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An agency-theoretic analysis of the external auditor's use of the internal auditor in conducting the financial audit

DeBruine, Marinus, Ph.D.

The Ohio State University, 1991

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AN AGENCY-THEORETIC ANALYSIS OF THE
EXTERNAL AUDITOR'S USE OF THE INTERNAL
AUDITOR IN CONDUCTING THE FINANCIAL AUDIT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate School
of The Ohio State University

By

Marinus DeBruine, B.B.A.

* * * * *

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LIST OF SYMBOLS

Players:

O - owner, client-firm (principal)
M - manager (agent)
EA - external auditor (agent/principal)
xA - assistant auditor, xA ∈ {IA, JA} (agent)
IA - internal auditor (xA employed by O)
JA - junior auditor (xA employed by EA)
C - court (exogenous to contract)

Variables:

e - managerial effort, e ∈ \{e_L, e_H\}
a - audit effort/assurance level, a ∈ [0,1]
r - audit task division ratio, r ∈ (0,1)
s - IA wages sharing ratio, s ∈ [0,1]
R^M - manager's compensation
R^{EA} - external auditor's compensation
R^{IA} - assistant auditor's compensation
R^H - manager's report of production outcome,
R^M ∈ \{L(ow), H(igh)\}
R^{EA} - external auditor's report,
R^{EA} ∈ \{U(nqualified), Q(ualified)\}
R^C - court ruling, R^C ∈ \{N(egligent), -N(egligent)\}
Parameters:

- **r** - minimum procedures level
- **x** - production outcome, \( x \in \{x_L, x_B\} \)
- **w** - investment outcome, \( w \in \{0, \hat{w} \text{(wealth at stake)}\} \)
- **B** - benefit of motivating the manager

- **\( \bar{U}^M \)** - manager's reservation utility level
- **\( \bar{U}^{EA} \)** - external auditor's reservation utility level
- **\( \bar{U}^{XA} \)** - assistant auditor's reservation utility level

Functions:

- **\( U^O \)** - owner's utility function
- **\( U^M \)** - manager's utility function
- **\( U^{EA} \)** - external auditor's utility function
- **\( U^{XA} \)** - assistant auditor's utility function

- **\( V^{EA} \)** - external auditor's disutility (for effort) function
- **\( V^{XA} \)** - assistant auditor's disutility (for effort) function

- **k** - probability of obtaining \( x_H \), \( k = k(e) \)
- **f** - probability of issuing the appropriate audit report, \( f = f(a) \)
- **g** - probability of no-negligence ruling, \( g = g(a) \)
CHAPTER I

INTRODUCTION

Many issues pertaining to the demand and supply of auditing have received considerable attention in recent years. Concerns over efficiency have permeated much of the auditing literature for some time, while concerns over effectiveness are more recent. Some examples of those concerns are pricing and competition in the audit industry [Simunic, 1980; Francis and Simon, 1987]; the nature and extent of auditor independence [Antle, 1984; Magee and Tseng, 1990]; contingent audit fees [Dye, Balachandran, and Magee, 1990]; low-balling [DeAngelo, 1981a, 1981b; Simon and Francis, 1988]; provision of MAS and other services [Beck, Frecka, and Solomon, 1988a, 1988b; Simunic, 1984]; opinion shopping as a motivation for auditor switching [Chow and Rice, 1982; Smith, 1986; Haskins and Williams, 1990]; and the effect of litigation in which the auditor is a defendant on audit quality [Palmrose, 1988]. The issues raised in the auditing literature reflect society's concerns about both the cost and the quality of the audit service provided by the external auditor.

Previous research documented a dramatic increase in the number of firms that have the internal auditor assist the external auditor as well as an increase in the scope of the assistance provided by the internal auditor [Maher and Ramanan, 1985; Wallace, 1984a]. Over the last
fifteen years, the American Institute of Certified Accountants (AICPA) has provided guidance for the external auditor's use of the internal auditor's work. Statement of Auditing Standard (SAS) No. 9 specifically stated that the internal auditor's work cannot be substituted for external auditor's work [AICPA, 1975]. Recently, the AICPA changed its position to allow the internal auditor to assist the external auditor in conducting the annual audit as long as the work is planned and adequately supervised by the external auditor [AICPA, 1989]. With the issuance of SAS 1... 65, which supersedes SAS No. 9, the Auditing Standards Board provided guidelines for the external auditor considering reliance on the internal auditor's work and specifically permits (limited) substitution.

This study uses a principal-agent model to explore the impact of the internal auditor assisting the external auditor on the external auditor's effort choice and the owner's welfare. Specifically, by comparing two audit arrangements, the study explores the potential reduction of agency costs arising within the contractual relationship between self-interested parties. The study adopts a model of external auditor effort (assurance) choice in the context of a decision-based demand for auditing by the owner of a firm. A decision-based demand for auditing arises from the owner's need to rely on financial reports for further investment decisions. Within this framework, the study explores the effects of non-observability of the audit effort choice and an imperfect legal system on the owner's demand for internal auditor assistance to the external auditor.
1.1 Motivation

From a practical perspective, establishing whether the internal auditor assisting the external auditor benefits firms is important for audit arrangement considerations as firms may not only be concerned with the cost of the annual audit but may also want a higher quality service from the external auditor. At the firm level, the question is whether the external auditor identifies his own self-interest with acting in the best interest of his client. As a rational decision maker, the external auditor is expected to minimize the sum of the expected costs of his audit effort (effort is unobservable to the owner) and liability losses regardless of the compensation received for the service.\(^1\) Then, as long as the external auditor can be held responsible for all potential audit failures, the self-interested external auditor will act in the best interest of his client. However, if society has adopted an enforcement system which enables the external auditor to escape liability for some audit failure occurrences -- possibly because litigation costs are excessive -- the client may desire but is unable to obtain a higher quality service.\(^2\) Under such a legal system, the 

---

\(^1\) Offering the external auditor an additional amount to provide more effort (and a higher quality service) is not effective when effort is not observable. The external auditor has no incentive to provide more effort than before unless his actions can be verified.

\(^2\) Audit services are demanded as monitoring devices, and, may be the least-cost contractual response to owner-manager conflicts of interest, i.e., agency costs. If agency costs vary across client-firms and over time for a given client, then differing levels of auditing are demanded. Ignoring client inputs, audit output can be characterized as independent verification of management-prepared financial data (the audit report) with an associated quality dimension [DeAngelo, 1981]. With the type of audit report as a constant, demands for differing levels of auditing are equivalent to demands for differing quality levels of the audit report.
external auditor’s expected liability loss is less than the expected loss due to audit failures, and the difference in expected losses must be borne by the client (and its owner).

To reduce some of the costs associated with audit effort, the external auditor may use an assistant to perform some of the audit tasks. For example, because the assistant’s hourly wage is lower than the external auditor’s hourly wage (which reflect their respective opportunity costs), the external auditor assigns as many tasks to the assistant as is cost-effective from his perspective. Of course, in accordance with the generally accepted auditing standard on supervision (SAS No. 22), the external auditor should adequately supervise the work of the assistant. As the assistant assumes some of the external auditor’s tasks, the external auditor’s personal effort costs decline, and the external auditor can be expected to assign additional tasks to the assistant (increase the total audit effort) because now the expected marginal liability costs exceed the marginal effort costs. Therefore, the addition of an assistant has a two-fold effect on the external auditor’s audit effort choice: (1) the external auditor reduces the proportion of audit tasks he performs; and (2) the external auditor is willing to choose a higher level of total audit effort (resulting in a higher quality service, ceteris paribus).

This assistant can be employed by the external auditor, in which case the assistant is called a junior auditor. When the junior auditor assists the external auditor, the external auditor considers both auditors’ effort costs (opportunity costs) in choosing the total effort
level for the particular audit engagement. Alternatively, the firm can motivate the external auditor to substitute the firm's internal auditor for the junior auditor. In that case, the firm employs (pays for) the assistant, and the external auditor considers only his personal effort costs in choosing the total effort level. Consequently, the external auditor may choose a higher quality level than the firm may desire.

1.2 Contribution

Having the internal auditor assist the external auditor in order to control costs seems inappropriate when audit effort and the quality of the service are not observable. To control costs under such conditions, the controllability concept suggests that the internal auditor's wages be the responsibility of the external auditor. This study investigates when this control over costs comes at the expense of the (unobservable) quality of the service obtained.

The model facilitates an investigation of the impact of having the internal auditor assist the external auditor in conducting the annual audit on the behavior of the external auditor and the payoff to the firm (and its owner). From a modeling perspective, an arrangement in which the external auditor employs (pays) the junior auditor is equivalent to an arrangement in which the owner deducts all the internal auditor wages from the (negotiated) audit fee. Therefore, having the internal auditor assist the external auditor expands the contracting opportunities among the owner and external auditor.

An important result of the study is the identification of a device with which the firm might increase the quality of the service obtained.
By having the internal auditor assist the external auditor and by negotiating the amount of the internal auditor's wages to be deducted from the audit fee paid to the external auditor, the firm can manipulate the external auditor's effort choice (and, therefore, the amount of competent and relevant evidence to be collected and examined). Society as a whole benefits if the quality increase obtainable under a more effective but, at the same time, costlier legal system can be approached by having the internal auditor assist the external auditor.

Further, the study considers the effects of some of the instruments available for implementing the social objective of reducing the error rate in the issuance of the audit report (and accompanying inefficiencies). Specifically, this study investigates the effects on the owner's design problem of changing certain variables such as firm size, the external auditor's reliance on the assistant auditor's work, and the legal system's effectiveness. The results indicate that large firms should benefit more from having the internal auditor assist the external auditor than small firms, and an increase in the legal system's effectiveness should reduce the number of firms benefiting from having the internal auditor assist. The results suggest that facilitating firms in having their internal auditor assist the external auditor in conducting the financial audit may help accomplish society's objective of reducing the probability that the inappropriate audit report is issued.

1.3 Dissertation Outline
The remainder of the dissertation is organized as follows. Chapter 2 reviews the relevant literature. Chapter 3 formulates the model and presents the mathematical program representing the owner's design problem. Chapter 4 contains the analysis including the optimal solution to the owner's design problem and considers the impact of changes in certain parameters on the optimal solution. Chapter 5 discusses the effects of altering certain assumptions of the model and the implications of the results for practice and research. Chapter 6 summarizes the dissertation and discusses limitations and possible future extensions of the study.
CHAPTER II
LITERATURE REVIEW

This section reviews the relevant literature. Some evidence of concerns about the internal auditor's assistance of the external auditor is presented and discussed. This material motivates the search for an economic rationale for the firm's demand for having the internal auditor assist the external auditor after controlling for wage differentials. Further, to facilitate comparisons with the model developed for this study, agency models of auditing are presented and discussed. The chapter concludes with a section on centralized versus decentralized contracting.

2.1 Internal Auditor's Role

Continued client pressure to increase the role of the internal auditor in the financial audit process has led to the development of the "wrap-around" audit, in which the external auditor oversees the activities of the internal auditor and performs a minimal number of prescribed procedures as deemed necessary under the circumstances. To

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3 A "wrap-around" audit can be thought of at the procedure level, the transaction cycle level, or the financial statement level. Therefore, the description of "wrap-around" audit applies whenever the external auditor relies on the internal auditor's work.

4 Recently, smaller CPA firms have expressed an interest in taking on internal audit assignments for public companies [PCPS, 1989]. Replacing the internal auditor with another external auditor acting as
focus on the welfare implication of the internal auditor assisting the external auditor, the internal auditor's functions within a firm are assumed to be separable into managerial and financial audit functions.\(^5\)

Within the last twenty years, the internal auditor's monitoring of management's production activities expanded to include assisting the external auditor in conducting the financial audit [Maher and Ramanan, 1985; Wallace, 1984a]. In a recent survey of internal auditors, Peacock and Pelfrey [1989] found that, with the exception of analytical review, internal auditors were perceived to be performing almost half of the audit work. Wallace [1984a,1984b] provides empirical support for the existence of a (cost-saving based) demand for having the internal auditor assist the external auditor by showing that the reduction in external auditor fee as a result of the internal auditor's assistance outweighs the related increase in the internal auditing department's budget. Wallace's findings reveal that the transfer price (internal hourly billing rate) for internal auditors was approximately $18 compared with an external hourly billing rate in excess of $25 for junior auditors performing tasks that internal auditors could supply such as sampling, compilations, and work paper preparation. Obviously, an internal auditor does not affect the issue raised here.

\(^5\) The internal auditor performs functions within the firm which benefit the external auditor such as being part of a well-designed internal control system to prevent or detect theft and unauthorized perquisite consumption by the firm's employees. Such benefits are realized whether or not the internal auditor assists the external auditor in the financial audit process. Therefore, in order to focus on the effect of audit arrangement on audit effort choice, the effects of all internal auditor functions, except assisting the external auditor, could be incorporated as a state variable.
this demand would arise whenever internal auditors operate as efficiently as junior auditors for lower wages.

Alternatively, the owner's demand may also be explained by differential efficiencies. For example, if internal auditors are more efficient in performing certain financial audit tasks and work for wages identical to those of junior auditors employed by the external auditor, total audit costs might be lower (while the external auditor can obtain the same level of assurance). Although this rationale admits the feasibility of lower audit costs, its implementation presumes that (1) the owner can identify and assess these efficiency differentials or (2) competitive market conditions lead the external auditor to suggest the use of the internal auditor in return for a lower audit fee.

The preceding rationales for the owner's demand for having the internal auditor assist in the annual audit raises several questions. For example, why wouldn't internal auditors leave the owner's firm and hire on as junior auditors if wage differentials cause lower audit costs? Or, why would the external auditor consider accepting lower fees by allowing the use of a more efficient internal auditor to cut audit costs? Or, how can a firm be assured that having the firm's internal auditor assist the external auditor leads to an increase in the quality of the service?⁶ Obtaining answers to the first two questions requires explicit consideration of competition in the demand and supply of input factors, and is beyond the scope of this study. The last question will

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⁶ These and other questions may be appropriate for similar settings where quality is not observable or where the firm lacks the knowledge or expertise to judge the quality of the service at the time of contract settlement.
be addressed in this study by identifying the contracting cost
differentials between the two audit arrangements when both (junior and
internal) auditors are equally efficient and command an identical wage
structure (i.e., when the labor market is efficient).

SAS No. 9 allows the external auditor to "rely on" the work of the
internal auditor only when the external auditor has satisfied himself
regarding the competence and objectivity of the internal auditor [AICPA,
1975, 1989; Barret and Brink, 1980] while SAS No. 65 allows the "use of"
the internal auditor in conducting the financial audit. Recent survey
studies found that external auditors seem to be more concerned with the
internal auditor's competence and work performance than objectivity
[Margheim, 1986; Messier and Schneider, 1988; Schneider, 1984, 1985]. Their results seem to imply that external auditors are most interested

7 Note that SAS No. 9's "rely on" refers to internal auditor work
done before the financial audit and SAS No. 65's "use of" refers to
reliance on internal auditor work done during the financial audit. Of
course, the external auditor retains sole responsibility for the issued
audit report that accompanies the manager's financial report regardless
of the extent to which the work of the internal auditor is used in
arriving at the auditor's report. If both auditors had reporting
responsibility, the problem setting changes drastically. Hansen and
Balachandran [1989] have the internal and external auditor perform the
same job (verifying the manager's report) independently and the results
of each can be used to assess the performance of the other as they
conduct their respective audits in a perfectly correlated environment
(similar to Sappington and Demski [1983]). They study the desirability
of communication between the auditors and show that the owner may obtain
more auditing by not revealing the results of the internal auditor's
report before the external auditor issues his report. Since both
auditors work in a correlated environment, the owner makes truthtelling
the dominant strategy for the (less costly) internal auditor, and
designs a forcing contract based on each auditor's report as in Demski
and Sappington [1984].

8 Factors used in evaluating internal auditor objectivity may
include reporting structure (organizational status) and degree of access
to operations and records.
in the internal auditor's credentials such as professional affiliation and certification.

Having the internal auditor assist the external auditor may raise independence concerns. Auditor independence from management is crucial in the demand for auditing in general, and especially when management demands attestation about assertions made in the financial statements [Kinney, 1988]. This study views the owner as demanding attestation and assumes that the use of the internal auditor does not impair the external auditor's independence.

