ON THE RELATIONSHIP BETWEEN AUDIT RISK AND SECURITY MARKET MEASURES OF RISK

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ABSTRACT

This research investigates the relationship between security market measures of risk and audit risk. The auditor's decision making environment is extended to include the actions of the client firm's shareholders. Using the Nash equilibrium concept it is shown that, in equilibrium, the expected costs of auditing increase with the probability of a "bad" outcome in the securities markets. This result obtains in both strict liability and negligence regimes. The result is driven, in part by the insurance role of auditing. In empirical tests an association is established between security risk and audit fees. These tests suggest that security market measures of risk may provide information useful to the auditor in his decision making.

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Chapter 1

INTRODUCTION AND LITERATURE REVIEW

Introduction

The purpose of this research is to investigate the relationship between the risk faced by auditors in providing audit services to client firms and the risk faced by the shareholders of those firms. The existence of a relationship is of interest since the theory of finance indicates how information from security markets can be used to provide measures of the risk faced by shareholders. This research is concerned with how auditors might use this information to help them assess audit risk.

The main idea is to investigate the hypothesis that: Security Market Returns (SMR) can provide information useful to the auditor in assessing risk. For such a hypothesis to be true a logical connection between shareholder risk and auditor risk must be established. The linking of the two types of risk is plausible since, on the one hand, it is well established that the systematic and residual components of the variance of a firm's security returns (in a CAPM mean-variance world) are affected by the business and financial risk of the firm and, on the other hand, it also seems plausible to conjecture that audit risk would be affected by the client firm's business and financial risk[1]. Of particular interest is how the fortunes of shareholders and auditors are likely to be linked in an economy where legal liability rules allow shareholders who incur losses to take actions which could result in post audit losses to auditors.

The remainder of the current chapter reviews the relevant literature. Chapter 2 describes the auditing environment and sets up the auditor's decision model. Chapter 3 models the effect of risk in an environment where the auditor and shareholders oppose one another in a non-cooperative game. Chapter 4 derives empirical hypotheses about the use of market risk measures in the competitive pricing of audit services and provides tests of the hypotheses. Chapter 5 summarizes and concludes the research.

Literature Review

The literature review covers several topics which are germane to this research. They are: a definition of audit

[1] One type of auditing problem which suggests a linkage between the business risk of the client firm and audit risk occurs whenever the auditor must assign a value to an account balance which is contingent upon the realization of future cash flows. For example, consider the case where business risk is the result of stochastic demand for the client firm's product. In such a case it seems reasonable to infer a relationship between, say, increased variance in the process generating demand and *ceteris paribus* an increased probability that the value assigned to inventories will differ from the *ex post* realized value of the inventories by an amount which exceeds a fixed level of materiality.

risk, the decision theory approach to the auditor's decision problem, auditor's legal liability, and the utilization of risk measures in empirical research in auditing.

Definition of Audit Risk

It has long been recognized by the auditing profession that the auditing activity takes place in an environment of risk. Risk is typically categorized as either audit risk or business risk. Audit risk has been defined as:

> ... the risk that the auditor may unknowingly fail to appropriately modify his opinion on financial statements that are materially misstated. (SAS No. 47 AICPA 1983 para. 2)

In order to operationalize audit risk it has been decomposed into various components. Elliot and Rogers (1972) started by relating the auditor's objectives to two hypotheses. The first is that an account balance shown on the auditee's financial statement is correct. The alternative hypothesis is that the amount is materially in error. They go on to distinguish the two types of errors which can occur in the context of a statistical sampling problem and associate a risk measure with each. α risk is defined to be the probability that the auditor will reject a correct (within the bounds of materiality) account balance, i.e., commit a type I error. β risk is analogously defined to be the probability that the auditor will accept an account balance which is materially in error, i.e., commit a type II error. They conclude it is more critical for the auditor to control β

risk. They further suggest that the choice of the level of the β risk be set in response to the level of reliance the auditor can assign to other auditing procedures.

The AICPA (1981) proposed the following risk model.

$$UR = IC \times AR \times TD$$

where:

UR = ultimate risk, the risk of an undetected material error,

IC = internal control risk, risk of the internal control system failing to detect a material error,

AR = analytical review risk, the risk that analytical review will not detect a material error,

TD = substantive test of details risk, the risk that substantive tests will not detect a material error.

It is the ultimate or joint risk which the auditor attempts to control. The CICA (1980) proposed a similar risk model. Unfortunately, lacking from both of these models is an explicit linkage to the costs of auditing errors.

In the professional literature a linkage between β risk and audit errors is noted by Brumfield, Elliot, and Jacobsen (1983). They point out that audit risk can translate into business risk for the auditor. In their usage business risk is the damage to the auditor's practice which is the result of litigation, sanctions, and loss of reputation due to audit failures. They also note that the connection between audit risk and business risk is through common factors which influence both the inherent risk (such as the performance of the economy) of the audit and business risk.

Further discussions of audit risk can be found in Cushing and Loebbecke (1983) and Moore and Thornton (1987). The latter reference is of particular interest since it develops a model which relates the auditee's business and audit risk to the quantity and quality of auditing purchased.

Auditor Decision Models

Scott (1973) proposed the application of Bayesian statistical decision theory to the auditor's problem of asset valuation and audit design. In his model the auditor must assess a loss function, typically derived from the net benefits of the audit to users, in order to determine how much auditing to perform and what valuation to report. Conceptually the advantage of this approach is that it incorporates a measure of the benefits from auditing which can be compared with the costs, thereby allowing for the endogenous choice of optimal decision variables. In this type of model the auditor is described as a rational economic agent. This greatly adds to the credibility of normative analysis, which prescribes one type of behavior or another to the auditor[2]. One practical

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[2] For example, in terms of economic modelling it is appealing to have the choice of the quantity of auditing and the levels of α and β risk determined endogenously in response to the costs and benefits faced by the auditor.

difficulty in this approach is that financial statements are used by many different parties, making it unlikely that there exists a single loss function which can be used to derive socially optimal results.

Scott points out that auditor's legal liability implies that the loss function is asymmetric, because legal liability typically allows recovery only for actual losses. In a subsequent paper Scott (1975) investigates how the auditor's loss function is derived from the use shareholders make of financial statements in making consumption-investment decisions. The innovation in this line of research is that it formally links the production of audits with the factors that determine the demand for auditing and therefore enables the research to address issues of social welfare incorporated in the institutional structure of auditing.

Kinney (1975) gives an account of the use of decision theory in determining optimal sampling in auditing. He sets up a model in which the auditor assigns costs to both incremental audit production and to each type of audit error. In the decision theory approach, the auditor gives explicit consideration to his prior beliefs about the state that describes the financial statements of the client (i.e., whether or not they contain material errors). The auditor uses these beliefs to endogenously determine a cost minimizing level of α and β risk as well as an optimal decision rule and audit size. This is in contrast to the traditional approach (such as Elliot and Rogers', where the probabilities of the two types of auditing errors are set in response to the auditor's assessment of the effectiveness of the internal control system. Kinney goes on to show, through simulation, how the cost parameters effect the optimal choice of the auditor's decision variables.

Further reviews of the literature related to auditor decision making can be found in either Felix and Kinney (1982) or Scott (1984).

Auditor's Legal Liability

In the decision theory approach an important factor in the choice of the optimal values for auditing decision variables is the assessment of the cost of a type II error. One of the primary contributors to this cost is the auditor's potential for legal liability when such an error occurs. It has been pointed out (Antle 1982) that auditors may be forced to bear risks through liability not only to assure the quality of the information they produce, but also as a facet of an optimal risk-sharing contract. This section provides some institutional details describing the auditor's exposure to legal liability.

Of particular interest in this thesis is the mechanism by which auditors may suffer *ex post* redistributions of wealth[3] based upon legal claims of inadequate audit quality. Legal liability is recognized as a prominent cause of risk in the current auditing environment. (See, for example, Collins (1985).)

The main issues to be reviewed are: under what circumstances are auditors legally liable? to whom is the auditor liable? and for what measure of damages is he potentially responsible?

Claims are often brought against auditors in the common law of torts for negligent misrepresentation or pursuant to the civil liability provisions of the securities regulations, especially Section 11 of the Securities Act[4] and

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[3] An auditor's reputation is another area where losses are potentially large. Unfortunately, reputation is difficult to quantify and there are few rigorous models of how reputations are developed and maintained. Dopuch and Simunic (1982) suggest that the auditor's credibility is affected by lawsuits since they are among the few observable characteristics correlated with audit quality.

In Simunic and Stein (1987) it was assumed that the auditor can invest in a reputation, say, for quality as a means of differentiating his product in an effort to obtain economic rents. While it is difficult to measure the value of an auditor's reputation, if changes in the reputation affect the demand for the auditor's services then reputation can be equated with his future stream of cash flows. Thus, changes in reputation are potentially an important source of audit risk, though they are not dealt with explicitly in this paper.

Palmrose (1988) provides evidence that non-Big Eight accounting firms had a higher incidence of litigation during the period 1960 - 1985 than Big Eight firms. This supports the claim that Big Eight firms may be quality differentiated. If, as seems likely, quality and reputation are associated with one another by accounting consumers, then lawsuits may be an important determinant of the value of an auditor's reputation.

[4] 15 U.S.C. §§77k

Rule 10(b)[5] under the Securities Exchange Act[6]. In torts brought for deceit five elements have emerged[7]:

1. A false representation
2. Knowledge or belief that the representation is false
3. Intention to induce reliance based upon the misrepresentation
4. Justifiable reliance upon the representation
5. Damages resulting from that reliance.

In the history of auditors' legal liability the critical element has been the third point, which has been interpreted as requiring either actual or constructive fraud for the existence of liability to a third party not in privity to the auditor[8]. Recently this requirement has been eroded as courts have expanded the class to whom auditors are liable for negligence[9]. Some commentators (for example, Minnow (1984)) have even suggested that there is a trend towards strict

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[5] 17 C.F.R 240.10b-5 (1980).

[6] 15 U.S.C. §§ 78 et seq.

[7] W. Prosser (1971). Taken from the Restatement of Torts 525.

[8] This was established in the famous case of Ultramares v. Touche 255 NY 170, 174 N.E. 441.

[9] See Ostling (1986). Also note the policy proposed in the Restatement (Second) of Torts would expand liability for negligence to those parties for whom there exists a "knowing reliance." This is a larger class of users than the one (expounded in Ultramares) for which defandants have "reasonable foreseeability." The former standard has been followed by some courts. See Ryan v. Kanne 170 NW 2d 395. and more recently, Rosenblum, Inc. v. Adler 93 NJ 324.

liability (see Moore and Thornton (1987) for a further discussion) in this realm analogous to similar trend in the law governing product liability cases.

Under the securities laws the standard is one of due diligence. This standard is severe under the Securities Act of 1933 since the burden of proof is upon the defendant to show that due diligence was taken (the plaintiff has the burden of proof under the Securities Exchange Act of 1934). Damages under the securities acts are generally calculated as the difference between the share price at the time of the misrepresentation (registration statement for the Securities Act) and the share price at the time the misrepresentation was discovered by the market (Kellog (1984) discusses this issue).

In both security and common law the auditor generally has the right to ask for contribution from joint tortfeasors. This would, in principle, reduce the amount of damages the auditor must pay. However, auditor suits frequently follow in the wake of client firm insolvency (see St. Pierre and Anderson (1984)) which makes this right of little practical value[10]. Additionally, many courts allow joint and several

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[10] This may be the source of the popular "deep pockets" theory under which auditors are sued because they are the only party involved which either has the wealth to pay the damages or has liability insurance which can be drawn upon. See, however, the Australian case, Cambridge Credit Corp. v. Hutcheson, in which the damages awarded exceeded the wealth of the firm's partners (apparently the pockets were not deep enough).

liability which can result in the auditor having to pay for the entire amount of the damages even though other parties may have contributed to the loss[11].

Kellogg (1984) looked at the issue of whether stock prices fall in anticipation of the discovery of an audit error or subsequent to discovery. At issue was whether lawsuits (and the search for audit errors) are triggered by shareholder losses or whether the discovery of audit errors results in shareholder losses. His study provides evidence consistent with both hypotheses.

St. Pierre and Anderson (1984) looked to characterize factors associated with lawsuits against auditors. They found that significant accounting losses, the onset of insolvency, and a drop in share price were all factors associated with lawsuits. Additionally, they classified the alleged causes of action and found that errors in the interpretation of GAAP and GAAS were frequently claimed by plaintiffs.

Palmrose (1987) found evidence that there were more suits against auditors during periods of economic downturns. She also found that business failures and claims of management fraud were often coincident in suits againsts auditors.

In an analytical paper DeJong (1985) demonstrated how

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[11] The case is even worse under the civil liability provisions of the Racketeer Influenced and Corrupt Organizations Act, 18 U.S.C. §§ 1961 et seq. The law allows for treble damages and has been applied to auditors. See Schact v. Brown, nos. 82-2089, 82-2090 (7th Cir. April 8, 1983).

the procedural rules of law involving access to class action suits and contingent payment of legal fees would have the effect of increasing the number of lawsuits brought against auditors. This results, in equilibrium, in higher levels of auditing being performed.

Ebke (1984) and Causey (1979) provide extensive commentary upon the development of auditor legal liability.

Risk Measures in Empirical Auditing Research

Empirical auditing research frequently must recognize and control the risk in the auditor's environment. Two lines of research have given explicit recognition to audit risk. One line of research attempts to ascertain the degree of competitiveness in auditing markets by looking for fee differentials after controlling for factors which contribute to the cost of audit production. In these studies it is necessary to control for risk in order to separate fee differentials attributable to risk bearing from those attributable to economic rents. The second line of research looks for systematic client firm characteristics leading to audit qualifications. In this research it is recognized that auditors may qualify an opinion in situations of high audit risk in order to avoid potential legal liability.

Shank and Murdock (1978) investigated the relationship between financial risk and uncertainty qualifications. They noted that when faced with issues of asset realization or of a client's ability to obtain future financing the auditor must in essence make a forecast of future financial results. They conjectured that systematic risk would be an appropriate measure of the risk faced by auditors in these situations[12]. Defining audit risk as the probability the auditor will qualify his audit opinion they found a relationship between a firm's market beta and audit risk for firms with betas greater than .8.

Dopuch, Holthausen, and Leftwich (1987) use beta and own variance to control for risk in their study of auditor opinion qualifications. They argue that increases in these risk measures imply a greater probability of a negative stock market return which can lead to litigation against the auditor. Consequently they predict these measures to be useful in determining the probability of an auditor qualification. They find that the model including market measures out-performs the model using accounting financial variables alone.

In another opinion qualification study Dugan and Shriver (1987) conclude that the evidence is mixed on the value of beta as a proxy for uncertainty in the audit environment. They extend the analysis to more fundamental notions of business risk. They hypothesize that the measures,

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[12] They assumed that own variance would be diversified away in an analogy to the results in the portfolio theory of finance. A different interpretation of the portfolio effect is given by Simunic and Stein (1988) who note that, for instance, auditor industry specialization may create dependencies across clients in the future cash flow streams of the auditor.

the degree of financial leverage and the degree of operating leverage, may better describe the firm-specific elements of the audit environment that leads to the auditor giving an uncertainty qualification. Their empirical analysis, however, fails to lend support for this hypothesis.

Simunic (1980) compares the audit fees charged by Big Eight auditing firms and those charged by non-Big Eight firms in a study of the competitiveness of the U.S. auditing market. To control for risk he notes that certain types of assets, inventories and receivables, are inherently more risky than others and includes these measures as explanatory variables. Further he conjectures that the financial condition of the client will affect the share of any potential legal losses that will have to be borne by the auditor. Thus variables on profitiability and the existence of a "subject to" qualification were included. His empirical results cannot reject the hypothesis of competition in the auditing market.

Francis (1984) replicates much of the Simunic study on Australian data. In order to control for risks associated with the auditor's loss exposure he includes the quick ratio and the equity to debt ratio, reasoning that these measures would effect the auditor's perception of risk since they are commonly used to assess the financial well-being of firms. His evidence does not support the use of these risk measures.

Firth (1985) looked at the competitiveness issue on New Zealand data. He included the market measure of risk in his regressions on fees. He found that unsystematic risk was a statistically significant factor explaining audit fees.

Finally Simon (1985), Palmrose (1986), and Francis and Simon (1987) provide additional evidence on audit fee determination. Simon found additional evidence for the empirical relationship between fees and size in U.S. fee data without risk adjustment. Palmrose in another study of audit fees found evidence which supported the hypothesis of product differentiation between the Big Eight and non-Big Eight segments of the auditing market. Her study did not include controls for possible risk differences. Francis and Simon in a study of Big Eight fee premia suggest the use of own variance, debt to equity ratio, and the existence of operating losses to control for risk.

In summary the literature suggests several points. It is recognized that risk is an important consideration in the auditing environment. Unfortunately researchers and the profession alike have found it difficult to quantify and develop good *ex ante* measures for risk. A number of researchers have looked to the theory of finance to suggest factors which affect the market riskiness of client firms. It has been conjectured that market risk and audit risk are linked through either the system of auditor product liability or through the effect of business risk. Currently, the connection between client firm market risk and audit risk has not been rigorously explored in the auditing literature.

Chapter 2

THE AUDITOR'S DECISION MODEL

This chapter introduces a simplified version of the auditor's decision model and describes the important institutional arrangements assumed in this paper. A general description of the auditor's decision problem, a definition of audit risk, the relationship between client firm risk and audit risk, and the role of legal liability are given.

The Auditor's Decision Model

In this section a simplified model of the auditing process is presented[13]. Figure 1 depicts the auditor's decision problem. I assume the auditor enters into a fixed fee contract with the client firm's shareholders[14] and that the

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[13] For a further development of this point see Scott (1973) or Kinney (1975).

[14] The nature of the contracting between the auditor and the firm is subject to various interpretations. While putatively the auditor answers directly to shareholders through the board of directors the influence of management or a subgroup of shareholders may be pervasive, see Herman (1981). The management of the firm may have considerable influence over the hiring, retention, and fees of the auditor which can serve to lessen the auditor's independence. The possibility of an auditor-management coalition adds greatly to the complexity of analyzing auditing contracts, Antle (1982).

auditor seeks to maximize profits[15]. Further it is assumed that the auditor offers his service in a competitive market. This implies that audit fees do not include any economic rents[16]. These assumptions are in no way contradictory. Competition requires the auditor to operate efficiently in order to obtain a normal return.

Before analyzing the auditor's decision problem, depicted in Figure 1, I will introduce some notation.

$s \in S$ = are the states of nature. To simplify the analysis the financial statements are considered to be either Fair or Not Fair. Not Fair financial statements are ones in which there exist relevant[17] material errors.

$a \in A$ = the opinion of the auditor about the

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[15] The assumption of profit maximizing behavior by the auditor is a reasonable first approximation for audit firms consisting of many partners. Explicit recognition of a more comprehensive auditor objective function would require greater knowledge than is currently available about auditor (audit firm) preferences. If the audit firms of interest were single practitioners a model incorporating risk aversion might be more appropriate. However, the firms in the sample are sufficiently large to make it unlikely they were audited by a single individual.

