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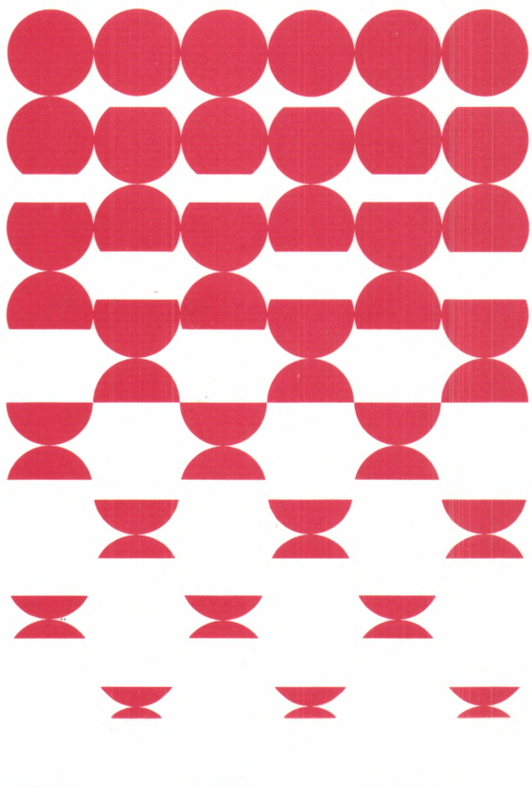
Research Study No. 3



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Cost-Benefit Analysis of Auditing

A research study prepared for the Commission on Auditors' Responsibilities

Research Study No. 3

By Melvin F. Shakun
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Foreword

After years of growth in many forms of regulation, there is now considerable interest in evaluating the extent and effectiveness of regulation. Frequently there is question whether the benefits of a particular program exceed its costs.

In a free market, individuals have a choice whether or not to buy a particular item; they can make their own evaluations of the costs and benefits of alternatives. The Commission on Auditors' Responsibilities found that because of various regulatory requirements for independent audits and professional standards for the performance of audits, the extent of audit services is not determined in a free market; that is, individual users have a limited ability to balance the costs of an audit against its benefits. Therefore, it is essential that those who establish the requirements and standards consider the resulting costs and benefits.

Cost-benefit analysis is a recently popular discipline, but its techniques are still in the early stages of development. Attempts to measure costs and benefits of particular programs of regulation have not been notably successful. Attempts to relate cost-benefit analysis to audit services have been rare.

The Commission asked Professor Melvin F. Shakun to investigate the application of cost-benefit analysis to audit services. Professor Shakun's study identifies a number of promising approaches for analyzing costs and benefits from the points of view of the economy as a whole, of the individual audit client, and of the auditor.

Although there is not presently available sufficient data to permit the application of these techniques, we hope that this study will encourage future research in this important area.

This is the third of four studies to be published from the background research for the Commission on Auditors' Responsibilities. The studies are not part of the Commission's report, but the Commission believes they contain useful material that warrants wide distribution.

Publication does not necessarily constitute endorsement or approval by either the AICPA or the Commission. Authors of research studies are responsible for the content and recommendations.

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Introduction

The role of the independent auditor and the need for auditing arise from the potential conflict of interests between users of financial information and its preparer.[1] The benefits of auditing are thus associated with the benefits provided by financial information. By measuring such benefits in relation to the cost of auditing, a balance between the two elements can be struck: in this study we shall apply cost-benefit analysis to the audit function.

In the allocation of resources in the economy, benefits of auditing may be measured by a reduction in the cost of accounting information errors. Such errors may result from fraud, clerical errors, inappropriate selection or application of accounting principles, including inadequate disclosure and failure to reasonably estimate the outcome of future events.[2] As discussed below, errors in accounting data—earnings, sales, inventories, and so forth—can affect estimated return and risk, which can affect efficient resource allocation. Estimated risk is affected not only by actual errors but also by lack of confidence in accounting data. By increasing confidence and reducing errors, auditing reduces the associated cost of accounting information errors. However, in so doing, a cost is incurred.

Figure 1 shows the cost-of-information-errors curve decreasing with increased auditing, while the cost-of-auditing curve is increasing. If these two curves are added, we obtain the curve for the total cost of information errors and auditing.

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1. See Commission on Auditors' Responsibilities, *Report, Conclusions, and Recommendations* (New York: 1978), pp. 1-11. Hereinafter cited as CAR, *Report*.
2. Commission on Auditors' Responsibilities (1975), p. 16.

Figure 1 shows that with the cost (amount) of auditing (*X*), the total cost of information errors and auditing (*Y*) is minimized. This occurs at the point where the marginal increase in auditing cost equals the marginal decrease in information error cost. At this point, the cost of auditing is balanced against its benefits (reduction of information errors). Thus, no more nor less auditing should be done.

Underlying the cost-of-information-errors curve in figure 1 is a logical concept, illustrated below, which says that auditing leads to a reduction in information errors which, in turn, leads to a reduction in the cost of information errors in the allocation of resources in the economy.

Auditing → Reduction in information errors → Reduction in the cost of information errors in the allocation of resources

To elaborate on this concept graphically, we may think of a curve that relates greater information error reduction to greater auditing cost (figure 2).

In turn, using arguments from capital budgeting and portfolio theory (see the next two sections, following), information error reduction may be related to the cost of inefficient resource allocation as in figure 3, which shows the latter decreasing with information error reduction.

The reasoning underlying this curve is developed in the following section.