Because both arrangements between the owner and external auditor involve a second auditor, the analysis requires an assumption regarding the minimum number of audit tasks the external auditor must perform (in conformance with the standard on proper supervision) to obtain assurance that the second auditor acts as directed. If objectivity is an issue, the external auditor may simply reduce the reliance on the work of the internal auditor. Having the internal auditor assist the external

---

9 Auditor independence may be induced by professional affiliation. Yoon [1990] suggests that in settings where effort and outcome are not verifiable, auditor independence (from the manager) can be obtained by requiring the auditor to be a member of a professional organization. Rules, regulations and requirements of the audit profession create outside public information through the judicial process. The external auditor will have a strong incentive to be independent if a punitive threat exceeds the benefit of deviant behavior (such as not expending audit effort and then issuing an unqualified report).

10 Auditor independence, along with a penalty structure for noncompliance, may be a sufficient condition for preventing collusive behavior. However, auditor independence may not prevent the manager from overreporting and, to detect the manager's overreporting, the external auditor must be motivated to expend audit effort. Here, the focus is on the external auditor's effort choice rather than his reporting choice, and the net benefits of dishonest reporting decrease with audit effort. Therefore, an independent external auditor will not become less independent when expending more audit effort.
auditor then merely raises the minimum number of procedures the external auditor performs (when compared to the use of the junior auditor). Because task division between the auditors is a strategic variable in this setting, the external auditor’s concerns regarding the internal auditor’s objectivity will have welfare implications for the owner.

2.2 Agency Models of Auditing11

In agency models, individuals are assumed to be motivated by self-interest. An agency problem arises whenever cooperative behavior, which maximizes the group’s welfare, conflicts with one individual’s self-interest. As a result, the total welfare obtainable as a group may be diminished as deviations from the optimal behavior cause inefficiencies and entail welfare losses for some or all individuals involved. With each party acting in his own self-interest with the knowledge that all others will act in their self-interest, and with the restriction that only observable variables can be contracted upon, the solution approach to the principal’s design problem can be specified.

Using the terminology of the audit setting, the owner’s problem is to choose the contract which maximizes expected utility subject to the external auditor: 1) finding it in his best interest to accept the engagement and 2) choosing the (non-observable) effort (assurance) level

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11 Another model of auditing, called the "market model" [Scott, 1988; Blazenko and Scott, 1986] or "signaling model" [Melumad and Thoman, 1990] employs the auditor as a device enabling managers or firms to signal their type to other market participants. Although having the internal auditor assist the external auditor may prove to lead to a higher quality of the audit report (a potential signal), the focus in this study is not on adverse selection issues but instead on a single firm and its contractual relationship with its (existing) external auditor.
that maximizes his expected utility. That is, the contract must be self-enforcing and pareto-optimal.\(^2\)

A potential value of external auditing is its decrease of the likelihood that (intentional) misstatements appear in the manager's report. This requires an adequate penalty structure to motivate the desired behavior in the manager. The modeling and motivational issues that may develop have been addressed in stewardship demand for auditing studies [Antle, 1982; Baiman, Evans, and Noel, 1987; Gjesdal, 1981; Ng and Stoeckenius, 1979]. Stewardship demand for auditing studies view the auditor's role as providing information used by the owner for contracting purposes. These studies compute the owner's net benefit as the difference between the value of productive output minus the cost of eliciting the manager's desired behavior and the cost of inducing the external auditor to audit effectively.

Ng and Stoeckenius [1979] analyze the stewardship role of the external auditor with the external auditor modeled as a technology. Antle [1982] changes the external auditor to a self-interested, utility-maximizing individual which creates an additional design problem for the principal: the manager and external auditor may have an incentive to choose actions not desired by the principal. In Antle's model, the manager's action choice affects production and is subject to moral hazard. Further, the manager's report coincides with the external auditor's report and occurs after the external auditor's action choice.

\(^2\) If, at optimality, the incentive compatibility constraint is not binding and therefore can be dropped, a cooperative solution can be obtained.
Baiman et al. [1987] analyze the stewardship role of the external auditor differently. In their study, the external auditor is hired to improve the risk-sharing between the owner and manager. Unlike Antle's model, the manager's action does not affect production and the external auditor attests to the truthfulness of the manager's report. Further, the manager's actions are limited to underreporting and consuming the difference between the high and low outcomes. In addition, the authors introduce an exogenous, noisy public signal that with positive probability reveals the realized production outcome before the contracts are settled. Finally, they preclude collusive agreements between the manager and external auditor. For this setting, the authors derive optimal contracts for the manager and auditor, and establish sufficient conditions for auditing to have value.

Antle's assumption that the external auditor chooses an action before the manager reports and Baiman et al.'s double-transfer assumption are convenient but are not representative of all audit settings. Antle's external auditor cannot attest to the truthfulness of the manager's report while the manager's reporting choice in Baiman et al. is limited to underreporting the production outcome. Changing the assumptions in each setting to conform to practice changes the analyses and results. Antle's application of the Revelation Principle would be inappropriate when the external auditor observes the manager's report before issuing the audit report because the external auditor cannot credibly precommit to his auditing strategy. The double transfer assumption reduces the audit setting to a sharecropper setting where the external auditor is hired to prevent the sharecropper from reporting the
lowest outcome and selling (or consuming) the rest of the crop for personal gain. Elimination of the double transfer assumption allows over- or under-reporting of the non-observable production outcome by the manager.

An additional value of external auditing arises when the owner uses the manager's report to make investment decisions [Wallace, 1980, 1987]. This decision-based demand view of the role of auditing is consistent with models used in Balachandran and Ramakrishnan [1987] and Balachandran and Nagarajan [1987]. In this view, the owner engages an external auditor to report on the fairness of the manager's report by certifying whether the statements are presented in accordance with generally accepted accounting principles and providing assurance that the financial reports are not materially misstated. Accordingly, this demand for auditing parallels the demand for external reporting. As long as the opportunity costs of not being able to base the investment decisions on the manager's report are higher than the cost of auditing, a demand for auditing exists.

Balachandran and Ramakrishnan [1987] analyze the possibility of agency costs reductions by the mutual monitoring among audit firm members. They develop contracts based on ex post observable audit output. Their results indicate that agency costs may disappear as the audit firm grows and the client is able to write contracts dependent on the performance of the audit firm with other clients. Agency costs resulted from the unobservable audit effort, uncertainty in the audit process, and risk-aversion of the auditor. In Balachandran and Ramakrishnan's model of the audit process, the owner will eventually
know the production outcome (net of the manager's consumption of perquisites), for example, when selling ownership in the firm or when solvency problems lead to court investigations. Essential features of their model are: (1) this signal may appear after the manager has left the firm or the owner is otherwise unable to recover any losses from the manager, and (2) this signal occurs before the contract with the external auditor is settled.

The audit setting adopted in this study is similar to Balachandran and Ramakrishnan [1987] except that the owner observes the realized production outcome after the contract between the external auditor and owner is settled. This sequence of events prevents the owner from using the production outcome in the contracts offered to the manager and external auditor. The external auditor is liable for the amount of the owner's loss. The owner can sue the external auditor whenever the observed outcome reveals that an audit failure occurred. Therefore, the independent external auditor is motivated to expend audit effort by an effective legal system.13

Under a strict liability legal system, the owner recovers the loss from the external auditor whenever the external auditor issues the inappropriate audit report - i.e., whenever an audit failure occurs. Under a due care legal system, the owner recovers the loss only after the court rules that insufficient audit evidence has been collected and

13 A recent U.S. District Court decision stated that "The liability of the external auditor may extend to individuals whom the maker of the representation intends to benefit or to a "limited class" of individuals for whose benefit the maker intends to supply the information ... or when the maker knows the recipient intends to supply this information." [Baliga, 1990]. Therefore, the owner can sue in case of an audit failure even though the manager may have engaged the external auditor.
disallows the external auditor's due care defense of following professional standards.\textsuperscript{14} Accordingly, the external auditor will be held liable for the owner's loss only if the court establishes that error (audit failure) could have been avoided by following prescribed due care standards such as Generally Accepted Auditing Standards (GAAS).

Balachandran and Nagarajan [1987] study the effect of alternative legal systems on the owner's welfare in a principal-agent setting involving a risk-neutral client and its risk-averse (external) auditor. In their study, under an error free due care legal system, the courts can perfectly apply socially optimal due care standards when issuing a negligence ruling. They show that, when coupled with supplementary insurance, a legal system which admits a due care defense is preferred to a strict liability legal system in which the external auditor is held liable whenever the revealed outcome differs from the auditor's report. The owner prefers the due care legal system because its implementation does not require external auditor knowledge of a costless internal audit report, thus requiring the external auditor to process less information before choosing the appropriate audit effort level, and the risk-averse external auditor bears less risk under a due care legal system.

This study differs from Balachandran and Nagarajan [1987] in that the court is imperfect in establishing lack of due care.\textsuperscript{15} Arguably,

\textsuperscript{14} Professional and regulatory standards - e.g., SAS No. 47 - impose general requirements for sufficient audit evidence (due care) to support the external auditor's report [AICPA, 1983].

\textsuperscript{15} Another difference involves risk preferences. Balachandran and Nagarajan assume that the external auditor is risk-averse. To focus on the motivational implications of the setting, all parties involved in this study are assumed risk-neutral. Then, with a risk-neutral external auditor, the risk-sharing savings obtained for their results disappear.
because the due care standards themselves are not sufficiently specific, the court may have difficulty determining if the external auditor did in fact exercise due care. A court with imperfect ability to establish lack of due care may still be effective when the probability of a lack of due care (negligence) ruling decreases with the amount of audit evidence available in the external auditor's defense.16

2.3. Contractual Arrangements

At the most general level, this study considers centralized versus decentralized contracting. The Revelation Principle [Myerson, 1982] asserts that any non-cooperative equilibrium outcome of a decentralized structure can be replicated by a centralized (two-tier) structure provided there are no restrictions on communication, contract

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16 The problem of motivating the external auditor becomes trivial if the owners can use a monitoring system to design a forcing contract and induce the first-best effort choice. A monitoring system provides the owner with (additional) information regarding the agent's action choice. Costless monitoring systems have been shown to reduce the welfare loss attributable to the presence of information asymmetry [Holmstrom, 1979] and limited liability [Baiman, May, and Mukherji, 1990]. Holmstrom [1979] shows that a costless monitoring system has value whenever it enables the principal to use the generated information to reduce agency costs. Baiman, May, and Mukherji [1990] demonstrate that there are increasing returns to the principal of improving an imperfect but costless monitoring system's ability to detect lying by the agent.

In the audit setting, if a costless legal system monitors the external auditor's action choice, the owner can attain the first-best outcome provided the audit effort level discovered during the legal process can be contracted upon. However, the legal process does not begin until after the contract with the auditor has been settled, and the owner cannot use the legal system's discovery in the contract design.
complexity, and commitments.\textsuperscript{17} To study the issue of decentralized contracting profitably in light of the Revelation Principle, at least one of these assumptions must be violated. In this study, the ability to write arbitrarily complex contracts is constrained by the limited liability imposed by the audit setting.

In a study of centralized versus decentralized decision making, Melumad and Reichelstein [1987] identify the conditions under which delegation is performance equivalent to communication-based centralization (i.e., leads to similar outcomes for the principal). They show that since communication improves decision making as well as provides better incentives, delegation and centralization schemes are performance equivalent in special cases only. They note that in the absence of communication, it is always in the principal's interest to delegate authority over jointly observable decisions to the better-informed agent.

Melumad and Reichelstein's results do not extend to the audit setting even though authority over the decisions is delegated to the better-informed external auditor (agent). The external auditor determines how much evidence to collect and examine before issuing the audit report as well as which report to issue. However, the first

\begin{footnotesize}
\textsuperscript{17} The incentive for truthful revelation relies on the principal's ability to commit. Then, according to the Revelation Principle, the search for an incentive compatible mechanism can be limited to considering only those equilibria in which the agent reveals his private information honestly, and no other coordination mechanism can possibly offer the principal a higher expected utility than the best incentive-compatible direct mechanism. In particular, any mechanism involving delegation of decision making can, without loss of performance, be replaced by a completely centralized mechanism.
\end{footnotesize}
decision is not jointly observable -- causing the moral hazard problem and rendering this variable non-contractible.

Melumad, Mookherjee and Reichelstein [1989] compare the performance attainable by centralized (two-tier) contracting with that of delegated (multi-tier) contracting. In their setting, two agents are involved in a production process, and the principal must decide whether to contract with each agent individually or with one of the agents, who in turn, contracts with the second agent and decides the effort allocation between the agents. The authors conclude that delegated contracting generally entails a loss to the principal due to a distortion in the allocation of production between the two agents and the principal's inability to make aggregate production decisions dependent on any information about the second agent's costs. The agent-turned-principal's utility for his share of the production process determines the subcontract offered to the second agent which results in a loss to the principal. Thus, Melumad et al. show that centralized contracting is desirable from a "control perspective" as it avoids the decision biases associated with delegated contracting.

Unlike Melumad et al., this study investigates a setting where one of the agents (the external auditor) takes an unobservable action under either arrangement. The audit setting assumes that either arrangement involves an assistant who helps collect and examine the audit evidence required by the external auditor who, based on an examination of all collected audit evidence, issues the audit report. Traditionally, the external auditor employs a junior auditor (decentralized contracting). Alternatively, the owner can design a contract that substitutes the
internal auditor for the junior auditor (centralized contracting). The chief difference between the two contractual arrangements is that the external auditor employs (pays for) the junior auditor while the firm employs (pays for) the internal auditor. Removing the cause of Melumad et al.'s loss from delegated contracting by having one agent decide on the (unobservable) action in either arrangement should make the principal indifferent between the arrangements. Then the existence of a preference for one arrangement over the other may indicate that additional benefits are obtainable from the contracting choice.
CHAPTER III

THE MODEL

This chapter presents an audit setting containing the moral hazard problem. Sections one and two describe the basic problem leading to the owner's demand for auditing. Sections three and four formalize the specific assumptions describing the audit setting and contractual arrangements. The final section contains the mathematical program representing the design problem faced by the owner.

3.1. Approach

This study uses a principal-agent model to explore the impact on the external auditor's effort choice and the resulting welfare effects of having the internal auditor assist the external auditor in conducting the financial audit. Specifically, the study compares two audit arrangements to explore the potential for reducing agency costs arising within the contractual relationship between self-interested parties.

The study adopts a model of external auditor effort (assurance) choice which focuses on a decision-based demand for auditing. A decision-based demand for auditing arises from the owner's need to rely on financial reports for further (investment) decisions. Within this framework, the study explores the effects of non-observability of the
external auditor's effort choice and an "imperfect" legal system on the owner's demand for internal auditor assistance of the external auditor.

All parties are assumed risk-neutral in order to focus on the motivational implications of the non-observable effort choice in a constrained setting. Due to the global risk-neutrality assumption, the owner does not engage an external auditor to improve the risk-sharing between himself and the manager (as in Baiman et al. [1987]).

To create a demand for auditing, this study models a setting in which the owner is unable to motivate the manager, in the absence of auditing, to provide the desired level of productive input. The manager’s private observation of the realized outcome and the manager's ability to affect his own wealth with his report results in either shirking (when no external auditor is engaged) or overreporting behavior (when an external auditor is engaged). Furthermore, the owner can neither sell nor rent the firm to either the manager or the auditor to obtain the first-best efficient solution. Lack of wealth and/or limited liability constraints prevent the owner from selling or renting the firm to the manager, while the institutional requirement of independence prohibits the external auditor from having any financial interest in the client firm.

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18 When the agent is risk-averse in a basic agency setting, a second-best outcome forces the principal to trade off risk-sharing and efficiency in the optimal contract [Holmstrom, 1979; Shavell, 1979], and it becomes too costly for the principal to sell or rent the firm (decision problem) to the risk-averse agent.

19 The first-best outcome maximizes the total expected surplus for the principal while the agent is held to his reservation utility in each possible state.
3.2. Demand for Auditing\textsuperscript{20}

The general economic setting considered features a risk-neutral, wealth-maximizing owner (O) of a production function who employs a risk-neutral manager (M) to provide labor as input for the productive output and to report on the productive output \( x \in \{x_L, x_H\} \) to the owner. The realization of \( x \) is affected by the manager's effort choice \( e \in \{e_L, e_H\} \). Let \( k(e) \) denote the probability with which \( x_H \) obtains given the manager's effort \( e \). Assume that

\begin{align*}
(1) \quad & k(e_H) = \frac{1}{2} \text{ and } k(e_L) = 0.
\end{align*}

The manager's additively separable utility function is

\begin{align*}
(2) \quad & U^M(I, e) = I^M - V^M(e).
\end{align*}

\( V^M(e) \) represents the manager's disutility for effort with \( V'(e) > 0 \) and \( V''(e) \geq 0 \). Assume that the manager has a reservation utility \( U^M \geq 0 \) and has no initial wealth. Assume further that

\begin{align*}
(3) \quad & x_L - V^M(e_H) < 0.
\end{align*}

That is, the manager's cost for providing high effort exceeds the value of the low production outcome and, in conjunction with the assumption on the manager's initial wealth, this assumption prevents the owner from renting (or selling) the firm to the manager.

