# The Auditor's Sampling Decision in The Presence of Redundant Internal Controls

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*Redundant internal controls are commonplace and auditors must decide how best to test them. Professional literature provides four approaches. The first tests only one control at low risk of overreliance. The second transaction-links redundant controls with a deviation defined as lapse of both and tests at low risk of overreliance. The third tests one control at low risk of overreliance and tests the other at higher risk. The fourth tests both controls at moderate risk of overreliance. This paper applies utility theory to the auditor's decision regarding the third and fourth approaches and considers implications for the other two approaches.*

## INTRODUCTION

In a well-designed system of internal control, some redundancy relative to specific internal control objectives is likely. In regard to adequately addressing the specific control objectives, some of these redundancies may be necessary while others may be unnecessary. Unnecessary control redundancies may occur as a result of establishing controls that accountants, managers, or auditors simply expect to exist, although the applicable control risk has already been sufficiently mitigated through another internal control. For example, although purchase order limits relative to specific suppliers and specific organizational units may be programmed into a system, a company may maintain a policy of requiring that purchase orders be authorized by a budget manager prior to being placed. Although the controls are redundant and the programmed control has a very low probability of failure relative to the control objective of ensuring that purchase orders are properly authorized, both managers and auditors may derive a measure of comfort from knowing that purchase transactions are being reviewed by a human being. Necessary control redundancies are likely to be established where a single control has more than a remote possibility of lapse or incomplete coverage and the control objective is important enough to make the establishment of the redundant control cost effective. For example, although a computerized system may post certain transactions automatically to both subsidiary ledger and general ledger control accounts, it is still necessary to reconcile subsidiary ledgers to the associated general ledger control accounts on a regular basis due to other transaction postings that may not be automatically dual-posted. Another example is where a charitable organization receives contributions through a computerized lockbox process wherein a bank automatically captures check amounts along with the applicable attribution fund codes from preprinted remittance advices that the donors received through direct mail appeals. Although the automatic attribution of the donations to the fund codes on the remittance advices is an important internal control, it does not provide complete assurance that every donation is recorded and used in accordance with donors' wishes. Some donors may have written memos on their checks signifying their desire to have their donations attributed to some fund or purpose other than that coded on the remittance advices that they returned with their checks. Consequently, the charitable organization may establish a transaction-linked redundant control by having an employee scan image files of the checks received through the lockbox, looking for such donor memos.

In the auditor's consideration of internal control as part of a financial statement audit, the existing professional standards require an auditor to follow a top-down approach that starts with the financial statements and an understanding of the related financial reporting risks and proceeds to a consideration of entity-level controls as those controls pertain to accounts, disclosures, and assertions that have potential for material misstatement in the financial statements (PCAOB, 2007). Although an auditor is required to test internal controls to verify whether significant financial statement assertions are sufficiently addressed, there is no requirement to test all controls that are redundant to a particular assertion, unless the redundancy of the particular controls is considered an important control in itself (PCAOB, 2007). However, the testing of redundant controls is not discouraged and potentially may be an efficient and highly effective audit strategy compared with the testing of a single internal control that pertains to a specific financial statement assertion. In regard to auditing in the presence redundant internal controls, authoritative literature identifies four possible courses of action: (1) test only one of the controls at a low risk of overreliance; (2) transaction-link the redundant controls and test at a low risk of overreliance on the basis of a control deviation being defined as the failure of both controls to operate on a specific transaction; (3) test one of the controls at a low risk of overreliance and test the redundant control at a higher risk of overreliance; and (4) test each of the controls at a higher risk of overreliance (AICPA, 2014).