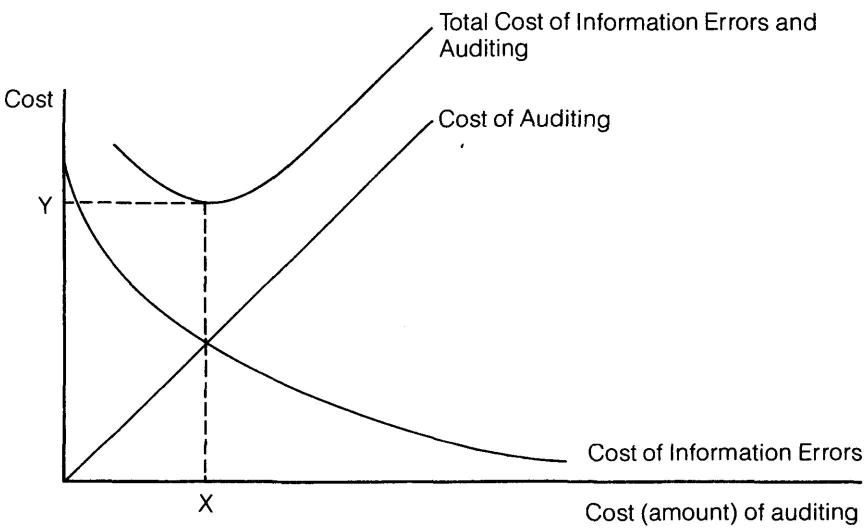

Figure 1
Auditing and information error costs

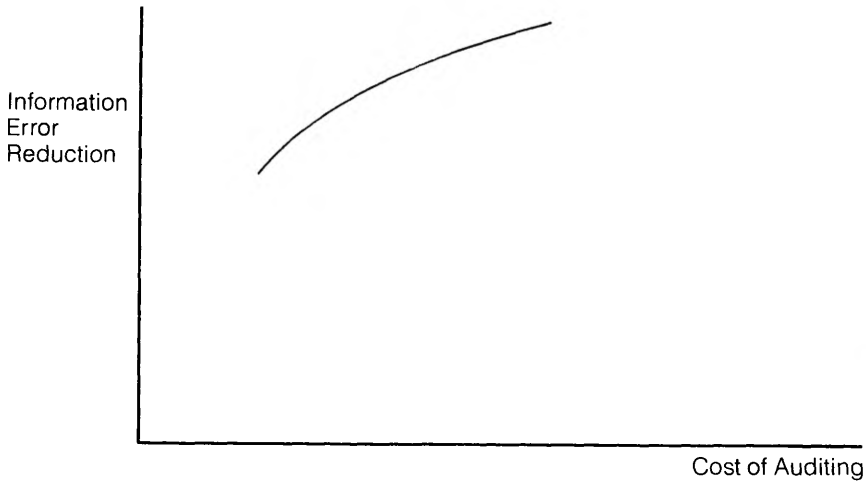

Figure 2
Information response to auditing

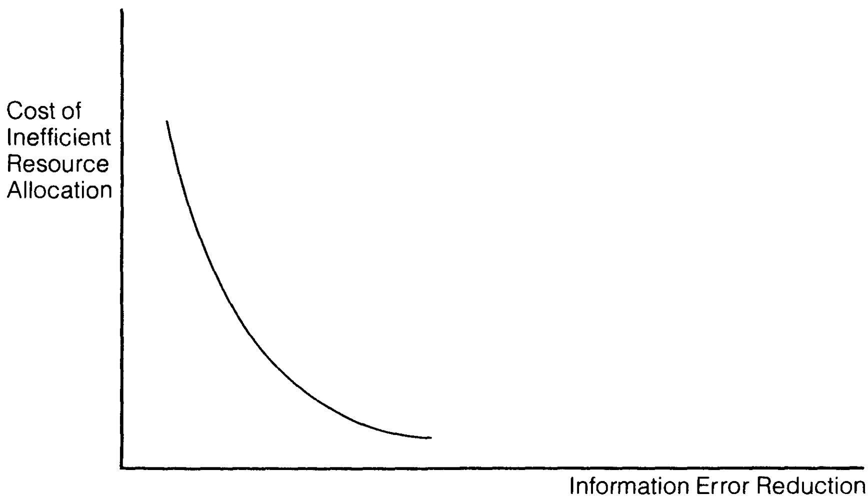

Figure 3
Resource allocation response to information error reduction

Earnings Errors and Inefficient Resource Allocation in Capital Budgeting

The problem faced by a firm in choosing investments is termed *capital budgeting*. If the percent returns on available investment opportunities (projects) are ranked in decreasing order, a rate-of-return-on-investment curve (r) may be drawn. Thus, r in figure 4 is a decreasing function of investment (I). The marginal cost of capital (m) is defined as the cost of each additional dollar obtained for making capital outlays. In general, m tends to increase as investment increases, though remaining constant over an initial investment range.[3]

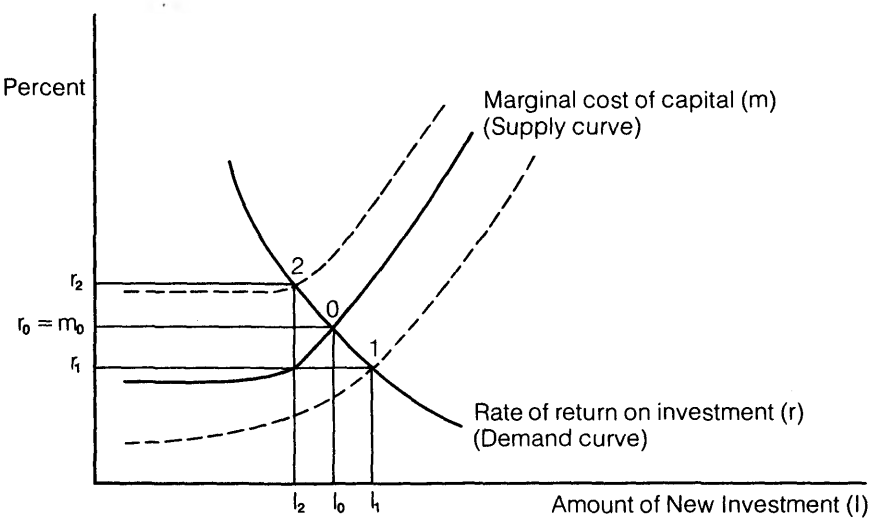

Figure 4
The capital budgeting decision process

In figure 4, the optimal investment level is I_0, corresponding to point 0, where the supply and demand curves intersect. Thus, in capital budgeting the firm should invest in projects having a rate of return greater than r_0.

As noted, the marginal cost of capital (m) is the incremental cost of each additional investment dollar. Firms with high earnings will have

3. For a detailed discussion of r and m and the capital budgeting process, see Weston and Brigham, 1972, chaps. 7 and 11.

their marginal-cost-of-capital curves shifted to the right. In other words, with higher retained earnings, lower marginal capital costs will be possible up to a higher level of new investment. (See example and figure 5, below.) Further, firms with low earnings risk will be favored by the capital markets and will have lowered marginal-cost-of-capital curves. (See the section, "Auditing, Portfolio Theory, and Capital Budgeting.")

Thus, the marginal cost of capital as estimated by the firm is a function of net income over time, depending on both expected earnings and risk.[4] The effect of accounting errors on earnings is to shift the estimated marginal-cost-of-capital curve (m) to one of the dotted curves in figure 4, so that an otherwise optimal investment schedule may not be achieved. Otherwise put, the optimal equilibrium point between supply and demand for capital is shifted from point 0 to point 1 or 2. Thus, the effect of errors on earnings can result in inefficient capital investment by the firm. Auditing can reduce such errors, thereby reducing the cost of inefficient resource allocation to the firm and to the national economy. (See the section "Auditing, Portfolio Theory, and Capital Budgeting.")