Both know that the manager observes production outcome \( x \) after providing effort \( e \) and before reporting, and that the owner will not observe (consume) the production outcome \( x \) until after the contract with

\textsuperscript{20} This section has the sole purpose of motivating the manager's overreporting strategy and the resulting decision-based demand for auditing. The assumptions in this section are chosen so that the benefits from alternative audit arrangements can be established with minimal reference to the parameters in the basic (owner-manager) agency problem.
the manager has been settled. The internal control system prevents the manager from consuming \( x_H - x_L \) and reporting \( x_L \).\(^{21}\) Further, assume that the manager can overreport with impunity.\(^{22}\) Then the owner's problem is limited to a moral hazard on the choice of \( e \): the manager shirks and always reports a high production outcome in order to receive a higher wage payment. The owner's best strategy in this setting is to offer a fixed wage \( I^M \). The manager, in turn, provides effort \( e_L \), and has no incentive to issue a false report.

Additionally, assume that the owner makes further investment decisions (before observing the realized production outcome) which contribute to the owner's end-of-period wealth. Let \( w \in (0, \hat{w}) \) represent the owner's net investment outcome with \( w \) equal to \( \hat{w} \) when the investment decision is based on the appropriate audit report, and \( w \) equals 0 otherwise. Assume that \( \hat{w} \) is greater than zero and common knowledge.

The sequence of events in the basic agency problem is as follows:

![Figure 1. Owner-Manager Setting](image)

\(^{21}\) This assumption prevents the manager from underreporting the production outcome without the owner learning the realized production outcome in the future.

\(^{22}\) The implications of relaxing this assumption are discussed in chapter 5.
3.3. Audit Setting

To maximize end-of-period wealth, the owner engages a risk-neutral external auditor (EA) to verify the manager's report. The external auditor has an additively separable utility function

\[ U_{EA}(I,a) = I_{EA} - V_{EA}(a). \]

\( I_{EA} \) represents the negotiated audit fee and \( V_{EA}(a) \) is the dollar measure of the auditor's disutility for audit effort \( a \in [0,1] \), with \( V'(a) > 0 \), \( V''(a) = 0 \), and \( V(0) = 0 \). The external auditor has known initial wealth of at least \( \hat{w} \), and has reservation utility \( U_{EA}^* > 0 \).

When the owner engages an external auditor, the manager is induced to supply \( e_H \) but overreports the production outcome whenever \( x_L \) obtains. As a result of engaging the external auditor and in addition to the expected investment outcome \( \hat{w} \), the owner obtains the expected value of the production output increase minus the manager's compensation increase. Let \( B \) equal the benefit to the owner from motivating the manager to take the desired action. Formally,

\[ B = E\{x|e_H - x|e_L\} - E(I_{M(R^A)} - I_{M}), \]

where \( I_{M(R^A)} \) is the solution to the owner's problem of enticing the manager to accept the contract and provide high effort. For convenience, assume that \( B \) approaches zero.

\[ ^{23} \text{In this study, the external auditor's disutility for effort, } V_{EA}(a), \text{ is a linear function. This linearity is unconventional but greatly simplifies the ensuing analysis of a setting in which the external auditor makes use of an assistant.} \]

\[ ^{24} \text{The magnitude of } B \text{ affects the owner's decision to engage an external auditor but is of little importance for the remainder of this study since } B \text{ is not affected by changes in the external auditor's assurance choice.} \]
By collecting and examining competent and relevant audit evidence, the external auditor obtains assurance regarding the probability of misstatements in the manager's report and, with positive probability, issues the inappropriate report in which case the owner sues the external auditor using the existing legal system. The next section describes the specific assumptions regarding the audit technology and legal environment.

3.3.1. Audit Technology

The external auditor issues an audit report based on the evidence obtained during the financial audit. By collecting and examining audit evidence, the external auditor obtains a level of assurance as to whether the manager's report of x contains any material misstatements. The level of assurance the external auditor obtains is reflected in the quality component of the audit report. That is, the higher the level of assurance obtained before issuing the audit report, the lower the probability that the inappropriate audit report has been issued, ceteris paribus. Assume further that the assurance level obtained is directly related to the audit effort level $a \in [0,1]$ with $a = 0$ denoting that the external auditor expends no effort (obtains no assurance) before issuing the audit report and $a = 1$ denoting that the external auditor obtains full assurance. Further, assume that the audit technology leads to equal probabilities for Type I and Type II error occurrence.\(^{25}\) Let $f(a)$ denote the probability that the auditor issues the appropriate

\(^{25}\) In conjunction with the manager's overreporting when induced to expend high effort, this assumption greatly simplifies the presentation of the owner's design problem.
report at effort level \( a \). The function \( f(a) \) is common knowledge with \( 0 \leq f(a) \leq 1, f'(a) > 0, \text{ and } f''(a) < 0 \). These statements reflect diminishing returns to evidence collection and examination.

The sequence of events with an external auditor added to the basic agency problem is as follows:

\[ \begin{align*}
& \text{O contracts} \\
& \text{M supplies} \\
& \text{EA reports} \\
& \text{M chooses} \\
& \text{EA issues} \\
& \text{O pays M and EA}
\end{align*} \]

\[ \begin{align*}
& \text{O invests based on reports} \\
& \text{O observes realised production and investment outcomes} \\
& \text{EA sues EA} \\
& \text{EA rules} \\
& \text{EA pays damages to O}
\end{align*} \]

**FIGURE 2. OWNER-MANAGER-EXTERNAL AUDITOR SETTING (O-M-EA)**

### 3.3.2. Legal Environment

Both the owner and the external auditor know that when the further investment decisions are based on the inappropriate audit report, the owner incurs a loss and suits the external auditor using the existing legal system. This study will examine the impact on the external auditor's effort choice of two different legal systems, an "imperfect" strict liability legal system (hereafter called a strict liability
legal system) and an "imperfect" due care legal system (hereafter called a due care legal system).26

Under a strict liability legal system, an exogenous factor such as a statute of limitations may prevent the owner from recovering the loss in some cases. As a consequence, a strict liability legal system may not perfectly motivate the external auditor to choose the owner's desired level of audit effort if the penalty cannot be set in excess of the loss due to the audit failure.27

This study also investigates the contractual relationship under a due care legal system in which rulings interact with the external auditor's action choice. Any imperfection, such as a statute of limitations, produces the same results in a more straightforward manner, but an imperfection not related to the action choice has less theoretical appeal. Under a strict liability legal system, the additional parameter must be introduced as a constant without reference to the assurance choice so that the model does not endogenize the effects to the same extent as under a due care legal system. A due care legal system is effective if it establishes negligence (lack of due care) more frequently when the external auditor obtains a low rather than high level of assurance before issuing the audit report.

26 Note that under a "perfect" strict liability legal system the and a "perfect" due care legal system the external auditor is motivated to take the desired action. This study considers the effects of imperfections in the legal system such as the existence of a statute of limitations and/or the court's inability to determine whether due care has been exercised in each instance.

27 An audit failure denotes the issuance of an inappropriate audit report given the manager's report and the realized production outcome.
Let $g(a)$ denote the probability that the due care legal system issues a no-negligence ruling when the external auditor chose effort level $a$ and issued the inappropriate audit report with $0 \leq g(a) \leq 1$, $g'(a) > 0$, and $g''(a) < 0$.\textsuperscript{28} That is, the likelihood that the external auditor can establish sufficiency of audit evidence in a due care defense increases with the amount of evidence collected and examined (audit effort expended). Assume that $g(a)$ is common knowledge. Furthermore, in case of an audit failure, the courts always rule negligence when the external auditor expends no effort ($a = 0$) and no-negligence when the external auditor expends full effort ($a = 1$). Under this legal system, costless but imperfect courts issue a ruling whenever the owner sues the external auditor.\textsuperscript{29}

Figure 3 summarizes the effects of the assumptions regarding the manager's effort and reporting choices, the external auditor's effort and reporting choice, and the expected payoffs to the owner, manager, and external auditor when the owner invests based on the external auditor's report.\textsuperscript{30} First, the manager chooses an effort level. Due

\textsuperscript{28} Note that $g(a) = 0$ under a "perfect" strict liability legal system, while $g(a) - c > 0$ under a strict liability legal system with a statute of limitations.

\textsuperscript{29} Since litigation is costless, the owner always goes to trial when a loss occurs, and the external auditor chooses his action in response to potential legal liability. The assumption of a costless legal system reduces the complexity of the analysis. If litigation were costly instead, the owner might not bring suit in some cases, and the external auditor's as well as the owner's incentives have to be considered in that case.

\textsuperscript{30} Only the owner's investment outcome is modeled here. For an example, the owner's investment decision could be based on the external auditor's report as follows: expand current capacity when the external auditor issues a unqualified audit report and reduce current capacity
to the model assumptions, the manager is induced to choose the high effort level. Second, nature chooses the high or low production outcome with probability $k(e)$ and $1 - k(e)$, respectively. Third, after observing the production outcome, the manager reports the high outcome (H) because there is no penalty for overreporting. Finally, the external auditor chooses an effort level $a$ which affects (1) the probability that the external auditor issues the appropriate audit report (U or Q), and (2) the probability that the court rules negligence (N) in case of an audit failure.

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when the external auditor issues a qualified audit report. As a result of these decisions, the owner will increase his wealth by $\hat{w}$ whenever the external auditor issues the appropriate report.

31 In a later section (5.1), the study discusses the implications of relaxing the no-penalty assumption.
Manager chooses effort level

Nature chooses production outcome

Manager issues report $R^M$

Auditor chooses effort level $a$ and report $R^A$

Court issues ruling $R^C$

**Figure 3. Partial Game Tree of the O-M-EA Setting**
3.4. Audit Arrangement

Assume further that there exists a (risk-neutral) assistant auditor (xA) with utility function

\[ U^{xa}(I,a) = I^{xa} - V^{xa}(a) \]

where \( V^{xa}(a) \) denotes the assistant's disutility for effort with \( V^{xa}(\cdot) \leq V^{ea}(\cdot) \). The assistant auditor operates a similar audit technology but has a beginning wealth of less than \( \hat{w} \). The external auditor uses an assistant auditor to reduce audit effort costs. The assumption on the beginning wealth prevents the assistant auditor from competing against the external auditor and the principal will not engage the assistant auditor to issue the audit report.

The external auditor issues an audit report at total effort level

\[ a = a^{xa} + a^{ea} \]

where \( a^{xa} \) and \( a^{ea} \) represent the audit effort expended by the assistant auditor and external auditor, respectively. Note that the external auditor determines the total amount of audit evidence to be collected and examined as well as how much audit evidence each auditor collects and examines (task division). Let \( r \) be the audit effort task division ratio such that

\[ a^{ea} = r \cdot a \text{ and } a^{xa} = [1 - r] \cdot a. \]

Because \( V(a) \), the dollar measure of disutility for effort \( a \), is linear, the external auditor's disutility for \( a^{ea} \) can be written as

\[ V^{ea}(a^{ea}) = r \cdot V^{ea}(a) \]

and the assistant auditor's disutility for \( a^{xa} \) can be written as

\[ V^{xa}(a^{xa}) = [1 - r] \cdot V^{xa}(a). \]
Further, let $\mathcal{r}$ be the minimum procedures level (including supervision) such that for any $r < \mathcal{r}$, the external auditor does not supervise adequately and the court will deny a due care defense and award punitive damages.\textsuperscript{32,33} Assume that the minimum procedures level $\mathcal{r} \in (0,1)$, remains constant, and is common knowledge.\textsuperscript{34}

Before contracting with the external auditor, the owner chooses the audit arrangement. Further, when the owner decides to have the internal auditor assist the external auditor, the owner must determine the proportion of the internal auditor's wages that will be paid by the external auditor (or deducted from the negotiated audit fee $I_E^A$). Let $s \in [0,1]$ denote the internal auditor's wages sharing ratio such that $s \cdot I_E^A(a,r)$ represents the portion of the internal auditor's wages to be deducted from the external auditor's fee. Then, denoted as the EA-JA arrangement, $s = 1$ and the external auditor employs (pays for) the assistant auditor (junior auditor JA). Denoted as the EA-IA

\textsuperscript{32} The model assumes that performing some minimum amount of audit tasks satisfies the supervision requirement. Instead, supervisory costs could be modeled separately (and in addition to the costs incurred in collecting and examining the audit evidence). For example, denoting supervisory costs as a function of the amount of work performed by the assistant, $C_E^A(a^{ZA})$, the external auditor's audit cost function changes to $V_E^A(a^{EA}) + C_E^A(a^{ZA}) + V_E^A(a^{ZA})$. Then, removing the minimum procedures level constraint, the external auditor has the assistant do all the work -- i.e., $a^{ZA} = 0$ and $a^{ZA} = a$ -- and the external auditor's audit cost function reduces to $C_E^A(a) + V_E^A(a)$ and must be less than $V_E^A(a)$ in order for the external auditor to use an assistant. Note that different representations are equivalent if $C_E^A(a)$ in the model with explicit supervision equals $\mathcal{r} \cdot [V_E^A(a) - V_E^A(a)]$ in the naive model.

\textsuperscript{33} The punitive damages assumption is imposed to preclude $r < \mathcal{r}$.

\textsuperscript{34} $\mathcal{r} \in (0,1)$ because $\mathcal{r} = 0$ indicates that the assistant auditor performs all audit tasks and $\mathcal{r} = 1$ indicates that the external auditor does not use an assistant auditor.
arrangement, $s < 1$ and the owner employs the assistant and chooses the proportion of (observable) internal auditor wages to be deducted from the external auditor's fee.\textsuperscript{35}

The sequence of events in the audit arrangement is as follows:\textsuperscript{36}

\begin{center}
\begin{tabular}{|c|c|c|}
\hline
O & H & EA \\
\hline
chooses contracts & supplies & issues report \\
\hline
s, H, EA & e & a \\
\hline
\end{tabular}
\end{center}

\begin{center}
\begin{tabular}{|c|c|c|}
\hline
O & C & EA \\
\hline
invests based on reports & observes realised production and investment outcomes & issues ruling \\
\hline
& & EA \\
\hline
\end{tabular}
\end{center}

\begin{center}
\begin{tabular}{|c|c|c|}
\hline
O & C & EA \\
\hline
sues & EA & pays damages to C \\
\hline
\end{tabular}
\end{center}

\textbf{FIGURE 4. OWNER-EXTERNAL AUDITOR-ASSISTANT AUDITOR SETTING}

\textsuperscript{35} Observe that the owner cannot design a forcing contract based on the information contained in the internal auditor's wages. In particular, the observed wages reflect the amount of effort the internal auditor expended. Then, because the owner can predict the task division and infer the total audit effort level, the owner can design a contract based on the internal auditor's wages such that if the external auditor chooses that level of internal auditor use, the owner pays to the external auditor his reservation utility and less otherwise. However, the external auditor can assign additional tasks for the internal auditor without intending to rely on the results (thereby bringing the inferred total effort to the desired level).

\textsuperscript{36} The manager's action choice is suppressed because the manager plays no role in the choice of arrangement.
3.5. Mathematical Program

The owner's design problem for choosing the audit arrangement is:

(11) \[ \max \left[ f(a) + [1 - f(a)][1 - g(a)] \right] \cdot w - I^{EA}(a) - [1 - s] \cdot I^{xA}(a,r) + B \]

subject to:

(12) \[ I^{EA}(s) - r \cdot V^{EA}(s) - s \cdot I^{xA}(a,r) - [1 - f(a)][1 - g(a)] \cdot \hat{w} \geq \bar{U}^{EA} \]

(13) \[ a, r \in \text{Argmax } I^{EA}(s) - \hat{r} \cdot V^{EA}(\hat{a}) - s \cdot I^{xA}(\hat{a}, \hat{r}) - [1 - f(\hat{a})][1 - g(\hat{a})] \cdot \hat{w} \]

(14) \[ r \geq 1 \]

(15) \[ I^{xA}(a,r) - [1 - r] \cdot V^{xA}(a) \geq \bar{U}^{xA} \]

The individual rationality constraints (IR) in statements (12) and (15) ensure that the contract offer is attractive to each auditor.\(^{37}\)

The incentive compatibility constraint (IC) in statement (13) achieves goal congruence between the owner and the external auditor. The minimum procedures constraint (MP) in statement (14) reflects the professional guidelines concerning the external auditor's supervision of the

\(^{37}\) The program reflects the specified task division between auditors from statement (8) and the equivalent disutility formulations from equations (9) and (10). Using the more general expression of equation (7), the program becomes

(11') \[ \max \left[ f(a) + [1 - f(a)][1 - g(a)] \right] \cdot w - I^{EA}(a) - [1 - s] \cdot I^{xA}(a, \alpha) + B \]

subject to:

(12') \[ I^{EA}(s) - V^{EA}(s^E) - s \cdot I^{xA}(a^x) - [1 - f(a)][1 - g(a)] \cdot \hat{w} \geq \bar{U}^{EA} \]

(13') \[ a, a^E, a^x \in \text{Argmax } I^{EA}(s) - V^{EA}(a^E) - s \cdot I^{xA}(a^x) - [1 - f(\hat{a})][1 - g(\hat{a})] \cdot \hat{w} \]

(15') \[ I^{xA}(a^x) - V^{xA}(a^x) \geq \bar{U}^{xA} . \]
assistant auditor. There is no incentive compatibility constraint for the assistant auditor because the external auditor supervises the tasks performed by the assistant auditor.

