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AUDITORS' USE OF BASE RATE EVIDENCE: INSIGHTS FROM A COGNITIVE STYLES MODEL

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Good auditors sometimes draw different conclusions from quite similar audit evidence. This may result from differences in auditors' information gathering and processing styles. In particular, differences in auditors' cognitive styles preferences may lead to differential reliance on base rate evidence. Base rate evidence -- such as information from auditors' past judgments -- is important because it is both relevant and inexpensive. One line of research suggests under-utilization of such evidence in the opinion forming process; another suggests the opposite. A comparison of methodological differences indicates that the framing of the experimental tasks may be contributing to the conflicting results. This paper presents the results of an empirical investigation of framing effects in evidence use and provides support for the proposition that framing may be an important factor. In addition, the use of cognitive styles models is proposed as a possible basis for explaining individual differences in base rate and sample evidence use.

Keywords: Cognitive styles, professional skepticism, base rate evidence, auditing, framing

INTRODUCTION

Base rate evidence, such as information from auditors' past judgments, is important in auditing because it is both relevant and inexpensive. Auditing research has long suggested under-utilization of base rates in evidence integration (Hulme, 1991). However, other research suggests over-reliance on base rates (Id.). A comparison of the methodological differences in the two groups of studies indicates that the framing of the experimental tasks may be contributing to the conflicting results (Hulme, 1993).

This article first presents the results of an empirical investigation of framing effects in auditors' use of base rate evidence in the opinion formulation process. The results support the proposition that framing may be an important factor. Then, a cognitive styles model is proposed as a possible basis for explaining individual differences in base rate and sample evidence use.[1] The purpose is to provide a framework which might explain why different accountants may derive different conclusions from the same audit evidence. Specifically, under study in this article is whether it is possible that differences in auditors' preferred information gathering and processing styles also may lead to differential reliance on base rate evidence. (Hulme & Karayan, 2001).

In order to test for these framing effects, an empirical study was performed. (Hulme, 1991). The study provides some support for the relevance of sample evidence representation -- framing -- as a factor in base rate use. These results also may be rooted in differences in the subjects' cognitive styles, that is, preferences in gathering and processing information resulting from genetic, cultural, and educational sources. (Contra, Pashler, McDaniel, Rohrer & Bjork, 2009).

[1] The extent to which cognitive styles explain human behavior is far from clear. (*Compare, e.g.*, Chabris & Simons, 2012 *with* Wagner & Huang, 2011).

"BASE RATE" INFORMATION: IMPORTANCE AND RELEVANCE

Using base rate evidence is important to auditors. Auditing is a process of obtaining and evaluating evidence in order to form a judgment (American Accounting Association ["AAA"], 1973, p. 2). Because the evidence obtained is often imperfect, the nature of the judgment is probabilistic at best (Mautz & Sharaf, 1961, p. 3) and sometimes plainly heuristic. Furthermore, because evidence is obtained from many sources at different times, judgments often depend on the sequence in which the evidence is obtained and on how the evidence is integrated. Thus, understanding probabilistic judgment and the factors that influence evidence integration is an important component of auditing research (Felix & Kinney, 1982).

Two types of evidence are potentially relevant in decision making under uncertainty as well as in a specific task setting, such as the assessment of fraudulent financial reporting ["FFR"]. The first type of evidence is base rates such as information about a given client (e.g., from prior period working papers) or relevant population statistics (e.g., industry norms). The second type of evidence is sample evidence obtained during the audit about a specific client, or information about the resolution of specific issues in other audits. For example, sample information relevant to the question of FFR would be a client's management and engagement characteristics.

Empirical studies of auditors' integration of base rate and sample evidence have consistently shown under-weighting of base rate evidence in favor of sample evidence (Hulme, 1991). This is a finding of considerable importance in auditing where base rate evidence from auditors' past judgments is relatively inexpensive to obtain and potentially relevant to the formulation of current judgments.