For example, suppose unaudited figures give either of the dotted marginal-cost-of-capital curves in figure 4 with associated investment levels—rates of return (I_1,r_1) or (I_2,r_2). Further, suppose auditing results in the solid m curve and "optimal" values (I_0,r_0). Assume the numerical values given in table 1.

Table 1: Example of loss or opportunity cost associated with audited and unaudited accounting data

Accounting Data	Investment Level (Millions of Dollars)	Rate of Return (Percent)	Loss or Opportunity Cost (Dollars)
Audited	$I_0 = 40$	$r_0 = 10$	None
Unaudited	$I_1 = 44$	$r_1 = 8$	40,000
Unaudited	$I_2 = 36$	$r_2 = 12$	40,000

Then point 1 represents an incremental investment of 4 million dollars on which there is an approximate average loss of 1 percent or $40,000. Point 2 has an opportunity cost of $40,000, representing lost return due to investing only 36 million instead of 40 million dollars. Consequently, from this point of view, it is worth up to $40,000 in auditing fees to determine a "correct" marginal-cost-of-capital curve.

4. See Brigham and Gordon, 1968, equations (5) and (17), or Elton and Gruber, 1975, p. 152, equation (23). Also see Litzenberger and Rao, 1972.

As a further illustration, assume that during a given year a company had total earnings of $59 million available for common stockholders, paid $27 million in dividends, and retained $32 million.[5] Assume, further, that to adhere to the same capital structure policy, the retained earnings should equal 77 percent of the net addition to capital, with 22 percent being debt and 1 percent preferred stock. With $32 million in retained earnings, the total amount of new capital that can be obtained using debt, preferred stock, and internally generated equity is $32 million ÷ .77 or $41.6 million. This $41.6 million would consist of $32 million equity, $9.2 million debt, and $.4 million preferred stock, corresponding to the 77, 22, and 1 percent figures, respectively, for the capital structure given above. (See column (1), table 2.)

Table 2: Cost of capital using internally generated equity, debt, and preferred stock

	(1) Amount of Capital in Millions of Dollars (or Percentage)	(2) Component Cost	(3) = (1)×(2) Amount of Cost (or Percentage Product)
Debt	$ 9.2 (22%)	3.6%	$ .33 (.0079)
Preferred stock	.4 (1%)	7.5%	.03 (.0007)
Internal common equity	32.0 (77%)	10.0%	3.20 (.0770)
	$41.6 (100%)		$3.56 (.0856)

$$\text{Marginal cost} = \text{average cost} = \frac{3.56}{41.6} = 8.56 = 8.6\%$$

Now assume the component costs for debt, preferred stock, and common equity shown in column (2), table 2. Then, as shown, the marginal cost of capital is 8.6 percent—up to $41.6 million of new capital.

Suppose that beyond $41.6 million, the company must sell new equity issues at a cost of 10.4%. The weighted marginal cost of capital for capital in excess of $41.6 million is calculated as 8.9 percent in table 3.

Table 3: Cost of capital using new common stock

	(1) Proportion	(2) Component Cost	(3) = (1)×(2) Product
Debt	22%	3.6%	.0079
Preferred stock	1%	7.5%	.0007
Common equity (new)	77%	10.4%	.0801
	100%		.0887 or 8.9%

5. This Illustration is based on example given by Weston and Brigham, 1972, pp. 318-324.

Figure 5 shows the marginal-cost-of-capital curve (*m*) for this simple illustration (solid *m* curve).

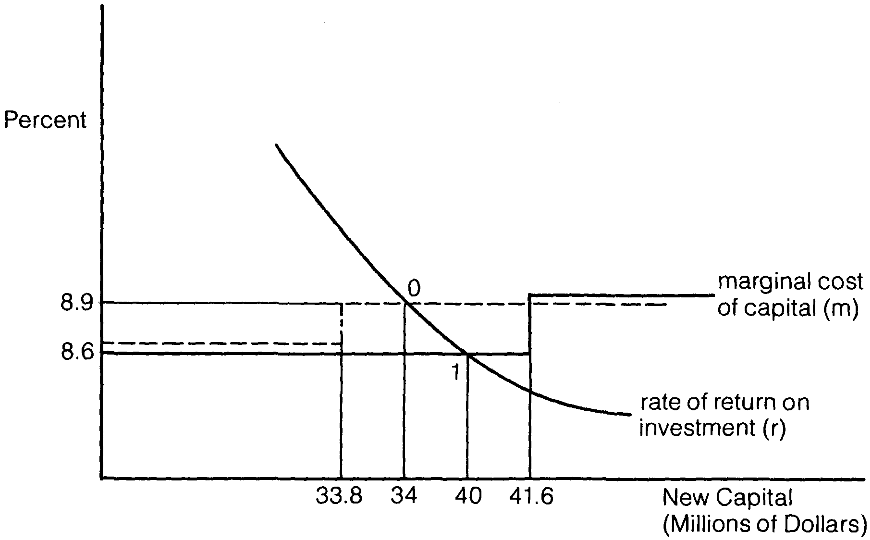

Figure 5
Marginal-cost-of-capital and rate-of-return curves

The marginal cost of capital is 8.6 percent until $41.6 million; then, it jumps to 8.9 percent.

Now suppose that due to accounting errors, the earnings are not $59 million but $53 million, as determined by an audit. With the company still paying $27 million in dividends (for example, the company may have already paid out this amount or it may wish to maintain a constant dividend), this leaves $26 million retained earnings. This means that the jump point from 8.6 to 8.9 percent in the marginal cost of capital occurs at $33.8 million (22/.77 = 33.8) instead of $41.6 million—see dotted *m* curve in figure 5.[6] If the rate-of-return-on-investment curve (*r*) is as shown in figure 5, then the optimal investment level is at $34 million (point 0) instead of $40 million (point 1). Thus, without auditing there would be an incremental investment of $6 million at an average loss of .15% [(8.9−8.6)/2 = .15] or a $9000 investment loss.

6. In addition to shifting the *m* curve to the left, there can be a misestimation in the level of either segment of the curve as illustrated in figure 4, due to risk.

Auditing, Portfolio Theory, and Capital Budgeting

Figure 4, as discussed above, deals with the capital budgeting decision of the firm. It also illustrates the capital budgeting process for investors—the portfolio problem if there is no risk. Investors, in the absence of risk, would have a one-asset portfolio holding the asset which gives the highest return on investment (*r*). If available investor resources exceeded the capacity of this highest return investment to absorb them, then allocations would be made on successively lower rate-of-return investments until point 0 had been reached.