The model described in this chapter is one of moral hazard. The moral hazard is on the external auditor's effort (assurance) choice. The effort choice desired by the owner may not be incentive compatible for the external auditor. For instance, if the first-best solution calls for the external auditor to choose a high effort level and for the owner to offer the external auditor a fixed audit fee, the external auditor has an incentive to choose a low effort level if that choice minimizes the sum of his expected liability losses and effort costs. Formally, the type of moral hazard considered in this model is one of hidden action and similar to problems studied in the literature (see, for example, Holmstrom [1979] and Baiman [1982, 1990]).
CHAPTER IV

ANALYSIS

This chapter analyzes the mathematical representation of the owner's design problem developed in chapter 3. The first section establishes the properties of the optimal solution. Because the existing legal system affects the optimal solution, the properties of the optimal solution are derived under both legal systems as defined in the legal environment section of chapter 3. The second section provides comparative statics results under both legal systems. The final section demonstrates the effect of the owner's choice of contractual arrangement on the external auditor's effort choice and the owner's welfare by way of a numerical example.

4.1 Properties of the Optimal Solution

This section establishes certain properties of the optimal solution to the owner's design problem under different legal systems. As defined in the legal environment section of chapter 3, a strict liability legal system is a legal system under which the external auditor will be found negligent whenever an audit failure occurs within the statute of limitations. On the other hand, a due care legal system is a legal system under which the external auditor will be found negligent whenever an audit failure occurs and the court establishes a
lack of due care. Proposition 1 provides the optimal solution when the assurance level is contractible. When the assurance level is not contractible, the optimal solution under a strict liability legal system is provided by proposition 2, and the optimal solution under a due care legal system is provided by proposition 3. Note that in proposition 2, under a strict liability legal system, the actions of the external auditor do not affect the frequency of the damage awards given an audit failure occurred (i.e., \( g(a) \) is a constant). In contrast, proposition 3 assumes a due care legal system which allows the external auditor a due diligence defense (and \( g(a) \) is increasing in \( a \)).

Before proceeding, it will be useful to determine the task division ratio chosen by the external auditor. Lemma 1 establishes that the external auditor will assign as many audit tasks to the assistant auditor as permitted under generally accepted auditing standards. This result holds regardless of the audit arrangement chosen by the owner.

**LEMMA 1:** For any effort/assurance level, the external auditor maximizes his expected utility level by relying as much as feasible on the work of the second auditor, i.e.,

\[(16) \quad r = \xi.\]

**PROOF:** The result follows immediately from the assumptions regarding both auditors' disutility for effort \([V^A(a) \leq V^E(a)]\) and the minimum procedures constraint \( MP^E [r \geq \xi] \).

Q.E.D.

Proposition 1 provides the properties of the first-best efficient solution. This is the contract the owner would implement if the chosen effort level were jointly observable and verifiable.
PROPOSITION 1: Under any legal system, the first-best solution is defined by:

\[ (\forall a): \]
\[ (17) \; \xi \cdot V^{E^A}(a^*) + [1 - \xi] \cdot V^{E^A}(a^*) = f'(a^*) \cdot \hat{w} ; \]
\[ (18) \; I^{E^A}(s) - \xi \cdot V^{E^A}(a^*) - s \cdot I^{E^A}(a^*, \xi) - [1 - f(a^*)] \cdot \hat{w} = \bar{U}^{E^A} ; \] and
\[ (19) \; I^{E^A}(a^*, \xi) - [1 - \xi] \cdot V^{E^A}(a^*) = \bar{U}^{E^A} . \]

PROOF: From Lemma 1: \( r = \bar{r} \). Further, when the effort choice is contractible, the owner determines the desired effort level \( a^* \) (at which the owner's marginal benefit from auditing equals his marginal cost) and offers the external auditor a contract which provides the external auditor with an expected utility level equal to his reservation utility when providing the desired effort level and less utility at any other effort level.

Q.E.D.

Note that in the first-best case where \( a^* \) is chosen without regard to \( g(a) \), the "imperfectionless" of the legal system in motivating the auditor's actions can be ignored. The external auditor relies as much as possible on the work of an assistant auditor (i.e., \( r = \bar{r} \)). Further, the external auditor obtains the efficient level of effort before issuing the audit report and receives only his reservation level of expected utility \( \bar{U}^{E^A} \). In addition, the EA-JA and EA-IA arrangements yield identical (first-best) welfare levels for the owner.

When the effort level is not observable and therefore not contractible, the owner always obtains the second-best outcome in the EA-JA arrangement \( (s = 1) \) as stated below.
LEMMA 2: Under a strict liability legal system with \( g(a) = c > 0 \) \( \forall a \), the owner does not obtain the first-best outcome in the EA-JA arrangement.

PROOF: Since the audit fee cannot depend on the unobservable effort level, the external auditor's incentive compatibility constraint binds. The external auditor's effort choice is obtained by solving the first order condition \( \frac{\partial I_C^{EA}}{\partial a} = 0 \) to get

\[
(20) \quad r \cdot V^{EA}(a^0) + [1 - r] \cdot V^{JA}(a^0) = \\
\left[ f'(a^0) + g'(a^0) - f'(a^0)g(a^0) - f(a^0)g'(a^0) \right] \cdot \hat{w}.
\]

Since \( g'(a) = 0 \) \( \forall a \) by assumption, the RHS reduces to

\[
(21) \quad f'(a^0)[1 - g(a^0)] \cdot \hat{w} < f'(a^0) \cdot \hat{w},
\]

and the external auditor chooses a lower effort level than the owner desires. In turn, the lower effort level implies

\[
(22) \quad U^o - U^o(a^0) < U^o(a^*) = U^o^*.
\]

Q.E.D.

Note that the owner cannot influence the external auditor's choice by offering a higher fee \( I^{EA} > I^{EA} \) to the external auditor. The external auditor's choice of \( a^0 \) is determined in equation (20).

Further, the minimum fee necessary to engage the external auditor is determined by

\[
(23) \quad I^{EA} = r \cdot V^{EA}(a^0) - [1 - r] \cdot V^{JA}(a^0) - [1 - f(a^0)] \cdot [1 - g(a^0)] \cdot \hat{w} = \bar{U}^{EA}
\]

In the case of a higher audit fee, (23) is replaced by

\[
(24) \quad \tilde{I}^{EA} = r \cdot V^{EA}(a^0) - [1 - r] \cdot V^{JA}(a^0) - [1 - f(a^0)] \cdot [1 - g(a^0)] \cdot \hat{w} > \bar{U}^{EA}
\]

making the owner strictly worse off.

The results obtained thus far indicate that the observability of the effort choice plays a key role in obtaining the first-best outcome.
in the EA-JA arrangement. In particular, when effort is not observable, the owner cannot induce the desired outcome in the EA-JA arrangement.

We can now turn to the main result of the analysis: as developed in propositions 2 and 3, the owner may obtain the first-best outcome in the EA-IA arrangement even when the effort level is not observable and thus not contractible.

Proposition 2 states that, when the legal system does not award damages for every audit failure occurrence, the owner can obtain a higher quality service by having the internal auditor assist the external auditor and choosing $s$.

**PROPOSITION 2:** Under a strict liability legal system with $g(a) - c > 0 \forall a$, the solution to the owner's design problem is defined by:

\begin{align}
(25) & \quad r \cdot V^{EA}(a) + s \cdot [1 - x] \cdot V^{IA}(a) - f'(a) \cdot [1 - g] \cdot \hat{w} ; \\
(26) & \quad I^{EA}(s) - r \cdot V^{EA}(a) - s \cdot I^{IA}(a, x) - [1 - f(a)] \cdot [1 - g] \cdot \hat{w} = U^{EA} ; \\
(27) & \quad I^{IA}(a, x) - [1 - x] \cdot V^{IA}(a) = \bar{U}^{IA} ; \\
(28) & \quad s^* = 1 - \frac{f'(a) \cdot g \cdot \hat{w}}{V^{IA}(a) \cdot [1 - x]} \quad |a = s^* ; \\
(29) & \quad 0 \leq s < 1 ; \\
(30) & \quad a^0 < a \leq s^* ; \quad \text{and} \\
(31) & \quad U^O(a^0) < U^O(a) \leq U^O(s^* ) .
\end{align}

**PROOF:** First, the owner derives the desired effort level $a^*$ by solving the following equation with the left hand side representing the owner's marginal disutility for audit costs and the right hand side representing the owner's marginal utility for the gross benefit of auditing:

\begin{align}
(32) & \quad r \cdot V^{EA}(a) + s \cdot [1 - x] \cdot V^{IA}(a) + [1 - s] \cdot [1 - x] \cdot V^{IA}(a) = f'(a) \cdot \hat{w} .
\end{align}

Then, the owner substitutes equation (25) in equation (32) and derives the optimal responsibility ratio $s^*$ in the resulting equation by solving
(33) \[ f'(a^*)[1 - g] \cdot \hat{w} + [1 - s] \cdot [1 - x] \cdot V^I_{\text{IA}}(a^*) = f'(a^*) \cdot \hat{w} \]
to obtain equation (28). Lemma 2 established that \( s^* = 1 \) whenever the legal system does not award damages for every audit failure occurrence. \( s^* > 1 \) would indicate that the external auditor pays a premium to use the internal auditor instead of the junior auditor and implies that the second RHS term is negative which contradicts the assumptions regarding the particular setting. Alternatively, the external auditor can have his junior auditor perform the work more cheaply. Hence \( s^* < 1 \).

Further, \( s^* < 0 \) implies that the owner is willing to pay the external auditor for letting the internal auditor assist the external auditor. This would provide the external auditor with an incentive to assign work to the internal auditor in excess of the amount which he intends to use (rely on), increasing overall audit costs without increasing the effort level.\(^{38}\) Hence \( s \geq 0 \) and statement (29). Statement (29) implicitly imposes an upper bound on the total effort level the owner can induce. Hence statements (30) and (31).

\[ Q.E.D. \]

When the legal system allows the external auditor a due care defense in case an audit failure occurs, conditions exist under which the external auditor chooses an effort level equaling or exceeding the owner's desired (first-best) effort/assurance level \( a^* \). This result occurs whenever the external auditor's marginal expected liability costs...

\(^{38}\) Because the external doesn't intend to rely on the excess work done by the internal auditor, no additional supervision costs are incurred to act as a constraint on the external auditor effort choice. With \( s < 0 \), the external auditor chooses \( a \) to maximize his objective function, then continues to assign more tasks to the internal auditor to collect additional fees (see also footnote 35).
exceed the owner's marginal expected benefit of auditing at the owner's desired level of effort.

**Lemma 3:** Under a due care legal system there exists a cutoff audit effort level \( a^c > 0 \) such that

\[
g'(a) \cdot [1 - f(a)] \geq f'(a) \cdot g(a) > 0 \quad \forall a \leq a^c
\]

and

\[
0 < g'(a) \cdot [1 - f(a)] < f'(a) \cdot g(a) \quad \forall a > a^c.
\]

**Proof:** See Appendix A.

Therefore, under a due care legal system, the external auditor may provide the owner's desired level of audit effort in the EA-JA arrangement (when the induced effort level \( a = a^c \)) or an even higher level of audit effort (when the induced effort level \( a < a^c \)).

**Proposition 3:** Under a due care legal system the solution to the owner's design problem is defined by:

\[
x \cdot V'_{EA}(a) + s \cdot [1 - x] \cdot V'_{IA}(a) =
\[
[f'(a) \cdot [1 - g(a)] + g'(a) \cdot [1 - f(a)]] \cdot \hat{w};
\]

\[
I_{EA}(s) - x \cdot V'_{EA}(a) - s \cdot I_{IA}(a, x) - [1 - f(a)] \cdot [1 - g(a)] \cdot \hat{w} = \bar{U}_{EA};
\]

\[
I_{IA}(a, x) - [1 - x] \cdot V'_{IA}(a) = \bar{U}_{IA};
\]

\[
s^* = 1 - \frac{[f'(a) \cdot g(a) - g'(a) \cdot [1 - f(a)]] \cdot \hat{w}}{V'_{IA}(a) \cdot [1 - x]} \] \quad \text{for } a = a^c
\]

\[
a^* > a^c \implies 0 \leq s < 1; \text{ and}
\]

\[
a^* \leq a^c \implies s = 1.
\]

**Proof:** Statements (36), (37), (38), and (39) are derived as in Proposition 2. From Lemma 3 we get that

\[
a^* > a^c \implies g'(a^*) \cdot [1 - f(a^*)] < f'(a^*) \cdot g(a^*).
\]

Hence statement (40). Similarly,

\[
a^* \leq a^c \implies g'(a^*) \cdot [1 - f(a^*)] \geq f'(a^*) \cdot g(a^*)
\]
which implies that the second RHS term in statement (39) is nonpositive. Of course, if \( s \) exceeds 1, the external auditor will have the junior perform the tasks instead of the internal auditor. Hence statement (41).

Q.E.D.

4.2. Comparative Statics

To study the incentive effects of having the internal auditor assist the external auditor, the comparative statics properties of the solution to the owner's design problem are provided. Comparative statics results help predict changes in the optimal solution as a result from a change in one of the setting's parameters. As with the previous section, the comparative statics properties are provided for both legal systems.

PROPOSITION 4: Under a strict liability legal system with a statute of limitations \([g(a) - c > 0]\), we have

\[
\begin{align*}
\frac{\partial a^*}{\partial \hat{w}} &> 0; \quad \frac{\partial a}{\partial \hat{w}} > 0; \quad \frac{\partial a^0}{\partial \hat{w}} > 0; \\
\frac{\partial a^*}{\partial \hat{x}} &< 0; \quad \frac{\partial a}{\partial \hat{x}} < 0; \quad \frac{\partial a^0}{\partial \hat{x}} < 0; \\
\frac{\partial a^*}{\partial g} &= 0; \quad \frac{\partial a}{\partial g} \leq 0; \quad \frac{\partial a^0}{\partial g} < 0; \\
\frac{\partial a^*}{\partial \hat{w}} &\geq 0; \quad \frac{\partial a^0}{\partial \hat{w}} < 0; \quad \frac{\partial a^0}{\partial \hat{x}} < 0; \\
\frac{\partial a^0(a)}{\partial \hat{w}} &> 0; \quad \frac{\partial a^0}{\partial \hat{x}} < 0; \quad \frac{\partial a^0(a)}{\partial g} \leq 0.
\end{align*}
\]

PROOF: See Appendix A.

In words, proposition 4 shows how the owner's desired effort level and the external auditor's effort choice change as the wealth at stake \( \hat{w} \), the minimum procedures level \( \hat{x} \), or the legal system's probability of ruling no-negligence \( g(a) \) changes. An increase in the wealth at stake
(e.g., an increase in the size of the firm) leads to a higher desired effort choice $a^*$, which may or may not lead the owner to change the proportion of internal auditor wages to be deducted from the external auditor's wages. This indeterminate result is obtained because an increase in the wealth at stake simultaneously increases $a$ and decreases $s^*$, while, in turn, an increase in $a$ increases $s^*$. Further, an increase in the minimum procedures level $\xi$ results in a lower desired effort level because the audit costs at each effort level increase with an increase in the external auditor's personal effort. This point is pursued further in chapter 5 where the external auditor's reliance on the internal auditor's work can differ from his reliance on the junior auditor's work. Finally, a decrease in the legal system's effectiveness in motivating the external auditor to choose the desired effort level increases the proportion of internal auditor wages to be deducted from the external auditor's audit fee.