[16] This assumption is used in the empirical tests of Chapter 4. If fees contain non-zero economic rents then there may be a confounding between fee differences due to risk and those due to market power.

[17] The qualifier, "relevant", is used to discount the case in which there exists off-setting material errors in, say, account balances the sum of which does not effect the decisions of financial statement users.

fairness of the financial statements. The auditor can either Accept or Reject the financial statements. An accept opinion is interpreted by financial statement users as a certification that the financial statements do not contain any relevant material errors.

$q \in Q$ = the auditor's choice of auditing intensity, effort, or quality, for a given client. The auditor is restricted to performing either a high quality test or a low quality test. The low quality test may be a null audit, i.e., no testing is done.

$z \in Z$ = these are the signals which emerge from the audit test. A "good" signal results in an upward revision of the auditor's prior probability assigned to the event "The financial statements are fair." It is assumed the revision is accomplished according to Bayes' rule.

$c(a,s,z,q)$ = is the cost of an audit error. c(I) refers to the costs associated with a type I error, i.e., a false rejection of a fair financial statement. c(II) is the cost of falsely accepting an unfair financial statement. The cost of a type II error may depend upon the auditor's test, q, and signal, z, if the courts use this information to determine the presence of negligence.

h(q) = the incremental cost of performing audit tests.

Typically I will assign a value of zero as the cost of the low audit test.

Since fees are assumed to be fixed and constant they play no real role in the analysis. This allows the auditor's profit maximization problem to be analyzed in terms of an equivalent cost minimization problem. On the far right side of Figure 1 the auditor's payoffs (in costs terms) are given for each terminal node. The structure encompasses several simplifications. It is assumed that branches of the tree in which the high test is performed include a fixed incremental cost, h. The auditor is always assigned the cost, c(I), whenever a type I error occurs. In contrast, the cost, c(II), is assigned only when both a type II error occurs and either the auditor chose the low test or, if the high test was chosen, the auditor ignored the evidence, i.e., the outcome of the test was the "bad" test result.

Moving to the left, it can be seen that the auditor must decide upon an audit opinion without knowing the true condition of the financial statements. However, the auditor does get to update his beliefs about the fairness of the financial statements by observing the signal, z, from the test, q, if a test was performed. At the far left the initial node indicates the point at which the auditor chooses whether or not to perform an audit test. It should be noted that it is at this point the auditor is assumed to negotiate the fixed fee, and makes a simultaneous choice[18] of the level of audit testing and a decision rule which maps audit evidence, z, (if any) into his choice set A. His minimization problem is:

$$2.1)\quad \min_{q \in Q} \left[\Sigma_Z \, p(z|q) \, \min_{a \in A} \{ \Sigma_S \, c(a,s,z,q) \, p(s|z,q) \} + h(q) \right]$$

where,

$p(s|z,q)$ is the posterior[19] probability of the auditor over the states, S. These probabilities are conditioned by the signal received, z, and the audit plan, q, and,

$p(z|q)$ is the probability of receiving a signal, z, from the set Z given the audit plan, q.

In assessing the parameters, c(•), of his cost minimization problem, 2.1), the auditor must quantify the audit risk. The auditor's problem will be examined in more

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[18] It should be emphasized that the auditor's choice of opinion is conditional upon the information he receives from the audit test and therefore is not independent of the choice of the audit test.

[19] This probability is arrived at by means of Bayes' rule. This implies that I also assume the prior probabilities, p(s), and the likelikhood functions, p(z|s), exist and are well defined.

detail in Chapter 3; however, the intuition is that in order for the auditor to make his expected cost calculation he must be able to estimate the outcomes, c(•), and also be able to assess a probability distribution over those outcomes. It is a hypothesis developed in this thesis that information acquired from security market returns (SMR) may be used by the auditor to help make these assessments.

At this point it is important to recognize some of the potential limitations in the modelling strategy used in this research. For instance, I take the demand for auditing as an exogenous fact. This is done in order to avoid the complications which are induced when another strategic player, for example, the client firm's management, is added to the analysis. In models using principal-agent formulations the demand for auditing may be derived endogenously for essentially two reasons. A moral hazard demand for auditing can occur if the agent, the firm's management, is effort averse and the agent's effort is both unobservable and affects the productivity of the principal's resources. The demand for auditing is derived from the ability of parties to write an utility improving contract, conditional upon the auditor's report. This contract, which is only available when there is an auditor, induces the agent to provide a greater amount of effort and provides both the principal and agent with higher levels of expected utility.

A risk-sharing demand for auditing can occur in situations where the agent possesses asymmetric information which could be used for contracting but must be discounted since the information can be strategically manipulated by the agent. In these models the agent frequently must bear more risk than in a first best solution because contracts cannot be based upon the agent's information. The use of an auditor to verify the agent's reports makes it possible to base contracts between the principal and agent upon these reports. In turn these contracts may result in a more efficient risk-sharing arrangement.

One problem in introducing an auditor into the principal-agent model is that the auditor's actions may also be subject to agency problems. With three players in the game many subgaming issues arise which need to be addressed. For example, the possibility of coalition formation among the players may make it impossible for an equilibrium point to occur. Baiman et al (1987) have derived some results in a principal-agent model with an auditor. However, they use some very restrictive assumptions in order to make the game tractable.

The model developed in this research assumes the demand for auditing exists and does not address the issue of why the auditor is hired in the first place. The spirit of the research does, however, relate to the issue of the moral hazard problem in hiring an auditor. It is conjectured that the imposition of legal liability is an important institutional method for disciplining the auditor should he decide to shirk. The legal liability system in effect is a supra-contractual arrangement in an environment in which it may be difficult (or costly) for the auditor and the users of financial statements to write explicit contracts.

Another potential limitation in the model is the assumption of risk-neutrality by the auditor. Above the requirement for a risk-averse auditor to be compensated for bearing risk, it is unknown how relaxing this assumption would change the analysis. It is possible that different equilibrium behavior could result when risk-aversion is introduced. In purely descriptive terms the seriousness of this assumption may not be great since auditor's who are very risk-averse are unlikely to be competitive in the market for audits.

Definition of Audit Risk

A brief digression is made to clarify the usage of the term audit risk applied in this research. As noted in Chapter 1 it is common to define *audit risk as the probability that an auditor will fail to give a qualified opinion to a set of financial statements which are materially in error.* This definition is a useful starting point in an attempt to identify the operational causes of an audit failure.

If an audit is viewed as a set of sequential procedures leading to an opinion, then an audit failure is the result of an error not being detected or corrected by one of those procedures. In this view it makes sense to decompose audit risk as is done in the various risk models (as described by Cushing and Loebbecke (1983)) into component risks. The overall control of audit risk can be disaggregated in terms of the reliability of the component procedures and the initial uncertainty over relevant events.

In contrast, for the purposes of this research, it is useful to broaden the definition of audit risk to *include both uncertainty about the probability of an audit error and the distribution of the costs of those errors*[20] [21]. This is so since, in the context of decision theory, the auditor's *ex ante* choice of an audit test, q, and a decision rule, $a(z|q)$, are endogenously determined and depend upon upon the costs associated with each decision variable.

One way of seeing the difference between these two approaches to audit risk is by examining the probability

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[20] For a risk neutral auditor, additional uncertainty is not priced and he will use expected values in order to pick among alternative actions. In this case the incremental costs associated with additional risk do not include a risk premium *per se*, but rather the expected value of any losses which can be anticipated, as well as the cost of any additional auditing effort undertaken in response to the risk of the environment.

[21] Another advantage of integrating expected costs is that it naturally leads to consideration of the impact of auditing errors on third parties. In Chapter 3 the behavior of shareholders is brought into play. The important aspect to keep in mind is that audit risk is an issue because of the effects faulty audits have upon financial statement users and that these effects are be translated into costs faced by the auditor.

spaces which correspond to each approach. In both cases it may appropriate to consider the underlying sample space as the net dollar amount of any audit errors, i.e., the difference between, say, the reported income and the true income. In the traditional approach a probability is assigned to event that the audit error is not a member of the set $[M^-, M^+]$, where the M's refer to the lower and upper materiality bounds. Audit risk is this probability when an unqualified opinion is given.

In contrast, under the alternative approach we can think of forming a random variable which is a mapping from the space of audit errors into the space of auditor losses. This random variable has a probability distribution which is induced by the probability distribution of audit errors. Using this distribution to assess audit risk has greater decision relevance since it incorporates information about both the likelihood of audit errors and severity of their consequences.

The obvious conceptual advantage of this broadened view of audit risk is that it is consistent with economic notions of how rational agents will behave. That is, auditors are modelled as making explicit trade-offs between the probability of audit error and the costs of those errors in deciding upon the optimal allocation of audit resources.

This still leaves unanswered the question: how does one operationalize audit risk? Note that the relevant uncertainty relates to both the probability and magnitude of post audit losses. Institutional structure can provide some general information useful to assessing risk such as: under what circumstances auditors may face potential risks and also, to some extent, the size of those risks[22].

Legal Liability

From the wealth of institutional facts available about auditor liability (see chapter 1) this paper will abstract the following elements:

1. Auditor liability has two preconditions: that some party has sustained a loss due to the auditor's action and that the auditor has failed to meet some legally proscribed standard of care.
2. The damages claimed by plaintiffs are frequently related to declines in the market price of the client firm's share price and that the subsequent auditor's losses are a function of the shareholder losses.
3. Auditor negligence is an issue of faulty representation. Therefore, whenever an auditor commits a type II error he is potentially subject to post audit losses if the requisite evidence of negligence can be found.

Firm Risk and Audit Risk

The uncertainty in the future cash flows of the client firm is a primary source of audit risk. Consider the

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[22] For instance, the Securities Acts set out when and for what measure of damages auditors (and others) can be held liable for actions which come under their jurisdiction.

auditor's problem of assigning a value to a firm's assets. The true value is a function of the assets' ability to generate cash flows. Business risk represents the uncertainty[23] of those cash flows. For instance, a non-diversified firm in an industry with large demand uncertainty operates in an environment of high business risk. Consequently, the valuation of its assets may fluctuate greatly over time. This causes two problems for the auditor. First, the share price of the firm is also likely to fluctuate to the extent the demand uncertainty is correlated with the market[24]. It is conjectured that share price fluctuation can cause investors to suffer losses for which the auditor may be held liable.

The second problem for the auditor is that it is inherently difficult to estimate the value of assets which generate highly variable cash flows. This is so since the values assigned to those assets depend upon a forecast of the future cash flows associated with that asset. This is, at best, an imprecise operation which admits to the possibility of error. The failure to detect such an error could be interpreted by a court as evidence of auditor negligence.

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[23] Conine (1982) notes that business risk is determined by several factors. Among them are the degree of operating leverage, stochastic product demand and prices, and stochastic variable production and marketing costs.

[24] Rubinstein (1973) originally developed a model of systematic risk which incorporated stochastic product demand.

Another aspect of firm risk is financial risk[25]. Financial risk is a function of the proportion of debt in the firm's captial structure. Financial risk increases the expected costs the auditor might bear due to a client firm's bankruptcy[26]. Further financial risk can contribute to audit risk by increasing the probability of financial distress, thereby leading to a search for audit errors[27].

From the above discussion one may conclude that business risk can lead to audit risk in two ways. First, increased business risk increases the probability of shareholders suffering losses[28], a prerequisite for lawsuits. Second, business risk increases the difficulty in valuing firm assets and assessing the firm's financial position. This makes it more difficult for the auditor to determine the appropriate amount of auditing effort and it also makes it more likely that if a bad outcome should occur the auditor's judgment

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[25] Bowman (1979) links systematic risk with firm debt measures. Also see Hamada (1972).

[26] Simunic (1980) discusses how the joint and several provision of liability laws will cause the auditor of a bankrupt client to bear a greater percentage of the liability losses in the case of a successful lawsuit.

[27] Palmrose (1987) finds evidence linking client firm financial distress and litigation against auditors.

[28] This is, perhaps, at best a crude association. Nonetheless, if auditors are sometimes held responsible for shareholder losses which they did not cause (due to the inability of the courts either to correctly determine the cause or to associate the correct amount of damages with the cause), then factors which in general increase the likelihood of client firm losses may result in post audit liability.

will be questioned by the shareholders, and the courts will find the auditor's work to be negligent. Finally, it is noted that financial risk can also affect audit risk by increasing the probability of financial distress in the client firm.

Chapter 3

THE AUDITOR'S DECISION MODEL WITH AUTONOMOUS SHAREHOLDERS

In this chapter the effects of introducing autonomous shareholders into the auditor's decision model are analyzed. The purpose is to link security market returns (SMR) with audit risk through the impact of SMR upon shareholder behavior. One intuition is that, *ex post,* shareholders may revise their beliefs about the *ex ante* fairness of a firm's financial statements in light of the observed return. They then use this revised belief along with knowledge of the institutional setting (i.e., the existing liability rules and court's behavior) to decide whether or not to sue the auditor. In turn, once auditors have a rule for predicting shareholders' behavior they can incorporate this knowledge into their risk assessment of the client firm and make the appropriate adjustments in their audit plan and fee[29].

One of the goals of the following analysis is to examine conditions under which information about the risk of a client firm's common stock can be used by the auditor to assess the riskiness of the auditing environment. Equilibria

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[29] In the model the fee is assumed to be constant and determined prior to the onset of any auditing effort. However the fee will reflect any anticipated risk.

are examined in which, given the assumptions of the model, audit costs increase with the *ex ante* riskiness of the firm's securities. This result motivates the empirical tests in Chapter 4.

The Auditor's Decision Model

A common simplification of the auditor's decision problem, as described in Chapter 2, is given in Figure 2. It can be seen that for a given audit test result, z, and auditing intensity, q, the auditor chooses an opinion, a, which minimizes expected costs. This is done by balancing the expected costs of committing a type I error with those of committing a type II error. With reference to Figure 1, this choice is depicted in the right-most branches of the decision tree. The expected value of the least cost decision at this stage is then used as data for the auditor's choice of the optimal level of auditing intensity. Note that the costs within the boxes are normalized such that only the incremental costs to the auditor of issuing a false opinion[30] are given.

It is important to recognize that in most studies of the auditor's decision problem the value assigned to each realization of the cost function, c(a,s,z,q), is assumed to be given exogenously. (See, for example, Kinney (1975).) In

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[30] The costs assume the auditor is not acting fraudulently. That is, no attempt is made to model the costs and benefits of the auditor acting in collusion with other parties involved with the firm.

contrast, this research recognizes that the costs of a type II error, c(II), are likely to vary with the shareholders' return. From Figure 1 it is clear that the value assigned to c(II) can affect the auditor's decisions and therefore the expected cost of the audit. The question to be addressed is: how is this cost influenced by the distribution of the client firm's stock returns?

One approach to answering this question is to return to the idea of representing the auditor's loss function as a random variable in which auditing errors are mapped into auditor's losses. In this context the issue is how to assign a value to a given auditing error. Two stylized facts are used to motivate the use of SMR in making this mapping.

First, shareholders' losses are used to prompt the search for auditor errors. This makes sense under two quite different sets of circumstances. On the one hand, if negative stock price returns are more likely to occur when auditing errors exist then it makes sense to search for these errors following a negative return. On the other hand, even if auditing errors were independent of the realized return the existing legal liability rules imply it is potentially beneficial for shareholders to find errors only when they have demonstrable losses.

Second, the magnitude of the ultimate shareholders' losses which are attributable (or perhaps, more relevantly, assigned by the court) to the auditor is an increasing function of total shareholders' losses. The intuition behind this "fact" is that even if the courts could perfectly determine the existence of both audit errors and negligence, it would be difficult to factor out the portion of the loss attributable to the auditor. Further, if such factoring were possible, it is unlikely that audit errors map into losses in a way which is independent of other variables. Before analyzing these issues some additional notation is required; it is given in Table 1.

In the model it is assumed the stock price of a given firm is a function, $t(\theta_i,s_j)$, of θ_i, a variable which represents all factors that are uncorrelated with the fairness of the financial statements, and s_j, the fairness of the financial statements. The auditor's opinion, a_n, is used by shareholders to condition their beliefs about a given s_j. Thus, the *ex ante* stock price is given by[31]:

3.1) $$t_0 = \sum_{s_j \in S} \sum_{\theta_i \in \theta} t(\theta_i,s_j)\ p(\theta_i)\ p(s_j|a_n)$$

The *ex post* stock price is determined by the realization of a pair $(\theta i, s_j)$. In the analysis that follows the realized stock price is restricted to four values with the following

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[31] The *ex ante* stock price is assumed to be the first price at which information provided by the current audit is impounded. As a result when losses are assessed it is assumed the auditor is not held responsible for declines which predate t_0.

structure[32]:

$$t_1(\theta_1, s_1) > t_2(\theta_2, s_1) = t_3(\theta_1, s_2) > t_4(\theta_2, s_2)$$

The structure is such that stock price reveals the true condition of the financial statements only when both factors are either "good" or "bad". For the intermediate cases the price does not reveal which factor is good and which factor is bad. It is assumed that, in these cases, neither the shareholders nor the courts can observe the true states[33].

Costs to the auditor of type I and type II errors are assumed to be functions:

3.2a) $c(a_2, s_1, q, z) = \text{constant},$ for all q and z.

3.2b) $c(a_1, s_2) = f\ (\ t_0(a_1) - t_k),$ for each q, z and k= 3,4

The cost $c(a_2, s_1)$, also denoted as c(I), is assumed to be a fixed amount. The costs included in this quantity include the expense of additional audit tests (which may be required by the client), loss of client good-will, etc[34]. The cost of a type II error, c(II), can take on many different values, as

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[32] For a numerical example see appendix 1.

[33] In a noisy rational expectations economy the price can reflect the true states without the individual investors being able to perfectly infer the states from the price. See Grossman and Stiglitz (1980).

[34] Kinney (1975) offers a more complete discussion of the costs to the auditor of a type I error. Note that it is assumed the auditor is not held liable to shareholders for type I errors, that is auditors cannot be too "conservative" from the shareholders point of view.

seen in 3.2b), These costs depend upon several factors and will be discussed later. At this point the conjecture is made that, in equilibrium, the expected value of c(II) is a non-decreasing function of the decline (if any) of the share price subsequent to the auditor's opinion.

Before turning to further analysis of c(II) it is worthwhile to return to the "facts" mentioned above, taking into account the additional structure imposed upon the model. The second fact is the more easily addressed, that is, it seems reasonable to conclude that security market risk is positively associated with the magnitude of potential auditor losses. The key is the way in which audit errors interact with other factors. Consider the following extreme cases:

1. The losses due to audit errors are independent of other factors, the courts can determine the causal relationship between the error and the loss, and the auditor is held responsible only for losses attributable to audit error. Here security market risk would play no role since the courts correctly "factor out" losses attributable to other causes.
2. Same as 1, but the losses due to audit errors are not independent of other factors. Consider the two functions t' and t'' given in Appendix 1. In t' the stock price is an additive function of the fairness of the financial statements and in t'' the stock price is a multiplicative function of fairness. When the t' model is used the courts

can readily determine the loss attributable to audit error conditional upon observing a realization of (θ_i, s_j), since the incremental loss caused by an audit error is 5 units regardless of the realization of θ_i. In contrast, when the t'' model determines stock prices, the incremental loss caused by an audit error depends upon the realization of θ_i[35]. Therefore the magnitude of the loss for which the auditor is potentially at risk can be seen to be sensitive to factors which affect the stock price.