In the real world, of course, risk exists, and portfolio theory deals with both expected return and risk of return. Accounting data (presumably improved by auditing) is used to estimate expected return and risk which provide informational inputs to portfolio models.[7] Portfolio theory is concerned with the question of how to efficiently diversify a portfolio of securities under conditions of risk given an investor's preferred trade-offs between risk and return. Sharpe and Lintner extend portfolio theory to explain how the expected return of a security is related to risk.[8] Their model is called the capital assets pricing model in which the expected return of a security is related to a defined systematic risk.

The systematic risk for a security measures the extent to which the security's return is subject to the variability of the market as a whole. From a portfolio viewpoint, systematic risk measures the contribution of a security to the total riskiness of the portfolio—that is, it measures the riskiness of the security. Other risk components (called "unsystematic") of each security tend to cancel out when securities are combined in a portfolio. The larger the systematic risk, the larger the risk premium required by investors over and above the expected return of a riskless security.

Systematic risks must be estimated from accounting data. Empirical findings suggest a relationship between accounting data reflecting firm characteristics—such as financial leverage and stability of production, sales, capital expenditures, earnings, and dividends—and systematic risk.[9] Whatever portfolio model is used, an error analysis could develop the cost of inefficient portfolios due to information errors, against which the cost of auditing could be balanced (see figure 1).

The collective portfolio decisions of investors provide the costs of equity and debt funds which are used in firms' and industries' capital budgeting decision processes. The optimal investment level by the firm

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7. See Lev, 1974, chap. 12.
8. Lev, 1974, chap. 12.
9. Lev, 1974, chap. 13.

depends on the marginal cost of capital (figure 4). Firms having low risk and high earnings will have favorable marginal cost of capital curves which are lowered and shifted to the right. Firms having good investment opportunities will have their *r* curves shifted upwards and to the right (figure 4). Thus, firms having both favorable investment schedules and marginal costs of capital will have higher equilibrium investment levels I_0 with these higher amounts being supplied by investor portfolio decisions favoring such firms. From the point of view of welfare economics, increased investment by such firms will increase gross national product.[10]

From an overall viewpoint the foregoing model traces the contribution of auditing to economic output. Thus, an analysis of the effect of information errors could in principle develop the cost of *inefficient resource allocation* as measured by loss in overall economic output. The cost of auditing to reduce information errors could be balanced against this loss (as in figure 1). Auditing of information for quarterly as well as annual reports could be considered. In principle, social as well as economic goals could be included.[11]

One final point concerns the effects of auditing on the distribution of wealth. Assuming investors have diversified their portfolios, the effects of accounting errors on the distribution of wealth among investors tend to cancel out. Thus, auditing appears to have a more important impact on allocation of resources rather than on distribution of wealth. However, one may pose the hypothesis that the percentage of the population who are investors in various countries increases with audit quality. This hypothesis has yet to be tested; if true, then one can say that *good auditing* is associated with broader participation in investments—a distributional effect.

Audit Adjustments and Auditing Fees

As discussed above, errors in accounting data—earnings, sales, inventories, and so forth—can affect estimated expected return and risk, which can affect efficient resource allocation. One benefit of an audit is to deter undesirable behavior.[12] Financial information that is to be audited may be considerably more reliable than it would be if it were not to be audited. Thus, the audit adjustments actually made are a mini-

10. Investment behavior is also related to gross national product and national income by macroeconomic models (see Evans, 1969).
11. See the section of this book entitled "Auditing and Linear Programming"; also Seidler and Seidler, 1975.
12. See, *Report*, pp. 1-11. Independent auditor.

mum measure of the effect of an audit. Bearing this in mind, one way to characterize the effect of an audit is to determine the dollar amounts of audit adjustments. It is then of interest to relate adjustment amounts (for example, in net income) to auditing fees, keeping in mind differences in transaction volumes, total assets, and quality of internal control among various companies. We note that one way to estimate auditing's deterrent effect mentioned above would be to compare audit adjustments on first-time audits (which may occur, for example, with acquisitions or companies going public) with subsequent audits. Finally, data relating auditing fees to company characteristics (such as size, complexity, and type of business) have also been analyzed using a regression modeling approach (see the Appendix).

Auditing and Linear Programming

Another approach for studying the effect of auditing on resource allocation is via linear programming. Linear programming is a technique which provides a general approach to resource allocation decisions.

As a simple illustration of linear programming, consider a firm that wishes to allocate its production capacity (resource) to each of two products so as to maximize profits.[13] We let x_1 and x_2 represent, respectively, the number of units of product 1 and product 2 to be made per day. The unit profit margins on products 1 and 2 are $3 (thousand) and $5 (thousand), respectively. Therefore, the firm wishes to maximize profit, $Z = 3x_1 + 5x_2$. Assume the production facility that can make either of the two products is available eighteen hours per day, and that the number of production hours required per unit of product 1 is three hours and per unit of product 2 is two hours. Therefore, we have the restriction that $3x_1 + 2x_2 \leq 18$. Assume the sales potential for product 1 is four units per day and for product 2 is six units per day. This gives rise to the constraints $x_1 \leq 4$ and $x_2 \leq 6$. Since x_1 and x_2 may not be negative (negative production is not possible), we also write $x_1 \geq 0$ and $x_2 \geq 0$. Thus, the linear programming formulation is

Maximize $Z = 3x_1 + 5x_2$

subject to the constraints

$$x_1 \leq 4$$
$$x_2 \leq 6$$
$$3x_1 + 2x_2 \leq 18$$
$$x_1 \geq 0, x_2 \geq 0$$

13. Illustration from Hillier and Lieberman, 1967, chap. 5.

Figure 6 shows the formulation.