PROPOSITION 5: Under a due care legal system, we have:

$$\frac{\partial a^o}{\partial \omega} = 0; \frac{\partial a^o}{\partial \xi} = 0; \frac{\partial a^c}{\partial g(a)} < 0; \text{with, depending on } f, V^E, V^I,$$

Case 1 ($a^* \leq a^c$):

$$\frac{\partial a}{\partial \omega} > 0; \frac{\partial a}{\partial \xi} < 0; \frac{\partial a}{\partial g(a)} < 0;$$

$$\frac{\partial s}{\partial \omega} = 0; \frac{\partial s}{\partial \xi} = 0; \frac{\partial s}{\partial g(a)} = 0;$$

$$\frac{\partial U^O(a)}{\partial \omega} > 0; \frac{\partial U^O(a)}{\partial \xi} < 0; \frac{\partial U^O(a)}{\partial g(a)} < 0; \text{or}$$

Case 2 ($a^* > a^c$):

$$\frac{\partial a}{\partial \omega} > 0; \frac{\partial a}{\partial \xi} < 0; \frac{\partial a}{\partial g(a)} \leq 0;$$

$$\frac{\partial s}{\partial \omega} < 0; \frac{\partial s}{\partial \xi} \geq 0; \frac{\partial s}{\partial g(a)} \geq 0;$$

$$\frac{\partial U^O(a)}{\partial \omega} > 0; \frac{\partial U^O(a)}{\partial \xi} < 0; \frac{\partial U^O(a)}{\partial g(a)} \leq 0.$$

PROOF: See Appendix A.

When economies of scale apply to audit effort, the cutoff effort/assurance level $a^c$ does not change as the investment outcome $\hat{w}$ or the minimum procedures level $x$ changes. In conjunction with statement (50), the property that $\frac{\partial a}{\partial \hat{w}} > 0$, statement (49) implies that as the investment outcome increases it becomes more likely that Case 2 applies. Similarly, as the minimum procedures level decreases, the Case 2 results are more likely to apply. The welfare effects for Cases 1 and 2 are similar to the results reported in proposition 4 with one exception. As the comparative statics results for Case 1 indicate, the owner’s welfare decreases whenever the legal system becomes less effective in motivating the external auditor. In contrast, the Case 2 results indicate that this may or may not be the case depending on whether $s^*$ is less than zero. That is, whenever the owner has the ability to adjust $s$ to offset changes in the legal system’s effectiveness, the owner’s welfare may not be affected by changes in the legal system’s effectiveness in motivating the desired audit effort level (as in statement (48) of proposition 4).

Proposition 5 can be restated in terms of the overall net benefit of auditing changes. The owner’s marginal net benefit from having the internal auditor assist the external auditor changes with changes in the

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39 For an example of economies of scale, consider the amount of audit effort required to verify accounts receivable balances when a small firm has as many customers as a large firm, and the individual account balances are equally material to both firms. Then, although the amount of audit effort required may be equal, the external auditor’s expected liability loss from issuing the inappropriate report may differ for those firms.
wealth at stake, the minimum procedures level, or the due care legal system's effectiveness ratio. As noted previously, the owner deducts all internal auditor wages from the external auditor's fee (i.e., $s - 1$) whenever $a^* \leq a^o$. The external auditor then chooses $a$ to equal $a^o$, providing the owner with a net benefit $U^o(a)$ equal to $U^o(a^o)$. Therefore, there are no further comparative statics results on the welfare improvements from having the internal auditor assist the external auditor for Case 1 ($a^* \leq a^o$).

PROPOSITION 6: Under a due care legal system, provided $a^* > a^o$, we have

\begin{align*}
\frac{\partial [U^o(a) - U^o(a^o)]}{\partial s} & > 0; \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial s^*} < 0; \\
\frac{s^* - 1}{g(a)} & > 0; \\
0 < s^* < 1 & \Rightarrow \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g(a)} > 0; \quad \text{and} \\
0 < s^* < 0 & \Rightarrow \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g(a)} < 0.
\end{align*}

PROOF: See Appendix A.

The comparative statics properties of propositions 5 and 6 yield several insights. First, the owner improves his welfare by having the internal auditor assist the external auditor, and as the investment outcome increases, these welfare improvements increase. This result suggests that larger firms have a greater incentive to have the internal auditor assist the external auditor than smaller firms do and is consistent with the empirical evidence that large firms tend to have the internal auditor assist the external auditor.

Secondly, as $S$ decreases, the range over which $s$ can be used effectively (to induce the first-best effort level $a^*$) increases. As noted earlier, this result allows the owner to react to decreases in the legal system's effectiveness by adjusting the choice of $s$. Proposition
6 shows that in an audit environment where the external auditor increases his reliance on another auditor’s work, the owner’s incentive to have the internal auditor assist the external auditor increases, ceteris paribus.

Finally, in a setting where the legal system moves toward stricter liability, the owner’s incentive to have the internal auditor assist the external auditor depends on the owner’s desired effort level and choice of $s$. If the desired effort level exceeds $a^*$, then $s < 1$ and the owner has the internal auditor assist the external auditor. Then a move toward a stricter legal liability system increases the owner’s welfare whenever $s^* \geq 0$ and decreases the owner’s welfare when $s^* < 0$ (and $s = 0$), ceteris paribus.

4.3. Example

The following example demonstrates that under certain conditions the owner does not receive his preferred level of effort and that the owner could benefit from having the internal auditor assist the external auditor. The results obtained in the example motivate the search for the conditions under which the owner’s demand for having the internal auditor assist the external auditor exists.

Assume the following functional forms and values:

- the probability of issuing the appropriate report $f(a)$ equals $2a - a^2$;
- the probability of a no-negligence ruling $g(a)$ equals $a$;
- the minimum procedures level $\tau$ equals $1/5$;
the wealth at stake \( \hat{w} \) equals 1;

the external auditor's disutility for effort equals \( a \);

the assistant auditor's disutility for effort equals \( h_a \);

the external auditor reservation utility \( \bar{U}^{EA} \) equals .1; and

the assistant auditor's reservation utility \( \bar{U}^{EA} \) equals 0.

These statements specify the probability with which the appropriate audit report will be issued, the probability that the court rules no-negligence when an audit failure occurred, the proportion of audit tasks to be performed by the external auditor, the expected investment outcome (wealth at stake), each auditor's disutility for collecting and examining audit evidence, and each auditor's reservation utility.

Solving the design problem when the owner can contract on the effort level results in the first-best efficient outcome. This is the policy the owner would implement if observability of the chosen effort level were possible. Let the first-best levels be denoted throughout by * superscripts and let \( U^0 \) denote the expected value of the owner's objective function in the mathematical program (chapter 3, section 3.5). Then the first-best effort level, total audit outlay (\( AO \)), and realizable objective function value for the EA-xA arrangement are:

\[
(a) \quad a^* = .7; \quad AO(a^*) = .457; \quad U^0(a^*) = .480.
\]

40 The model assumes that the audit effort range is normalized to the [0,1] interval and that \( B \), the expected production increase minus expected manager's compensation increase, equals 0. In conjunction with the assumption that \( \hat{w} \) equals 1, the analysis of the example can be graphically depicted within the [0,1] \( \times [0,1] \) square. A summary of the example is presented in Appendix B.

41 The total audit outlay consists of the audit fee paid to the external auditor and the portion of the internal auditor wages not deducted from the audit fee.
Note that the audit fee offered to the external auditor includes an expected liability loss amount (ELL). Of course, the audit fee could be reduced by the amount of the expected loss without changing the outcome in this setting because the owner offers an audit fee which depends on the effort choice a. That is, the owner can commit to not sue the external auditor, and audit outlays at the time of contract settlement can be reduced by the amount of the expected liability loss (here: .027) to arrive at the expected total audit costs (AC) of .43.

Solving the owner’s problem when the effort choice is not contractible, the induced effort level, total audit outlay, and realizable objective function value for the EA-JA arrangement (s = 1) are:

(b) \( a^o = .553; A_0(a^o) = .431; U_0(a^o) = .458. \)

Notice that the owner prefers the external auditor to provide more effort -- i.e., obtain more assurance -- before issuing the audit report because the owner’s marginal expected utility for assurance \((f'(a)\hat{w} = .8)\) exceeds the external auditor’s marginal utility for assurance \((([f'(a) + g'(a) - f'(a)g(a) - f(a)g'(a)]\hat{w} = .6)\) at the induced assurance/effort level. The differences in outlays and net benefits obtained between the outcome sets (a) and (b) are due to the non-observability of the effort choice and a legal system which does not hold the external auditor liable for every audit failure. This result is possible because, at the time of the effort level choice, the external auditor knows that, in case of an audit failure, the court may rule that the external auditor exercised due care.
When the owner substitutes the internal auditor for the junior auditor in this setting, the external auditor chooses a higher total audit effort provided his marginal disutility for hiring additional labor exceeds his marginal disutility for supervising the internal auditor at the EA-JA effort/assurance level. Therefore, the owner may prefer the EA-IA arrangement over the EA-JA arrangement as long as the increase in gross benefits exceeds the increase in effort/assurance cost.

Appendix B contains a summary of the example as well as the outcomes obtained when the sharing ratio $s$, denoting the proportion of internal auditor wages to be deducted from the external auditor's audit fee, is fixed at zero (outcome set c) and derived at optimality (outcome set d). Outcome set c reveals that the external auditor chooses an effort/assurance level which results in "over-auditing" when not being held responsible for any of the internal auditor's wages. This result obtains because the external auditor chooses that effort level at which his marginal disutility for supervising the internal auditor equals his marginal disutility for expected liability losses.

In order to maximize expected net benefits from auditing in the EA-IA arrangement, the owner chooses to hold the external auditor responsible for some of the internal auditor's wages. Before offering the external auditor the contract, the owner establishes the desired effort level and then determines $s^*$, the optimal proportion of the internal auditor's wages for which the external auditor will be held responsible. Outcome set d reveals that the owner can thus achieve the first-best outcome in the example setting.
The owner's expected gross benefit of auditing (EGB) and the external auditor's expected liability costs (ELL) are functions of the external auditor's effort choice \( a \), respectively \( f(a) \cdot \hat{w} \) and 
\[ [1 - f()] \cdot [1 - g(a)] \cdot \hat{w}. \]
Since \( \hat{w} \) equals 1, 
(60) \( EGB(a) = f(a) \) and \( ELL(a) = [1 - f(a)] \cdot [1 - g(a)] \).

The external auditor's dollar measure of audit effort costs
(61) \( V^{EA}(a,r,IA) = \bar{r} \cdot a + h[1 - \bar{r}] \cdot a \)  
(62) \( V^{EA}(a,r,IA) = \bar{r} \cdot a + 1/5a \)  
when the external auditor employs the assistant auditor (EA-JA audit arrangement) and 
when the owner employs the assistant auditor without deducting any internal auditor wages from the external auditor's fee (EA-IA audit arrangement). Figure 5 reflects the specific assumptions made for this example.
The owner maximizes the expected net benefits from auditing \( U^o \) while the external auditor minimizes the sum of his expected liability losses and effort costs \( ELL + \mathcal{V}_{EA|s} \). The owner's net benefit of auditing, expected gross benefit minus audit costs, is the difference between the EGB and the \( \mathcal{V}_{EA|s=1} \) curves.\(^{42}\) Figure 6 reveals the owner's expected net benefit from auditing and the external auditor's expected disutility as functions of effort level \( a \). Note that for the parameter

\[^{42}\text{Note that audit costs } \mathcal{V}_{EA|s=1} \text{ do not equal the audit outlay or audit fee paid to the external auditor and his assistant, which must include compensation for expected liability losses to entice acceptance.}\]
values and functional forms assumed in the example, the owner's net benefit function has a maximum at an effort level different from that at which the sum of the external auditor's expected liability losses and effort costs has a minimum.

FIGURE 6. OWNER'S NET BENEFITS VERSUS EXTERNAL AUDITOR'S COSTS
CHAPTER V

DISCUSSION

This chapter considers the effects of altering some of the assumptions used in constructing the stylized model of the audit setting. In particular, the effects of having the internal auditor assist the external auditor on the manager's action choice will be discussed. Further, the effects of the owner not knowing \( r \) as well as the implications of the external auditor's reliance on the internal auditor's work when \( r^J_A \leq r^I_A \) and the situation in which incremental \( r \) equals 0 will be discussed in light of the results presented in chapter 4. The chapter concludes with a discussion of the implications of the results for firms which engage external auditors, the policy implications for standard setting in auditing and the legal community, and the implications for auditing and managerial research.

5.1. Effect of Audit Arrangement on the Manager's Actions

Previous studies using a principal-multiple agents model [Antle, 1982; Baiman et al., 1987; Yoon, 1990] in the audit setting investigated interactions between owner, manager and auditor. These studies' major focus was directed towards investigating manager/auditor interactions. In particular, they identified and investigated the subgame problem in
which the manager and auditor play a strategy combination to improve their expected payoffs at the expense of the owner's.

In contrast, this study's main focus is investigating owner/auditor interactions, and the model is constructed so that manager/auditor interactions are minimized. Changing the model by assuming that the owner can punish the manager for overreporting the production outcome, the external auditor's choice of effort/assurance level (amount of competent and relevant evidence to be collected and examined) and accompanying effort level choice affects the manager's action choice in a predictable manner: a higher auditor effort choice is more likely to induce the manager to issue a truthful report than a lower auditor effort choice when overreporting is punishable.

As shown in chapter 4, the choice of arrangement affect the external auditor's effort choice which, in turn, may affect the manager's reporting choice. [Recall that the manager receives the low wage, \( I^H(Q) \), when the manager reports the high outcome and the external auditor issues a qualified report.] The effects of relaxing this assumption on the owner's audit arrangement choice is discussed next.

Suppose the owner can punish the manager for overreporting the production outcome. Then, in a sequential setting where the manager reports the production outcome before issuance of the external auditor's report, the manager reports the true production outcome whenever the probability that the inappropriate audit report has been issued equals zero. However, when there exists a probability that the inappropriate audit report may be issued the manager must be sufficiently punished to
not have an incentive to overreport; otherwise, the qualitative results reported in Chapter 4 apply.\textsuperscript{43}

5.2. Some Considerations Regarding the Task Division between Auditors

The analysis in Chapter 4 is based on the assumptions that the minimum proportion of total audit effort to be expended by the external auditor, $r$, is between zero and one, remains constant, and is common knowledge. Moreover, the model assumes that the external auditor reliance on another auditor's work is not affected by who employs the other auditor. This section looks at the effect of relaxing these assumptions on the optimal solution and the owner's welfare.

5.2.1. Minimum Procedures Level Unknown

When the external auditor has private information with regard to $r$, the owner might still benefit from having the internal auditor assist the external auditor.\textsuperscript{44} For example, if the legal system is ineffective in motivating the external auditor (Case 2) even when the external auditor does all the work, the owner benefits from having the internal auditor assist the external auditor. Proposition 7 provides the conditions under which the owner chooses the alternative arrangement.

\textsuperscript{43} To incorporate the effect of the external auditor's effort choice on the manager's actions, the probability of issuing the appropriate report, function $f$, can be replaced by a new function $f_1$ with $f_1(a) \geq f(a) \forall a$. Intuitively, all qualitative results obtained earlier apply to this new function.

\textsuperscript{44} Although professional standards are public, the owner may not know how the courts will apply those standards.
PROPOSITION 7: When the minimum procedures level \( r \) is private knowledge, the owner prefers having the internal auditor assist the external auditor whenever Case 2 conditions apply.

PROOF: The owner prefers having the internal auditor assist the external auditor whenever

\[
(63) \quad \left\{ \frac{[f'(a^*)g(a^*) - g'(a^*)[1 - f(a^*)]] \cdot \hat{\omega}}{(V^{'x}(a^*) \cdot [1 - E_\xi]} > 0 \right. 
\]

where \( E_\xi \) represents the owner's expectation of \( \xi \). This condition holds for Case 2 \( (a^* > a^c) \).

Q.E.D.

However, the desired effort level \( a^* \) depends on \( \xi \). Then, an additional cost is incurred whenever the owner chooses based on Case 2 conditions when, in fact, Case 1 conditions apply. That is, the owner is worse off whenever the internal auditor assists the external auditor and

\[
(64) \quad a^*|_r < a^c < a^*|_E_\xi. 
\]

The parameter values under which the owner prefers having the internal auditor assist the external auditor are setting specific and not investigated in this study.