The question of an association between the distribution of security market returns and the existence of audit errors is more subtle. There are two possibilities which can be addressed. One is whether the return generating process changes when an audit error occurs. If this is the case then a price series with a high variance in the historical price may serve to disguise the change in the process. This implies that greater uncertainty in the SMR could result in fewer lawsuits being brought against the auditor.

An alternative interpretation is that the probability of committing an auditing error is more likely in an environment of greater SMR risk. The argument rests upon the existence of common factors which contribute to both the

[35] In this case it is hard, if not impossible, to factor out the incremental impact of the audit error. In such situations the rule for damages applied by the courts becomes critical.

firm's measured security market riskiness and to the risk of committing auditing errors. For example, it may be argued that it is more difficult to correctly interpret and apply GAAS and GAAP in environments where there is a good deal of uncertainty about those elements which effect the current valuation and future performance of the firm. If the market measures of risk reflect the uncertainty then they may be used as instruments for the underlying uncertainty and therefore useful in the assessment of the audit risk. In summary the intuition is that increased riskiness[36] in the firm's future cash flows is impounded in the measures of security market risk. In turn, increases in these measures may be related to an increased probability that it will be revealed, *ex post,* that the auditor committed an auditing error.

Equilibrium Analysis with Autonomous Shareholders

In this section the costs of c(II) are investigated when the shareholders' actions are determined endogenously. The framework for the analysis is in terms of a simplified game-theoretic structure where the shareholder decides whether or not to sue the auditor depending upon the legal environment, the auditor's opinion, and the realized stock price. Two legal liability regimes are investigated, one where the auditor is strictly liable for auditing errors and another

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[36] The notion of increasing risk is detailed by Rothschild and Stiglitz (1970).

where the auditor has a negligence defence available to him.

Figures 3a and 3b depict the auditor-shareholder game. These figures add the shareholders' decision tree to that of the auditor. The auditor's decision tree ends with "nature" moving to decide the fairness of the financial statements[37]. It should be pointed out that the behavior of the client firm's management is taken as exogenous. The auditor (and shareholders) assess a prior distribution over management's propensity to report the financial statements truthfully, but the models used in this thesis do not allow for management to behave strategically[38].

As stated previously the demand for auditing is taken as exogenous. In the model the auditor serves two purposes. First, the shareholders could use the auditor's signal (opinion) to update their priors about the fairness of the financial statements[39] through the function, $p(s_j|a_n)$, which

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[37] It is assumed that the firm's management prepares financial statements prior to the auditor starting his auditing procedures. The auditor, however, does not learn the true condition of the financial statements, but is allowed to perform tests in order to reach a level of assurance about the financial statements' fairness.

[38] Both Antle (1982) and Baiman et al (1987) discuss the complications in the analysis which occur when managers are treated as players in a three person management-auditor-shareholder game.

[39] Once a price is determined for each firms' security investors then can make optimal portfolio decisions. This suggests a productive role for the auditor. This issue is not explicity modelled in this research. Scott (1975) furthers the ideas by relating the investors' consumption-investment problem to loss function faced by auditors. This ties the auditor's choice of action to the welfare of investors.

appears in equation 3.1). The role of the auditor in this case would be to provide an independent assessment of whether the firm's management communicated information truthfully. The second purpose is one of insurance. Once again the optimality of the role of the auditor as an insurer is not derived from the model herein, however, under certain conditions the auditor may act as an insurer by bearing the risk of bad share price outcomes. This is likely to happen when it is impossible for the courts to distinguish between the losses caused by θ_i and those caused by s_j. In this case it may be optimal for the auditor to bear risk due to his moral hazard problem. Though, strictly speaking, in this model since the auditor is risk-neutral bearing risk in and of itself imposes no penalty.

It is assumed that the true condition of the financial statements is not perfectly revealed even though it is a factor in determing the share price. The shareholders use the share price to learn what they can about the fairness of the financial statements and about the auditor's behavior. The shareholders' action is to determine whether or not to sue the auditor under the extant liability regime. The shareholder's decision problem is given by:

$$3.3) \quad \max_{j \in J} \left[\left\{ \sum_{q \in Q} L(t_0, t_k) \bullet p(s_2 | t_k) \bullet p(q_m < q^+ | a_n, t_k) \right\} - w(j_p) \right] \bullet j(a_n, t_k) \quad \text{for all k.}$$

Starting from the left of expression 3.3) are the various components that enter the shareholders' decision problem. First, L(•) represents the amount of damages suffered by the shareholders. This is a gross amount and in practice the auditor would not be held accountable for the entire amount of the loss. The courts will attempt to adjust the gross amount to reflect the damages caused by the audit failure. $p(s_2|t_k)$ is the probability the courts and shareholders assign to the event that the financial statements are false given the realization of a particular share price. $p(q_m<q^*|a_n,t_k)$ is the probability that shareholders and courts assign to the event that the auditor chose a level of auditing less than the due care level. This is a cumulative measure where m represents the set of auditing intensities less than q^*. It is worth noting that in a strict negligence regime this quantity is set equal to 1, i.e., there is no due diligence defense. w(•) is the cost[40] to the shareholder of his action, j, either to sue or not sue the auditor.

Another issue related to the amount of damages for which the auditor is to be held accountable is the question of which parties have actually suffered a loss. For instance, what loss in wealth have shareholders who owned shares prior to the incidence of an audit error suffered as a result of the

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[40] The cost of suing is, for the sake of simplicity, assumed to be non-reimbursable. Procedural aspects of the law are abstracted from in this research, though they clearly influence the choice of shareholders' actions.

auditor's failure to uncover an error in the financial statements? In order to avoid having to split the firm's shareholders into different classes (eg. old vs. new shareholders) I will somewhat obscure the issue by claiming that the failure to uncover errors decreases the wealth of all shareholders. This is due to the conjecture that management would not provide materially incorrect financial statements except as part of an effort to conceal expropriations of wealth from shareholders. As a consequence, the auditor's failure to uncover errors can reduce the shareholders' ability to recover losses or prevent further expropriations.

Returning to the game depicted in Figures 3a and 3b, the terminal nodes show the shareholders' outcomes. Losses subscripted with an "a" indicate the auditor gave an unqualified opinion. Another simplifiing assumption which is made is that an unqualified opinion is taken as a pre-condition for auditor liability. The losses subscripted with an "r" indicate that the auditor qualified his opinion and hence immunizes himself from the costs, c(II). Moving to the left are the nodes depicting the shareholders' information sets prior to choosing j. The similarly shaded squares comprise each information set. The shareholder has six information sets at this point. The next two sets of nodes to the left indicate nature's moves with regard to the fairness of the financial statements and the realization of the variable θ_i. The remainder of the nodes are the same as in

Figure 1.

Comparing Figures 1 and 3 it is clear that the shareholders are introduced in such a way as to extend the auditor's decision problem to recognize the endogenous nature of the costs, c(II). These costs can be rationally anticipated by the auditor only in a setting where there exists an equilibrium in auditor-shareholder behavior.

In order to analyze the equilibrium shareholder behavior needed for the auditor to calculate his expected costs a set of rules must be specified indicating when and for what measure of damages the auditor is liable. The next two sections look at different sets of liability rules and some of the possible equilibria in these regimes.

Equilibria with Strict Liability

The Nash equilibrium concept is used in the ensuing analysis. Equilibria are found by, first, eliminating dominated strategies (given certain assumptions about cost conditions) and then inspecting the remaining strategies to see if they are Nash, i.e., neither of the players would want to diverge from their strategy given the strategy of the other player.

In the first regime to be explored it is assumed the auditor is liable for losses under the rule of strict liability. This is of interest since, as previously discussed, there appears to be an element of strict liability in the reasoning of some recent case law[41]. Also strict liability provides a good benchmark for comparison with the negligence defense regime in the next section. Strict liability requires that any type II error, regardless of the level of care, results in the auditor being held liable.

In terms of the model a strict liability regime implies that an audit error exists whenever either of the following pairs of events are observed: $\{a_1, t_3\}$, and $\{a_1, t_4\}$. Since it is assumed that t_2 is not distinguishable from t_3 it is likely that the courts will conclude, with some probability, that there is evidence for the existence of an auditing error whenever either the event $\{a_1, t_2\}$ or $\{a_1, t_3\}$ occurs. If the courts cannot see beyond the evidence given by the stock price (i.e., if they cannot observe either s_j or θ_i) the probability, $p(s_2|a_1, t_2)$[42], is assigned a number greater than zero but less than 1. The probability, $p(s_2|a_1, t_4)$, is set equal to one and the probability, $p(s_2|a_1, t_1)$is set equal to zero. The rule of strict liability is equivalent to setting $p(q_m<q^*|a_1, t_k)$ equal to one, i.e., the auditor is assumed to be negligent whenever an audit error is found by the courts.

From Figures 3a and 3b it can be seen that the shareholders' six information sets consist of the following

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[41] The New Jersey court in Rosenblum v. Adler, cited above, discusses the efficiency of auditors as insurers of risks. This is a step on the road to strict liability.

[42] Since t_2 and t_3 have the same value, t_2 is included in the conditioning statements when either of the two values is used to update a prior probability.

pairs of observations: $\{a_1,t_1\}$, $\{a_1,t_2$ or $t_3\}$, $\{a_1,t_4\}$, $\{a_2,t_1\}$, $\{a_2,t_2$ or $t_3\}$, and $\{a_2,t_4\}$. Since the shareholders can choose either to sue, j_1, or not sue, j_2, at each information set this results in $2^6 = 64$ possible shareholders' strategies. To simplify the analysis those strategies where the shareholder chooses to sue subsequent to observing a_2 are eliminated. This is because a qualified opinion is assumed to immunize the auditor from liability. A suit which follows after observing a_2 fails and costs the shareholders $w > 0$, therefore these strategies are dominated by ones in which the shareholders do not sue subsequent to a_2. The remaining shareholders' pure strategies are given in Table 2. The table shows the mappings from the information sets into the action space.

Shareholder strategies 1-4 are eliminated since they require the shareholder to sue whenever t_1 occurs and these strategies are dominated since the shareholders will always lose these suits. Also strategies 6 and 8 are eliminated since they require the shareholders not to sue when t_4 occurs and this is also assumed to be nonoptimal unless the cost of suing, w, is greater than the damages to be recovered, in this case with certainty.

The auditor has four pure strategies if he chooses the high audit intensity, q_1, and two if he chooses the low audit intensity, q_2. They are given in Table 3. Auditor strategies 1 and 4 are assumed to be dominated by 5 and 6, respectively, since they require the auditor to disregard the results of a costly auditing test. Strategy 3 is assumed to be dominated since it requires the auditor to choose an action that is inconsistent with the audit test.

The expected damages which the shareholder can collect are given by:

$$3.4) \quad D_{nk} = L_{nk}(t_0(a_n), t_k) \bullet p(s_2 | a_n, t_k) \bullet p(q_m < q^+ | a_n, t_k)$$

This expression consists of three elements: a measure of the shareholders' damages, the probability the courts find an auditing error, and the probability the courts find the auditor acted negligently. The expected amount of damages the auditor will have to pay are given by the expression[43]:

$$3.5) \quad c(a_1, q_1, z_1, s_2) = [\sum_{k \in K'} D_{nk} \bullet p(t_k | s_2, z_1, q_1)] \bullet p(s_2 | z_1, q_1) \bullet p(z_1 | q_1)$$

where K' is the set of returns for which the auditor can potentially be held liable. The last two probabilities can be taken together as the probability of the occurrence of a type two error given the level of auditing intensity. This is also denoted by $p(II | q_1)$.

There are six possible combinations of shareholders'

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[43] This allows the auditor to calculate the costs in the upper righthand box of Figure 2, given a decision rule which assigns a_i to the observation of z_i.

and auditor's pure strategies in this game. Table 4 gives the expected costs to the auditor of the possible equilibria. There are several types of factors which contribute to the costs. For instance, from the first row of Table 4 it can be seen that the expected costs to the auditor associated with the play $\{AUD_2, SH_5\}$ are:

$$c(AUD_2 | SH_5) = \left[\sum_{k=2}^{4} D_{nk} \bullet p(t_k | s_2, z_1, q_1) \right] \bullet p(II | q_1) + c(I) \bullet p(I | q_1) + h(q_1)$$

This expression has three components. The first is the value of transfer payments to the shareholders weighted by the probabilities that the outcomes t_k, k = 2, 3, 4 should occur and the likelihood of a type II error given the high audit intensity. The second component is the expected costs of a type I error given the high audit intensity. The third element is the incremental production cost of the high audit level.

Table 5 sets up the game in normal form. The shareholders' non-dominated pure strategies are SH_5 and SH_7. The former consists of the play: do not sue if t_1 is observed, sue otherwise. The latter strategy is: sue if t_4 is observed, do not sue otherwise. The auditor's strategies are A_2 (choose the high audit intensity, q_1, and pick the unqualified opinion, a_1, if the high signal, z_1, is drawn and a_2 otherwise), A_5 (low audit intensity, unqualified opinion), and A_6 (low audit intensity, qualified audit opinion).

In the table the auditor's costs are the expected costs of each strategy described in Table 4. Since the auditor must choose his actions before the outcome, t_k, is observed his decision is based upon these expected costs. In contrast the shareholders' choice of action is subsequent to the realization of t_k and, hence, can be a function of the realized share price.

From Table 5 it can be seen that the equilibria which are attained will depend upon the various cost parameters. For example, if D_{12} is less than w, then the only equilibria which can occur involve the shareholder using strategy SH_7. On the other hand, if D_{12} is greater than w then SH_5 may be optimal.

If SH_5 is optimal for the shareholder then there are three possible equilibria. The cost conditions of the auditor will determine which one obtains. A typical situation is depicted in Figure 4. In this figure the total expected costs to the auditor of each strategy is plotted against $p(\theta_2)$. The auditor's costs for the cases where the shareholder plays SH_5 are:

$$c(AUD_2 | SH_5) = \left[\sum_{n=2}^{4} D_{nk} \bullet p(t_k | s_2, z_1, q_1) \right] \bullet p(II | q_1) + c(I) \bullet p(I | q_1) + h(q_1)$$

$$c(AUD_5 | SH_5) = \sum_{k=2}^{4} D_{nk} \; p(t_k)$$

$$c(AUD_6 | SH_5) = c(I) \bullet p(I | q_2)$$

As can be seen the costs of both $\{A_2, SH_5\}$ and $\{A_5, SH_5)$ depend upon the probability distribution of t. The distribution of t is determined by the joint distribution of s and θ. If we fix $p(s_2)$ at some level then it can be seen that for small probabilities of the "bad" state, θ_2, occurring the auditor chooses the low audit level and issues an unqualified report, i.e., $\{A_5, SH_5\}$ is the equilibrium. For high probabilities of θ_2 the auditor qualifies his report and $\{A_6, SH_5\}$ is the equilibrium. It is for the intermediate levels of θ_2 that it the equilibrium, $\{A_2, SH_5\}$, involving the high level of auditing obtains.

Conclusions

In a strict liability regime an increased probability of the occurrence of the "bad" state leads to higher *ex ante* expected costs to the auditor of producing an audit. (This is depicted by the dark line in Figure 5.) These higher costs are the result of the auditor being liable for shareholders' losses which are perceived to be caused by auditor's errors. The "risk" of the bad state affects the cost parameterization of the auditor's strategies since bad states can either: 1) be confused for bad auditing, or 2) exacerbate the damage done by a faulty audit. In equilibrium, greater risk results in the least cost strategy being more expensive.

One surprising aspect of the result is that the higher auditing costs are not necessarily driven by the cost of performing higher intensity audits. Instead the costs could result from the auditor issuing a "protective" qualification and thereby absorbing the costs of a relatively likely type I error.

In this model the auditor sometimes acts as an insurer. This occurs when the equilibrium involves strategies AUD_2 or AUD_5. In these cases the extent of the inability of the courts to distinguish between share price declines caused by unfair financial statements and those caused by unlucky and uncorrelated events results in the auditor being held liable for losses when the state s_1 obtains[44]. This fact can increase the expected liability losses if courts on average over estimate the occurrence of the event $\{\theta_1, s_2\}$.

Equilibria with a Negligence Defence

The situation changes if the auditor is allowed a negligence defense. In the model the auditor is considered to be non-negligent if he performs the high level of auditing, q_1, and gives an opinion consistent with the audit test. (That is, the auditor could still be held negligent if he gives the opinion a_1 following the receipt of z_2). In order to simplify the analysis it is assumed that the courts can accurately determine *ex post* whether the auditor was negligent. The

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[44] In terms of the model this insurance aspect is driven by the inablility of the courts to observe s_2 directly. Hence they sometimes infer the existence of s_2 from a decline in stock price when in fact θ_2 was the real cause of the decline.

strategies available to the players are the same as under the strict liability regime (see Tables 2 and 3).

Dominance arguments allow the game to be pared down to the same set of pure strategies as in the strict liability case. Table 6 shows the auditor costs for the various combinations of pure strategies, Table 7 shows the normal form game, and Table 8 shows the possible pure strategy equilibria and corresponding cost conditions. From an examination of Table 8 it can be seen that there is no pure strategy Nash equilibrium in which the auditor chooses the high audit level, AUD_2.

The fact that the high audit level is not an equilibrium even though it may have the lowest expected costs is surprising. However, a mixed strategy equilibrium is possible. Let the following cost conditions hold (see Table 6):

$$3.6)\quad c(I|q_1)\, p(I|q_1) + h(q_1) < \min \{\sum_{2}^{4} D\, p(t_k),\ c(I|q_2)\, p(I|q_2)\} \quad \text{and} \quad D_2 > w.$$

An example of a mixed strategy equilibrium is (the details of this equilibrium are given in in Appendix 2):

$$3.7)\qquad p(SH_5) = \frac{c(I)\, p(s_1|z_2, q_1) + h(q_1) - D_4\, p(t_4)}{D_2\, p(t_2) + D_3\, p(t_3)}$$

$$p(A_2) = (D_2 - w) / D_2$$

The expected cost to the auditor of this mixed strategy is equal to:

$$c(I)\ p(s_1 | z_2, q_1) + h(q_1)$$

the cost of AUD_2. In this equilibrium the auditor randomizes between the high audit and the low audit unqualified opinion alternatives. The expected cost is equivalent to that of the high audit alternative but is achieved through randomization. The shareholders always sue when t_4 occurs, never sue when t_1 occurs and randomize when t_2 or t_3 occurs.