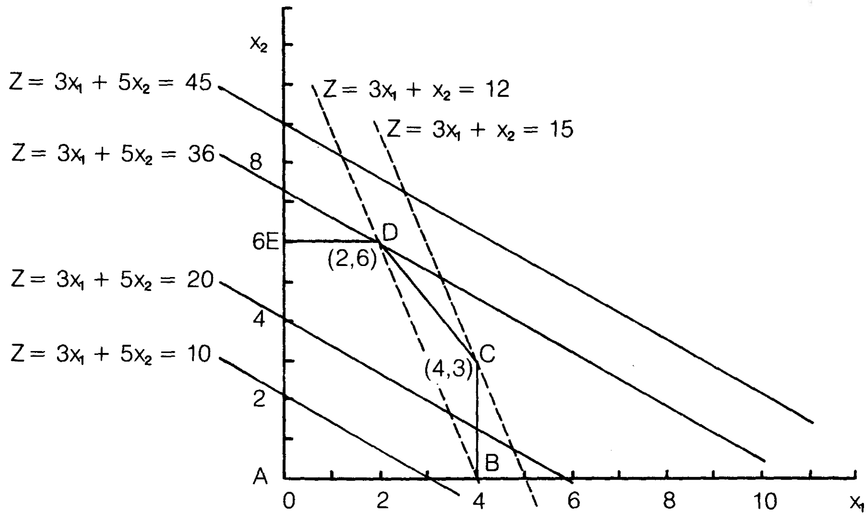

Figure 6
Illustrative linear programming problem

Any point (x_1,x_2) in the region ABCDE is a feasible solution in that it satisfies the constraints. The point D ($x_1 = 2$, $x_2 = 6$) is the optimal solution in that it gives the largest profit $Z = 36$, while satisfying the constraints. Three other lines representing profits Z of 10, 20, and 45 are also drawn. Note that $Z = 3x_1 + 5x_2 = 45$ is not feasible since this line does not intersect the feasible region ABCDE. Thus the optimal solution of this linear programming problem is to produce $x_1 = 2$ and $x_2 = 6$ units of product 1 and 2, respectively, giving a profit of $Z = 3(2) + 5(6) =$ \$36 (thousand).

In using linear programming, errors in information can result in inefficient utilization of resources (here, production capacity). For example, suppose the unit profit margin of \$5,000 for product 2 is wrong because of an accounting error and should be \$1,000. Then $Z = 3x_1 + 1x_2$, and from figure 6 the optimal solution becomes $x_1 = 4$ and $x_2 = 3$, giving a profit $Z = 3(4) + 1(3) =$ \$15 (thousand). If, however, the original solution $x_1 = 2$, $x_2 = 6$ is used—it will be used if unknowingly the accounting error exists in the unit profit margin for product 2—the profit $Z = 3x_1 + 1x_2 = 3(2) + 1(6) =$ \$12 (thousand) (see figure 6). This is less than the \$15,000 profit that a correct unit-profit-margin figure for product 2 would yield.

Thus, errors in information upon which linear programming depends can result in inefficient utilization of resources. This has been illustrated graphically in figure 6 for two decision variables x_1 and x_2.

When there are more than two variables, methods known technically as sensitivity analysis and parametric programming allow us to study the effect on optimal solutions of informational errors.[14] The cost of such informational errors should be balanced against the cost of auditing which can reduce such errors.

A particular form of mathematical programming—goal programming[15]—has been used to model the achievement of social goals as well as economic ones.[16] The effect of information errors on goal programming may be studied via sensitivity analysis, parametric goal programming, and goal programming under uncertainty.[17] The cost of informational errors can be balanced against the cost of auditing to produce more reliable information for allocation of resources, not only for achievement of economic goals but also for achievement of social ones.

Auditing and Decision Theory

It is also of interest to apply cost-benefit analysis at the level of the individual auditing firm which must decide how much auditing to do. Classical statistical sampling techniques offer formal methods for choosing the audit sample size and estimating financial statement amounts. Since these techniques are reasonably well known, we do not review them here.[18] However, recently more comprehensive cost-benefit approaches—based on so-called decision theory and Bayesian methods—have been suggested.[19] The approach described in Scott (1973) will serve to illustrate these techniques.

For substantive tests of amounts on financial statements, Scott (1973) suggests that the auditor specify his expected probabilities of such amounts before audit sampling. The auditor's prior probabilities are directly affected by his evaluation of internal control.[20] Then an audit sample is taken. Scott shows how to statistically combine the prior probabilities with the information obtained from sampling to calculate probabilities of financial statement amounts after auditing (known technically as posterior probabilities).

14. Hillier and Lieberman, 1967, 1974; Wagner, 1975; Itami, 1974; Flavell and Salkin, 1975.
15. Ijiri, 1965, and Lee 1972.
16. Charnes, Colantoni, et al., 1972; Schinnar and Cooper, 1975; and Charnes, Cooper, and Kozmetksy, 1973.
17. Lee, 1972, chap. 7.
18. For example, see Stettler, 1974, chap. 28, and Elliott and Rogers, 1972.
19. See Corliss, 1972; Chesley, 1975; Felix, 1974; Kinney, 1974; Loebbecke, 1974; Scott, 1973; Sorensen, 1969. For a general theory of evidence in auditing, see Toba, 1975.
20. For some recent quantitative approaches to internal control, see Cushing, 1974; Ishikawa, 1975; Smith, 1972; and Yu and Neter, 1973.

Since current financial statement practice reports a single figure for each amount, Scott shows how to obtain this number (known technically as a point estimate) using the posterior probabilities so as to minimize a user's expected loss. A user's loss is the loss suffered when a decision is based on erroneous financial information and is inherent in the auditor's concept of materiality. This loss is illustrated by the curve for the cost of information errors as previously discussed in figure 1. In general, the loss curve of various users may be different; the auditor himself has his own loss function. Thus, there is a basic need to know the decision model of users (for example, the capital budgeting and portfolio models discussed above).

So much for the use of the audit sample information once the sample is taken; but, how large should the sample be in the first place? Scott's approach also allows the auditor in substantive tests to optimally choose the sample size so as to minimize a total expected loss consisting of the cost of auditing plus the user's expected loss in deciding with erroneous information.[21] This total cost is illustrated by the curve for the total cost of information errors and auditing in figure 1. For a numerical example of the decision theory approach, the interested reader is referred to Felix (1974).

Theoretically, what may be needed is a decision theory analysis combining compliance tests of internal control and substantive tests of financial statement amounts. A model describing the sequence of audit steps and decisions undertaken by the auditor—a decision process model of auditing—could provide the structure needed to undertake such a decision theory analysis.[22] One could attempt to determine how much auditing is needed on the basis of materiality (user losses) and allocate this between compliance and substantive tests.

Game Theory Approaches to Auditing

As noted above, the loss curve for various users may be different. Further, in general the loss suffered by a user will depend on the decision choices of others as well as his own. Such considerations lead us into the realm of game theory which is concerned with decision situa-

21. Technically, this is an expected loss as seen before the sample is taken and assuming optimal use of the actual sample information once obtained. This mathematical procedure of optimally choosing the audit sample size is known as preposterior analysis; see Scott, 1973.
22. A decision process model of auditing is generally outlined by Felix, 1974, and Loebbecke, 1974.

tions involving conflict and cooperation among two or more decision makers (players).[23]

Under a game theory approach to auditing, we would try to consider explicitly in relation to one another the preferences and decision choices of at least two of the various interested parties (e.g., management executives, board of directors, present investors (debt or equity), potential investors, creditors, regulators, employees, suppliers, customers, researchers, "society," and the auditor).

