such attorneys may be called upon to

equals zero, there would be no growth (although it would still be described as exponential). In fact, if X is positive but very small, the result would be exponential growth that appears to be limited and linear growth and if X is negative, the result would be a decline. For those unable to excuse this common use of a mathematical term, substitute a word like “explosive,” and read on.

112. See supra Introduction; see also James S. Kirk & Co. v. Fed. Trade Comm’n, 59 F.2d 179 (7th Cir. 1932).
113. See supra note 6 and accompanying text.
114. See supra notes 7-15 and accompanying text.
115. See supra note 38 and accompanying text.
116. "Tools arm the man. One can well say that man is capable of bringing forth a world; he lacks only the necessary apparatus, the corresponding armature of his sensory tools. The
manage such evidence in making their client's case. Dealing with statistical experts on these matters can, at the very least, be an exasperating, albeit necessary, experience. In order to maintain that presented evidence is statistically sound and in compliance with various judicial standards, an attorney must have a working knowledge of the statistical procedures involved as well as the manner in which these procedures lend themselves to evaluation in the context of rules of evidence. At least as important is the attorney's ability to evaluate and criticize sampling evidence offered by adversaries. What passes for statistical evidence (so far) is often of marginal technical quality, and a lack of proficiency with this type of evidence translates directly into missed opportunities to weaken substantially an opponent's case. Finally, courts have sometimes felt compelled to commission statistical samples on their own initiative.\footnote{117} When a judge proposes to sample a subset of cases to determine damages for a significantly larger population of cases,\footnote{118} or proposes to systematically sample every hundredth piece of evidence as representative of all possible evidence,\footnote{119} a competent advocate must be able to evaluate these proposals. Where these proposals deviate from statistical practice or from evidentiary standards, a mastery of issues related to sampling evidence can easily be determinative.

To do his work well a workman must first sharpen his tools.\footnote{120} This Article has set out to provide resources to facilitate this sharpening process. This Article reviewed representative cases

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beginning is there. Thus the principle of a warship lies in the idea of the shipbuilder, who is able to incorporate this thought by making himself into a gigantic machine, as it were, through a mass of men and appropriate tools and materials. Thus the idea of a moment often required monstrous organs, monstrous masses of materials, and man is therefore a potential, if not an actual creator."
\end{quote}

\footnote{117} \textit{See supra} note 15 and accompanying text.
\footnote{118} \textit{See id.}
\footnote{119} \textit{See id.}
\footnote{120} The origins of this ancient Chinese wisdom are long since lost.
illustrating the development of statistical sampling evidence.\textsuperscript{121} It further examined new attitudes portrayed in federal judicial materials.\textsuperscript{122} This Article has cited numerous cases employing statistical sampling evidence.\textsuperscript{123} It has reviewed new federal standards for scientific evidence\textsuperscript{124} and has provided a thorough survey of the adoption of these standards by state courts.\textsuperscript{125} Finally, this Article has offered a primer of statistical sampling issues along with analytical procedures that address the various elements of the federal evidentiary standards.\textsuperscript{126} Certainly, the authors intend this Article to serve a pedagogical function. Yet learning without praxis is a hollow enterprise.\textsuperscript{127} It is our hope readers will also view this Article as a call to action.

\textsuperscript{121} \textit{See supra} notes 2, 3, 29-33, 34-37; Part I.
\textsuperscript{122} \textit{See supra} notes 5, 6 and accompanying text.
\textsuperscript{123} \textit{See supra} notes 7-15 and accompanying text.
\textsuperscript{124} \textit{See supra} Part II.
\textsuperscript{125} \textit{See supra} note 43 and accompanying text.
\textsuperscript{126} \textit{See supra} Part III.
\textsuperscript{127} "What good is it to sharpen a knife every day if you never use it for slicing?" JEAN-PAUL SARTRE, DIRTY HANDS, act 5, sc. 3, (GALLIMARD 1948).