From the analysis a picture quite similar to the strict negligence case can be drawn. Figure 5 shows that for low levels of $p(\theta_2)$, holding $p(s_2)$ constant, the auditor will choose the low level of auditing and give an unqualified opinion. This can be seen from the costs to the auditor of the pure strategy plays, $\{A_5, SH_5\}$ and $\{A_5, SH_7\}$. They have expected costs:

$$c(AUD_5 | SH_5) = \sum_{k=2}^{4} D_{nk}\ p(t_k)$$

$$c(AUD_5 | SH_7) = D_{n4}\ p(t_4)$$

Both costs increase with the probability of θ_2. These costs will become large for high levels of θ_2. At some point the auditor will, depending upon the relative costs, either give a "protective" qualification or choose to perform the higher intensity audit. In the latter case a mixed strategy is required.

Conclusions

When the auditor has a negligence defense the shareholders must assess probabilities of both an auditing error and that it was committed negligently. This changes the game between the auditor and the shareholders in that a high intensity audit is not part of a pure strategy equilibrium. As in the strict liability case an increased probability of a bad state realization, θ_2, increases the probability of a bad return, t_k, which in turn increases the expected costs to the auditor. Once again this result is driven by increasing liability losses which are, in part, due to the inablity of courts to always correctly distinguish between losses (and the corresponding amounts) caused auditing errors and those caused by other factors.

The analysis in this chapter provides a simplified framework for showing the relationship between security market risk and audit risk. The models assume that neither shareholders nor courts have sufficient information to invert the function used to price securities. Therefore a decline in a share price can be due to either a bad state realization or to the financial statements having been in error. Shareholders may use a stock price fall to instigate the search for auditing errors and are occasionally rewarded for their efforts.

One aspect of this model is that auditors sometimes appear to act as insurers of stock price outcomes. This can occur if either: 1) the courts are unable to determine the causes of shareholders' losses or 2) cannot accurately determine damages from causes. While this research does not address the social optimality of auditors' legal liability as an institution (nor their role as insurers), the institution contains mechanisms which seem useful to mitigating the problems of moral hazard and truthful reporting by the auditor. It is possible that, given the costs of determining the existence, cause(s), and effects of auditing errors, it is efficient to sometimes penalize the auditor in cases when he is, in fact, not at fault.

The goal set out at the beginning of this chapter was to establish a link between risk in security markets and, ultimately, audit costs. The main economic institution for this link is the system of legal liability. The games are used to demonstrate a mechanism in which the costs to the auditor of different equilibrium strategies are parameterized, in part, by the probability of the occurrence of a bad state (and thereby a low share price). In particular it was seen that the costs of a type II error are sensitive to bad outcomes. (Since bad outcomes are conjectured to trigger the search for auditing errors and may sometimes be used as evidence for the existence of such errors.) In turn the cost parameters influence the auditor's choice of auditing intensity, decision rule, and opinion. Each of these are critical determinants of the cost of producing an audit.

In Chapter 4 security market measures of risk are used to parameterize the likelihood of bad returns. In terms of the models in Chapter 3 this information is valuable to the auditor since it may allow him to anticipate the occurrence of situations in which shareholders will sue and thereby expose the auditor to post audit losses.

Chapter 4

EMPIRICAL IMPLICATIONS

This chapter develops the empirical implications of the theory described in the preceding chapters. The first section specifies the hypotheses to be tested. The next section discusses the particular models chosen for the tests and describes the data. The third section reports the results of various diagnostic tests made to check the the maintained assumptions required to apply Ordinary Least Squares (OLS). The fourth section reports the results of the tests of hypotheses and of sensitivity analysis. The final section summarizes the empirical results.

Empirical Links

Above it was shown that the auditor operates in a complex decision-making environment. The auditor must choose a decision rule and a level of auditing effort in order to accomplish the audit. This choice depends upon the auditor's beliefs about the possible outcomes and estimates of the and cost parameters. Of particular interest is the evaluation of the cost of giving a false unqualifed opinion, $c(a_1,s_2)$. Expressions 3.4) and 3.5) displayed factors which affect these costs. In order to simplify the analysis it is assumed that losses are limited to the actual damages suffered by shareholders. Thus the function L(•) is taken as an appropriate measure of shareholders' losses.

In Chapter 3 the argument was made that shareholders look at the realized stock price in order to decide whether or not to sue the auditor. In the model shareholders can use the stock price to either gain information about the existence of an error in the financial statements or, alternatively, to determine whether the losses from an auditing error justify the expense of litigation[45]. A rational auditor, anticipating the actions of shareholders, will use an expression such as 3.5) in order to evaluate the cost of a type II error for each level of auditing effort. This requires the auditor to assess the possible values of t_k and the probabilities over these values.

One way of estimating the possible distribution of share prices is by looking at historical data and using a model such as the empirical market model to predict the future distribution of t. The model is generally easier to work with in return form and since there is a one-to-one mapping from prices into returns this is done for convenience.

I will assume stock returns are formed in accordance with an empirical market model:

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[45] There are various interpretations of the relationship between share prices and auditing errors which are consistent with the model. See pages 32-34 above for further discussion.

4.1) $$r_i = a + \beta_i r_m + e_i$$

4.1a) $$E(r_i) = a + \beta_i E(r_m)$$

where,

E = the expectation operator,

r_i = the return to firm i's shares,

e_i = the risk free rate,

a = a constant,

β_i = the "beta" of firm i,

r_m = the return to the market index.

The variance of the return to firm i is given by:

4.2) $$var(r_i) = \beta_i^2 var(r_m) + var(e_i)$$

In the portfolio theory of finance the own-variance, i.e., $var(e_i)$, is assumed to be diversifiable and only the "market risk" is priced by shareholders. However, both elements of risk are important as predictors of stock price returns and possible shareholders' losses. For instance, if shareholders use the occurrence of a negative return to institute the search for auditor errors[46], then it may not matter whether the loss is due to systematic or unsystematic factors. It should be noted that the own component of the historically measured variance, like the systematic component,

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[46] The evidence in Kellog, previously cited, is consistent with this conjecture.

is affected by those factors which influence business and financial risk variables. As a result, firms with high business and financial risk will usually have large own variances as well.

It is interesting to ask whether one component or the other of the security's variance is more important from the auditor's point of view. Borrowing the notation of the standard regression model, define r_i to be the actual return to firm i; $\hat{r}_i$ to be the predicted value of the return, given beta and the realized return on the market; and Er_i to be the *ex ante* expected return given beta and the expected return on the market. The deviation for a given return is:

$$r_i - Er_i = (r_i - \hat{r}_i) + (\hat{r}_i - Er_i)$$

where, $$\hat{r}_i = \alpha_i + \beta_i \, r_m$$

where the left hand side of the first expression represents the total deviation. The right hand side is decomposed into two terms representing the deviation due to firm specific factors and the deviation due to the market factor, respectively.

Clearly a case could be made that, in terms of auditor losses, the portion of the deviation due to firm specific factors is the more important. It seems reasonable to expect the firm specific deviations to be more closely associated with auditor errors than deviations due to market factors[47] [48]. A line of reasoning would be that a negative SMR in a down market is consistent with expectations[49] and therefore provides no evidence of auditor negligence[50]. In contrast, a large negative deviation from $\hat{r}_i$ indicates a large within period fall in the firm specific element of the return. One possible explanation for such an event would be that the market acquired information which implies an error in a previous financial statement.

Unfortunately, neither the investor nor the auditor can know the outcome of the market at the time the audit is planned. The relevant issue is: which of the available security risk measures is of help in assessing audit risk *ex ante*? Since both systematic and non-systematic factors are affected by real variables, both measures should help in assessing the business and financial risk of the firm. In particular, the own variance measures the unexpected shocks

[47] If financial statements are misstated the beta used to estimate the expected return may also be called into question. However, investors can be expected to use many sources of information, not just time series data, to assess the riskiness of a security.

[48] Some have conjectured that auditor lawsuits are more common during economic downturns. This is conjectured since auditors may be the only party connected with the client that has sufficient funds. (See Minnow p. 76.)

[49] Additionally this deviation represents the market risk which is priced in the market and the investor expects to bear.

[50] A related issue is whether the courts can (or do?) effectively factor out the market influence upon the share price in light of a discovered auditing error. If the courts could do this then one would expect to find, at most, a small relationship between "beta" and audit risk.

experienced by the firm which, to the extent these shocks are not readily understood by investors, could provoke the search for auditing errors and subsequently lead to auditor losses.

Let us assume the return to security i is normally distributed with mean given by 4.1a) and variance given by 4.2). For any critical value, D[51], determined by shareholders, a Z-score[52] can be computed. The value, D, represents the largest (D will usually be non-positive) return for which shareholders will sue[53] the auditor. The Z-score can then be used to determine the probability of a return being less than the critical value. This is one way to operationalize a proxy measure for audit risk[54].

This suggests we can concern ourselves with how changes in the market model parameters affect the Z-score and

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[51] Note that the " D", an exogenously given shareholder cutoff point, used in this chapter is distinct from "D_k", a measure of recoverable shareholder damages, used in chapter 3.

[52] The symbol "z" in this chapter is distinct from the z's used in Chapters 2 and 3 where they denoted the result of an audit test.

[53] Normally D would be determined endogenously in an equilibrium model of shareholder and auditor behaviour. The actual D chosen will be very sensitive to the costs of litigation. For now it is assumed D is given exogenously.

[54] For example, let there be two firms with return distributions R_1 and R_2. Assume there is a common critical value, D, then $z_1 < z_2$ implies $Pr[r_1 < D] < Pr[r_2 < D]$. The larger the Z-score for a given D, the riskier the audit. This is true since if one were to take the r_i from the support $r \in (-1,D)$ and to form a new (truncated) distribution, m, such that $m_i \in [-1,D]$, then the distribution m_2 (corresponding to r_2) is riskier than m_1 in the sense of (at least) second order stochastic dominance.

consequently the probability of litigation.

$$4.3)\quad Z = [D - E\,r_i] \,/\, sd(r_i) = \frac{D - (a + \beta_i\, E\,r_m)}{[\beta_i^2\, var(r_m) + var(e_i)\,]^{1/2}}$$

Equation 4.3) defines the Z-score in terms of the components of the market model. Note that D is used to represent the shareholders' critical value in returns space. Since the legal system requires actual damages in order to sustain a suit the largest value for D would be zero. This is consistent with defining the loss function as t - t'. In the sequel D will frequently be assumed to be equal to a zero return.

Next we turn to how $z[\ \beta_i,\ var(e_i),\ var(r_m)\ ]$ changes with changes in the various market risk parameters. The parameters of interest are β, $var(e_i)$, and, to a lesser extent, $var(r_m)$. The derivative of z w.r.t. beta, z_1[55], can be shown to be positive if:

$$4.4)\quad E\,r_m + \beta_i \left[\frac{var(r_m)}{var(r_i)}\right] [\ D - (a + \beta_i\ Er_m)\ ] \quad < 0$$

This in turn holds when:

$$4.5)\quad E\,r_m \ < \ (Er_i - D)\ \beta_i \left[\frac{var(r_m)}{var(r_i)}\right]$$

which can be written as:

[55] z_1 refers to the partial derivative of z w.r.t. its first argument, β_i. z_2 and z_3 are the partials w.r.t. $\sigma(e_i)$ and $\sigma(r_m)$, respectively.

$$4.6) \quad \frac{E\ r_m}{a - D} \quad x \quad \frac{var(e_i)}{var(r_m)} \quad < \quad \beta_i$$

By inspection condition 4.6) seems likely to hold true if β_i is large and the opposite to be true for β_i small. However, the relationship is not this straightforward. There is a mixed association between a firm's beta and the probability of loss, which is conjectured to be a proxy for audit risk. This result is not initially obvious. Increasing the beta has two effects (see Figure 6). As can be seen from the figure, increasing the firm's beta will cause the expected return to the firm to shift to the right[56]. *Ceteris paribus* this will decrease the probability of a return less than D. The second effect is in the opposite direction. Referring to equation 4.2), and as can be seen in the figure, it is clear that increasing beta increases the variance of r_i. This in turn increases the probability of a return less than D. Expression 4.6) indicates that which of the two effects dominates depends upon the values of the other variables.

The analysis of the other two parameters to be considered is in the same vein, though the results are straightforward to interpret.

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[56] The diagram was generated using betas of .5 and 2, respectively. These values were chosen in order to provide a difference which could be easily discerned. All other parameter values are identical for the two distributions. Note that in this particular case the higher beta firm has greater weight in the tail for all values less than -.07.

4.7) $$z_2 = \frac{E\,r_i - D}{2\ \mathrm{var}(r_i)^{3/2}} > 0$$

4.8) $$z_3 = (Er_i - D)\,\frac{\beta_i^2}{\mathrm{var}(e_i)} > 0$$

Both variance effects indicate a positive relationship between increased variance and the probability of loss. The results are fairly intuitive. Increasing these variance components fattens the tails of the return distribution without increasing the expected return, and therefore places more probability weight in the area where lawsuits can occur.

It is also possible to obtain a few results in terms of the expected value of negative returns. Two measures are used: the conditional expected value of negative returns (CNR) and the unconditional expected value of negative returns (UNR). Since the auditor may be forced to share in the losses of the shareholder (but not in the gains) when returns are less than D, it may be of interest to know the expected value of the shareholders' return[57], given they are less than D. This is the CNR. The UNR is the CNR times the probability of the return being less than D.

To make these measures more concrete, assume the

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[57] If the CNR is the expected value of the return given that it is less than D, then the expected amount of the loss for which the auditor may be held responsible could be some quantity V - CNR, where V is the value at which the courts start to accumulate losses. V, for instance, may correspond to the initial price (zero return) of the security.

returns are normally distributed with mean, $E[r_i]$, and variance, $var(r_i)$. Define the negative return[58] to be equal to $r_i - D$, where D is the point at which shareholders believe it is beneficial to sue[59]. Since only realized shareholder losses are actionable the negative return function is defined as:

$$\begin{cases} r_i - D & \text{if } r_i < D \\ 0 & \text{otherwise} \end{cases}$$

It can then be shown[60] that the CNR, given D, is:

$$E[r_i^L \mid r_i < D] = Er_i + \sigma(r_i) \bullet \left[\frac{-g(D')}{F(D)} \right]$$

where g( ) is a standard normal probability density function, F(•) the cumulative distribution function of r_i, and D' is standardized by[61]:

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[58] The negative return is defined "net" of D. This convention is adopted since D can be thought of as representing costs to the shareholder of searching for errors and initiating litigation. If the gain in expected utility of collecting potential damages does not exceed the loss in expected utility of these costs, then no suit is brought. The auditor is immune to small shareholder losses since the costs of litigation exceed the potential benefits.

[59] The auditor's loss function is assumed to be linear in shareholders' losses. Generally, the auditor's losses are some function, $f(r_i)$. It seems likely that $f'<0$ though the nature of f'' is an empirical issue.

[60] The proof is fairly straightforward. See Appendix 3.

[61] For example, if r_i is distributed normally with a mean of .1, a standard deviation of .2, and D set equal to zero then the folllowing quantities can be calculated.

$$D' = \frac{(D - E[r_i])}{\sigma(r_i)}$$

The UNR is defined as:

4.10) $$E(r_i^-) = E(r_i | r_i < D) \bullet Pr(r_i < D)$$

Hypotheses

In the above section various proxy measures for audit risk were developed. The supposition is that measures which quantify the risk borne by shareholders[62] may be useful to auditors in forecasting their future cash flows since the legal liability system can compel auditors to share stock market losses with security holders. The empirical tests look for a relationship between audit fees and the various

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$D' = (0-.1) / .2 = -.5$

$Pr(r_i < 0) = Pr(z < -.5) = .3085$

$E(z | z < .-5) = -.352 / .3085 = -1.14$

$E(r^-_i | r_i < 0) = (-1.14 \times .2) + .1 = -.128$

If D is set to -.20 then the values are -1.5, .0668, -1.934, and -.130, respectively.

[62] In Chapter 3 it was noted that losses can be suffered by two conceptually distinct groups of shareholders. Clearly new shareholders who have purchased shares, relying upon the auditor's attestation suffers a loss if the financial statements are false and the stock price declines. In Chapter 3 it was argued that current shareholders can suffer a loss if the auditor fails to discover management malfeasance and this failure allows for losses, which could have been prevented, to accumulate.

conjectured measures of security market risk. The hypotheses follow from the relations discussed in the previous section.

H1: Audit fees increase as the probability of shareholders' losses increase.

This hypothesis can be based upon the claim that shareholders' losses trigger the search for auditing errors. An increased probability of search then is assumed to translate into greater expected losses to the auditor. Two interpretations are possible. The first is that the existence of auditing errors is independent of returns and the courts require shareholders to have losses in order to show damages. This interpretation is plausible if the courts cannot separate the amount of damages caused by the audit failure from the amount attributable to other factors. Under this scenario the chain of events is: 1) shareholders' suffer losses, 2) this leads to a search for auditing errors and possible litigation, and 3) if auditing errors are found the auditors are compelled to compensate the shareholders.

The second interpretation is that the courts sometimes err in assigning fault to the auditor in the face of shareholders' losses. In Chapter 3 it was seen that due to the inability of courts to accurately distinguish between losses caused by auditors and those caused by other factors auditors sometimes had to bear the costs of bad outcomes regardless of the true cause. This requires auditors to anticipate this possibility and adjust their auditing plans and fees appropriately.

It is interesting to note that either interpretation is generally consistent with both the existence of a relationship between audit fees and $p(\theta_2)$, as conjectured in Chapter 3, and an observed relationship between audit fees and measures of security market risk. In the first interpretation courts are unable to disentangle the amount of the damages caused by the auditor's actions in the presence of other factors and in the second the courts are unable to determine whether the auditor was the cause of the damages. The link is that the distribution of returns is parameterized by $p(\theta_2)$ in such a way that higher levels of $p(\theta_2)$ lead to greater variance in the return distribution and to larger expected losses by the auditor.

To explore the plausibility of such a linkage consider two return distributions characterized by $p''(\theta_2) > p'(\theta_2)$. The first interpretation implies a greater weight is assigned to each element of the set of auditor's losses under $p''(\theta_2)$ than for $p'(\theta_2)$. This is related to return variability by the observation that in many cases greater variability "fattens" the tail of the return distribution from which auditor's losses are derived. In the second interpretation greater weight is given to the set of outcomes for which courts may construe auditing errors under $p''(\theta_2)$ than under

$p'(\theta_2)$. In terms of returns' distribution greater variability increases the likelihood of an outcome in the set (say returns less than D) in which auditor's errors are construed by the courts.

There are two related sub-hypotheses:

H1a: Audit fees increase with the residual standard deviation, $\sigma(e_i)$, of security returns.

This hypothesis is derived from expression 4.7). Increasing the residual variance, *ceteris paribus*, has the effect of increasing the probability of loss.

H1b: Audit fees may either increase or decrease with the market risk of a firm's security as measured by its beta. The sign and magnitude of the effect depend upon the factors given in expression 4.6).