A simple example will serve to illustrate the game theory approach. We consider a two-player game. Player I, the auditor, chooses either a modest size audit or an extensive audit. Player II, the firm, selects an accounting information system which may be of minimal or good quality. Thus, as shown in table 4, player I, the auditor, has two strategies shown as rows—strategy 1, to undertake a modest audit, and strategy 2, to do an extensive one. The strategies 1 and 2 of the firm, player II, are shown in columns.

Table 4: Game theory approach to auditing

		The Firm (Player II): Strategy 1 Minimal Quality Accounting System	The Firm (Player II): Strategy 2 Good Quality Accounting System	Row Minimum
The Auditor (Player I)	Strategy 1 (Modest Audit)	−20, −10 (−30)	7, −7 (0)	−20
	Strategy 2 (Extensive Audit)	3, −6 (−3)	−1, −8 (−9)	−1
	Column Minimum	−10	−8	

Table 4 shows the respective payoffs to each player corresponding to selected row/column strategy combinations. For example, if management chooses a good quality accounting system (its strategy 2) and the auditor does a modest audit (his strategy 1), the auditor receives a $7,000 net fee from the firm and the payoffs are shown as (7,−7). If with a good quality accounting system the auditor does an extensive audit, the auditor loses $1,000 and the firm now pays $8,000 (for example, assume the extra audit work costs the auditor $9,000, of which the client will only pay $1,000). Thus the payoffs (−1,−8) are shown in this case. If the firm chooses a minimal quality accounting

23. For an overview and bibliography of game theory, see Lucas, 1972.

system and the auditor undertakes an extensive audit, the payoffs are shown as (3,−6). This could occur, for example, if the extensive audit costs the auditor $9,000 more than the modest one, but the client can only be billed an additional $5,000. Thus the net payoff to the auditor will be $3,000 (7,000 − 9,000 + 5,000 = 3,000). The firm will now be paying $7,000 + $5,000 = $12,000 in auditing fees. However, suppose the minimal accounting system is $6,000 cheaper. Then the net cost to the firm is 12,000 − 6,000 = $6,000—hence the payoff entries (3,−6). Finally, if the firm chooses a minimal quality accounting system and the auditor does a modest audit, the payoffs are shown as (−20,−10), representing possible lawsuits against the auditor and the firm, as well as potential losses due to the use of erroneous accounting information in decision making by the firm.

In analyzing the game, we note that payoff combinations (7,−7) and (3,−6) are equilibrium points—have a stability about them—in the sense that there is no incentive for either player to unilaterally shift his strategy through these points. Thus, considering payoffs (7,−7), if player II is using his strategy 2, there is no incentive for player I to shift his strategy from 1 to 2, because if he does, his payoff will drop from 7 to −1. Similarly, considering payoffs (7,−7), if player I is using his strategy 1, there is no incentive for player II to shift his strategy from 2 to 1 or his payoff would drop from −7 to −10. In the same way (3,−6) is an equilibrium point. Thus (7,−7) and (3,−6) could represent stable solutions to the game.

On the other hand, if both players are very conservative, the so-called *maxmin payoffs* (−1,−8) could occur. This would result if each player tried to maximize his minimum payoff. Referring to table 4, the minimum payoff to player I, if he chooses his first row, is −20. Similarly, the minimum payoff to player I, if he chooses his second row, is −1. Therefore, by choosing row 2, player I maximizes his minimum payoff. Similarly, player II maximizes his minimum payoff by choosing column 2. The resulting payoffs (−1,−8) are the maxmin payoffs.

If we add the payoff pairs in table 4, we obtain the numbers in parentheses. The largest sum—here, zero—indicates the so-called joint maximum solution, namely (7,−7). Thus (7,−7) both gives the highest total payoff and is also an equilibrium point—a good candidate for a solution to the game. However, player II could ask that the audit fee corresponding to row 1, column 2, be changed to 5 instead of 7, arguing that the new payoff (5,−5)—replacing (7,−7)—is justified on the grounds that (5,−5) is better for the auditor than (3,−6), and claiming the $2,000 reduction in audit fee as an incentive for the firm to go to a good quality accounting system.

Although game theory approaches to auditing appear to have promise, considerable research is needed. Some recent efforts in this direction may be cited: (1) Demski and Swieringa (1974) consider decision choices and preferences of the auditor and auditee, who cooperatively formulate an audit approach; (2) Hamilton (1975) considers auditor, manager, and owner in a three-player auditing game formulation; (3) Fromovitz and Loeb (1975) formulate audit report decisions as a zero-sum game between auditor and society with society controlling the expected cost of a lawsuit.

In general, a cooperative game analysis of auditing would appear to have promise. However, as stated, considerable further research is required.

Summary and Concluding Remarks

In this study we have attempted to delineate various approaches to measuring and balancing the costs and benefits of auditing at the level of the firm and in the economy as a whole. Several promising approaches have been described. At the level of the economy as a whole, capital budgeting and portfolio theory have been used to discuss the contribution of auditing to economic output. In principle, the loss in overall economic output due to information errors can be balanced against the cost of auditing which serves to reduce information errors. While additional detailed work is needed, the model as presented develops the basic theoretical reasoning for balancing the costs and benefits of auditing at the level of the economy as a whole. At the level of the firm, linear programming—a widely used technique for resource allocation decisions—has been used to study the cost of information errors in the utilization of resources. The cost of such information errors should be balanced against the cost of auditing which can reduce such errors. With respect to the individual auditing firm that must decide how much auditing to do, we have discussed the use of so-called decision theory methods to balance the cost of auditing against a user's expected loss in deciding with erroneous information. The problem of multiple users with different loss curves leads naturally to consideration of the possibilities for game theory approaches to auditing. These are brought out through an auditing game in which the auditor and the firm are the players. Finally, the results of a study relating auditing fees to various company characteristics are presented (see Appendix).

In all, the area of cost-benefit analysis in auditing holds considerable promise and merits extensive further research. Hopefully, this study provides a base from which such work may proceed.

Factors Affecting Audit Fees

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A number of studies of audit fees have been made, but these studies have generally omitted many variables relevant to audit fee determination. The results have generally shown very simple relationships, such as audit fees as a percentage of sales.

The audit fee required for a given company is a complex function of many company-specific variables. To attempt to determine which are the most significant variables affecting audit fees, and what the functional relationship is, we undertook an empirical study of audit fees for our firm's clients.

Study Method

We identified a number of variables that could reasonably be expected to affect audit fees. These variables included the following:

Size (revenue, income, assets, equity)

Industry (manufacturing, financial, etc.)