The proper use of base rates is an important but often neglected issue in auditing. For example, in discussing the assessment of the probability of fraud, the U.S. National Commission on Fraudulent Financial Reporting (1987, p. 21) places little emphasis on the low incidence of fraudulent financial reporting. They determined that "the incidence of fraudulent financial reporting cannot be quantified with any degree of precision," and concluded that "such an estimate is unnecessary." However, Joyce & Biddle (1981, p. 347) indicate that the failure of auditor subjects to make proper use of base rates "has practical significance because auditors most often make judgments concerning low base rate, high consequence events (e.g., fraud)."

BASE RATE EVIDENCE USE FROM A BAYESIAN PERSPECTIVE

Many audit judgment tasks can be characterized as a two event prediction problem (Johnson, 1983). The auditor must determine the probability that the sample evidence, D, originates from one state, H, as opposed to its complement, H'. For example, as part of internal control evaluation auditors must determine from compliance test results whether there is compliance with a particular control. Furthermore, in analytical review auditors must determine from various statistical procedures whether an account balance is consistent with expected values. Likewise, in the detection of fraudulent financial reporting auditors must determine if client management and engagement characteristics observed during the audit indicate fraud. Along this line, a Bayesian perspective sheds light on the use of base rate evidence by auditors.

Bayes' theorem can be intuitively described in the following terms (Ashton, 1982, pp. 94 96). Assume that an auditor currently assigns a subjective probability, P(H), to the truth of a particular hypothesis, H, such as the possibility of an inventory overstatement. If the auditor obtains evidence, D, that is conditionally related to H, such as the existence of a product obsolescence problem, then the auditor's confidence in H should increase.

In Bayes' theorem, the relationship between D and H is expressed formally as P(D|H). This is the conditional probability of observing the evidence D, given the truth of hypothesis H. Bayes' theorem can be expressed in the odds form as shown below:

where	$P(H\|D)/P(H'\|D) = [P(D\|H)/P(D\|H')] * P(H)/ P(H')$ Posterior Odds = Likelihood Ratio * Prior Odds
	P = Probability H = Outcome, i.e., Inventory Overstated D = Data, i.e., Unusual Transactions

In the above equation, P(H) is the prior probability. This is the base rate, that is, the degree of belief before evidence is obtained. P(H|D) is the posterior probability of H considering both the base rate and the sample evidence, D. P(D|H) is the conditional probability of observing the sample evidence, D, when the hypothesis, H, is true.

The following normative expectations regarding the use of base rate and sample evidence follow directly from the above equation. First, the base rate will have a relatively greater impact when P(H) is close to zero or unity. In these cases the prior odds ratio dominates in determining the posterior odds. FFR is a situation where the prior probability is normally low. Second, the likelihood ratio will have a relatively greater impact when P(D|H) is much larger than P(D|H'). If either the prior odds or the likelihood ratio is close to one, that factor is unimportant in determining the posterior odds.

The next section addresses whether these expectations are born out in practice. In other words, how well do decision makers adhere to the Bayesian probability calculus?

CONFLICTS IN THE LITERATURE

Despite the normative appeal of the Bayesian model, most of the auditing studies of base rate use have demonstrated an apparent under-weighting of base rates by practicing auditors responding to case studies in a laboratory setting. Typical of these studies is Joyce & Biddle (1981), which examined fraudulent financial reporting. The experimental design was a 2x2 factorial with base rates of management fraud of 1% and 19% and false positive (test procedures signal fraud when none is present) rates of 4% and 20%. The positive hit rate (test procedures correctly signal fraud) was held constant at 80%. The results showed that although subjects systematically responded to the base rates, these responses were not nearly as extensive as required by Bayes' theorem.

Joyce and Biddle (1981) concluded that the performance of auditor subjects was better than that of students in psychology experiments and cautioned against applying the results of psychology experiments of base rate use to phenomenon such as fraud. However, Holt (1987) concluded that the differences between the Joyce & Biddle (1981) results

and the earlier results of Kahneman &Tversky (1972) were due entirely to subtle differences in the framing of the Joyce and Biddle experimental problems and was not due to the audit context of the decision task or the use of auditors as subjects. An exhaustive analysis of the conflicts in the literature can be found in Hulme (1991).