From the comparative statics properties (Proposition 5) we know that the induced effort level \( (a) \) increases as the wealth at stake \( (\hat{\omega}) \) increases, the minimum procedures level \( (r) \) decreases, or the legal system's effectiveness \( (1 - g) \) increases. Accordingly, it appears likely that when \( \xi \) is not public, the owner is more likely to benefit from having the internal auditor assist the external auditor in cases where the investment outcome is high and/or the legal system's effectiveness is low, ceteris paribus.
5.2.2. Minimum Procedures Level Differentials

When the external auditor cannot rely on the internal auditor's work to the same extent as that of the junior auditor's, or

\[ r_{JA} < r_{IA}, \]

the owner does not obtain the desired effort/assurance level in any setting. As mentioned in Chapter 2, this setting occurs when the internal auditor's objectivity and/or competence level are in question and the external auditor reduces reliance on the internal auditor's work. In such settings, the external auditor increases his share of the total tasks to be performed which, in turn, may cause a reduction in the total effort/assurance level choice. Whether the owner can benefit from having the internal auditor assist the external auditor when reliance differentials exist depends on the specific parameter values.

PROPOSITION 8: Under a due care legal system, \( r_{JA} < r_{IA} \) implies

\[ U^O(a) < U^O(a^*). \]

PROOF: \( r_{JA} < r_{IA} \) raises the audit costs for the O-EA-IA arrangement because at each effort level

\[ r_{JA} \cdot V^{EA}(a) + [1 - r_{JA}] \cdot V^{JA}(a) < r_{IA} \cdot V^{EA}(a) + [1 - r_{IA}] \cdot V^{IA}(a). \]

Accordingly, the owner prefers a lower effort level for the EA-IA arrangement than for the EA-JA arrangement. The resulting welfare reduction has two components: (1) the higher cost curve decreases the owner's net benefits from auditing at each effort level and (2) the increase in the marginal audit cost curve at each insurance level results in a lower effort level which further decreases the owner's net benefits from auditing.

Q.E.D.
If reliance differentials are present, the owner may be better off by having another independent auditor assist the external auditor. The following corollary shows that engaging another (independent) auditor to assist the external auditor may improve the owner's welfare.

**COROLLARY:** When $x^{JA} < x^{IA}$, the owner prefers having another independent auditor assist the external auditor for Case 2. This result follows immediately from propositions 3 and 8. When the owner engages another independent auditor to assist the external auditor, the extent of reliance differential disappears and the earlier obtained results hold. In particular, since (from proposition 3)

\[(68) \quad a^* > a^c \implies U^O(a^c) < U^O(a),\]

the owner is always better off engaging another independent auditor in Case 2.

The comparative statics properties when the owner prefers using another independent auditor instead of the internal auditor are similar to those of proposition 6. In addition, when $x^{JA} < x^{IA}$, the owner's welfare improvement from choosing another independent auditor in place of the internal auditor increases with an increase in the extent of reliance difference; i.e.,

\[(69) \quad \partial U^O(a)/\partial (x^{IA} - x^{JA}) > 0.\]

5.2.3. **Fixed Minimum Procedures**

This subsection reviews the audit arrangement choice when the external auditor benefits from the internal auditor's work with a fixed amount of supervision. For example, the external auditor's (personal) cost of supervising another auditor's auditing of two or three divisions may not differ. This setting could be represented by a "kinked" audit
effort cost curve. The external auditor has the junior auditor audit the third division whenever the reduction in expected liability losses (benefit to the external auditor) exceed the increase in the junior auditor's wages (cost to the external auditor). However, when the owner pays for the internal auditor's wages, the external auditor has an incentive to assign the internal auditor the third division to audit even if the increase in the internal auditor's wages exceed the reduction in the expected liability losses.

The owner's best response in this setting is unaffected by the absence of variable supervisory costs. As in proposition 3, the owner first determines \( a^* \) and then chooses \( s^* \) where

\[
(70) \quad s^* = 1 - \frac{\exp'(a) - g'(a)}{V'(a)} \cdot \frac{\hat{w}}{1 - a - a^*}.
\]

Note that \( s^* < 1 \) whenever \( a^c < a^* \) but, unlike proposition 3 results, \( s^* > 0 \). That is, the owner should always deduct some portion of the internal auditor's wages from the external auditor's fee. Otherwise, the external auditor has an incentive to choose an effort level higher than needed to satisfy the owner (because expected liability costs decrease while personal effort costs do not change when \( x \) equals zero). Because this solution does not depend on the incurrence of (additional) personal costs by the external auditor, it holds for other contractual relationships (managerial settings) in which agents have control over costs but cannot be held fully accountable for the quality of the (productive) output.
5.3. **Implications of the Results**

Propositions 2 and 3 establish the circumstances in which the owner prefers to have the internal auditor assist the external auditor. In particular, whenever the legal system's probability of awarding damages in case of an audit failure is less than 1, the owner may benefit from having the internal auditor assist the external auditor. This welfare improvement is possible because the owner can motivate the external auditor to alter his effort/assurance level choice. The extent of the welfare improvement depends on the functional forms and parameter values of the setting. Propositions 4, 5, and 6 establish the effects of changes in the parameters of the problem setting on the owner's audit arrangement choice and welfare. Propositions 7 and 8 show that the owner may obtain welfare improvements even when the minimum procedures level is not known or when the external auditor cannot rely on the internal auditor's work to the same extent as that of the junior auditor's.

5.3.1. **Implications for Practice**

Because the external auditor's initial assessment of client-firm specific variables and the legal environment affects the nature and amount of evidence actually collected, client-firms may not receive the audit quality desired. This study derives conditions under which the firm obtains a lower than desired quality level. The study also shows that a client-firm desiring a higher quality service than currently received may obtain the higher quality service by having the internal auditor assist the external auditor and not deducting the full amount of the internal auditor's wages from the external auditor's negotiated fee.
A major result of the analysis shows that, by having the internal auditor assist the external auditor, client-firms now have a device with which they can manipulate the external auditor's effort/assurance choice (audit quality selection). As shown in Lemma 2, client-firms are unable to manipulate the effort choice by increasing the audit fee paid to the external auditor. Proposition 2 establishes, however, that client-firms can manipulate the effort/assurance choice by altering the structure of the agency relationship with the external auditor.

For internal auditors, the results suggest that objectivity and competence become increasingly important to the client-firm as it grows in size, as auditing standards permit increased reliance on the internal auditor by the external auditor, and/or as the legal system's effectiveness decreases. The increased importance of the internal auditor to the client-firm should invoke a greater willingness by a client-firm to support the professionalization of its internal auditing staff as well as promises opportunities for expanded internal auditor involvement in conducting the financial audit.

From society's perspective, the results suggest that facilitating client-firms in having the internal auditor assist the external auditor may mitigate the effects of an "imperfect" legal system. If the costs of changing the legal system and thereby the external auditor's liability increase litigation costs, then the creation of an environment conducive to internal auditor involvement may accomplish society's objective at a lower cost. Statement on Auditing Standards No.65 is a start in encouraging external auditors to accept internal auditor's work as a substitute for their own.
The model developed in this study is also useful in other managerial control settings where non-observability of the action is present and complete contracting is hampered by limited liability constraints. It should yield helpful insights for the study of optimal contractual relationships in sequential settings, such as the one analyzed in Suh [1987, 1988]. Managerial accounting textbooks hold out responsibility accounting as the correct approach to achieving goal congruence between the agent (manager) and owner (firm). Responsibility accounting is a system for evaluating individuals based on the activities under their supervision. As an aid to top management, responsibility accounting permits managers to delegate decision making to lower levels by assigning responsibility for action and establishing a way to evaluate performance. This section explores the model's implications for performance evaluation and compensation determination.

The results obtained in chapter 4 indicate that even when an agent (manager) has complete control regarding the costs of a project, it may not be in the owner's (firm's) best interest to use such costs in determining the agent's compensation. In effect, the results predict when and how the project's costs should be reflected in the agent's compensation. In particular, the results indicate the problem that can arise when the (quality of the) output is not observable before payment is made to the agent.

To illustrate the control problem created by having the internal auditor assist the external auditor, consider the incentive problem facing the owner in a sequential production setting. In this scenario, the assistant (internal auditor) can be viewed as the individual
receiving the financial report as input and applying certain procedures which require effort and affect the quality of the output (audit report). The assistant then forwards this higher quality intermediate product to the external auditor who, by supplying effort, may or may not increase the quality of the final product to the level desired by the firm. It is immediately evident from this setting that an effort averse external auditor has the incentive to induce the internal auditor to provide an intermediate product at the quality level which approaches or even exceeds the quality level desired by the firm (and its owner).

Suh [1987] analyzes a similar sequential setting in which an intermediate and final department are both involved in producing an output. Using a principal-agent model, Suh provides a justification for central headquarter's inclusion of the (noncontrollable) intermediate department's total cost in the final department manager's incentive structure. As a consequence, the final department manager does not have an incentive to induce the intermediate department manager to provide more effort than desired by central headquarters.

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45 Quality of the output refers to the probability that the appropriate report will be issued.

46 The owner's desired level is that level which the owner would choose if quality were verifiable (and thus contractible). The term "desired" will be used later to similarly denote first-best audit effort or assurance levels.

47 This application of the controllability concept falls under responsibility accounting in which costs are identified with persons who are assigned control of the costs. Suh's conclusion certainly applies also when the intermediate department manager is not a self-interested individual. In this case, even though collusion concerns disappear, the final department manager benefits from inducing the intermediate department manager to provide more effort than central headquarters.
In general, this study examines situations where the final department manager provides a lower (unobservable) quality product than central headquarters desires. In such cases, it may be optimal for central headquarters to not hold the final department manager responsible for controllable intermediate department costs in order to encourage additional effort input. Suh's model assumes that the quality of the output is fully reflected in the product's revenues which is jointly observed by the final division manager and central management and thus contractible. Specifically, the audit setting modeled in this study assumes that the quality of the audit report is not observed before the contract is settled and the external auditor is liable for any resulting losses only if found negligent. Then, it may be optimal for the owner to not hold the external auditor responsible for the internal auditor's wages in order to encourage a higher audit effort choice. In other words, contrary to Suh's results, holding the external auditor responsible for the internal auditor's costs (wages) may defeat the purpose of having the internal auditor assist the external auditor.

5.3.2. Implications for Research

As pointed out in the introduction, firms (and their owners) may be concerned with both the cost and the quality of the audit service received. The results obtained in chapter 4 indicate that client-firms cannot improve the quality of the audit service by increasing the negotiated audit fee to be paid to the external auditor. Instead,
client-firms may switch auditors in search for a higher quality service. The comparative statics properties suggest that firm growth, changes in supervisory standards, and changes in the legal system's effectiveness may initiate this search.

Consistent with DeAngelo [1981], the model assumes that agency costs vary across potential client-firms and perhaps over time for a given client. Differential agency costs across client-firms and over time for a given client imply a heterogeneous demand for audit services; i.e., differing levels of audit quality may be demanded. DeAngelo [1981] asserts that, as client-firms grow, they are more likely to switch from a non-Big Six to a Big Six auditor to obtain a higher quality audit. Subsequently, client size has been used as an independent variable in many audit fee and auditor switching studies. For example, Danos and Eichenseher [1986] find some empirical support for growing clients switching to larger audit firms. In contrast, Williams [1988] finds no empirical support for growing clients switching to larger audit firms. Williams specifically models changes in a firm's agency costs as three explanatory variables, two of which proxy for client growth. Haskins and Williams [1990] use change in sales revenues as a proxy for growth and litigation rate as a proxy for audit quality.

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48 This statement presumes the existence of differential disutilities for effort or liabilities among external auditors, although it may be that some auditors can diversify away these differences. The development of these considerations in a (more) dynamic model is beyond the scope of the study, and the statement does not contradict the static model presented in this paper as long as switching is costly to the firm.

49 In addition, auditor switches seem to be related to economies of scale [Simunic, 1980].
(following Palmrose [1988]) in a study of intra-Big Eight auditor changes. However, neither study considers the presence of an internal auditor assisting the external auditor as a potential factor in explaining auditor changes.

The results of this study indicate that having the internal auditor assist the external auditor may provide the client firm with an alternative to switching. Whenever the client-firm wants a higher quality service than it receives, it may be able to obtain this higher quality without switching to another audit firm by having the internal auditor assist the external auditor and not deduct the full amount of the internal auditor’s wages from the external auditor’s negotiated fee. This suggests that client-firms who have the internal auditor assist the external auditor are less likely to switch audit firms for the reason of obtaining a higher quality service. If it can be verified that having the internal auditor assist the external auditor leads to less switching, then the findings and interpretations of previous auditor switching studies may have to be reevaluated. As such, the current model may provide an additional step towards the development of a general theory of auditor changes.

At the most general level, the model addresses a case of centralized versus decentralized contracting. Melumad et al. [1989] compares delegated contracting to centralized contracting in a multiple agent setting where both agents have pre-contractual private information and concludes that delegated contracting generally entails a loss for the principal due to a distortion in the allocation of production between the two agents and the principal’s inability to make aggregate
production decisions dependent on any information about the second agent's costs.

In this study, contract complexity is constrained by the sequence of events and the limited liability imposed on the agents. The results of the analysis indicate that in settings which prevent the principal from achieving the first-best outcome, centralized contracting may be preferred to decentralized contracting. This suggests that, if subjected to similar constraints, some Melumad et al. [1989] settings will no longer belong to the set (of settings) in which decentralized contracting is preferred to centralized contracting.
6.6.1. **Summary**

This study suggests an economic rationale for the owner’s demand for having the internal auditor assist the external auditor in conducting the annual audit (EA-xA arrangement with \( s < 1 \)) and presents a framework for studying the determinants of the owner’s audit arrangement choice. Within this framework, the owner obtains potential welfare improvements as a result of reductions in agency costs.

This study uses a principal-agent model to explore the impact of having the internal auditor assist the external auditor in conducting the financial audit on the external auditor’s effort/assurance choice and the resulting welfare effects. The study provides an alternative economic rationale for this phenomenon by assuming that the wage differential between a junior auditor (employed by the audit firm) and an internal auditor (employed by the client-firm) is zero.

Specifically, by comparing audit arrangements, the study explores the potential for reducing agency costs arising within the contractual relationship between self-interested parties. The study adopts a model of external auditor effort/assurance choice which focuses on a decision-based demand for auditing. A decision-based demand for auditing arises from the owner’s (client-firm’s) need to rely on financial reports of the production outcome (for further investment decisions). Within this
framework, the study explores the effects of non-observability of the external auditor's effort choice and a due care legal system on the owner's demand for having the internal auditor assist the external auditor.

The study explicitly models the combination of limited liability and non-observable effort choice as the source of the agency cost in the owner-external auditor relationship. The external auditor's limited liability results in a suboptimal total audit effort choice which cannot be improved upon by paying the external auditor a higher audit fee but can be improved upon by having the internal auditor assist the external auditor.

The results obtained in a parametric analysis of the audit setting suggest that the owner's demand for having the internal auditor assist the external auditor arises from the legal system's less than perfect ability to motivate the external auditor to expend audit effort (i.e., to obtain the desired level of assurance) before issuing the audit report. The external auditor minimizes the sum of his expected utility for audit effort and expected liability losses. The main result states that when the legal system does not always award damages whenever an audit failure occurs -- i.e., allows the external auditor a due care defense or applies a statute of limitations, the owner might induce the desired effort level choice by having the internal auditor assist the external auditor and choosing the proportion of internal auditor wages to be deducted from the external auditor's fee. This result is significant because an alternative source of motivating audit effort
choice, auditor reputation, may be costly to the owner, which might prevent the owner from eliciting the desired audit effort.

The source of the potential welfare improvement is the increase in total audit effort under the alternative audit arrangement when the external auditor does not have to pay for all the internal auditor's wages. Intuitively, the external auditor assigns audit tasks to the junior auditor up to the point where his marginal disutility for having the junior auditor perform an additional task equals his marginal utility for its related reduction in expected litigation losses. Under the alternative arrangement, the external auditor assigns audit tasks to the internal auditor so that his marginal utility derived from having the internal auditor perform an additional task equals his marginal disutility for having to supervise the internal auditor's additional work. Then, whenever the external auditor's marginal disutility for supervising the internal auditor as he performs the additional task is lower than his marginal disutility for having the junior auditor perform the additional task, the alternative arrangement results in a higher audit effort choice and a higher welfare level for the client-firm (and its owner).

6.2. Limitations

Several limitations of the study must be recognized. An implicit assumption of the study is that the external auditor maintains (does not impair) his independence while relying on the work of the internal auditor. This assumption is not without loss of generality since the internal auditor is not independent from the entity being audited, and
it is not clear at what reliance level the external auditor's independence might become impaired. According to Yoon [1990], professional affiliation imposing due professional care and truthful reporting may be needed to ensure external auditor independence. In a similar vein, requiring professional affiliation for the internal auditor mitigates independence concerns which may arise when the internal auditor assists the external auditor in conducting the financial audit.