Complexity (reliance on internal auditors, quality of internal control, physical complexity, legal complexity, reporting complexity, degree of automation of accounting records, degree of centralization of accounting and financial control, public/private company)

This selection of variables is not the only set possible for analysis; other variables could have been included.

To collect this data, we designed a questionnaire (see exhibit B for questionnaire and factors for translating qualitative data to quantitative form). A stratified random sample was drawn from the firm's 1975 audit client file as follows:

- 100 clients with audit fees from $2,000 to $49,999 (audit fees less than $2,000 were deemed to be for accounting services other than auditing)

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- 100 clients with audit fees from $50,000 to $249,999
- All clients with audit fees of $250,000 and up

The questionnaire was sent to the audit engagement partners for these clients. The sample did not include the separate engagements of subsidiaries, affiliates, or divisions of a corporate entity. To prevent duplication of clients, the engagement partner of a top corporate reporting entity was asked to respond for the entire audit of that corporation. We received 196 usable responses. Because we regard the actual audit fees of the firm's clients to be proprietary information, we multiplied all audit fees in the sample by a constant (a random number selected from the range .80 to 1.25). This had the effect of preserving all the essential relationships for this study, but protecting the confidentiality of our fee structure.

Several cautions should be observed in interpreting the results because of possible subjectivity in the data collected.

- The respondents were required to make subjective judgments to determine responses for some of the questions.
- The respondents were required to select the best answer to a series of questions when the correct answer may not have been provided as a selection choice on the questionnaire.
- The respondents may have made different judgments when faced with the same set of circumstances.

These limitations and others reduce the reliability of the data and conclusions to a certain extent.

Using the adjusted fee data and the other information elicited by the questionnaire, we used multiple regression techniques to analyze the significant relationships in the data.

To facilitate the identification of key variables, we separated the financial data into five subsets:

- The entire file of 196 clients.
- A file of 129 large clients (those with audit fees over $50,000).
- A file of the remaining sixty-seven small clients.
- A file of sixty manufacturing clients.
- A file of forty-two financial clients (banks, insurance companies, etc.).

As a result of analyzing these five files, we determined that the most significant variables affecting audit fees were the following:

- A size variable (sales or assets depending upon the dominant nature of the client's business).
- The degree of complexity in locations and product lines (which affects the number of audit teams and the need for specialized skills).

- The degree of accounting and financial centralization (which affects the number of audit teams involved in an audit).
- The percentage reduction of audit scope because of reliance on internal auditors.
- The number of additional reports required (which affected the number of full-scope audits required).
- The percentage realization of standard audit fees (i.e., the ratio of actual to standard fees).

Although the other data collected in our study were also correlated to audit fees, their effects were largely captured by the factors mentioned above, so it was not necessary to include them separately in the models developed. For example, the quality of internal control was largely captured by the degree of reliance on internal auditors and the legal complexity variable was largely captured in the number-of-separate-reports variable.

Other factors may affect the audit fee, but they were not covered in the survey questionnaire, and they may not be easy to quantify. They include the capabilities and experience of the auditors, the time of year in which the work was completed, and the urgency of completing the work. This is especially true for the sample file of small clients, for which a reliable regression equation could not be obtained. A greater number of factors evidently affect the audit fees of these small clients.

The most successful audit fee model was for the manufacturing companies.The model developed was as follows:

$$\text{Expected audit fee} = \begin{bmatrix}\text{fee realization fraction}\end{bmatrix}\left[1 - \begin{pmatrix}\text{audit reduction fraction based on reliance on internal auditors}\end{pmatrix}\right]\left[12{,}700\begin{pmatrix}\text{number of audit reports in excess of one}\end{pmatrix} + 4.777\sqrt{\text{sales} \times \text{complexity}}\right]$$

where the complexity variable ranges from 1 for a centralized, one-product, one-location company to 10 for a decentralized, multiproduct, multinational company.

Note the square root sign over the sales and complexity variables. This means that, other things being equal, fees do not rise as quickly as sales or complexity. For example, if two companies are otherwise similar but one is four times as large (measured by sales), its audit fee will only be twice as large ($\sqrt{4} = 2$).

The above model can be illustrated as follows: Suppose a manufacturing client with the following characteristics:

- Fee realization is 95 percent of standard.

- Due to reliance on internal auditors, the audit scope can be reduced by 20 percent.
- Five separate audit reports are required.
- Sales equal $2 billion.
- The company is a decentralized, multiproduct, multinational company.

The expected fee would be

$$(.95)(1-.20)[12{,}700(5-1)+4.777\sqrt{2{,}000{,}000{,}000\times 10}\,]$$
$$=\$552{,}000.$$

Obviously, the actual fee would differ from $552,000 based on specific factors not included in the model. This model only explains 94.3 percent of audit fee variance.*

For financial companies (e.g., banks and insurance companies), assets were a more reliable indicator than sales, and the resulting model was as follows:

$$\text{Expected audit fee} = \begin{bmatrix}\text{fee real-}\\\text{ization}\\\text{fraction}\end{bmatrix}\left[1-\begin{pmatrix}\text{audit re-}\\\text{duction}\\\text{fraction}\\\text{based on}\\\text{reliance}\\\text{on inter-}\\\text{nal}\\\text{auditors}\end{pmatrix}\right]\left[6{,}600\begin{pmatrix}\text{number}\\\text{of audit}\\\text{reports in}\\\text{excess of}\\\text{one}\end{pmatrix}+3.474\sqrt{\text{assets}\times\text{complexity}}\right]$$

This model explained 84.8 percent of audit fee variance for financial companies.

For the additional models (for the large companies versus small companies and the entire sample of companies) see exhibit A (which also includes statistical significance data). These models are in identical form to those presented above.

On the basis of the best regression formula, one can calculate the expected audit fee for each client and compare it to the actual fee. An outlier is a case (client) for which the actual value has a large percentage deviation from the value predicted by the regression equation. All five sample files had outliers, but the financial group had a higher incidence of outliers. Although the regression variables are highly significant in this model, additional factors are also significant.

Many of the outliers in the overall model were financial institutions or public utilities, where the actual audit fee was below the expected fee. The uniformity of operations of these clients may lead to more efficient auditing. Public utilities have productive assets which require minimal auditing in years after construction or acquisition.

*That is, the adjusted index of determination (R^2) is .943.

Although the models developed do not fully explain the amount of audit fees, they present consistent, logical relationships. The selected independent variables are highly significant and permit a reasonably good fit considering the multitude of elements which can affect the audit fee. The models successfully identify the most critical factors, but do not present an accurate formula for use by accounting firms in developing fee proposals. Fee proposals still require a comprehensive review of the particular characteristics of a potential client.