THE RESEARCH HYPOTHESIS

The importance of the proper use of base rate evidence, combined with the need to resolve the apparent conflict in the literature, motivated the study underlying this paper. This study was an empirical investigation of framing effects in evidence use in order to test the proposition that framing may be an important factor. In the study, cases were designed to test a hypothesis concerning base rate use in a setting involving audit tasks and experienced decision makers. The task was a two-event prediction problem. Responding to base rate and sample evidence, subjects were asked to predict the posterior probability of an outcome, H. For this experiment, the audit issue could be either present, D, or absent, D'.

There were two possible outcomes, representing the presence of an overstatement, H, or an absence of overstatement, H'. The base rate was the prior probability of observing the outcome, P(H). The sample evidence was a pair of conditional probabilities indicating the relationship between the issue, D or D', and the outcomes, H or H'. The values of these probabilities were selected to produce a mixed evidence model. Specifically, the base rate values were chosen to produce an odds ratio less than one, and the sample evidence values were chosen to produce a likelihood ratio greater than one. These values should result in the base rate being viewed as negative evidence for H, an overstatement, and the sample evidence being viewed as positive.

Most studies of base rate use in the literature have concentrated on the properties of the base rate evidence. In this experiment, the focus was shifted to the properties of the other information input to a Bayesian decision tasks: the sample evidence. The pairings resulting from combining the two possible observed conditions, D and D', and the two possible outcomes, H and H', yield four conditional probabilities which are shown in the 2x2 table below:

		Overstatement	
		Present (H)	Absent (H')
Issue	Present (D)	P(D|H)	P(D|H')
	Absent (D')	P(D'|H)	P(D'|H')

The conditional probabilities on one diagonal, P(D|H) and P(D'|H')are confirming cases or positive signals for H and H' respectively, while the conditional probabilities on the other diagonal, P(D|H') and P(D'|H)are disconfirming cases.

The theoretical and empirical results of prior research support an expectation that the confirming sample evidence representation in the current study [conditional probabilities provided for confirming instances. That is, P(D|H) and P(D'|H') may result in greater sample evidence use. Because there is a trade-off between sample evidence use and base rate use, as discussed earlier, if sample evidence use is greater for the confirming representation, base rate use may be lower.

An opposite prediction can be derived from the Hogarth & Einhorn (1990) belief adjustment model. If the confirming sample evidence representation or framing leads to greater sample evidence use, as discussed above, the belief adjustment model would predict a stronger contrast effect. The confirming sample evidence representation would thus lead to greater base rate use than the disconfirming sample evidence representation.

It is also possible that the response to sample evidence represented as disconfirming could result in negative rather than positive adjustment of the probability of an account balance overstatement. This would lead to a consistent rather than a mixed evidence setting, possibly resulting in no order effect for the disconfirming sample evidence representation. The normative prediction is that representation will have no impact on sample evidence use, since the likelihood ratio is the same under either sample evidence representation. Thus, the normative expectation would be that sample evidence representation would have no impact on base rate use.

There is no empirical evidence to indicate whether alternative sample evidence representations will lead to differential sample evidence use, or if there will be an impact on base rate use. Thus the research hypothesis in this section of this article is that, in a mixed evidence setting, there will be no difference in base rate use by subjects receiving sample evidence represented as confirming and by subjects receiving sample evidence represented as disconfirming.

METHODOLOGY

The research design was a 2 X 2 factorial, with two issues (inventory obsolescence and collection of a delinquent accounts receivable) and two sample evidence representations (confirming and disconfirming). Because each subject was exposed to both issues, "issue" was a "within subject" factor. Sample evidence representation was manipulated between subjects.