Hypotheses 1a. and 1b. are of interest since previous researchers have used these measures in an *ad hoc* way to control for risk. These hypotheses may be difficult to test empirically since each relates to a component of total risk which, in cross-section, is not being held constant[63]. This implies that if, as the theory suggests, that total variance is the key concept the individual components may not be good

[63] I am indebted to Jim Brander for this intuition.

proxies for the real variable of interest.

H2: Audit fees increase with measures of expected shareholders' losses.

H2 is based upon 4.10). It is conjectured that CNR and UNR may measure potential shareholder losses. As such they may have greater association with audit risk and hence a greater ability to predict audit fees.

Data

In order to test the above hypotheses evidence was required about firms' audit fees and estimates of the market risk parameters. Audit fee data was obtained from Dan Simunic. This data is described in Simunic (1980). Data on the share price returns was obtained from the CRSP daily and monthly returns tapes. Additional share price data was collected from the Standard and Poors Daily Over the Counter manual. Regression analyses were run using the SHAZAM (see K. White (1987)) econometrics program.

The audit fee data consisted of 397 firms which responded to a survey done in 1977. Most of the firms had year ends in the period from December 1975 to June 1977[64]. The

[64] Of the 173 Firms in the weekly sample the distribution of year-ends was: prior to January 1976 -- 14%, from January 1976 through June 1976 -- 14%, from July 1976 through December

data consisted of audit fees for the most recent year end as well as information about accounting variables thought to be important factors in explaining audit costs[65]. From this set of firms a search was made to find firms whose common stocks were regularly traded.

A firm was considered for inclusion in this study if it met one of the following criteria:

1. there existed data on the firm in the CRSP monthly stock price return tape for the period commencing 60 months prior to, and running through, the reported year end for which audit fee data was available,

2. there existed data on the firm in the CRSP daily stock price return tape for the period commencing two years prior to, and running through, the reported year end for which audit fee data was available,

3. there existed data on the firm in the Standard and Poors Daily Over the Counter Manual for the period commencing 1 year prior to, and running through, the reported year end for which audit fee data was available.

1976 -- 59%, and after December 1976 -- 13%.

[65] Simunic (1980) describes factors which he found contributed to audit costs. They were size, complexity, and industry affiliation.

One hundred and twenty-five firms met the first criterion. This sample is referred to as the monthly sample. One hundred and eighty-three firms met the second criterion, however, 10 firms had to be dropped from consideration at this stage. These firms were discarded because either their return series included many missing observations or I was unable to positively match the firms with the audit fee data. This sample is referred to as the weekly sample. Many of these firms (116) were also included among the monthly sample. Finally, 79 firms matched the third criterion. This sample is referred to as the OTC (Over the Counter) sample. None of the OTC firms are included in either of the two previous samples.

Within the samples an OLS regression was run for each firm on the following model:

$$r_i = \alpha + \beta_i \bullet r_m + e_i$$

where, r_m was obtained using the appropriate value weighted market return from the CRSP tapes. From this regression estimates of β_i and $\sigma(e_i)$ were obtained.

For the weekly sample, daily return data was collected and then aggregated into weekly data. This procedure was used in order to avoid the problems associated with non-synchronous trading data (see Scholes and Williams (1977)). After weekly returns were calculated then parameter estimation was accomplished as with the monthly sample.

For OTC firms weekly price data was hand collected.

Returns were calculated using the mid-point of the end of week closing bid-ask prices. Returns were adjusted for capital changes and cash dividends. The individual firm returns were regressed upon the CRSP Daily Value Weighted Market returns in order to obtain the required parameter estimates.

However, this sample suffered from additional complications since there were many weeks in which these securities were thinly traded (see Table 9). From the table it can be seen, for example, that for 60% of this sample there were no weekly changes in price in twenty percent or more of the weekly trading periods. In addition, from the table it can be seen that the explanatory power of the market model is likely to be affected by the lack of price movement. In fact, the average r^2 for the OTC sample is but .06 (see Table 11). Many of the extreme values[66] of the beta estimate occur when there are a relatively large number of zero change observations.

Casual observation indicates that the number of no-change observations may be attributed to the fact that many of the firms traded at prices that were small compared to the

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[66] It is interesting to note from table 11 that the mean beta for this sample is .74, a relatively low value, given prior expectations about the riskiness of this sample. This value may be the result of several factors. For instance, the betas are not reliably measured due to the lack of trading. I would conjecture the lack of price movement would tend to weaken the covariance with the market and hence reduce the estimate of beta's value. The risk of these firms appears in the estimate of $\sigma(e_i)$ which, from the table, can be seen to be quite high, remembering that this is a weekly estimate.

bid-ask spread. This implies that even small price changes would reflect a relatively large percentage increase or decrease in the firm's value. Given that firm prices were usually quoted in 1/8th of a point increments, small changes in equilibrium prices might not be reflected in changes in the bid-ask spread. This could make it impossible to detect changes in the true price of the security. For these reasons the OTC sample was excluded from further analysis since the estimates appear to be unreliable.

Descriptive statistics of the samples[67] are displayed in Tables 10 and 11. Not unexpectedly, the weekly sample is comprised of firms which are larger and more complex than the OTC firms. The monthly sample firms are, on average, the largest firms. Figure 7 shows the distribution of firms' asset size.

Models

Following Simunic (p. 178) two forms of the fee regression model were used. The first model regresses the log of the audit fee on the log of assets and on other control variables. The second model transforms the dependent variable by dividing it by the square root of assets. These transformations are required since fees and assets do not

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[67] The statistics in these tables reflect all available observations. Similar statistics are given in the sequel for the samples reduced by the extraction of suspected outliers.

appear to be linearly related[68]. As mentioned above the variables proxy for fundamental factors such as scale, complexity, and risk which can be expected to contribute to the cost of producing the audit[69].

In addition to assets the other control variables used are: the square root of subsidiaries, the number of industries the firm participates in, a dummy variable indicating whether the firm is a utility, the percentage of assets which are either inventories or receivables and the percentage of assets which are held in foreign subsidiaries. Tests are run by including the variables β_i, $\sigma(e_i)$, and various other hypothesized measures of audit risk as explanatory variables in the audit fee regressions.

Specifically, the models used were:

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[68] The functional form used to analyze the data in this research is similar to the specifications in Simunic (1980), Francis (1984), Simon (1985), and Palmrose (1986). The relationship between audit fees and audit size is quite well documented empirically, though to the best of my knowledge, there is no theoretical work suggesting a particular functional form.

[69] As discussed in Simunic, these factors may be related to the risk of the audit as well as to the pure production of the audit. Conceptually the additional risk variables introduced in this research, since they are based upon security market measures of risk, can be interpreted as measuring the magnitude of potential losses, whereas the former variables measure audit risk in the sense of the auditor committing a type II error.

Model 1

$$\ln fee_i = b_0 + b_1 \ln assets_i + b_2 subsidiaries_i^{.5} + b_3 \, diversity_i + b_4 \, utility_i + b_5 \, current_i + b_6 \, foreign_i + \ldots b_n \, risk \; measures_i \ldots + e_i$$

Model 2

$$fee_i \, / \, assets_i^{.5} = b_0 + b_1 \, subsidiaries_i^{.5} + b_2 \, diversity_i + b_3 \, utility_i + b_4 \, current_i + b_5 \, foreign_i \ldots + b_n \, risk \; measures_i \ldots + e_i$$

Diagnostic Tests

Tables 12 and 13 show the correlation matrice for the weekly and monthly samples respectively. Multicollinearity does not appear to be a serious problem in the weekly data. In the monthly data beta and $\sigma(e_i)$ have a correlation of .6. This would indicate a conservative approach in interpreting the coefficients when both of these variables are present in the regression. Table 14 presents a cross-tab view of the relationship between the two variables in the monthly and weekly samples.

Test of Normality

Tables 15 and 16 indicate that the residuals of the original samples varied from the normal distribution in the sense of having non-zero third and fourth moments. This prompted a search for possible outliers. In the monthly sample one firm had an unusually low fee, $257,000 on assets of over $4 billion, and was removed from consideration. It is unknown whether the fee is correctly reported. After this observation was deleted the residuals of the monthly data are more nicely behaved[70]. See Table 16.

For the weekly data, four observations were removed. One observation was the one described in the previous paragraph and the other three were financial institutions. For these firms, assets may not be a commensurable measure of size in comparison to industrial firms. Once these firms were removed the residuals appear to be more "normal". However, the square root model was somewhat skewed and "fat-tailed", see Table 15. All subsequent analysis is done using the samples with the outliers removed.

Tests for Heteroscedasticity

Two tests were used to check for heteroscedasticity in the residuals, see Table 17. The Breusch-Pagan-Godfrey test described in Judge et al. (1980 p. 146) and the Harvey test

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[70] The search for outliers was done using plots of residuals against various variables. An observation was removed from the sample only if, upon examination of the firm's characteristics it seemed reasonable to conclude that its reported fee was either in error or in large measure determined by some factor(s) not included in the model.

(Judge et al. p. 149). The intuition behind the former test is that it checks to see if the residuals are a linear function of the independent variables. In both samples the residuals of the square root model appear to violate the homoscedasticity assumption.

Comparing the two models it seems likely that the cause of the heteroscedasticity is due to the non-linear relationship between fees and assets. By this criterion the log model is the better specification. But lacking any convincing theory about the functional form of auditing production functions both models are used. To correct the estimates all subsequent regressions of the square root model incorporated White's heteroscedasticity-consistent method[71]. (See White (1980).)

Specification

Since the theory developed above does not specify the functional relationship between audit fees and risk measures, there is the possibility of mis-specification. Ramsey's RESET test provides one method to test for omitted variables[72]. This

[71] White's method substitutes a diagonal matrix of the squared OLS error terms for G into the OLS variance-covariance matrix $\sigma^2(X'X)^{-1}(X'GX)(X'X)^{-1}$. See Kennedy (1985 p.108).

[72] If there is an omitted variable in a regression model the influence of the omitted variable is reflected in the error term. The RESET test uses powers of the error term to proxy for omitted variables. These transformed error terms are added to the regression and an F-test is used to test for the

test was run for each model and data set. These tests do not detect any strong pattern of mis-specification, see Table 18.

The theory indicates (expression 4.6) that if beta is a good proxy measure of risk through its contribution to the Z-score, then the coefficient on beta effect will not be constant. Thus, regressions which include beta (to control for risk) over a broad range of $\sigma(e_i)$ values are likely to be mis-specified. Figure 8 plots the results of a simulation where, for a set of fixed parameters, the change in the Z-score is plotted against beta for various levels of $\sigma(e_i)$. The figure suggests that the contribution of beta to risk is the most variable when both beta and $\sigma(e_i)$ are small. The effects appear to stabilize when beta exceeds .5 and $\sigma(e_i)$ exceeds .03, on an annual basis. Figure 9 shows the results of the simulation for values more typical of the sample. Note that .1 on an annual basis is approximately equal to .015 on a weekly basis, the minimum in the weekly sample. Table 14 shows the relationship between beta and $\sigma(e_i)$ in the weekly and monthly samples. The $\sigma(e_i)$'s in Table 14 are on a weekly and monthly basis, respectively.

Returning to Figures 8 and 9 it is clear that the usual OLS assumption of a constant effect of the independent variables does not hold for certain combinations of beta and own-variance. In cases were the effect varies over the range of the data the estimates are measures of the average effect.

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significance of the coefficients.

These figures do suggest the importance of partitioning the data on the basis of own-variance as was done. They also suggest that a further partitioning on beta may also be appropriate. This was not done since there were few observations with both very small betas and own-variances.

Since the measures β and $\sigma(e_i)$ are themselves estimates, the regressions may suffer from an errors in the variables problem. The use of OLS in this situation can result in asymptotically biased coefficients. A common method for dealing with this problem is by the substitution of instrumental variables for the variables which are measured with error. Note, however, that in this study the measures are instruments for some more basic risk measure. While the extent of the bias is unknown, including these imperfect measures is taken to be preferable to excluding risk measures from audit fee studies.

Tests

This section reports the results of the hypotheses given above. H1 hypothesized that audit fees would be increasing in the probability of loss. Two measures of probability of loss are used, the Z-score, and ploss. Ploss is the cumulative density of the Z-score. In order to calculate the Z-score it is necessary to assign values to D, Er_m, r_f, and $\sigma(r_m)$.

Estimates of the latter three values were obtained from CRSP market data for the 4-year period January 1974 through December 1977. Figure 10 plots the market index for this period. Figure 11 shows an average annual return and annualized $\sigma(e_i)$ for each 52 week period. As can be seen from the figure there is a great deal of variance in the actual market return. This makes it difficult to know how auditors and shareholders used this information to predict the expected future return. The average for the four year period was about 15%. This number was used to calculate the z-scores[73].

A variety of values for D and $\sigma(r_m)$ were tried. It should be recognized that many of the parameters used to calculate the z-scores were picked on an *ad hoc* basis. Sensitivity analysis is used to overcome some of the short comings. The fundamental problem is one of reconstructing the decision process used by shareholders and auditors. For instance, it is unknown what model the shareholders used to predict the expected return in the market. While the CAPM assumes stability with respect to this parameter clearly this does not govern investors expectations. Similarly without knowing the cost conditions faced by shareholders it is impossible to determine the correct D for each firm. The crudeness of the measures used should work in favor of the null hypothesis of no association. To the extent that the phenomena is visible through the limitations of the available

[73] Sensitivity analysis was done using 10% and 20%. The results didn't vary much with the lower number, but were not as strong with the higher number.

data increases the confidence in the result.

The results of ranging D and $\sigma(r_m)$ are shown in Tables 19 and 20. Table 19 displays the results on the z-scores. A smaller (more negative) z-score indicates a smaller probability of loss, therefore an increase in the z-score is predicted to be associated with greater risk. This implies a positive coefficient is predicted. From the table it can be seen that the coefficients are positive for almost all specifications on both samples. The t-values on the coefficients are significant for most of the weekly sample cases. The best results are for a D of -.75 and a higher value of $\sigma(r_m)$.

The results on the probability of loss are similar, see Table 20. The coefficient is expected to have a postitive sign and this is borne out by the evidence for most specifications. Once again the results are strongest for the weekly sample.

In comparing the monthly and weekly samples it is important to remember that auditors and investors are trying to estimate future risk, while the estimated parameters used are historical. The two samples provide different time frames for these estimates. It is likely that investors and auditors use both sets of information, though how they weight them is unknown. The weekly sample having a 2 year estimation period is more current than the monthly sample. However, the beta estimates from the monthly sample provide a better fit, see

Table 11. Also since the fee regressions use estimates of beta and $\sigma(e_i)$ estimated from over-lapping time periods (refer to Table 8) there is the possible problem of contemporaneous cross-correlation. This can lead to serious biases in the standard errors. Bernard (1987) indicates this problem may be more serious the longer the estimation interval. This could contribute to the monthly sample results.

Evidence for H1a and H1b are found in Tables 21 through 26. Generally, the results support the hypothesis, H1a, that audit fees are increasing in $\sigma(e_i)$. The strongest evidence is in the weekly data.

The hypothesis H1b was tested by partitioning the data as suggested by expression 4.6).

4.6) $$\frac{E\ r_m}{a - D} \times \frac{var(e_i)}{var(r_m)} < \beta_i$$

In terms of firm specific parameters this may be rewritten as:

$$K \bullet var(e_i) < \beta_i$$

where, K is a constant encompassing the non firm-specific elements. This suggests that betas contribute to risk when $\sigma(e_i)$ is small. This was implemented by ordering the samples on the basis of own variance. Low and High own variance subsamples were created by omitting observations with intermediate values of $\sigma(e_i)$. The tables show the results of the partitioning. As predicted the low samples tend to have larger positive coefficients than high samples. One subsample, weekly data model 2, even had a negative coefficient. Generally, the weekly sample supported the hypothesis more strongly than the monthly sample. Of particular interest are Tables 23 and 26 where statistics are given on a test of the difference between the beta coefficients in the low and high sub-samples. This test was accomplished by including a beta dummy variable to indicate observations from the low sample in a single regression that consisted of observations from both the high and low samples. A positive coefficient on the beta dummy indicates a positive difference between the low sample beta coefficient and that of the high sample. The T test of the dummy variable is equivalent to a Chow test.

Tables 27 and 28 report summary statistics for each of the sub-samples.

Tables 29 and 30 show the results of using the CNR and UNR measures. In these cases the expected coefficients are negative. Figure 12 plots the measures Ploss, CNR and UNR against the z-score. These values were determined using a simulation model. The negative coefficient is, at first look, surprising as intuition would lead one to believe that firms with smaller (more negative) z-scores also would have smaller CNRs and UNRs. Figure 13 shows two return distributions. R' is the less risky distribution having both a smaller beta and $\sigma(e_i)$. For a fixed value, Z, the probability $r_i < Z$ is greater expected value of r_i, given that $r_i < Z$, is larger (less negative) for R' than R''. And since the probability of a return being less than Z is less for R', then UNR is also larger.

Once again both samples are consistent with the hypothesis, H2, in terms of the sign of the effect. For a wide range of parameter values these results show significance in the weekly sample for both the CNR and UNR measures. For the monthly sample the results are consistent but not significant at conventional levels. Table 31 gives the correlations among the risk measures and Table 32 gives examples of how the risk measures map into one another. Table 33 summarizes the results of the regressions on the proxy measures of risk.

Conclusions

The data suggests that there is a relationship between audit fees and *ex ante* measures of security market risk. The argument was made in Chapter 3 that auditors would be sensitive to the likelihood of "bad" client firm stock returns. The hypotheses in Chapter 4 suggest that care must be taken in using the security market measures since their effect is not always straightforward. In particular, it was shown that the influence of beta upon audit risk varies with other factors.

With regard to the data, it is apparent that specification of the parameters and model also affect the results, though there is a fair amount of robustness in the results. The weekly data outperformed the monthly in all cases and the results for the monthly data lack statistical significance. This is somewhat surprising given that the weekly estimation period is a subset of the monthly estimation period and that the monthly estimates of individual betas have greater explanatory power as measured by an average r^2. In favor of the weekly data are the facts that the information was more current, in the sense that the estimates were not influenced by observations that preceded the decision point by more than two years, and that the weekly data had twice as many degrees of freedom.

With regard to model specification two alternative transformations were used to control for the influence of client firm size. Both of the transformations have been used and discussed in the literature. In the sample that I used the square root transformation consistently showed greater significance on the coefficients of interest than did the log model. However the square root model also showed evidence of heteroscedasticity which was adjusted for using White's method. Tests of the hypotheses showed significance at conventional levels using either model in conjuction with the weekly sample.

Some assumptions were needed about the values of parameters such as the expected return on the market, the variance of the market, and, most critically, about the shareholders' decision rule, D, in order to perform some of the tests. Sensitivity analysis was done with each of these parameters. The results of varying the expected return on the market were not reported as they were accomplished at a relatively preliminary point in the research, however the results, at that time were relatively insensitive to changes in the value used. The measure used was crude and a better model of how investors anticipate the market over time would be useful. The D value of -50% seemed to perform well with relatively little change in significance between the tests with D's of this value and those with D's of -25% and -75%. Once again the tests could be honed if information were available on how this value might vary cross-sectionally within the samples. Sensitivity on $\sigma(r_m)$ generally indicates improvement as the parameter value increases from .1 to .2 and some additional marginal improvement as the parameter value increases to .3. Sensitivity was not performed at higher levels since .3 seemed a reasonable upper bound for market variability.