In addition, to gain insights into the determinants of the owner's audit arrangement choice, the study assumes that the manager chooses one of only two possible actions: high effort/unreliable reporting and low effort/reliable reporting, and further assumes that the probability of a high production outcome equals $\frac{1}{2}$ when the manager chooses a high effort and zero otherwise. Moreover, the study assumes an audit technology in which Type I and Type II errors occur with equal probability. These assumptions greatly facilitated the analysis in chapter 4 but are not very likely to hold in practice and make it unlikely that the magnitude of the actual effects can be predicted by this model.

Further, the legal system is assumed to be costless to avoid having to consider the impact of costly litigation on the incentives of the owner. If litigation were costly to the owner, the owner may choose to make less use of the legal system, effectively causing the external auditor to choose a lower effort level. On the other hand, if the legal system were costly to the external auditor (i.e., resulting in costs in addition to the damages awarded to the owner), then the external auditor
may choose a higher effort level -- perhaps even higher than the first-best level desired by the owner.

Another limitation is the single-period assumption. Ignoring multi-period effects such as reputation may overstate the potential welfare improvements to the owner. If reputation effects cause the external auditor to choose a higher level of effort/assurance -- which may be even higher than the first-best effort/assurance level -- then the owner benefits less or not at all from having the internal auditor assist the external auditor provided that reputation is costlessly available to the owner.

Finally, the study treats the junior auditor and the internal auditor as supervised agents, with effort observable and contractible, and thus ignores potential incentive problems arising in the relationship between the auditors. The next section suggests ways to address some of the current study's limitations in future research.

6.3. Extensions

Several extensions of this study are possible. First, as indicated above, the model can be enriched by incorporating multi-period effects (reputation). Future analysis may lead to testable implications regarding the interaction between the owner's demand for having the internal auditor assist the external auditor and the owner's demand for auditor reputation.

Second, as indicated in section 5.3., the model addresses a case of centralized versus decentralized contracting. The results of the analysis indicate that in certain principal-multiple agents settings
where limited liability prevents the principal from achieving the first-best outcome, centralized contracting is preferred to decentralized contracting. As an extension, future research can explore the generalization of this result.

Third, the empirical validity of the assumptions crucial in obtaining the results can be studied. For example, with respect to the legal system, do external auditors perceive the statute of limitations clause in the Securities Acts as useful protection? Do external auditors view the due care defense option in case of a recorded audit failure as useful? Answers to these questions help establish the validity of the model and its predictions.

Finally, several implications of the model (see chapter 5) can be tested. For example, with respect to quality concerns, do large client-firms, that have the internal auditor assist the external auditor, switch less frequently to a larger sized audit firm than large client-firms that don’t? Or, with respect to obtained quality, do client-firms that have the internal auditor assist the external auditor litigate less frequently than client-firms that don’t? Answers to these questions may provide helpful insight in guiding the development of new auditing standards. In particular, if the quality of audit services is affected by the choice of audit arrangement, more attention may be directed at facilitating or encouraging, perhaps via professional standards setting, the external auditor’s use of the internal auditor in conducting the audit procedures.
APPENDIX A

PROOFS OF LEMMAS AND PROPOSITIONS

PROOF OF LEMMA 1

Existence of the cutoff effort level $a^c$:

Let $a = a^c$ such that

\[(A1) \quad [1 - f(a^c)]' - [(1 - f(a^c))(1 - g(a^c))]' = 0\]

and suppose $a^c \in (0,1)$. Then

\[(A2) \quad g'(a)[1 - f(a)] - f'(a)g(a) > 0\]

or

\[(A3) \quad g'(a)[1 - f(a)] - f'(a)g(a) \leq 0 \quad \forall a \in (0,1).\]

By assumption, the court rules negligence whenever the external auditor obtains no assurance ($a = 0$) and rules no negligence whenever the external auditor obtains full assurance ($a = 1$). Formally,

\[(A4) \quad 1 - f(0) = (1 - f(0))(1 - g(0))\]

and

\[(A5) \quad 1 - f(1) = (1 - f(1))(1 - g(1)).\]

But (A2) and (A4) contradicts (A5), and similarly, (A3) and (A4) contradicts (A5). Therefore, $a^c \in (0,1)$.

Uniqueness of cutoff effort level $a^c$:

Consider the function

\[(A6) \quad F(a) = g'(a)[1 - f(a)] - f'(a)g(a).\]

Then $a^c$ is unique iff $F(a)$ is strictly increasing or decreasing on $(0,1)$. Suppose not, then $F'(a) = 0$ for some value of $a \in (0,1)$. 

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Differentiating (A6) with respect to $a$ provides

\[(A7) \quad F'(a) = g''(a)[1 - f(a)] + g'(a)[-f'(a)] - f''(a)g(a) - f'(a)g'(a) \\
- g''(a)[1 - f(a)] - f''(a)g(a) - 2f'(a)g'(a) \quad \forall a \in (0,1).
\]

Now suppose that

\[(A8) \quad g''(a)[1 - f(a)] - f''(a)g(a) > 0.
\]

Then, at no assurance (when $g(a) = 0$ by assumption),

\[(A9) \quad g''(a)[1 - f(a)] > f''(a)\cdot 0 \cdot 1 = 0.
\]

This provides a contradiction as $g''(\cdot) < 0$. Therefore,

\[(A10) \quad g''(a)[1 - f(a)] - f''(a)g(a) \leq 0
\]

and

\[(A11) \quad F'(a) = g''(a)[1 - f(a)] - f''(a)g(a) - 2f'(a)g'(a) < 0 \quad \forall a \in (0,1).
\]

Q.E.D.

**PROOF OF PROPOSITION 4**

Part (i):

From proposition 1 [equation (17)] and the proof of proposition 2 [equation (32)], $a^*$ and $a$ are the solution to

\[(A12) \quad \lambda \cdot V^{EA}(a) + [1 - \lambda] \cdot V^{ZA}(a) = -[1 - f(a)] \cdot \dot{\omega} - f'(a) \cdot \dot{\omega}.
\]

Differentiating equation (A12) with respect to $\dot{\omega}$ provides

\[(A13) \quad [\lambda \cdot V^{EA}(a) + [1 - \lambda] \cdot V^{ZA}(a)] \cdot \frac{\partial a}{\partial \dot{\omega}} = f'(a) + f''(a) \cdot \dot{\omega} \cdot \frac{\partial a}{\partial \dot{\omega}}.
\]

Since $[\lambda \cdot V^{EA}(a) + [1 - \lambda] \cdot V^{ZA}(a)] > 0$, $f'(a) > 0$, and $f''(a) \leq 0$ \forall $a$, it follows that

\[(A14) \quad \frac{\partial a^*}{\partial \dot{\omega}}, \frac{\partial a}{\partial \dot{\omega}} > 0.
\]
From Lemma 2 [equation (20)], \( a^o \) is the solution to

\[
(A15) \quad \xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) - f'(a)[1 - g] \cdot \hat{w}.
\]

Differentiating equation (A15) with respect to \( \hat{w} \) provides

\[
(A16) \quad \frac{\partial}{\partial \nu} \left[ \xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) \right] \cdot \frac{\partial a}{\partial \hat{w}} = \\
\quad f'(a)[1 - g] + f''(a)[1 - g] \cdot \hat{w} \cdot \frac{\partial a}{\partial \hat{w}}
\]

Since \( \xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) > 0, \)

\( f'(a)[1 - g] > 0, \) and

\( f''(a)[1 - g] \leq 0 \ \forall a, \)

it follows that

\[
(A17) \quad \frac{\partial a^o}{\partial \hat{w}} > 0.
\]

Part (ii):

Similarly, differentiating equations (A12) and (A15) with respect to \( \xi \) and rearranging terms provides

\[
(A18) \quad [\xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) - f''(a) \cdot \hat{w}] \cdot \frac{\partial a}{\partial \xi} = \nu^{JA}(a) - \nu^{EA}(a)
\]

and

\[
(A19) \quad [\xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) - f''(a)[1 - g] \cdot \hat{w}] \cdot \frac{\partial a}{\partial \xi} = \\
\quad \nu^{JA}(a) - \nu^{EA}(a).
\]

Since \( \xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) - f''(a) \cdot \hat{w} \geq 0 \)

\( \xi \cdot \nu^{EA}(a) + [1 - \xi] \cdot \nu^{JA}(a) - f''(a)[1 - g] \cdot \hat{w} > 0 \)

and, by assumption, \( \nu^{JA}(a) - \nu^{EA}(a) < 0, \) it follows that

\[
(A20) \quad \frac{\partial a^o}{\partial \xi}, \frac{\partial a}{\partial \xi}, \frac{\partial a^o}{\partial \xi} < 0.
\]
Part (iii):

Since g does not appear in the solution for \(a^*\), we have
\[ \frac{\partial a^*}{\partial g} = 0. \]  
(A21)

When \(0 \leq s^* < 1\), the principal can induce the desired effort/assurance level \(a^*\), and the above conclusion applies:
\[ \frac{\partial a}{\partial g} = 0. \]  
(A22)

However, when \(s^* < 0\) in order to induce \(a^*\), the principal's best response is to set \(s\) equal to 0 and the external auditor chooses \(a\) such that
\[ \xi \cdot V^{EA}(a) = f'(a)[1 - g] \cdot \hat{w}. \]  
(A23)

Differentiating equation (A23) with respect to \(g\) provides
\[ \xi \cdot V''^{EA}(a) \cdot \frac{\partial a}{\partial g} = f'(a)[-1] \cdot \hat{w} + [f''(a)[1 - g] \cdot \hat{w} \cdot \frac{\partial a}{\partial g}]. \]  
(A24)

Rearranging terms provides
\[ \xi \cdot V''^{EA}(a) - f''(a)[1 - g] \cdot \hat{w} \cdot \frac{\partial a}{\partial g} = -f'(a) \cdot \hat{w}. \]  
(A25)

Since \(\xi \cdot V''^{EA}(a) - f''(a)[1 - g] \cdot \hat{w} > 0\) and \(-f'(a) \cdot \hat{w} < 0\), it follows that
\[ \frac{\partial a}{\partial g} < 0. \]  
(A26)

When \(s\) equals 1, the external auditor chooses \(a^0\) such that
\[ \xi \cdot V^{EA}(a^0) + [1 - \xi] \cdot V^{JA}(a^0) = f'(a^0)[1 - g] \cdot \hat{w}. \]  
(A27)

Differentiating equation (A27) with respect to \(g\) provides
\[ \xi \cdot V''^{EA}(a^0) + [1 - \xi] \cdot V''^{JA}(a^0) \cdot \frac{\partial a^0}{\partial g} = f'(a^0)[-1] \cdot \hat{w} + [f''(a^0)[1 - g] \cdot \hat{w} \cdot \frac{\partial a^0}{\partial g}. \]  
(A28)
Since \( \chi \cdot V'' \alpha \) + \( [1 - \chi] \cdot V'' \alpha \) - \( f''(a)[1 - g] \cdot \dot{w} > 0 \)
and \( -f'(a) \cdot \dot{w} < 0 \), it follows that

\[
\frac{\partial s}{\partial g} < 0 .
\]

Part (iv):

From proposition 2 [equation (28)],

\[
(A30) \quad s^* = 1 - \frac{f'(a) \cdot g \cdot \dot{w}}{V'' \alpha [1 - \chi]} | a - \alpha^* .
\]

Differentiating equation (A30) with respect to \( \dot{w} \) and rearranging terms provides

\[
(A31) \quad \frac{\partial s}{\partial \dot{w}} = -\frac{f''(a) \cdot g \cdot \dot{w} \cdot \partial a / \partial \dot{w} + f'(a) \cdot g}{V'' \alpha [1 - \chi]}
\]

Since \( f''(a) \cdot g \cdot \dot{w} \cdot \partial a / \partial \dot{w} < 0 \) and \( f'(a) \cdot g > 0 \), it follows that

\[
(A32) \quad \frac{\partial s}{\partial \dot{w}} < 0 .
\]

Differentiating equation (A30) with respect to \( \chi \) provides

\[
(A33) \quad \frac{\partial s}{\partial \chi} = -\frac{f''(a) \partial a / \partial \chi \cdot [1 - \chi] + f'(a) \cdot g \cdot \dot{w}}{V'' \alpha [1 - \chi]^2}
\]

Since \( f''(a) \partial a / \partial \chi \cdot [1 - \chi] + f'(a) \cdot g \cdot \dot{w} > 0 \) and \( f'(a) \cdot g > 0 \), it follows that

\[
(A34) \quad \frac{\partial s}{\partial \chi} < 0 .
\]

Differentiating equation (A30) with respect to \( g \) provides

\[
(A35) \quad \frac{\partial s}{\partial g} = -\frac{f''(a) \partial a / \partial g \cdot g + f'(a) \cdot \dot{w}}{V'' \alpha [1 - \chi]}
\]

Since \( 0 < s^* < 1 \Rightarrow \partial a / \partial g = 0 \) (see proof in part (iii), it follows that

\[
(A36) \quad \frac{\partial s}{\partial g} < 0 .
\]
Part (v):

The principal’s net benefit of auditing ($U^0$) can be represented by

\( U^0(a) = f(a) \cdot \hat{w} - [\lambda \cdot V^E(a) + (1 - \lambda) \cdot V^X(a) + V^E + V^X] \).

Differentiating equation (A37) with respect to $\hat{w}$ provides

\( \frac{\partial U^0(a)}{\partial \hat{w}} = f(a) + [f'(a) - \lambda \cdot V^E(a) - (1 - \lambda) \cdot V^X(a)] \cdot \frac{\partial a}{\partial \hat{w}}. \)

Since $a \leq a^*$ implies $[f'(a) - \lambda \cdot V^E(a) - (1 - \lambda) \cdot V^X(a)] \cdot \frac{\partial a}{\partial \hat{w}} \geq 0$, it follows that

\( \frac{\partial U^0(a)}{\partial \hat{w}} > 0. \)

Differentiating equation (A37) with respect to $\lambda$ provides

\( \frac{\partial U^0(a)}{\partial \lambda} = [f'(a) \cdot \hat{w} - V^E(a) - V^X(a)] \cdot \frac{\partial a}{\partial \lambda} - [V^E(a) - V^X(a)]. \)

Since $a \leq a^*$ implies $[f'(a) \cdot \hat{w} - V^E(a) - V^X(a)] \geq 0$, and since $\frac{\partial a}{\partial \lambda} < 0$ and $[V^E(a) - V^X(a)] < 0$, it follows that

\( \frac{\partial U^0(a)}{\partial \lambda} < 0. \)

Differentiating equation (A37) with respect to $g$ provides

\( \frac{\partial U^0(a)}{\partial g} = [f'(a) \cdot \hat{w} - (1 - \lambda) \cdot V^X(a)] \cdot \frac{\partial a}{\partial g}. \)

Since $a < a^*$ implies $f'(a) \cdot \hat{w} > (1 - \lambda) \cdot V^X(a)$ and $\frac{\partial a}{\partial g} < 0$, while $a = a^*$ implies $f'(a) \cdot \hat{w} = (1 - \lambda) \cdot V^X(a)$, it follows that

\( \frac{\partial U^0(a)}{\partial g} \leq 0. \)

Q.E.D.
PROOF OF PROPOSITION 5

Part (i):

The cutoff effort/assurance level \( a^c \) is the solution to (see lemma 3)

\[(A44) \quad g'(a^c)[1 - f(a^c)] - f'(a^c)g'(a^c) = 0 \, .\]

Differentiating equation (A44) with respect to \( \dot{\omega} \) provides

\[(A45) \quad [g''(a^c)[1 - f(a^c)] - f''(a^c)g(a^c) - 2f'(a^c)g'(a^c)] \cdot \partial a^c / \partial \dot{\omega} = 0 \, .\]

Since \( g''(a)[1 - f(a)] + f''(a)g(a) < 0 \forall a \in (0,1) \) (see proof of lemma 3), it follows that

\[(A46) \quad \partial a^c / \partial \dot{\omega} = 0 \, .\]

Similarly, differentiating equation (A44) with respect to \( r \) provides

\[(A47) \quad \partial a^c / \partial r = 0 \, .\]

Differentiating equation (A44) with respect to \( g(a) \) provides

\[(A48) \quad [g''(a^c)[1 - f(a^c)] - f'(a^c)g'(a^c) - f''(a^c)g(a^c)] \cdot \partial a^c / \partial g = f'(a^c) \, .\]

Since \( g''(a)[1 - f(a)] - f'(a)g'(a) + f''(a)g(a) < 0 \forall a \in (0,1) \) (see proof of lemma 3), it follows that

\[(A49) \quad \partial a^c / \partial g(a) < 0 \, .\]

Part (ii):

\( a^* \leq a^c \) implies that \( s = 1 \) and \( a = a^0 \) which the external auditor chose by solving (see lemma 2)
Differentiating equation (A50) with respect to \( \dot{w} \) and \( \bar{\lambda} \) provides
\[
\frac{\partial a}{\partial \dot{w}} > 0 \quad \text{and} \quad \frac{\partial a}{\partial \bar{\lambda}} < 0\
\]
similar to the results in proposition 4, parts (i) and (ii).