The instrument was patterned after the case used by Boritz, Gaber, & Lemon (1987). Fifty practicing auditors from a national CPA firm participated in the experiment. The instrument was administered as part of a firm-sponsored training program. All the subjects were at the rank of supervising senior, and all had three years of experience.

The case began with background information describing a successful retail computer company. The background information was designed to provide a reasonably complete description of the audit client and to add realism to the case. The background information established that the client was low risk.

The first issue assessed the probability that the inventory account balance was materially overstated as a result of the forthcoming introduction of a new computer model that would compete with existing models in a retail computer firm's inventory.

The second issue assessed the probability that the firm's account receivable balance was materially overstated considering a large six-month delinquent account receivable. Different values were used in each issue to determine if the results would be affected by differences in the level of diagnosticity. For the inventory and accounts receivable issues, the likelihood ratios were 5/6 and 8/2, respectively.

The experimental task consisted of four components: general instructions and background information, the inventory issue, the accounts receivable issue, and a post test questionnaire. The subjects first read the general instructions and background information. The subjects then read a description of the inventory issue and assessed the "probability that the inventory account of [the client] is materially overstated." This and all subsequent assessments were made using a 100 point probability response scale ranging from 0 to 100.

The two items of evidence were then presented. The sample evidence indicated: (1) the conditional probability that there was a new product introduction given an overstatement of inventory, P(D|H) and (2) the conditional probability that there was a new product introduction given an overstatement of inventory, P(D'|H') This data was described as coming from "an extensive on-line data base containing the results of all audits conducted by your [the subject's] firm in the United States over the last ten years."

The base rate evidence, derived from the same data base, was the rate of material overstatements of inventory for all clients similar to the experimental client. After each item of evidence, subjects again assessed the probability of a material misstatement in the inventory account. The sample evidence conditional probabilities were either the confirming cases

described above or the disconfirming conditional probabilities [P(D'|H) and P(D|H')] to achieve the sample evidence representation manipulation.

The same process was followed for the accounts receivable issue. The first of the two items of evidence was the sample evidence. This provided the confirming conditional probabilities relating delinquent accounts and the overstatement of accounts receivable. The second item of evidence was the base rate of material overstatements of the accounts receivable account in all previous audits. As before, the order of the evidence items and the representation of the sample evidence were each manipulated at two levels.

RESULTS

An ANCOVA was employed to test the hypothesis, with the subjects' final beliefs as the dependent variable, sample evidence representation as the independent variable, and initial belief as a covariate. This is illustrated by Table 1. The ANCOVA results presented there show no main effect for sample evidence representation in the inventory issue. However, for the accounts receivable issue, there was a moderately significant main effect for representation.

The F-values (probabilities) for representation are .21 (p=.6508) for the inventory issue and 2.82 (p=.1000) for the accounts receivable issue. The adjusted means (standard error of the mean) are essentially the same for the confirm representations and for the disconfirm representations in the inventory issue. The adjusted mean is 49.321 (2.729) for the confirming sample evidence representation. This compares to 46.079 (2.729) for the disconfirming representation. For the accounts receivable issue, the adjusted means (standard error of the mean) is significantly lower for the disconfirm representation in the accounts receivable issue, with an adjusted mean of 37.234 (3.064) compared to 44.566 (3.064) for the confirming representation. This result suggests that base rate use is greater when the sample evidence representation is disconfirming.

Table 1

ANCOVA: Dependent Variable = Final Belief

Issue: **Inventory**				
Source	SS	DF	F Value	Prob.
Covariate:				
Initial Belief	8268	1	4.40	.0001
Realism	1713	1	.20	.0040
Representation	39	1	.21	.6508
Error	8567	46		
Issue: **Accounts Receivable**				
Source	SS	DF	F Value	Prob.
Covariate:				
Initial Belief	21427	1	9.86	.0001
Representation	650	1	.82	.1000
Error	10845	47		

In sum, representation produces mixed results for the two issues in the ANCOVA tests. For the accounts receivable issue, with initial beliefs as a covariate in the ANCOVA, there is a moderately significant main effect for sample evidence representation. For the inventory issue there is no representation effect.