The overall impression of the empirical tests is that audit fees do, to some extent, reflect risk as measured in client firm's securities. The extent of the risk adjustment is relatively small compared to such production factors as the size and complexity of the client, but the data is consistent with the argument that audit fees include risk adjustments which are associated with security market measures of risk.

Chapter 5

Summary and Conclusions

This thesis started with a decision theory model of auditing in which the auditor chooses a cost minimizing audit plan and audit opinion to accomplish an audit. In order to make his choices the auditor must assign values to the costs of making type I and type II errors. In previous research the costs associated with these errors were modelled as being determined exogenously and without regard to whether the decisions made by the auditor result in a rational play by the affected parties.

In contrast the analysis in Chapter 3 assumes that the cost of a type I error, c(I,) is fixed, but that the cost of a type II error, c(II), is determined as the result of a game between auditors and shareholders. The important link in the strategic play of the game is the system of product liability in which auditors may havve to make transfer payments to shareholders when auditing errors are found by the courts. This establishes a conflicting set of interest between the auditors and shareholders which can be represented by a non-cooperative game.

Employing the Nash equilibrium concept, an analysis of equilibrium strategies shows how stock price information influences shareholders' behavior. In turn this affects the play of the game and the resultant equilibrium. The key point is that the risk of "bad" outcomes maps into the auditor's loss function and results in higher auditing costs. These costs reflect various factors such as: the costs of giving a protective qualification, additional auditing, insurance, or the recovery of an expected loss.

In Chapter 4 empirical hypotheses are formulated about the association of specific market based measures of security risk and audit risk. The main linkage between the theoretical analysis and the empirical work is the conjecture that variability in the distribution of stock returns is associated with the probability weights assigned to those outcomes for which auditors are at risk. Further, institutional considerations link those factors which affect return variability with auditor having to sometimes bear the risk of bad outcomes in stock markets. Various observations support this mechanism. For instance the inability of courts to distinguish shareholders' losses caused by auditors from those caused by other factors[74].

A specific hypothesis of interest is the value of a client firm's market "beta" as a proxy for audit risk. This measure has piqued some curiosity in the accounting literature

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[74] A secondary argument is that factors which determine risk in securities markets, such as stochastic product demand, also add to the difficulty of producing an error-free audit.

because of its prominence in the theory of finance. It is found that beta may be of value in measuring audit risk if it is recognized that its affect is not constant.

The main tests in Chapter 4 revolve around the association between audit fees and the probability of a security having a "sufficiently"[75] bad return. Evidence is found which supports the hypothesis of audit fees increasing in this measure which in turn can be derived using market measures of risk.

The research, herein, relied upon many assumptions which potentially limit its generality. In the auditor-shareholders game the greatest restrictions involve the assumed role of management and the ability of the courts to disentangle the determinants of stock prices. A more profound treatment of the subject would allow the firm's management to behave strategically. Unfortunately this embellishment has an exponential impact upon the complexity of the game. The difficulties of analyzing such a regime are noted by Antle (1982). Changing the court's access to information would also drastically change the analysis. In the extreme case, perfect information by the courts would make market risk irrelevant to the auditor since the courts would 1) correctly identify auditing errors, and 2) properly assign, given the liability rules, damages to the appropriate tortfeasors.

[75] Sufficiently means bad enough to provoke the shareholders into seeking compensation from the auditor through a lawsuit.

In the empirical analysis many assumptions were made with regard to the various parameter values needed to assess the probability of a loss. These have been previously discussed. The assumptions about the shareholders' decision rule, D, are, perhaps, the most heroic. This quantity is clearly endogenously derived on a firm by firm basis. This research would benefit from a better model (and data) of the shareholders' decision process.

One contribution of this thesis is that it refines and extends the understanding of the auditor's decision problem to include the assessment of risk when an additional economic agent is allowed to behave strategically. The empirical analysis provides new information useful to the understanding of the impact of risk in the supply of auditing services.

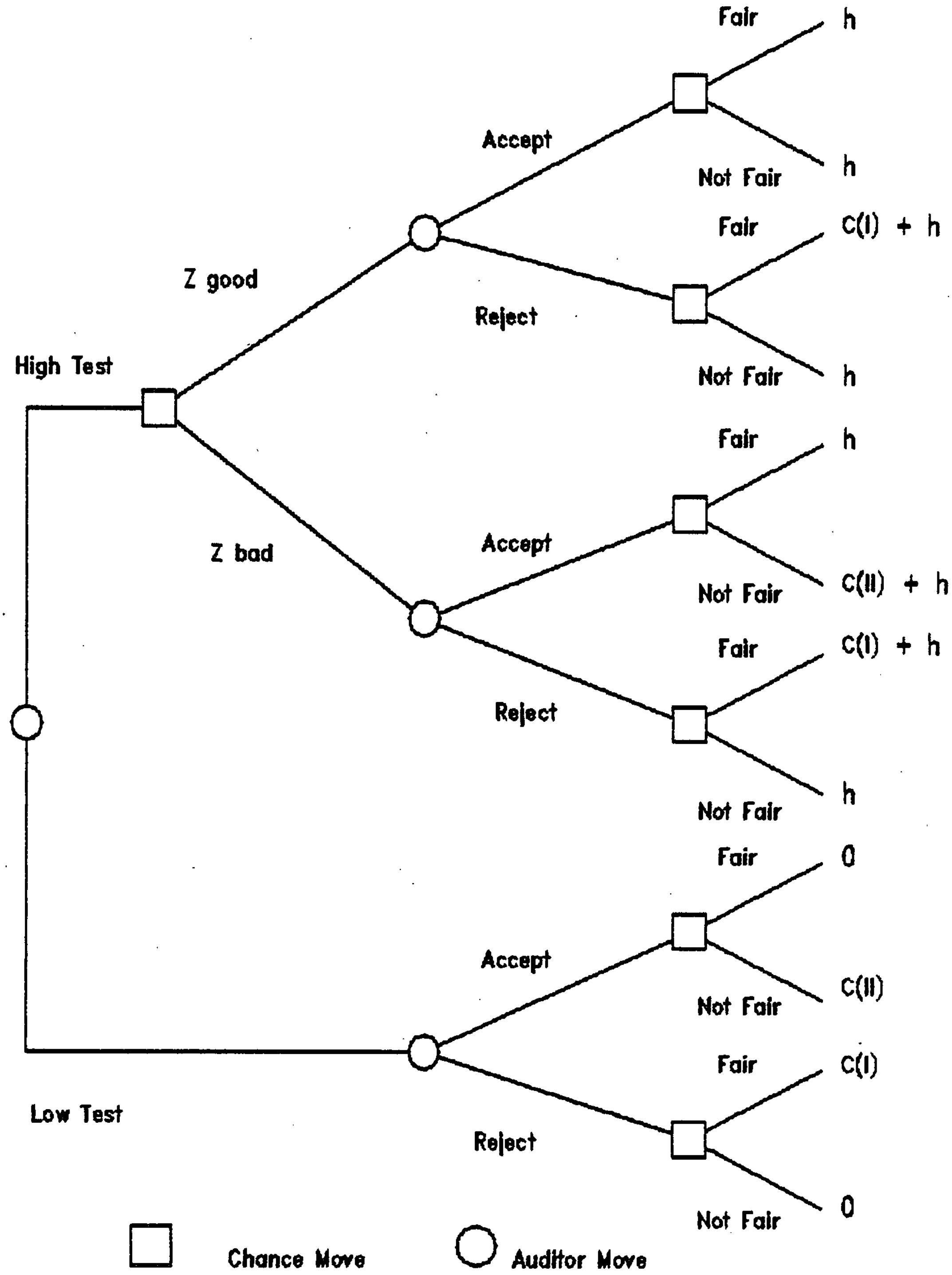


Figure 1. A simplified auditor's decision problem.

Nature

Auditor	s_1 (fair)	s_2 (not fair)	
a_1 (accept)	0	$c[a_1, q, s_2, z]$	Unqualified Opinion
a_2 (reject)	$(a_2, q, s_1, z\ )$	0	Qualified Opinion
	F.S. are true	F.S. are false	

Figure 2. The costs of the types of audit errors.

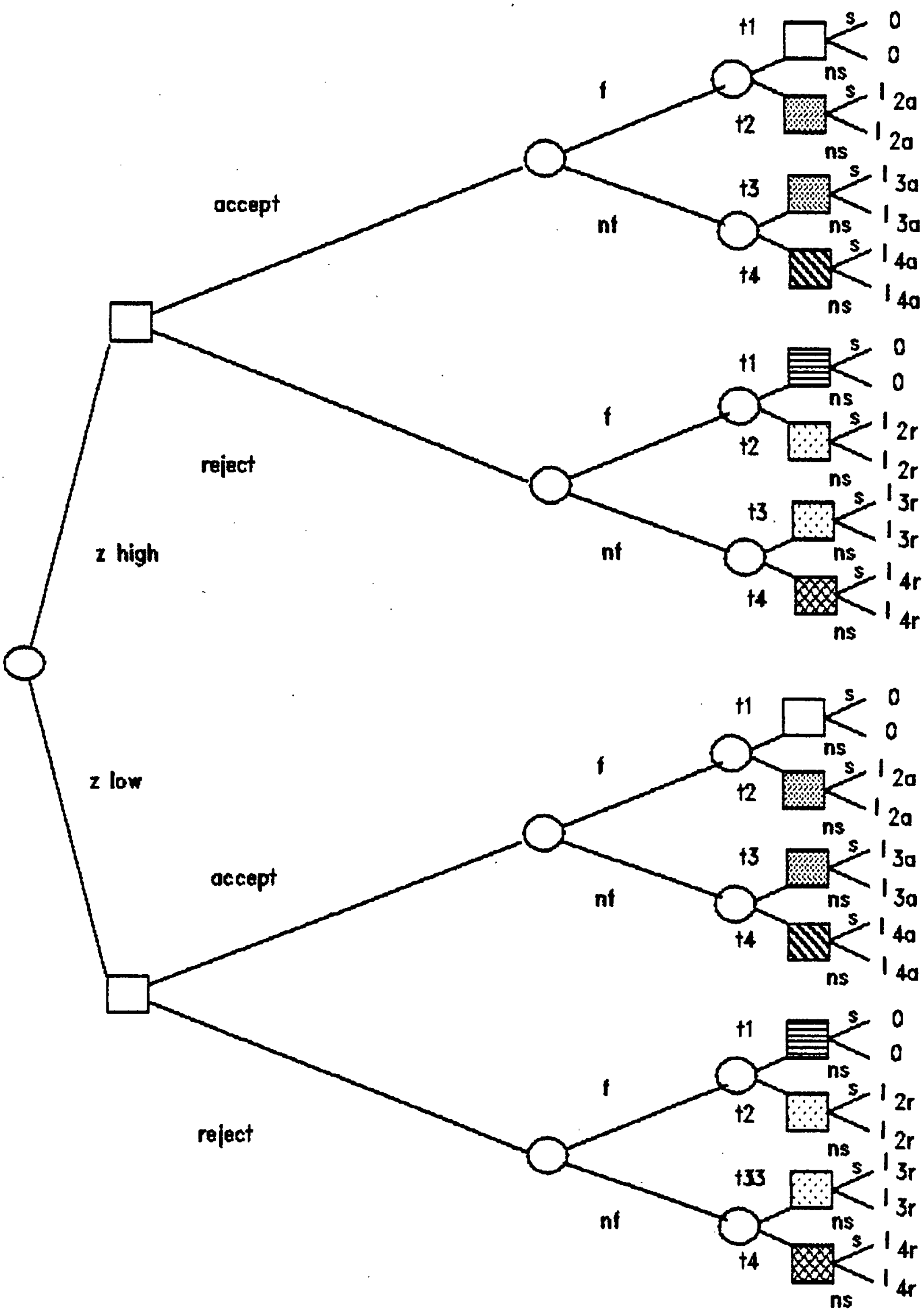


Figure 3a. Auditor-shareholder game, high audit level.

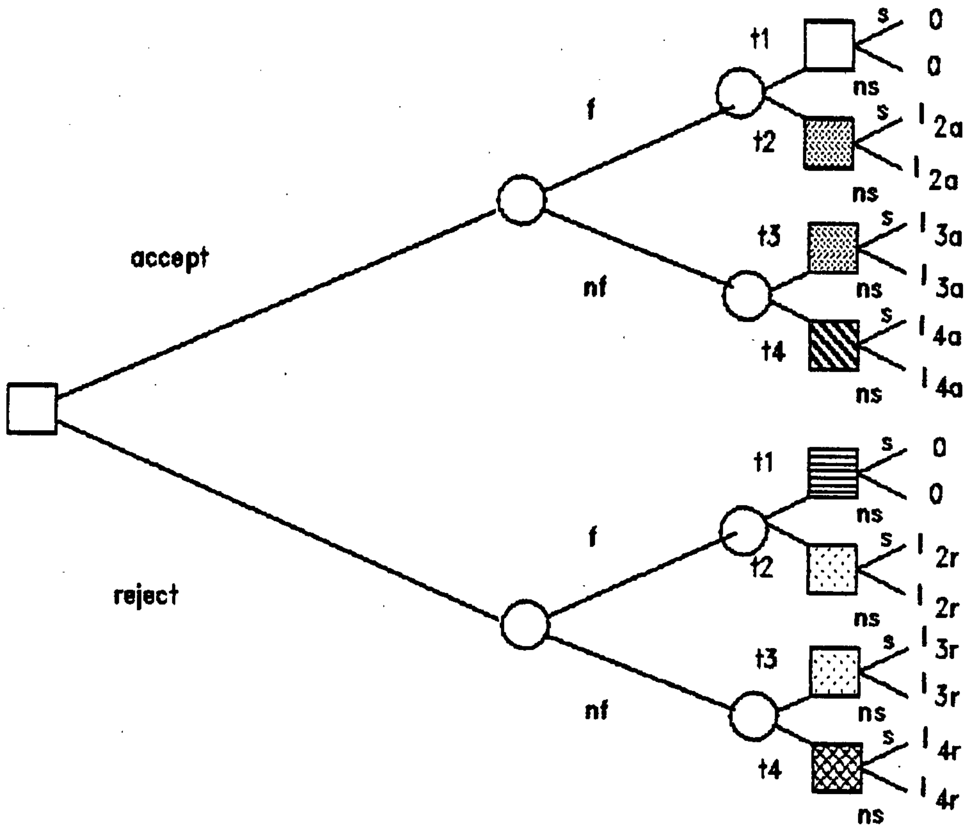


Figure 3b. Auditor-shareholder game, low audit level.

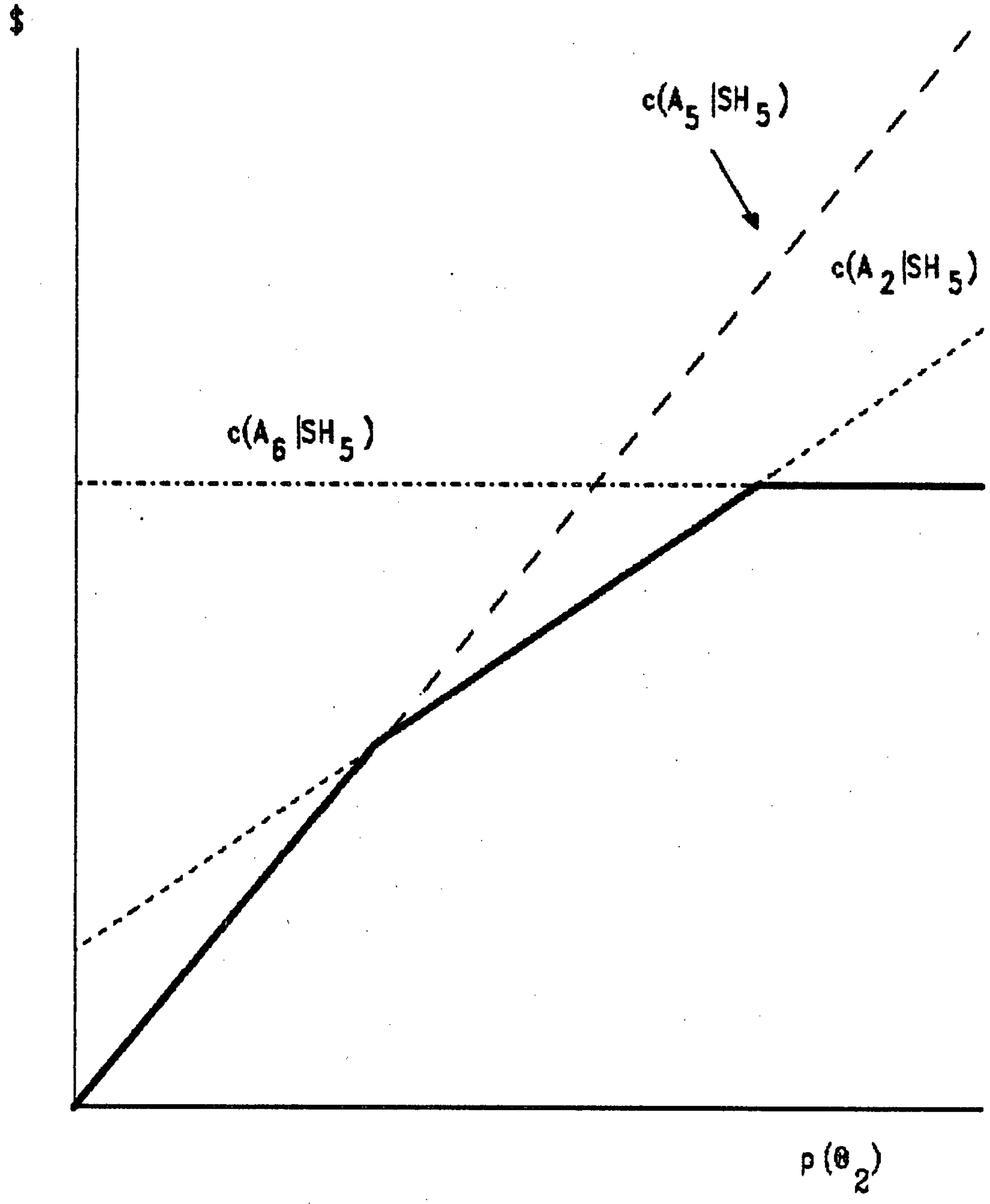


Figure 4. Expected auditor's costs under a strict liability regime.