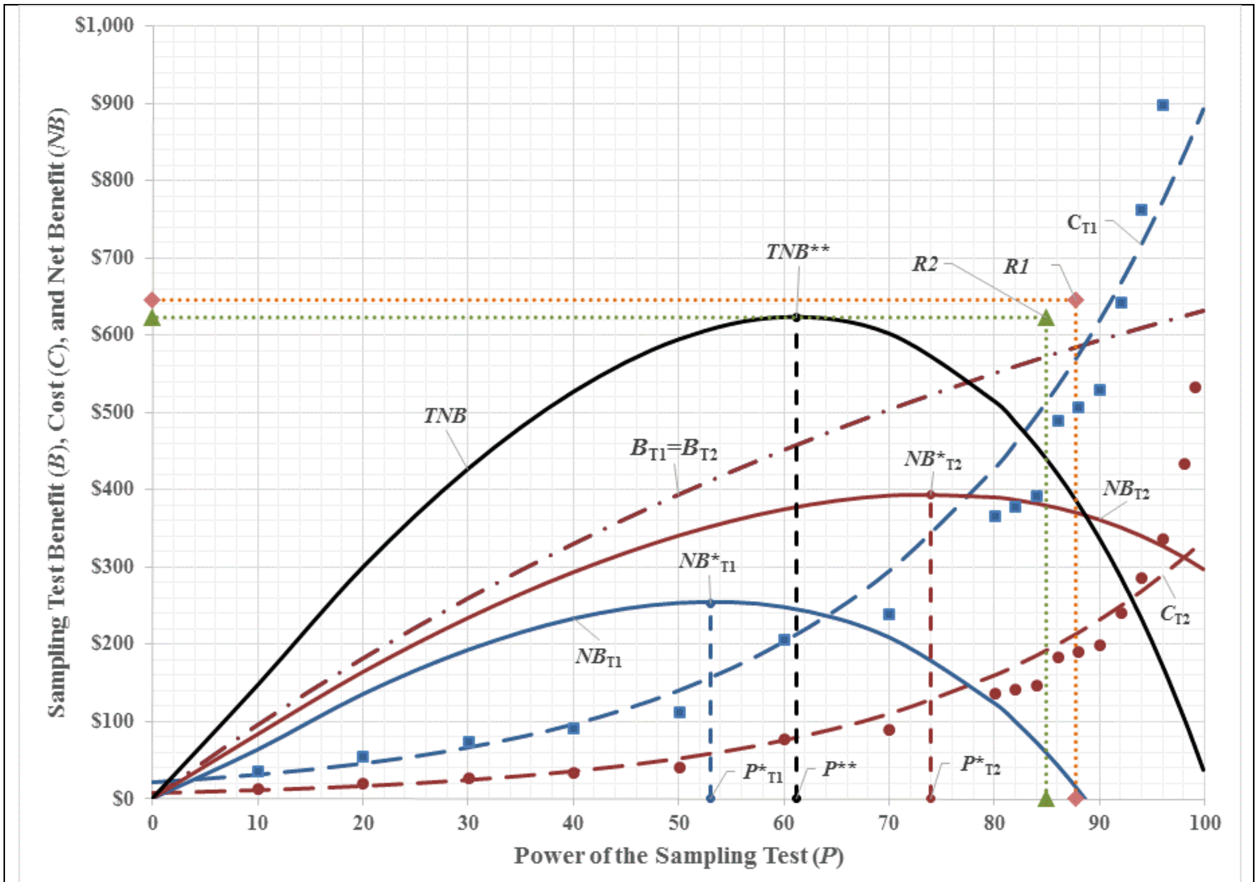
When considering the first approach relative to the other three, in order for the auditor to reach a target level of assurance, it is reasonable to conclude that the risk of overreliance that would apply in a test of only one of the internal controls would be lower than any of the risks of overreliance that would apply in the other three approaches which involve examining the operation of both controls. That is, in order to place the planned degree of reliance on an internal control, an auditor would require a sampling application with a higher power when examining only one control relative to a control objective than when examining two or more controls relative to the same control objective. Similarly, when considering the fourth approach relative to the third approach, it is reasonable to conclude that the single level of risk of overreliance that applies in the fourth approach falls somewhere between the high and low levels of risk of overreliance that are in view in the third approach. In a sense, the third and fourth approaches are simply nuances of a more general approach of testing both controls in a non-transaction-linked approach where, assuming independence between operations of the controls, the resulting risk of overreliance is the product of the separate risks of overreliance. This paper applies utility theory to model the auditor's sampling decision regarding this generalized two-sample approach and shows that testing redundant internal controls at different risks of overreliance is never suboptimal to testing the internal controls at the same risk of overreliance. This paper also gives consideration of the auditor's decisions regarding the first two single-sample approaches relative to the auditor's optimal decision from the two-sample context.