CONCLUSIONS FROM THIS EMPIRICAL STUDY

One of the most researched phenomena within the probabilistic judgment paradigm in behavioral auditing is base rate use. This research has consistently demonstrated under-utilization of base rates relative to sample evidence. The empirical component of the present research examined base rate use within the framework of audit cases using a step-by-step sequential belief revision methodology. The base rate and sample evidence values were selected to produce a mixed evidence setting. Subjects' initial beliefs or practice priors were incorporated into the analysis. The results of the present study provide mixed support for a link between sample evidence representation and base rate use. There was no sample evidence representation effect for the inventory issue. However, for the account receivable issue, sample evidence representation had a moderately significant effect on base rate use. Specifically, base rate use, as measured by final beliefs, was greater for the disconfirming sample evidence representation. This result is consistent with the trade-off predicted by Bayes' theorem, which is that more (less) sample evidence use would result in less (more) base rate use for the confirming (disconfirming) sample evidence representation.

There are several possible reasons for the weak representation effects observed in the present study. Specifically, the small sample size combined with large individual differences in prior beliefs, the extensive background information provided in the case and/or the subjects' prior experience with the issues seem to have produced very strong anchoring. This is supported by the significance of initial beliefs in the ANCOVA models.

A more important issue is the difference in representation effects observed in the two issues. There were two differences between the issues: the issues themselves, and the base rate and sample evidence values used in the issues. Since these differences are confounded, it is not possible to positively rule out one.

Even though there were differences between the initial beliefs for the two issues, several other factors suggest that the different evidence values is the most likely explanation for the different results obtained in the two issues. The structure of the two issues was the same: in each issue the auditor has become aware of an issue that may have an impact on an account balance. The nature of the evidence available in both issues is the same and the source of that information is the same. Finally, when issue was included as a factor in an ANCOVA, there was no difference in final beliefs caused by issue. Thus, it appears reasonable that the difference in results stems from the differences in the base rate and sample evidence values in the two issues.

In this way, sample evidence representation appears to have a moderate effect on base rate use under certain conditions. But the exact mechanism producing this result is not clear. Possible explanations include the impact of differences in numerical values presented in the two sample evidence representations and the process used to integrate initial beliefs and case specified base rates and sample evidence.

DIRECTIONS FOR FUTURE RESEARCH ALONG THE SAME LINES

This empirical study provides some support for the relevance of sample evidence representation or framing as a factor in base rate use in a mixed evidence setting. These results suggest several issues for future research. For example, future studies could be undertaken to provide more conclusive evidence of sample evidence representation effects.

There also was a large variance in initial beliefs suggesting a need for more insight into auditors' prior belief formulation process. Specifically, the relative importance of initial beliefs and case specified base rates and the how they are integrated could be explored. Because the final beliefs were so highly correlated with these initial beliefs, incorporating base rate information into auditors' knowledge structures may lead to greater use of base rates. Furthermore, the present study examined only probabilistic judgment and not the resulting choice of actions. Einhorn & Hogarth (1981) point out that choice processes depend not only on the determination of probabilities but also on individual risk preferences and the expected values of outcomes.

The weak congruence with Bayes' Theorem in the present study suggests a need to develop alternative theories of base rate and sample evidence use in a mixed evidence model. Three possible theories are:

1. Bayes' Theorem predicts that base rate and sample evidence use will trade off. Greater base rate use will only be obtained when there is less sample evidence use.

2. The belief adjustment model (Hogarth & Einhorn, 1990) predicts that greater base rate use would be accompanied by more sample evidence use because of the contrast effect.

3. The information-underweighting theory (Melone, Mcguire, & Roy, 1989) suggests that individuals would react with both lower base rate and sample evidence use in a mixed evidence setting.

Because prior research, as well as the present study, fails to consistently support one of these theories, it is possible that the results may be confounded by individual differences.