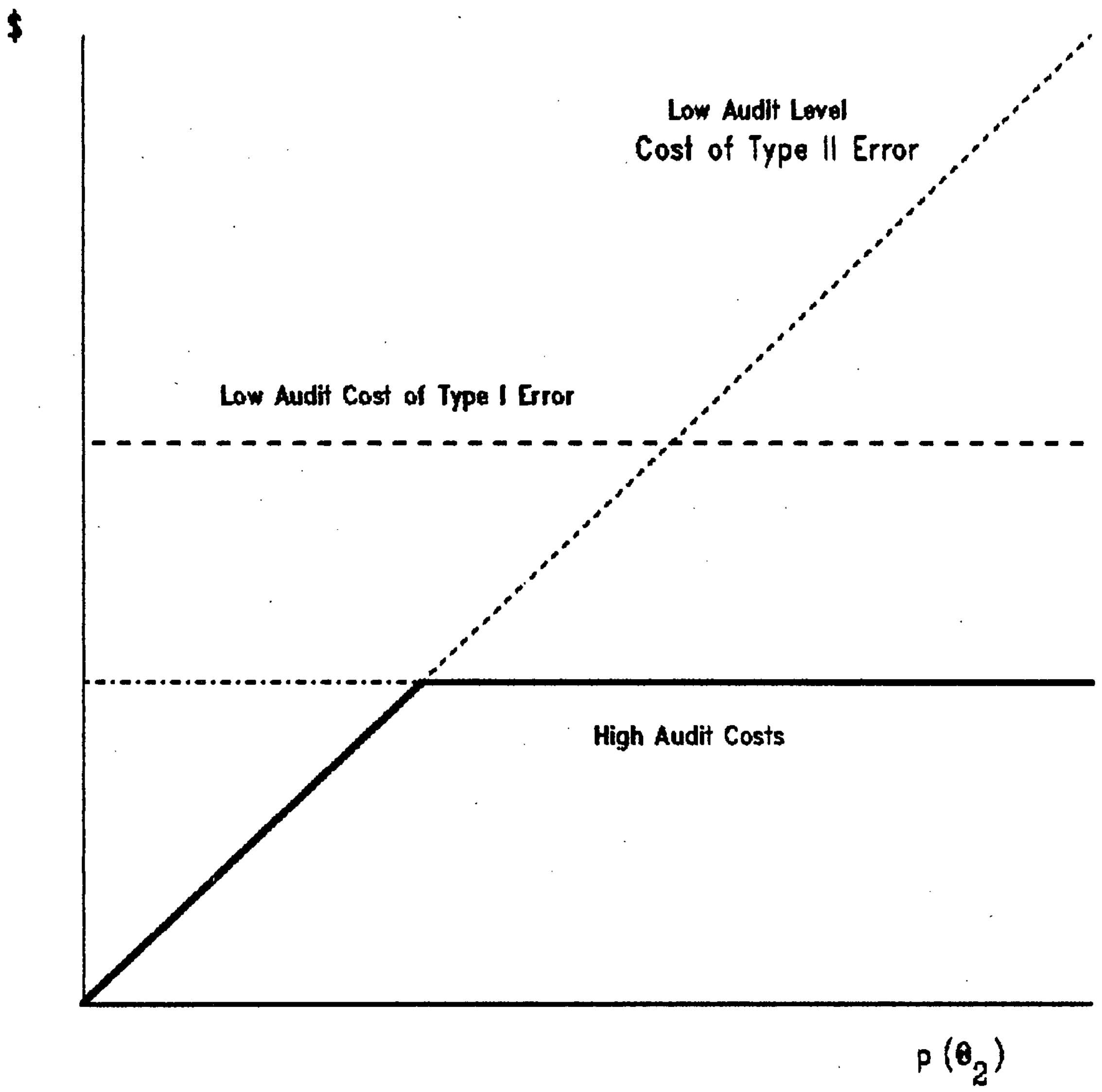


Figure 5. Expected auditor's costs under a negligence defense regime.

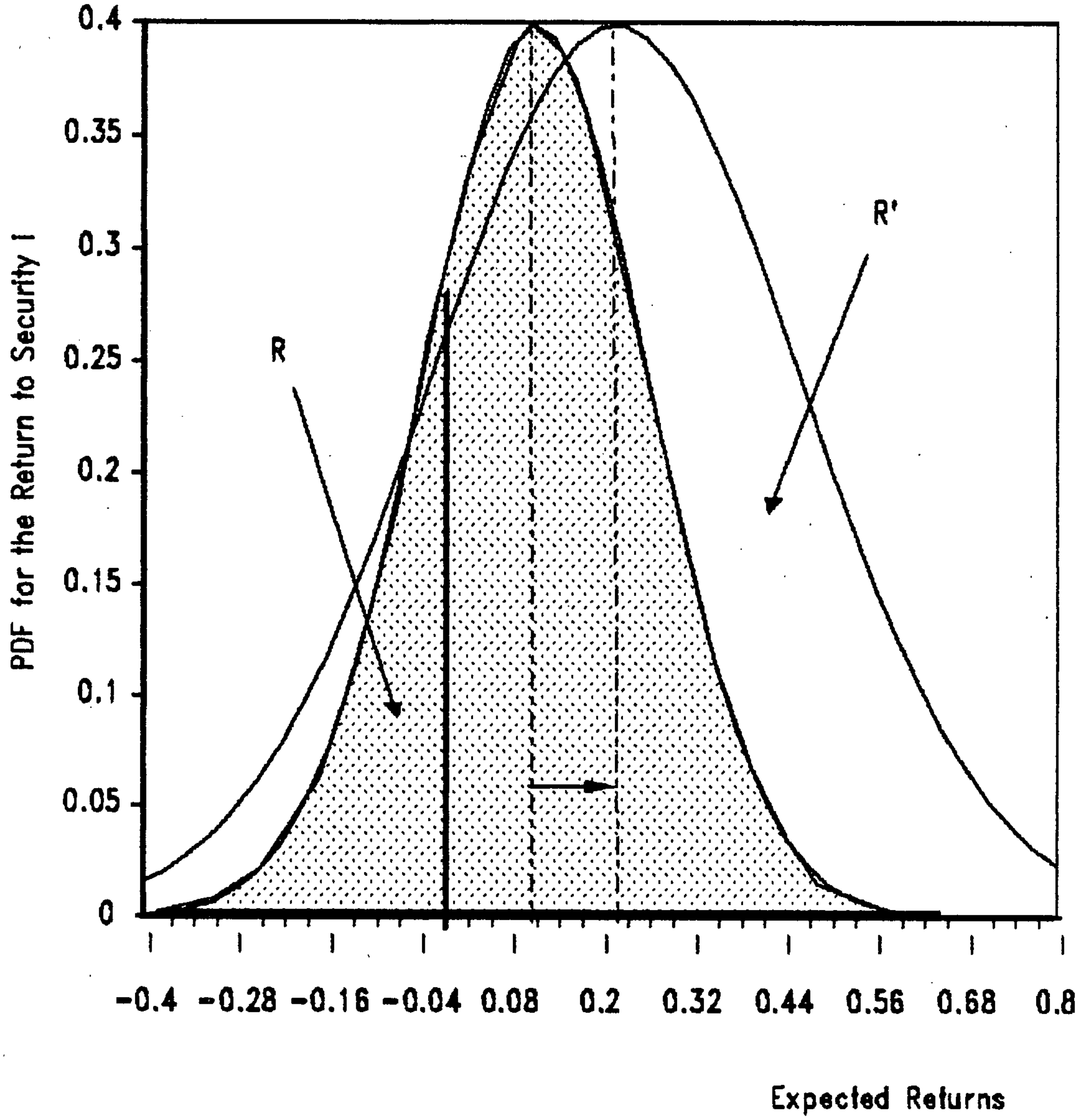


Figure 6. Shift in the return distribution as beta increases.

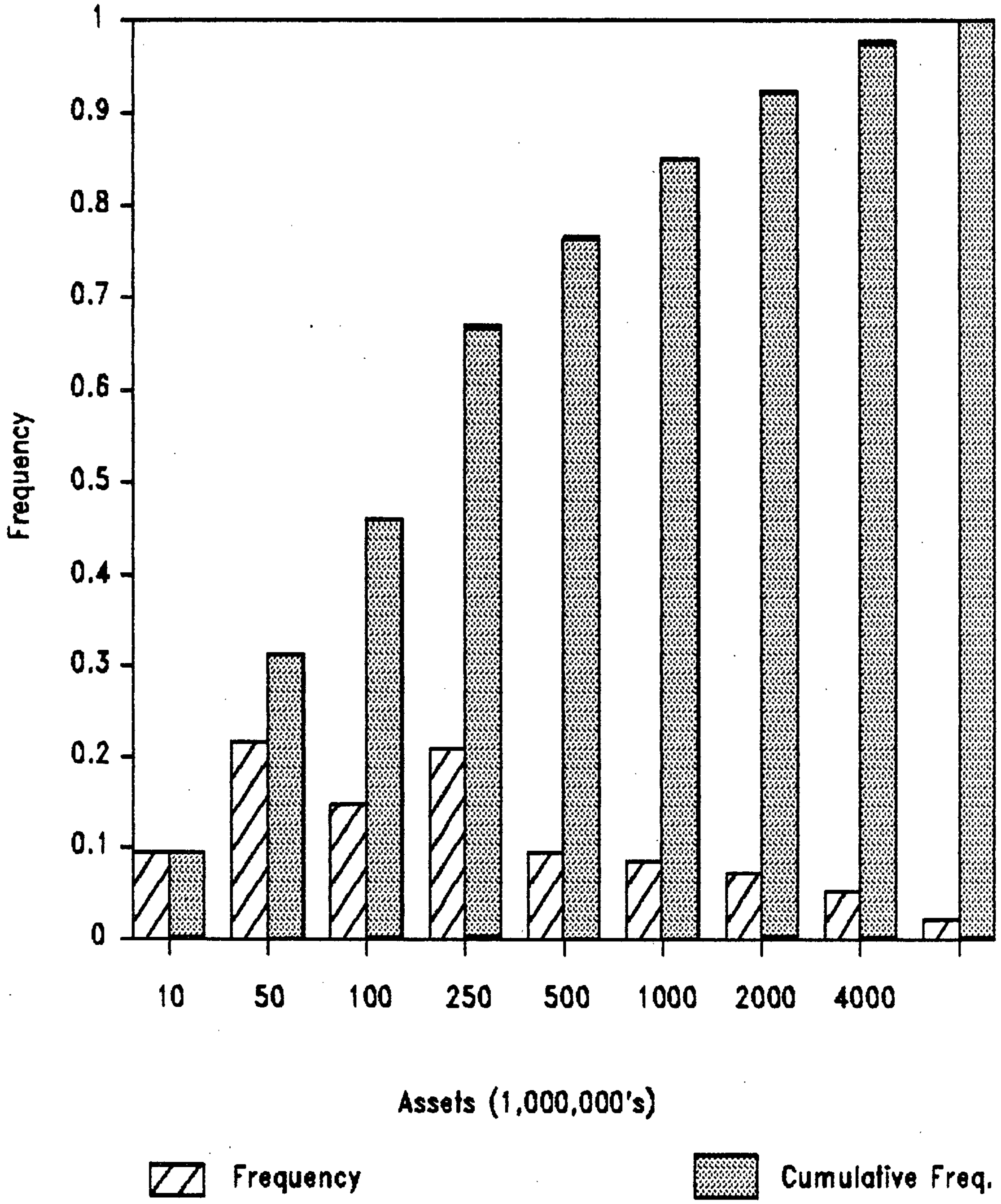


Figure 7. The size distribution of sample firms' assets.

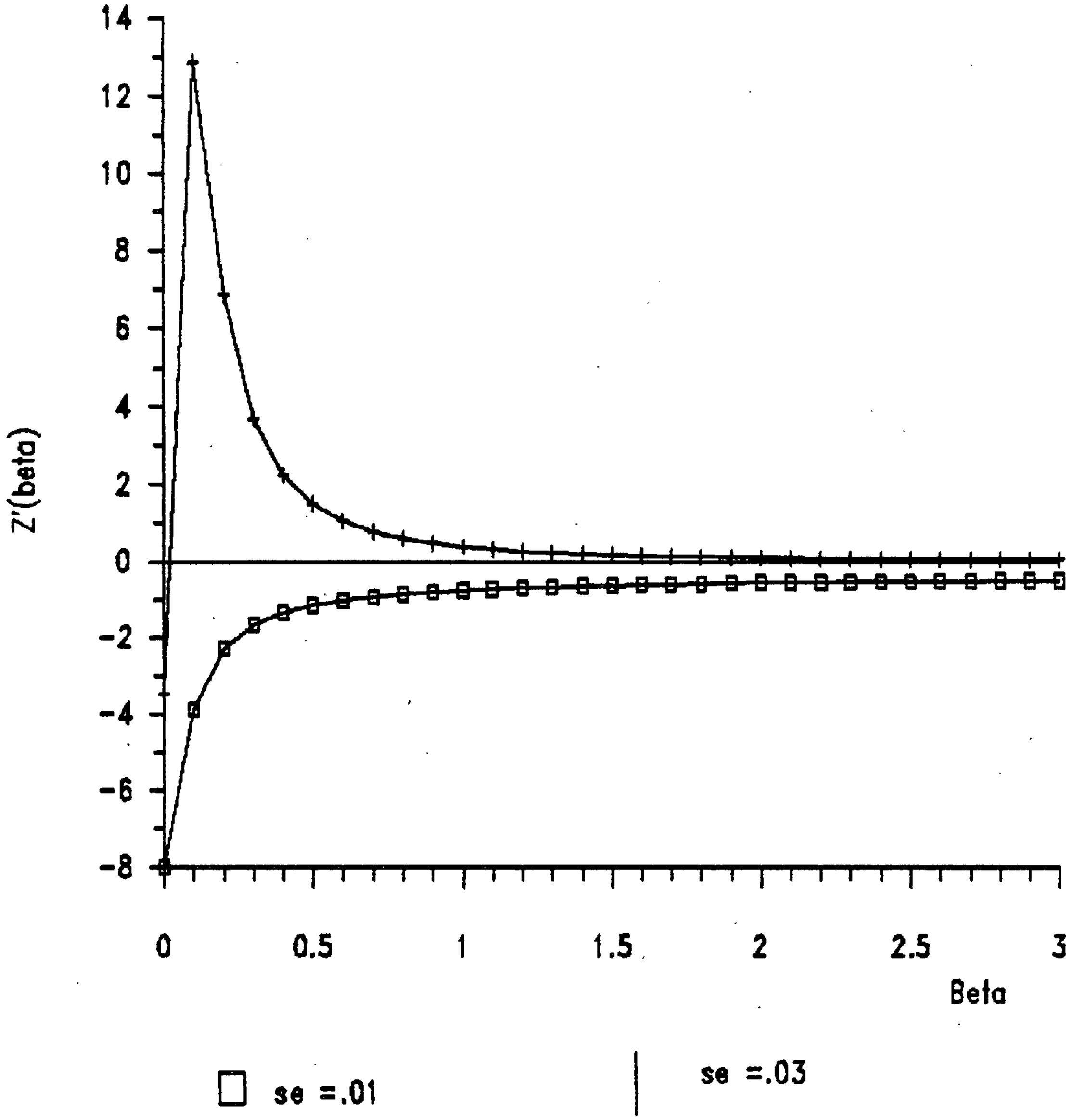


Figure 8. Simulation of the change in z-score as beta increases.

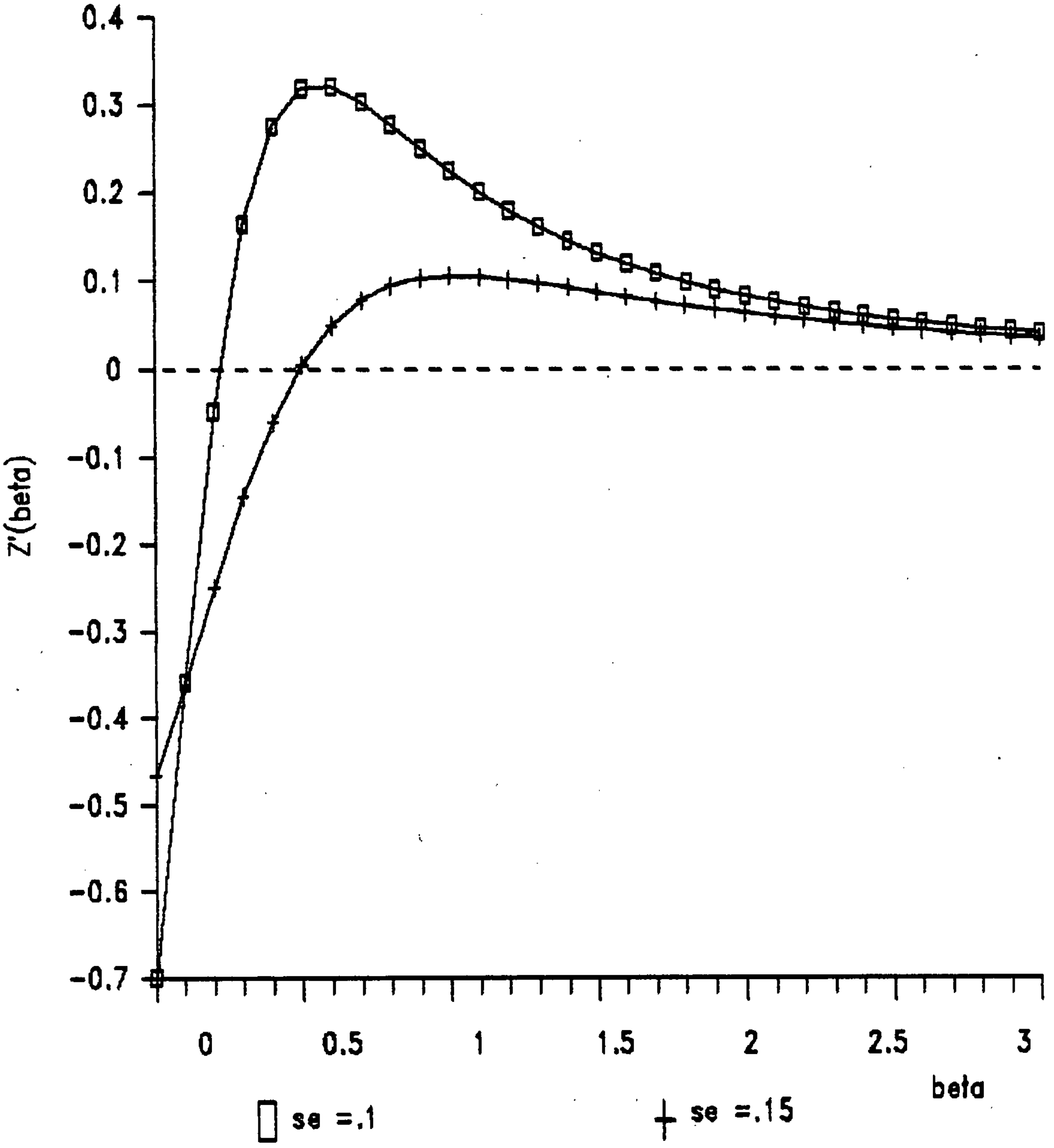
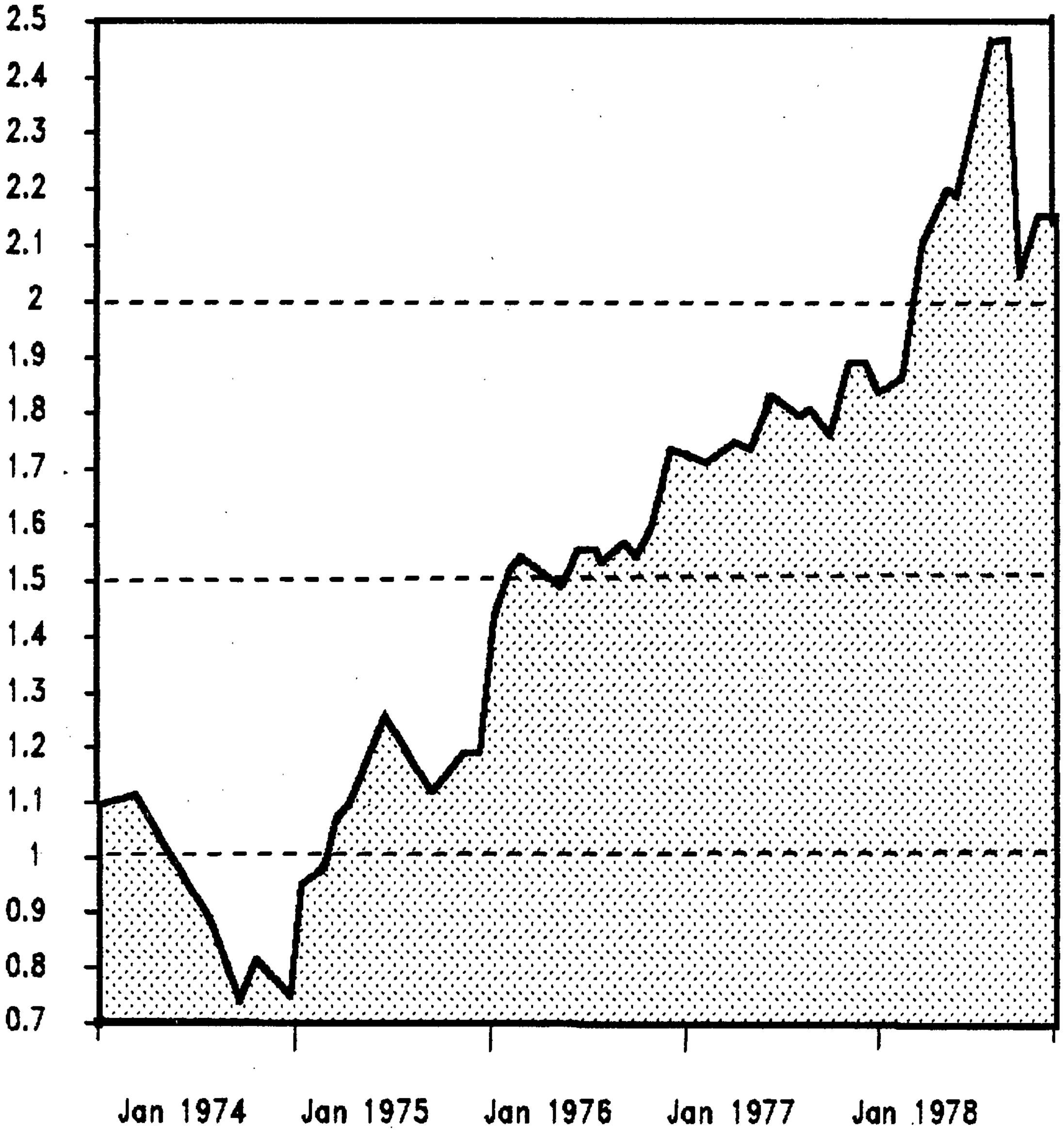