## ANALYSIS

This analysis focuses on an examination of the auditor's decision situation with respect to audit sampling options three and four, which are the two-sample approaches. This is followed by a preliminary consideration of the expansion of the decision situation to the single-sample audit sampling options one and two. Audit sampling options three and four are two-sample approaches that differ only in that option three permits the risks of overreliance for the two samples to differ while option four requires the risks of overreliance to be the same.

In control testing, the risk of overreliance is analogous to the risk of incorrect acceptance in more general hypothesis testing situations. In statistical parlance, this risk is also known as both the Type II error risk and as the beta risk (e.g., see Boockholdt and Finley, 1980). Consequently, $\beta$ is used to represent this risk, while $P$ is used to represent the power of the statistical test, $(1-\beta)$. In control testing, the auditor reduces the risk of overreliance by increasing the power of the test. In this analysis, $P$ is increased by increasing the sample size according tables similar to those presented in the AICPA audit guide. However, since the audit guide only presents sample size tables for a limited range of risks of overreliance, a computer model was built to reproduce these tables and then used to produce a more extensive set of sample size tables (not shown) at risk of overreliance percentages of 90, 80, 70, 60, 50, 40, 30, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, and 0.1. This permits the assessment of the sample size profile of a particular control sampling application where the estimated population error rate and the auditor's tolerable error rate have both been specified.

**FIGURE 1**
**ANALYSIS OF AUDITOR'S SAMPLING DECISION IN THE PRESENCE OF FULLY REDUNDANT CONTROLS**




$C_{T1} = a_{T1}e^{g_{T1}P} = 22.062e^{0.037P}$ (Cost of T1)
$C_{T2} = a_{T2}e^{g_{T2}P} = 8.273e^{0.037P}$ (Cost of T2)
$B_{T1} = 1{,}000(1 - e^{-0.01P})$ (Benefit of T1)
$B_{T2} = 1{,}000(1 - e^{-0.01P})$ (Benefit of T2)
$NB_{T1} = B - C_{T1}$ (Net benefit of T1)
$NB_{T2} = B - C_{T2}$ (Net benefit of T2)
$TNB = NB_{T1} + NB_{T2}$ (Total net benefit)

$NB^*_{T1} = \max(NB_{T1})$
$NB^*_{T2} = \max(NB_{T2})$
$TNB^{**} = \max\,(TNB)$
$R1 = NB^*_{T1} + NB^*_{T2}$ plotted at $[1 - (1 - P^*_{T1})(1 - P^*_{T2})]$
$R2 = TNB^{**}$ plotted at $\left[1 - \left(1 - P^{**^2}\right)\right]$
T1 = Sample Test 1; T2 = Sample Test 2

By multiplying the sample sizes obtained for a specific profile by a per-unit sampling cost, audit sampling cost profiles are obtained. In Figure 1 above, square data points represent the costs obtained for various $P$ for sampling test T1, with estimated population error rate of 1.5 percent, tolerable error rate of 3 percent, and cost per sampling unit of \$2.00. Similarly, round data points represent the costs obtained for various $P$ for sampling test T2, with estimated population error rate of 1.5 percent, tolerable error rate of 3.0 percent, and cost per sampling unit of \$0.75. The exponential function of the form

$$C = ae^{gP} \tag{1}$$

reasonably approximates the total cost behavior of each set of observations, with

$$C_{\mathrm{T1}} = a_{\mathrm{T1}} e^{g_{\mathrm{T1}} P} = 22.062 e^{0.037P} \tag{2}$$

representing the best-fitting cost function of this form for T1, and

$$C_{\mathrm{T2}} = a_{\mathrm{T2}} e^{g_{\mathrm{T2}} P} = 8.273 e^{0.037P} \tag{3}$$

representing the best-fitting cost function of this form for T2. The constant growth rate, $g$, is the same for both total cost functions because the estimated population error rates and the tolerable error rates are the same for both functions.

