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Education: Recent CPA Exams— A Statistical Note - The ABCs And Ds Of Bias

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limited to \$25 in 1982 and 1983 and \$75 in 1984. In 1986, 100% of all contributions can be deducted. The provision expires after 1986.

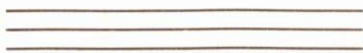
Also beginning in 1982, U.S. citizens working overseas will be granted a substantial exclusion from taxation for certain income earned abroad. The exclusion in 1982 is \$75,000 and increases by \$5,000 each year until 1986 when a \$95,000 exclusion becomes permanent. An excess housing allowance will also be permitted.

The Act also increases the amount of child care credit and creates a tiered structure. For taxpayers with adjusted gross income in excess of \$28,000, the credit is limited to \$480 for one child and \$960 for two or more.

Delayed Provisions

Some provisions of the new law do not become effective for several years, including "indexing." Beginning in 1985, individual tax brackets as well as personal exemptions and the zero bracket amount will be adjusted based on changes in the Consumer Price Index. Also beginning in 1985, a new net interest exclusion will be available. The exclusion will be 15%, but not more than \$450 (\$900 on a joint return) of the excess of qualified interest income over qualified interest expense. Qualified interest income includes income from regulated thrift institutions and corporate bonds. Qualified interest expense does not include home mortgage interest.

Our next article will address some of the business provisions, in particular, those affecting capital recovery. The impact of the 1982 changes for individuals makes it incumbent upon all practitioners to review the personal tax planning of their clients so that the least possible tax can be paid over the 1981-1982 period. In particular, taxpayers with substantial amounts of passive income should generally take steps to defer the receipt of that income until 1982.



Education

Recent CPA Exams — A Statistical Note

The ABCs And Ds Of Bias

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In recent years, objective questions of a multiple choice type have made up a significant part of the CPA exam. They have been used in all parts of the examination and have constituted from about one-third to one-half of each section as measured by time allowances.

For example (in objective questions) the May 1980 session Practice — Part I showed 135 minutes out of a minimum allowance of 200 minutes; Theory in the same exam represented 90 minutes out of 150 minutes minimum allowance. In the November 1978 exam Practice — Part II contained 100 of 270 minutes on the maximum allowance and Business Law in that exam devoted 105 minutes of 210 minutes on the maximum allowance to multiple choice. Almost without exception all of the questions in every exam have utilized a four answer choice format.

A basic assumption in objective testing is that no bias will exist towards one of the answer choices or against other choices. In elementary statistics there are several demonstrations that can be made to show that unconscious bias exists in most of us. A question can be posed as to whether the objective questions of the CPA exam have exhibited any bias on the part of the examiners. We should stress strongly that we are not implying bias in any sense of dishonesty. The bias we would be examining would be mainly an unconscious one: e.g., a preference for "c" over "d" for any of a variety of reasons, mostly unknown.

Several statistical tests are available that can determine whether such bias has been present. The customary test to use in such circumstances is known as the Chi-



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Square test, and is symbolized as X^2 . It is not a difficult test to understand.

If there were no bias present in the construction of the test then as the number of items sampled grew very large we would expect the relative frequency of each of the answer choices to approach one-fourth in the four-choice format. This is a reflection of the basic definition of probability. On the other hand, if the examiner has an unconscious bias towards, for example, the letter "b" then that answer will creep into the examination process more frequently than probability would indicate. It follows though that as "b" is chosen more frequently than it should be, then the relative frequencies of a, c, and d will decline.

The chi-square test does not presume that the actual distribution

will come out exactly as expected. Instead it says, in effect, that some variation would be expected by chance but that variation should not be too large. To make the critical decision as to when the variation is too large it is necessary only to compute a value for the variation as described below and compare it to a table of values for the X^2 statistic that has already been worked out.

The arithmetic value for the variation amount is computed by adding together the results of each comparison of, for example a's to be expected a's; b's to b's, etc. Each computation is

$$\frac{(\text{actual minus expected})^2}{\text{expected}}$$

If we tallied 200 multiple choice responses on a four answer choice then

Actual (what we counted)	Expected ($1/4$ of 200)	A-E	(A-E) ²	E	$E = X^2$
55	50	5	25	50	.5
45	50	-5	25	50	.5
58	50	8	64	50	1.28
42	50	-8	64	50	1.28
Total X^2					3.56

Some explanation of the reasoning for several of the computations is in order. The squaring step is designed to weight negative differences, as well as positive

differences. If we expected a value of ten then an actual value of thirteen should carry the same weight as an actual value of seven. In tabular fashion:

Actual	Expected	Actual Minus Expected	(Actual Minus Expected) ²
13	10	+3) not the same	9) the same weight
7	10	-3) as	9) as

Inlike manner the dividing by expected values is a logical step to compare the variations better. Clearly it is the relative magnitude of

the departure from expected rather than the absolute size of the departure. Consider two cases:

	Actual	Expected	Actual minus Expected (A - E)	(A - E) ²
Case 1.	20	30	-10	100
Case 2.	20	10	10	100

but the Case 2 variation is much more significant since it relates to a much smaller base.