Technical Discussion

The models tested were hypothesized based on our expectations of how the independent variables would be related to audit fees. Within this class of models, we identified the specific models that attained the best fit as evidenced by the following:

- The highest possible adjusted index of determination, which measures the extent to which the independent variables account for the variance in the dependent variable.
- A reasonable value and sign for the coefficients of each independent variable.
- The highest possible T values for the independent variables (which indicate the significance of the coefficients of each variable in the equation; a T value over 2 is significant for a sample size of thirty or more observations).
- The lowest possible correlation between the independent variables. This helps to insure that the impact of each independent variable can be separately measured by regression analysis. (Sales and assets were not used in the same regression model as independent variables because they have a high correlation and the resulting regression coefficients may be unreliable. We could not easily differentiate the separate effects of assets and sales on audit fees.)
- The lowest possible standard error of the estimate, which measures the expected range about the estimated regression plane.

Each model was processed with (a) an intercept determined from the data and (b) an assumed intercept of zero. A positive intercept would indicate that there is a basic cost of an audit before the size, complexity, and reports variables are introduced. A zero intercept would indicate that there is no basic cost of an audit. In all cases the intercept value determined from the data was not significant, therefore, we specified zero intercepts.

For the regression estimates to be considered unbiased, efficient, and consistent, four assumptions must be satisfied: normality of the residual values between actual and estimate, absence of multicollinearity among independent variables, absence of heteroscedasticity (a condition under which the points are not uniformly scattered about the regression line), and absence of autocorrelation of residuals. The residuals are not quite normal due to the effect of small clients in the sample; the difference is not significant and is tolerable. The multicollinearity between the two independent variables is statistically insignificant. There is some heteroscedasticity about the assets variable due to the effect of small clients. There is no significant heteroscedasticity about the reports variable. Autocorrelation is not a problem since the model involves cross-sectional, rather than time-series, data. On balance the assumptions are satisfied. The ordinary least squares regression coefficients and standard error of the estimate are efficient, consistent, unbiased estimators of the true population values.

Exhibit A

Multiple Regression Characteristics for Each File

File	*Entire*	*Large*	*Small*	*Manufacturing*	*Financial*
1st independent variable					
Name	A	A	B	B	A
Coefficient	4.524	4.518	2.657	4.777	3.474
T Value	17.9	14.6	12.3	14.4	9.2
2nd independent variable					
Name	C	C	C	C	C
Coefficient	11,429	11,535	1,911	12,728	6,636
T Value	12.5	10.2	3.7	11.0	2.8
Adjusted index of determination	.886	.887	.742	.943	.848
Correlation of independent variables	.70	.70	.22	.68	.68
Standard error of the estimate	60.6%	49.8%	63.7%	37.5%	63.2%

Note: The *Y*-intercept of these equations is zero.

A = $\sqrt{\text{assets} \times \text{complexity}}$

B = $\sqrt{\text{sales} \times \text{complexity}}$

Complexity = physical complexity × accounting centralization

C = number of reports minus one

Exhibit B

Audit Fee Questionnaire

(Parenthetical numbers represent weightings assigned for regression analysis.)

Note: This questionnaire is to be completed only for the top corporate reporting entity. If the selected engagement is a subsidiary (of either a PMM client or otherwise), affiliate, or otherwise does not result in a top corporate level audit opinion, so note and return the uncompleted questionnaire.

1. Client name: ______________________________

2. Audit fee for last audit completed: standard $__________
   actual $__________
   for fiscal year ended __________

   Note: Audit fee should include all audit fees, foreign and domestic, for the company and all subsidiaries. It should exclude management consulting, tax, and special work not related to the audit opinion. It should include annual (recurring) fees related to required filings such as 10-K's and S-8's, but exclude fees related solely to initial registrations, such as S-1's. The audit fee (standard and/or actual) may be an estimate within plus or minus 5%; in such case, please write "estimated" after the estimated standard and/or actual fees above.

3. Is the client publicly held? __ Yes __ No

   Registered with the SEC? __ Yes __ No

   Note: Use common definitions. If in doubt, describe facts.

4. What is the client's *predominant* business?

   __ Manufacturing __ Financial

   __ Merchandising __ Not for profit

   __ Other (explain ______________________________)

5. Consolidated financial information for latest fiscal year audited.

Sales or revenue:	$ __________
Income before extraordinary items and cumulative effect of accounting changes	$ __________
Net income	$ __________
Total assets	$ __________
Equity	$ __________

6. *Internal audit.* To what extent is the audit fee reduced because of participation of internal auditors (estimate)?

   (.60) __ More than 50%
   (.40) __ 30% to 50%
   (.20) __ 10% to 30%
   (.05) __ Some, but less than 10%
   (0.0) __ None

7. *Internal control.* Overall, what is the quality of internal controls for the entire entity (including subsidiaries)? Note that internal control includes the level of expertise of financial accounting personnel.

   (1) __ Excellent
   (2) __ Good
   (3) __ Fair
   (4) __ Poor
   (5) __ Virtually none

8. *Physical complexity.* Overall, how complex is the physical situation of the entity as measured by the number and location of operating units and the diversification of product lines? A "very simple" entity would have a single domestic place of business and a single product line. A "very complex" entity would have numerous locations for plants, offices, branches, salesrooms, etc., foreign and domestic, and numerous product lines.

   (1) __ Very simple
   (2) __ Fairly simple
   (3) __ Moderate
   (4) __ Fairly complex
   (5) __ Very complex

9. *Legal complexity.* Overall, how complex is the legal structure of the entity as measured by the number and jurisdictions of operating legal entities? A "very simple" entity would have a single, domestic legal operating entity. A "very complex" entity would have numerous operating legal entities (subsidiaries and affiliates), in numerous states and foreign countries.

   (1) __ Very simple
   (2) __ Fairly simple
   (3) __ Moderate
   (4) __ Fairly complex
   (5) __ Very complex

10. *Reporting complexity.* How many separate audit reports are issued annually for this entity? Consider reports containing a standard auditor's opinion, such as combining financial statements and separate reports on subsidiaries and affiliates. Do not count reissuances (such as 10-K's) nor special reports (e.g., debt compliance letters).

    Number of reports ______

11. How would you characterize the extent of automation of accounting records?

    (1) __ Not automated
    (2) __ Partially automated
    (3) __ Highly automated

12. What is the degree of centralization of accounting and financial control?

(1) __ Centralized (2) __ Decentralized

13. Please note any unique factors (not covered above) you believe would substantially affect the comparability of audit fees for this client with fees for other clients.

____

Audit Engagement Partner

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