For a complete modeling of the auditor's decision situation, benefit functions based on utility theory are needed. If the internal controls being examined in the two tests are fully compensating, then they are perfect substitutes and the auditor's sampling power preferences for the two tests may be described by a single benefit function of the general form

$$B = c\left(1 - be^{hP}\right) \tag{4}$$

In Figure 1, the benefit functions for T1 and T2 are the same and are set forth as

$$B_{\mathrm{T1}} = B_{\mathrm{T2}} = 1{,}000(1 - e^{-0.01P}) \tag{5}$$

With the constant growth rate, $h$, set equal to -0.01, this benefit function exhibits decreasing marginal utility for statistical power in the sample tests. Separate benefit functions would be needed for the sample tests in situations where the internal controls being examined are not considered to be fully compensating or redundant, i.e., where the successful operation of one internal control does not completely mitigate the residual control risk of a failure of the other internal control.

Having specified the benefit and the cost functions, net benefit functions can be obtained by taking the differences between the associated benefit and cost equations. In Figure 1, although the benefit functions are the same for the sample tests, the existence of separate cost functions leads to the existence of separate net benefit functions expressed as

$$NB_{\mathrm{T1}} = B - C_{\mathrm{T1}} \tag{6}$$

and

$$NB_{\mathrm{T2}} = B - C_{\mathrm{T2}} \tag{7}$$

These functions are concave-down, having global maxima at $NB^*_{\mathrm{T1}}$ and $NB^*_{\mathrm{T2}}$, with $P^*_{\mathrm{T1}}$ and $P^*_{\mathrm{T2}}$ representing the corresponding optimum sampling powers in stand-alone testing scenarios. The $P^*$ are found by setting the first derivative of the net benefit function equal to zero and solving to give

$$P^* = \left[ln\left(\frac{-ag}{cbh}\right)\right]/(h - g) \tag{8}$$

With the component values for $a$, $b$, and $c$ as provided above for $NB_{\mathrm{T1}}$ and $NB_{\mathrm{T2}}$, the optimum sampling power of T1 evaluates as

$$P_{T1}^{*} = \left[ln\left(\frac{-22.062\times0.037}{1000\times1\times(-0.01)}\right)\right]/(-0.01-0.037) = 53.3 \text{ percent} \tag{9}$$

providing for a valuation of the maximum net benefit of T1 as

$$NB_{\mathrm{T1}}^{*} = \left[1000\left(1-e^{-0.01(53.3)}\right) - 22.062e^{0.037(53.3)}\right] = \$255 \tag{10}$$

while the optimum sampling power of T2 evaluates as

$$P_{T2}^{*} = \left[ln\left(\frac{-8.273\times0.037}{1000\times1\times(-0.01)}\right)\right]/(-0.01-0.037) = 74.2 \text{ percent} \tag{11}$$

providing for a valuation the maximum net benefit of T2 as

$$NB_{\mathrm{T2}}^{*} = \left[1000\left(1-e^{-0.01(74.2)}\right) - 8.273e^{0.037(74.2)}\right] = \$395 \tag{12}$$

If the auditor evaluates the controls using the sample sizes corresponding with $P_{\mathrm{T1}}^{*}$ and $P_{\mathrm{T2}}^{*}$, a total net benefit of \$650 (i.e., \$255 + \$395) will be obtained and the resulting combined power of the tests will be

$$[1-(\beta_{\mathrm{T1}}^{*}\beta_{\mathrm{T2}}^{*})] = [1-(1-P_{\mathrm{T1}}^{*})(1-P_{\mathrm{T2}}^{*})] = [1-(1-0.533)(1-0.742)] = 88 \text{ percent} \tag{13}$$

This is plotted as result point *R1* in Figure 1.