To test for possible bias the five exams from May of 1978 through May of 1980 were analyzed. Every

response from each of the five sessions was tallied as to whether it was a, b, c, or d. As we prepare to manipulate the number results comparing expected to actual, a summary of the testing process might be

helpful. There are many table values available for a critical X^2 . The tables are arranged as (approximate)

Degrees of Freedom	Significance %		
	10%	5%	1%
1	2.7	3.8	6.6
2	4.6	6.	9.2
3	6.3	7.8	11.3
4	7.8	9.5	13.3
.			
.			
.			
n			

If the computed result exceeds the table value we assume bias is present, if the computed result is less than the table value then the difference between actual and expected has been small enough to presume that no bias exists. The statistical phrase when we find no bias is "fail to reject the null hypothesis."

The significance percentage is a judgment choice and we will use the traditional 5%. In everyday language this means our decision, by chance, would be wrong only once in twenty tries.

The degrees of freedom value comes from (n-1) in this type of problem. Since there are four classifications (a, b, c, d), degrees of freedom are (4-1) or three. In everyday language degrees of freedom means the number of observations that can vary in the problem. If we looked at 200 answer choices spread between a, b, c, d then as soon as we have tallied a, b, and c the d value is fixed. Only three of the four classifications are free to vary hence there are only three degrees of freedom. Our critical X^2 is at the intersection of 5% significance and three degrees of freedom and is 7.8.

The main test was in terms of the aggregate answer distribution from all five exams. In addition some analysis of the individual tests was made. The aggregate distribution is the soundest one to test because the law of large numbers should prevail, given the number of answers under observation.

Given the established significance level we proceeded with the test by utilizing the X^2 statistic and our tally. The results can be summarized as: (not in rigorous statistical language)

Practice I	failed to detect bias
Practice II	a significant bias exists
Auditing	failed to detect bias (but see below)
Law	failed to detect bias
Theory	failed to detect bias (but see below)

Since Practice II was the only section to indicate bias we will detail the test for it premised on the data from the five exams. The five tests included 188 multiple choice items. The computation for X^2 proceeds as

$188 \div 4 = 47$ items expected in each category of A, B, C and D.

The actual tally was:

A	44
B	63
C	50
D	31. The remaining calculations . . .

$$\text{are: } \frac{(44-47)^2}{47} + \frac{(63-47)^2}{47} + \frac{(50-47)^2}{47} + \frac{(31-47)^2}{47} = \frac{530}{47} \approx 11.3$$

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This computed value is larger than the critical value for X^2 of 7.8 and indicates that it is unlikely that this variation occurred by chance. The bias is due to disproportional choice of answer B over answer D.

The other four test sections did not reveal any examiner bias but there are several observations that can be made. The Auditing portion of the exams consisted of 300 questions which yields an expected value of 75 for each of the answer categories A, B, C and D. The actual tally was:

A	72
B	75
C	79
D	74

The observation that can be offered

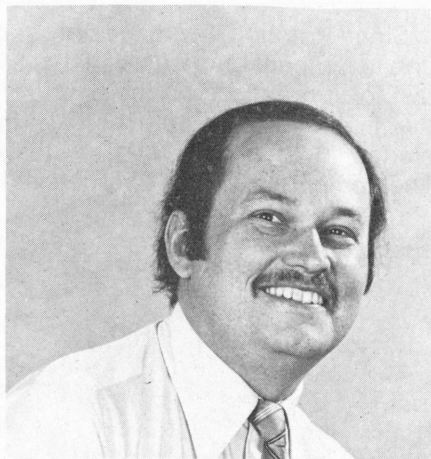
	Prior to May 1980	May 1980	Cumulative
A	55	15	70
B	56	8	64
C	52	16	68
D	37	21	58
	<u>200</u>	<u>60</u>	<u>260</u>
	(expected 50)	(expected 15)	(expected 65)

is that this section of the exam seems to display a purposeful intent on the part of the examiners to bring results almost exactly in line with expected. Each of the five component exams contained 60 multiple choice questions and even on the individual exams a very tight distribution was found. The lowest and highest individual counts were 11 D's and 19 C's found on the May 1978. All other results were even closer to the expected value of fifteen.

An observation on the Theory portions of the exams would suggest that the May 1980 exam was used to "catch up" on the normality of a distribution that was getting out of hand. It is impossible to make this point statistically but note

One other interesting anomaly in looking at the individual exam for May 1980 shows that Question 3 in Practice I had 20 multiple choice items without a single "A" answer. This is an exceptional event in terms of its probability. This question was the one devoted to federal income taxation. Under the supposition that this area of questioning could reveal bias it was tested separately, but other than the May 1980 result no significant departure was observed from a normal distribution.

In summary there appeared to be a close relationship of actual distribution to expected distribution in all areas of the exam except Practice II. In fact the Auditing distribution was so close as to suggest purposeful choosing of answers so as to maintain a close relationship. In a light vein, it is suggested that future test takers should, when uncertain on multiple choice questions in Practice II, opt for answer choice "b" in preference to "d." Ω



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