Differentiating equation (A50) with respect to \( g(a) \) provides
\[
\frac{\partial a}{\partial g(a)} < 0.
\]

Part (iii):
Since the principal chooses \( s = 1 \) whenever \( a^* < a_c \), it follows that
\[
\frac{\partial s}{\partial \dot{w}} = \frac{\partial s}{\partial \bar{\lambda}} = \frac{\partial s}{\partial g(a)} = 0.
\]

Part (iv):
Similar to proof of proposition 4, part (v) except that
\[
U^0(a) - U^0(a_c) < U^0(a^*)
\]
with the result that
\[
\frac{\partial U^0(a)}{\partial g(a)} < 0.
\]

Part (v):
Similar to proof of part (ii) except that
\[
\frac{\partial a}{\partial g(a)} = 0 \quad \text{whenever} \quad 0 < s^* < 1.
\]
Hence
\[
\frac{\partial a}{\partial g(a)} \leq 0.
\]
Part (vi):

For \( a^* > a^c \), proposition 3 [equation (39)] provides

\[
(A59) \quad s^* = 1 - \frac{[f'(a) \cdot g(a) - g'(a) \cdot [1 - f(a)]] \cdot \dot{w}}{V'IA(a) \cdot [1 - \xi]} \bigg|_{a = a^*}
\]

Differentiating equation (A59) with respect to \( \dot{w} \) provides

\[
(A60) \quad \frac{\partial s}{\partial \dot{w}} = \left\{ [g''[1 - f] - 2f'g' - f"g] \cdot \dot{w} \cdot \partial a / \partial \dot{w} - \right.
\]
\[
\left. [f'g - g'(1 - f)] / (V'IA \cdot [1 - r]) \right\}
\]

Since \( g''[1 - f] - 2f'g' - f"g < 0 \) (see proof of lemma 3) and \( f'g - g'(1 - f) > 0 \) (whenever \( a^* > a^c \)), it follows that

\[
(A61) \quad \frac{\partial s}{\partial \dot{w}} < 0 .
\]

Similarly, differentiating equation (A59) with respect to \( r \) provides

\[
(A62) \quad \frac{\partial s}{\partial r} = -\left\{ [g''[1 - f] - 2f'g' - f"g] \cdot \dot{w} \cdot \partial a / \partial r \cdot [1 - \xi] - \\
\left. [f'g - g'(1 - f)] / (V'IA \cdot [1 - r]^2) \right\}
\]

Since \( \partial a / \partial r < 0 \), it follows that

\[
(A63) \quad \frac{\partial s}{\partial r} \leq 0 .
\]

Differentiating equation (A59) with respect to \( g(a) \) provides

\[
(A64) \quad \frac{\partial s}{\partial g(a)} = \left\{ [g''[1 - f] - 2f'g'] \cdot \partial a / \partial g - f' \right\} \cdot \dot{w} / (V'IA \cdot [1 - r]) .
\]

Since \( \partial a / \partial g(a) = 0 \) whenever \( 0 < s^* < 1 \) [see proof of proposition 4, part (iii)], it follows that

\[
(A65) \quad \frac{\partial s}{\partial g(a)} \leq 0 .
\]
Part (vii):

Similar to the proof of proposition 4, part (v) except that $g$ is replaced by $g(a)$.

Q.E.D.

**PROOF OF PROPOSITION 6:**

The welfare difference between the two contractual arrangements is formalized in equation (A66).

\[(A66) \quad U^o(a) - U^o(a^o) = [f(a) - f(a^o)] \cdot \hat{w} - \]

\[\xi \cdot [V^{Ea}(a) - V^{Ea}(a^o)] - [1 - \xi] \cdot [V^{xa}(a) - V^{xa}(a^o)] \]

Differentiating equation (A66) with respect to $\hat{w}$ provides

\[(A67) \quad \partial \left( U^o(a) - U^o(a^o) \right) / \partial \hat{w} = f(a) - f(a^o) + [f'(a) - f'(a^o)] \cdot \partial a / \partial \hat{w} - \\
\xi \cdot [V^{Ea}(a) - V^{Ea}(a^o) + [1 - \xi] \cdot [V^{xa}(a) - V^{xa}(a^o)] \cdot \partial a / \partial \hat{w} .

\]

Since $a^o < a < a^*$ implies that

\[(A68) \quad [f'(a) - f'(a^o)] \cdot \hat{w} \geq \xi \cdot [V^{Ea}(a) - V^{Ea}(a^o) + [1 - \xi] \cdot [V^{xa}(a) - V^{xa}(a^o)],

it follows that

\[(A69) \quad \partial \left( U^o(a) - U^o(a^o) \right) / \partial \hat{w} > 0 .

Differentiating equation (A66) with respect to $\xi$ provides

\[(A70) \quad \partial \left( U^o(a) - U^o(a^o) \right) / \partial \xi = \\
- \quad [V^{Ea}(a) + V^{Ea}(a^o) + V^{xa}(a) - V^{xa}(a^o) + [(f'(a) - f'(a^o)] \cdot \hat{w} - \\
(\xi \cdot [V^{Ea}(a) - V^{Ea}(a^o)] + [1 - \xi] \cdot [V^{xa}(a) - V^{xa}(a^o)]) \cdot \partial a / \partial \xi .
\]
Since $\frac{\partial a}{\partial X} < 0$, and $a^o < a \Rightarrow -V^{EA}(a) + V^{EA}(a^o) + V^{XA}(a) - V^{XA}(a^o) < 0$, it follows that

\begin{equation}
(A71) \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial X} < 0.
\end{equation}

Differentiating equation (A66) with respect to $g(a)$ provides

\begin{equation}
(A72) \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g} = \left[ f'(a) \cdot \frac{\partial a}{\partial g} - f'(a^o) \cdot \frac{\partial a^o}{\partial g} \right] \cdot \hat{w} - \\
X \cdot [V^{EA}(a) \cdot \frac{\partial a}{\partial g} - V^{EA}(a^o) \cdot \frac{\partial a^o}{\partial g}] - \\
\left[ 1 - \tau \right] \cdot [V^{xA}(a) \cdot \frac{\partial a}{\partial g} - V^{xA}(a^o) \cdot \frac{\partial a^o}{\partial g}].
\end{equation}

When considering the effects of changes in the legal system's effectiveness on changes in the net benefit differential between the arrangements, three cases must be considered. In Case 1, the principal chooses $s$ equal to 1 whenever $a^* < a^c$ (and/or $x = 0$), and the external auditor chooses $a = a^o$. It follows that $a^* < a^c$ implies that

\begin{equation}
(A73) \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g} < 0.
\end{equation}

In Case 2A, the principal chooses $s = s* \in [0,1]$ whenever $a^c < a^*$ (and $x \neq 0$). Then $\frac{\partial a}{\partial g} = 0$ while $\frac{\partial a^o}{\partial g} < 0$. This provides

\begin{equation}
(A74) \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g} = \\
\left[ - f'(a^o) \cdot \hat{w} + \tau \cdot V^{EA}(a^o) + \left[ 1 - \tau \right] \cdot V^{XA}(a^o) \right] \cdot \frac{\partial a^o}{\partial g}.
\end{equation}

Since $a^o < a^*$ implies that $-f'(a^o) \cdot \hat{w} + \tau \cdot V^{EA}(a^o) + \left[ 1 - \tau \right] \cdot V^{XA}(a^o) < 0$, it follows that

\begin{equation}
(A75) \quad \frac{\partial [U^o(a) - U^o(a^o)]}{\partial g} > 0.
\end{equation}

In Case 2B, the principal chooses $s = 0$ whenever $s^* < 0$. Then $\frac{\partial a}{\partial g} < 0$ and $\frac{\partial a^o}{\partial g} < 0$. This provides
Rearranging equations (A24) and (A28) [from the proof of proposition 4, part (iii)] provides

\[ (A77) \frac{\partial a}{\partial g} = -\frac{-f'(a) \cdot \dot{\omega}}{\dot{\xi} \cdot V''_{EA}(a) - f''(a)[1 - g] \cdot \dot{\omega}} \]

and

\[ (A78) \frac{\partial a^0}{\partial g} = -\frac{-f'(a) \cdot \dot{\omega}}{\dot{\xi} \cdot V''_{EA}(a) + [1 - \dot{\xi}] \cdot V''_{EA}(a) - f''(a)[1 - g] \cdot \dot{\omega}} \]

Therefore, \( \frac{\partial a}{\partial g} < \frac{\partial a^0}{\partial g} \) and it follows that

\[ (A79) \frac{\partial [U^0(a) - U^0(a^0)]}{\partial g} < 0 . \]

Q.E.D.
APPENDIX B

EXAMPLE SUMMARY

Assumptions:
0 ≤ a ≤ 1 
V^{EA}(a) = a  
V^{EA}(a) = \frac{1}{4}a
f(a) = 2a - a^2  
U^{EA} = .01
\hat{w} = 1  
U^{IA} = 0
\xi = 1/5;  
s \in [0,1]

Settings:

a - observable action; EA-xA  
b - unobservable action; EA-JA: s = 1.000 - s^*
\hat{w} - value at stake
\xi - minimum procedures level

Outcome sets:

\begin{array}{lcc}
\text{a} & \text{b} & \text{c} & \text{d} \\
\hline
a & .700 & .553 & .742 & .700 \\
AO & .457 & .431 & .472 & .457 \\
U^0 & .480 & .458 & .478 & .480 \\
\end{array}

Legend:

a - effort/assurance choice 
\hat{f} - probability of issuing the appropriate report 
\hat{g} - probability of a no-negligence ruling 
\hat{w} - wealth at stake 
V - disutility for effort 
\hat{U} - reservation utility 
\xi - minimum procedures level 
s - IA wages sharing ratio 
AO - expected audit outlay (fee transfer from principal to auditors) 
U^0 - expected net benefit to principal (value of auditing)
Computations:

Outcome set a:

The first-best effort level $a^*$ is the solution to [see proposition 1, equation (17)]

$$v^* E A (a^*) + [1 - v] \cdot v^* A (a^*) = f'(a^*) \cdot \hat{w}$$

(B1)

Substituting the example parameter values in equation (B1) gives

$$a^* = .7$$

(B2)

The audit outlay, the sum of the audit fee paid to the auditor and the wages paid to the assistant, is

$$A O (a, s) = I^E A (s) + [1 - s] \cdot I^A (a, \lambda) \forall s$$

(B3)

where [from equation (18)]

$$I^E A (s) = v^* E A (a^*) + s \cdot I^A (a^*, \lambda) + [1 - f(a^*)] \cdot [1 - g(a^*)] \cdot \hat{w} + U^E A$$

and [from equation (19)]

$$I^A (a^*, \lambda) = [1 - \lambda] \cdot v^* A (a^*) + U^A$$

(B4)

(B5)

Because $s$ is not a factor when total effort is observable (see proposition 1), we can restate equation (B3) and substitute the example parameters values and $a^*$ to get

$$AO(a^*) = I^E A + I^A (a^*, \lambda)$$

$$= .457$$

(B6)

From proposition 1, the value of the owner's objective function in the first-best outcome is represented by

$$_0 (a^*) = [f(a^*) + [1 - f(a^*)] \cdot [1 - g(a^*)]] \cdot \hat{w} - AO(a^*) + B$$

(B7)

Substituting the example parameter values, $a^*$, and $AO(a^*)$ obtains

$$U^0 (a^*) = .480$$

(B8)
Outcome set b:

When effort is not observable, the external auditor chooses $a$ in the EA-JA arrangement according to Lemma 2 [equation (20)]

$\xi V^{EA}(a^n) + [1 - \xi] V^{JA}(a^n)$

$= [f'(a^n) + g'(a^n) - f(a^n)g(a^n) - f(a^n)g'(a^n)] \hat{w}$

$= f'(a^n)[1 - g(a^n)] + g'(a^n)[1 - f(a^n)].$

Substituting the example parameter values in equation (B9) obtains

$\hat{a} = .553.$

In the EA-JA arrangement, the owner pays the external auditor who, in turn, pays the junior auditor. Therefore, the audit outlay ($A_0$) in the EA-JA arrangement is equal to the audit fee; i.e.,

$A_0(a^n) = 1^{EA}$

where [from equation (23)]

$1^{EA} = \xi V^{EA}(a^n) + [1 - \xi] V^{JA}(a^n) + [1 - f(a^n)] [1 - g(a^n)] \hat{w} + \hat{\bar{U}}^{EA}.$

Substituting the example parameter values and $a^n$ in equation (B12) gives

$\bar{A}_0(a^n) = .431.$

Notice that $A_0(a^*) > A_0(a^n).$ This is due to the difference in expected liability costs at the specific audit effort levels. However, even though the audit outlay at the time of contract settlement is less than under the first-best outcome, the owner is strictly worse off overall as is revealed by the value of the objective function.

From Lemma 2, the value of the owner's objective function in the EA-JA arrangement is represented by
\[(B14) \quad U^O(a^o) = [f(a^o) + [1 - f(a^o)] \cdot [1 - g(a^o)]] \cdot \hat{w} - A_0(a^o) + B \]

Substituting the example parameter values, \(a^o\), and \(A_0(a^o)\) into the above equation (B14) gives

\[(B15) \quad U^O(a^o) = .458.\]

**Outcome set c:**

When the owner has the internal auditor assist the external auditor without deducting any internal auditor's wages from the audit fee, the external auditor chooses total effort level \(a = a^f\) such that [from lemma 2, equation (20)]

\[(B16) \quad \xi \cdot V_{Ea}(a^f) = [f'(a^f) + g'(a^f) - f'(a^f)g(a^f) - f(a^f)g'(a^f)] \cdot \hat{w}.\]

Substituting the example parameter values into equation (B16) gives

\[(B17) \quad a^f = .742.\]

When the owner doesn't deduct any of the internal auditor's wages from the external auditor's fee, the audit outlay is the sum of the audit fee and the internal auditor's wages; i.e.,

\[(B18) \quad A_0(a^f) = I_{Ea} + I_{Ia}(a^f, \xi)\]

\[= .472.\]

The value of the owner's objective function is

\[(B19) \quad U^O(a^f) = [f(a^f) + [1 - f(a^f)] \cdot [1 - g(a^f)]] \cdot \hat{w} - A_0(a^f) + B\]

\[= .478.\]
Outcome set d:

When the owner has the internal auditor assist the external auditor and deducts a proportion of the internal auditor wages from the audit fee, the external auditor chooses the total effort level \( a \) by solving [from proposition 3, equation (36)]

\[
(B20) \quad \xi \cdot V^{\text{EA}}(a) + s \cdot (1 - \xi) \cdot V^{\text{IA}}(a) = \\
\quad [f'(a) \cdot (1 - g(a)) + g'(a) \cdot (1 - f(a))] \cdot \hat{\omega} ;
\]

where the owner has determined \( s \) from solving [equation (39)]

\[
(B21) \quad s^* = \frac{[f'(a) \cdot g(a) - g'(a) \cdot (1 - f(a))] \cdot \hat{\omega}}{V^{\text{IA}}(a) \cdot (1 - \xi)} ;
\]

Substituting the example parameter values and \( a^* \) obtains

\[
(B22) \quad s - s^* = .175
\]

and the external auditor chooses audit effort level

\[
(B23) \quad a = .7 .
\]

When the owner has the internal auditor assist the external auditor and deduct a proportion of the internal auditor's wages from the audit fee, the total audit outlay is

\[
(B24) \quad AO(a,s) = I^{\text{EA}}(s) + [1 - s] \cdot I^{\text{IA}}(a,\xi) \\
\quad = .457 ,
\]

and the value of the owner's objective function is

\[
(B25) \quad U^O(a) = [f(a) + (1 - f(a)) \cdot (1 - g(a))] \cdot \hat{\omega} - AO(a,s) + B \\
\quad = .480 .
\]
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