The total net benefit function, $TNB$, is found as the sum of $NB_{\mathrm{T1}}$ and $NB_{\mathrm{T2}}$. Like its composite functions, $TNB$ is concave-down, having a global maximum, $TNB^{**}$, that has a corresponding component sample power, $P^{**}$, that is always between $P_{\mathrm{T1}}^{*}$ and $P_{\mathrm{T2}}^{*}$, inclusive. With the constant growth rates, $g$, being equal for $C_{\mathrm{T1}}$ and $C_{\mathrm{T2}}$, and the constant growth rates, $h$, being equal for $B_{\mathrm{T1}}$ and $B_{\mathrm{T2}}$, $P^{**}$ can be found as the unique value of $P$ where the sum of the slopes of $NB_{\mathrm{T1}}$ and $NB_{\mathrm{T2}}$ equals zero. That is, the following expression of the sum of the first derivatives of $NB_{\mathrm{T1}}$ and $NB_{\mathrm{T2}}$ set equal to zero

$$\frac{dNB_{\mathrm{T1}}}{dP} + \frac{dNB_{\mathrm{T2}}}{dP} = b_{\mathrm{T1}}c_{\mathrm{T1}}he^{hP} + a_{\mathrm{T1}}ge^{gP} + b_{\mathrm{T2}}c_{\mathrm{T2}}he^{hP} + a_{\mathrm{T2}}ge^{gP} = 0 \tag{14}$$

leads to the following expression of the component sample power that corresponds with $TNB^{**}$

$$P^{**} = \left[ln\frac{-g(a_{\mathrm{T1}}+a_{\mathrm{T2}})}{h(b_{\mathrm{T1}}c_{\mathrm{T1}}+b_{\mathrm{T2}}c_{\mathrm{T2}})}\right]/(h-g) \tag{15}$$

where the subscripts designate the components that may have unique values for the sample tests. If we allow for unique constant growth rates in either the cost or benefit equations, then $P^{**}$ may only be found by trial and error. However, with the values provided for $NB_{T1}$ and $NB_{T2}$, $P^{**}$ is directly solvable and is

$$P^{**} = \left[ln\left(\frac{-0.037\times(22.062+8.273)}{-0.01\times[(1\times1000)+(1\times1000)]}\right)\right]/(-0.01-0.037) = 61.3 \text{ percent} \tag{16}$$