A DIFFERENT DIRECTION: COGNITIVE STYLES AS AN EXPLANATORY FACTOR

Another approach to explain these individual differences may be found by applying Cognitive Styles theory, which deals with the possibility of patterns in individuals' information gathering and processing (Kitchener, 1983). The theory is rooted in neurological research suggesting that humans have complementary brain hemispheres, where the left hemisphere is characterized by a tendency to concentrate on details and the right hemisphere by a search for patterns (Taggart & Robey, 1981). A second processing dimension is based on notions of the neocortex -- a uniquely human portion of the brain -- having evolved on top of a more primitive mammalian brain that still exists in humans (MacLean, 1990). The "new brain" thinking mode seeks and processes information by applying deductive logic and a step-by-step approach. This is in contrast to the "mature brain" experiential (experimental) mode, which relies on instinct and prior experience along with motivation, dealing with people, innovation, memory, and understanding the big picture.

In addition to the influences from brain structure "hardware", some argue that "software" can be overlaid by cultural values and education (Hofstede, 1991), and that this can have an impact on what accountants do and why they do it (e.g., Gray, 1988; Chow, Shields, & Chan, 1991; and Harrison, 1993). Research has found that cognitive styles can affect accounting student performance on exams (Jones & Wright, 2012; Hulme, 1999) projects (Hulme, Martin, & Karayan, 2000), and tasks (Honn & Ugrin, 2012), as well as students' successful use of certain study aids (Jones & Wright, 2010). Research (e.g., Karayan, Martin, & Hulme, 2014) also has indicated that accounting students can have very diverse problem solving styles, suggesting that patterns in the use of base rate evidence too may be influenced by individual auditors' cognitive styles. Thus, although cognitive styles models may oversimplify influences on auditors' decision processes -- see, e.g., the literature cited in Dye & Carland (1995) – the theory nevertheless may serve as a useful descriptive model for research on auditors' use of base rate evidence.

Cognitive styles theory has been operationalized in a number of models, such as the Myers Briggs Type Indicator, Kolb's Experiential Learning Model (Baker, Simon, & Bazeli, 1987), and Herrmann's Brain Dominance Model (Lumsdaine & Lumsdaine, 1995). However, the instruments devised under almost all such models to measure individuals' cognitive styles require specialized training to interpret (Stout& Ruble, 1994) and have proven expensive to administer. An instrument which may provide a readily accessible basis for auditing research is the Raudsepp Problem Solving Styles Inventory (Raudsepp, 1992).[2] Like most Cognitive Styles models, Raudsepp proposes four fundamental patterns of human cognition. Raudsepp, for example, characterizes preferences in gathering and processing information: A=analytical, B=procedural, C=interpersonal, and D=conceptual.

A person whose highest score is in A may be described as analytical, logical, and quantitative. Mr. Spock on the old Star Trek series is almost a perfect "A" person. If the highest score is a B, the individual likely is a detail person, a list maker, practical, and well organized. When B's are faced with a problem they role up their sleeves and get to work. C's are concerned about feelings, both their own and those of others: they tend to be emotional and empathetic, and prefer working in a group.

[2] A self-scoring Raudsepp inventory, designed to enable students to discover their dominant preferences, and to use this information to build more effective teams, enhance their abilities to solve unstructured problems, and reduce friction with "others", is available *at http://faculty.woodbury.edu/karayanj/brain/brain* .

Finally, D's are likely to be imaginative, intuitive, and innovative. They often excel at getting the big picture, but may have difficulty expressing ideas to others.

Relating this model to evidence use, individuals with preferences in quadrant A would be likely to exhibit evidence use behaviors consistent with the belief adjustment model, while individuals with quadrant C preferences would be more likely to discount evidence of any kind and exhibit an information underweighting pattern. Individuals with quadrant B or D patterns should follow Bayes' Theorem. To determine this, an experiment should be designed to determine if such differences in thinking preferences may help explain the individual differences in base rate and sample evidence use. This appears to be the most promising line of future research resulting from the empirical study presented in this article.

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