At this power, the net benefit of T1 evaluates as

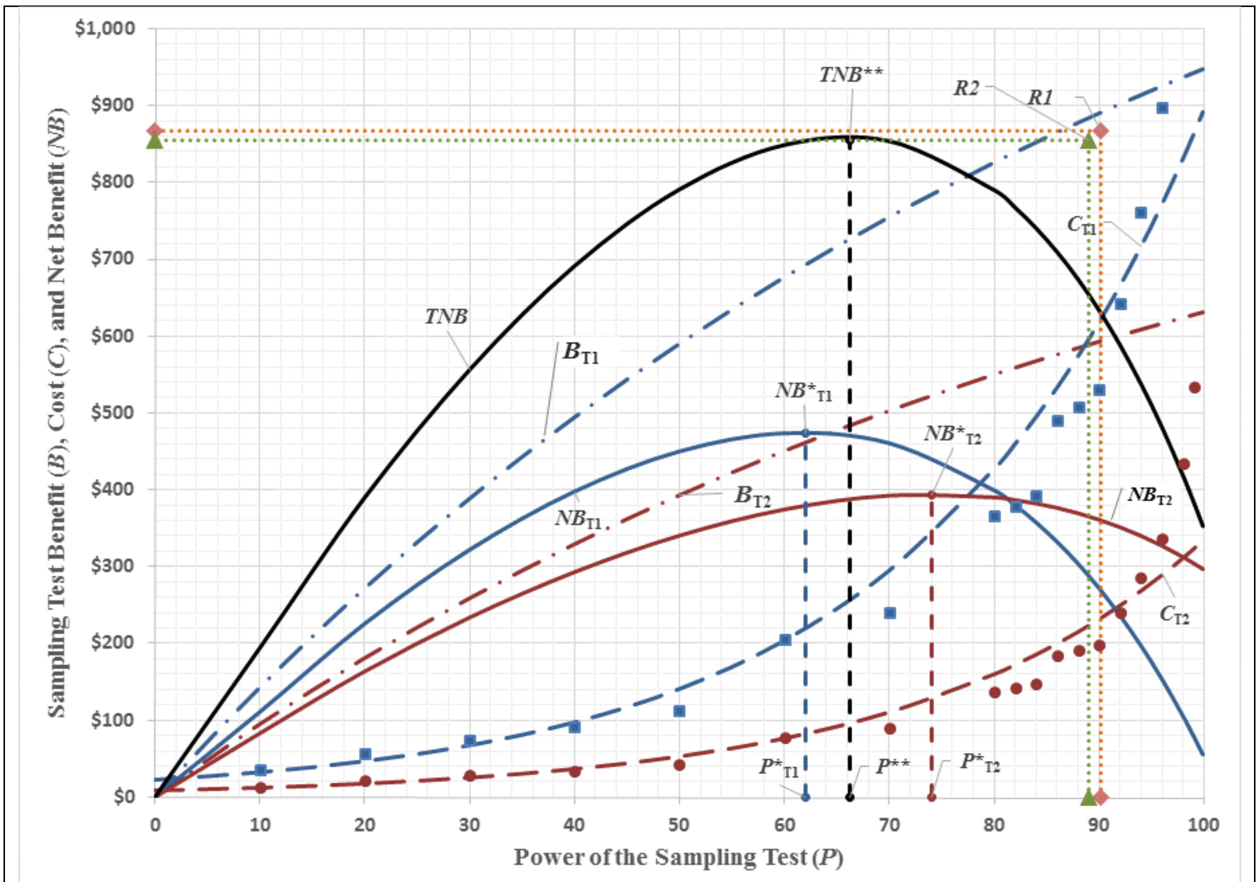
$$NB_{\mathrm{T1}} = \left[1000\left(1-e^{-0.01(61.3)}\right) - 22.062e^{0.037(61.3)}\right] = \$245 \tag{17}$$

and the net benefit of T2 evaluates as

$$NB_{\mathrm{T2}} = \left[1000\left(1 - e^{-0.01(61.3)}\right) - 8.273e^{0.037(61.3)}\right] = \$378 \tag{18}$$

This gives a total net benefit of \$623 (i.e., \$245 + \$378) and the combined power of the tests is 85 percent [i.e. $1 - (1 - 0.613)^2$]. This is shown in Figure 1 by the effective result point plotted as *R2*. Since *R2* lies below *R1*, the audit approach of testing both controls at the same risk of overreliance (i.e., $P^{**}$) is inferior in this case to the approach of testing each control at the separate risks of overreliance corresponding with the optimum net benefit point of each test (i.e., $P^*_{T1}$ and $P^*_{T2}$). However, both *R1* and *R2* lie above every point on both $NB_{\mathrm{T1}}$ and $NB_{\mathrm{T2}}$, implying that the third and fourth audit sampling approaches are superior to the first audit sampling approach in which only one internal control is tested.

**FIGURE 2**
**ANALYSIS OF AUDITOR'S SAMPLING DECISION IN THE PRESENCE OF PARTIALLY REDUNDANT CONTROLS**




| | | |
|---|---|---|
| $C_{\mathrm{T1}} = a_{\mathrm{T1}}e^{g_{\mathrm{T1}}P} = 22.062e^{0.037P}$ | (Cost of T1) | $NB^*_{\mathrm{T1}} = \max(NB_{\mathrm{T1}})$ |
| $C_{\mathrm{T2}} = a_{\mathrm{T2}}e^{g_{\mathrm{T2}}P} = 8.273e^{0.037P}$ | (Cost of T2) | $NB^*_{\mathrm{T2}} = \max(NB_{\mathrm{T2}})$ |
| $B_{\mathrm{T1}} = 1{,}500(1 - e^{-0.01P})$ | (Benefit of T1) | $TNB^{**} = \max\,(TNB)$ |
| $B_{\mathrm{T2}} = 1{,}000(1 - e^{-0.01P})$ | (Benefit of T2) | $R1 = NB^*_{\mathrm{T1}} + NB^*_{\mathrm{T2}}$ plotted at $[1 - (1 - P^*_{\mathrm{T1}})(1 - P^*_{\mathrm{T2}})]$ |
| $NB_{\mathrm{T1}} = B_{\mathrm{T1}} - C_{\mathrm{T1}}$ | (Net benefit of T1) | |
| $NB_{\mathrm{T2}} = B_{\mathrm{T2}} - C_{\mathrm{T2}}$ | (Net benefit of T2) | $R2 = TNB^{**}$ plotted at $\left[1 - \left(1 - P^{**^2}\right)\right]$ |
| $TNB = NB_{\mathrm{T1}} + NB_{\mathrm{T2}}$ | (Total net benefit) | T1 = Sample Test 1; T2 = Sample Test 2 |

In Figure 2, the assumption of fully compensating or redundant controls is relaxed. This is reflected in $B_{\mathrm{T1}}$ which is changed from $1{,}000(1-e^{-0.01P})$ to $1{,}500(1-e^{-0.01P})$, while $B_{\mathrm{T2}}$ remains equal to $1{,}000(1-e^{-0.01P})$, thereby making the benefit that the auditor receives for a particular sample size in T1 equal to 150 percent of the benefit that the auditor receives from an equally sized sample in T2. All other conditions remain as previously specified. From inspection of this graph, it is again seen that the total net benefit obtained from testing the controls at the separate levels of power or risk of overreliance corresponding with the maxima of the separate net benefit functions is superior to testing the controls at the single power specified by the maximum of the total net benefit function. However, *R1* and *R2* are closer in this situation than in the result obtained in the fully redundant controls scenario. In fact, it is possible for *R1* and *R2* to plot as the same point, but it is not possible for *R1* to plot below *R2*. From the plots of *R1* and *R2* in this scenario, it is again seen that the two-sample testing approaches provide the auditor with higher net benefits than that obtainable by the examination of only one control in a single-sample approach.

## CONCLUSIONS

This paper examined part of the auditor's audit sampling decision in the presence of the existence of compensating or redundant internal controls. Specifically, two of the options provided in the professional literature, testing one internal control at a low risk of overreliance and testing the other control at a higher risk of overreliance was compared with testing both internal controls at a single moderate level of overreliance. Through the analysis of net benefit functions constructed from cost and benefit functions that exhibit expected behavior over the complete range of audit sampling power, it was found that in situations where the internal controls are not fully compensating or redundant, it is possible that the two sampling approaches may, in limited circumstances, generate substantially equivalent net benefits to the auditor.

However, in neither the situation of fully compensating controls nor the situation of partially compensating controls, will the approach of testing the controls at the same moderate risk of overreliance produce a higher net benefit to the auditor than the approach of testing the internal controls at the risks of overreliance that correspond with the maxima of the separate net benefit functions associated with the control tests. However, even a limited amount of testing of a partially compensating or redundant control in conjunction with the more extensive testing of an associated internal control will lead the auditor to a greater net benefit than that attainable by testing only one of the internal controls.

Regarding the second sampling approach that involves testing transaction-linked redundant controls in a single-sample application, it is reasonable to expect that the auditor will be presented with a sampling situation in which the estimated population error rate is very close to zero. For example, in this paper, 1.5 percent was used as the estimated population error rate for each internal control. If the redundant controls are transaction-linked and a control deviation is then defined as the failure of both controls with respect to a specific transaction, then the auditor might estimate the population error rate to be 0.0225 percent (i.e., 1.5 percent squared). This should greatly reduce the sample size needed to obtain a low risk of overreliance, thereby reducing the cost and increasing the net benefit of the sampling application. However, the modeling of this single-sample audit approach relative to the two-sample approaches modeled in this paper is reserved for future research.

## REFERENCES

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