Figure 9. Simulation of the change in the z-score as beta increases.



Note : December 31, 1973 is set equal to 1.0

Figure 10. The market index from 1974 to 1978.

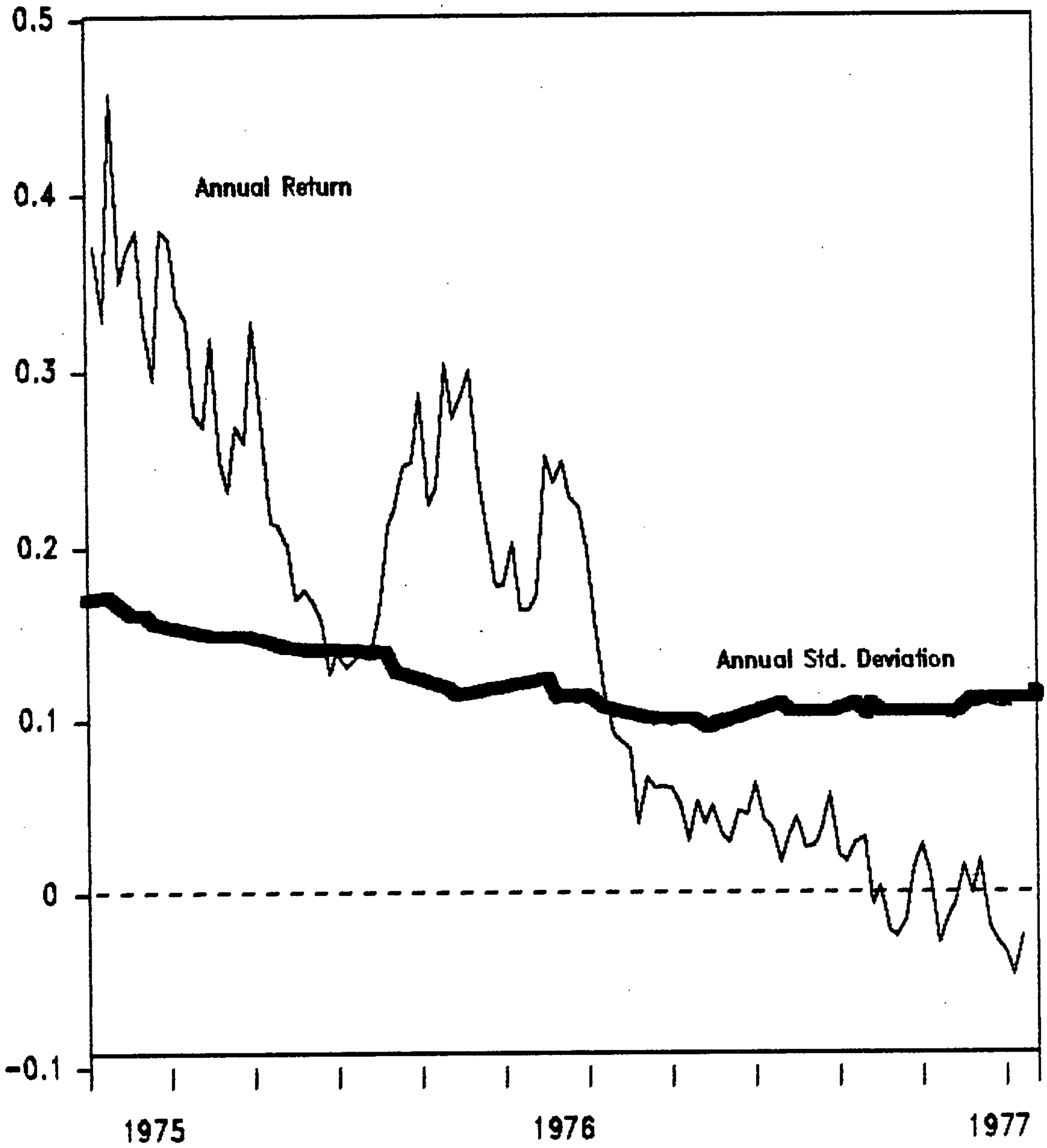


Figure 11. Annualized 52 week return statistics.

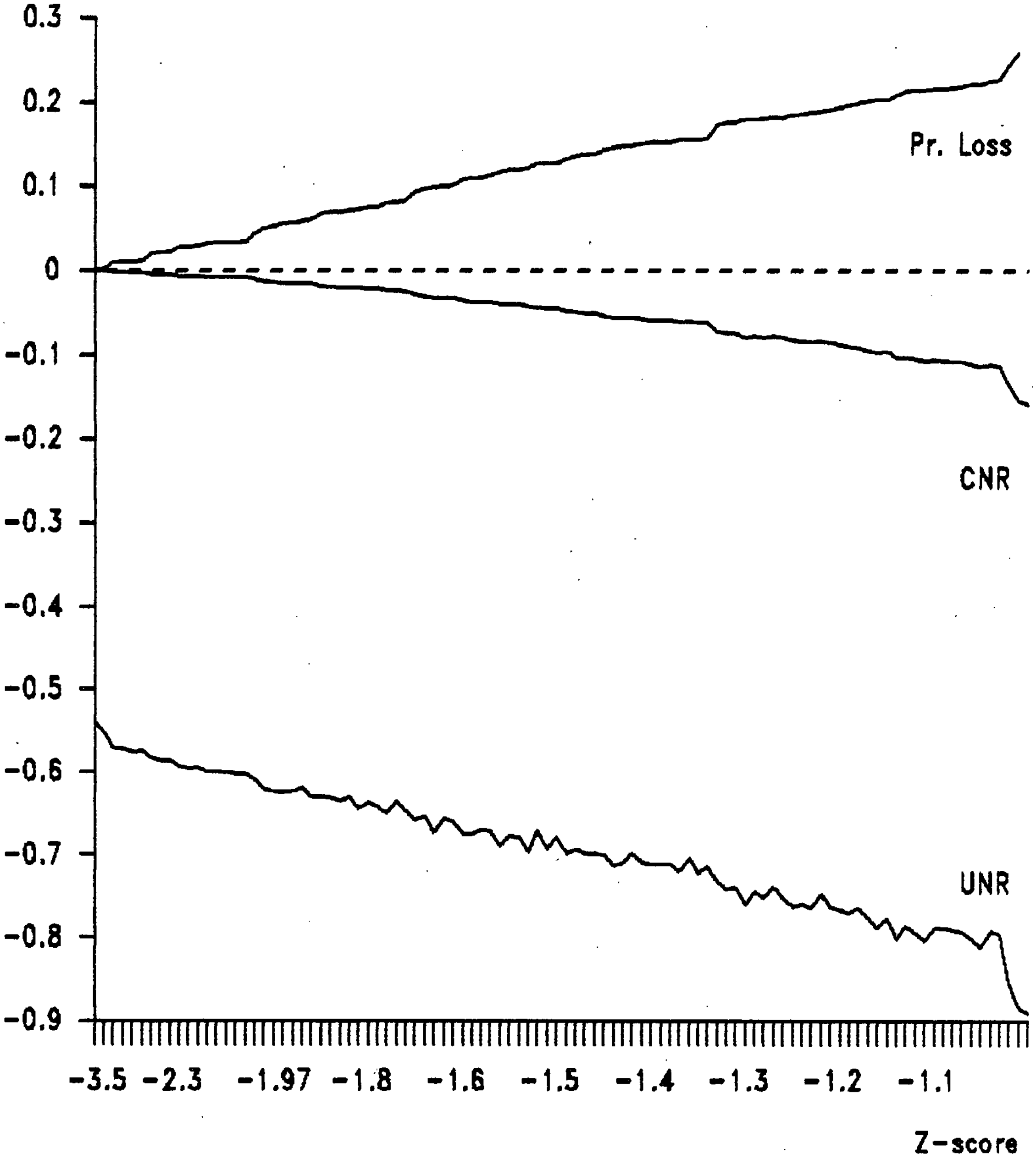


Figure 12. Simulation of the relationship between the various proxy measures of risk.

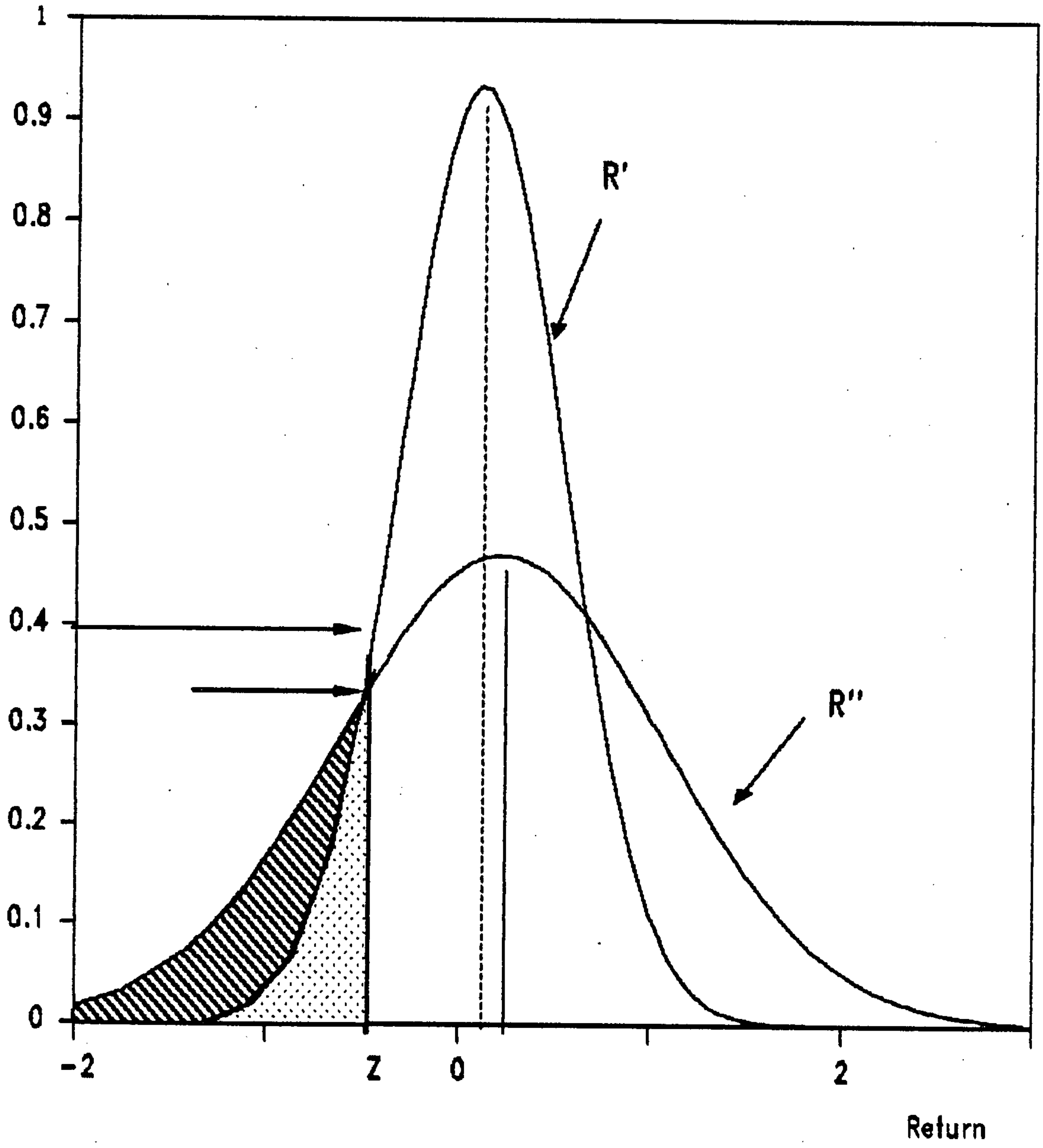


Figure 13. The relationship between the z-score and the CNR and UNR.

TABLE 1

NOTATION

a_1, a_2 = auditor opinion: accept (unqualified opinion) or reject (qualified opinion)

A_i = is the auditor's i th strategy

$c(A_i | SH_j)$ = the cost to the auditor of strategy i when the shareholder uses strategy j.

D_{nk} (a_n, t_k) = is the amount of damages awarded to the shareholder as a function of the audit opinion and the realized share price.

$h(q_m)$ = the production cost of the audit as a function of audit intensity.

$j_p(a_0, t_k)$ = shareholder action: sue or not sue the auditor.

w = the cost to the shareholder of suing the auditor.

L_{ka}, L_{kr} = shareholder loss function = $t_0 - t_k$ or 0 if $t_k > t_0$ subscript "a" indicates t_0 based upon an unqualified opinion, subscript "r" indicates t_0 based upon a qualified opinion.

$p(I | q_m)$ = the probability of making a type I error given the level of audit intensity chosen.

$p(II | q_m)$ = the probability of making a type II error given the level of audit intensity chosen.

$p(s_2|t_k)$ = the probability of the financial statements being unfair given the realized share price. This probability is used by the courts and represents their ability to distinguish losses due to θ_i from those due to s_j. Note that the following structure has been imposed: $p(s_2|t_1) = 0$, $0 < p(s_2|t_2) = p(s_2|t_3) < 1$, and $p(s_2|t_4) = 1$.

$p(q_m < q^+|a_2,t_k)$ = the probability the courts find the auditor to be negligent given the opinion, a_2, and the stock price. Under a strict liability regime this quantity is set to 1 for k = 2, 3, 4. With a negligence rule it is a positive quantity less than 1 for k= 2, 3, 4. q^+ is the level of due diligence.

q_1, q_2 = audit intensity: high or low.

s_1, s_2 = true condition of the fin. statements: fair, not fair.

SH_j = the shareholders' j th strategy.

θ_1, θ_2 = events which affect stock price and are uncorrelated with the fairness of the financial statements. They are the "good" and "bad" outcomes.

$t_0(a_n)$ = *ex ante* stock price conditioned upon the audit opinion, a_n.

Table 1--continued

t_k = *ex post* stock prices. They take on values:

$t_1 = t(\theta_1, s_1)$, $t_2 = t(\theta_2, s_1)$, $t_3 = t(\theta_1, s_2)$, and $t_4 = t(\theta_2, s_2)$. Note that $t_1 > t_2 = t_3 > t_4$.

TABLE 2

SHAREHOLDERS' STRATEGIES STRICT LIABILITY

Strategy	Information Sets		
	$\{a_1, t_1\}$	$\{a_1, t_{2,3}\}$	$\{a_1, t_4\}$
SH_1	j_1	j_1	j_1
SH_2	j_1	j_1	j_2
SH_3	j_1	j_2	j_1
SH_4	j_1	j_2	j_2
SH_5	j_2	j_1	j_1
SH_6	j_2	j_1	j_2
SH_7	j_2	j_2	j_1
SH_8	j_2	j_2	j_2

Note: Each of the above strategies assumes the shareholder does not sue when a "qualified" opinion is given.

j_1 = sue, j_2 = not sue

a_1 = unqualified opinion, a_2 = qualified opinion

TABLE 3

AUDITOR STRATEGIES

Strategy	High Audit Intensity z_1	High Audit Intensity z_2
A_1	a_1	a_1
A_2	a_1	a_2
A_3	a_2	a_1
A_4	a_2	a_2

Strategy	Low Audit Intensity
A_5	a_1
A_6	a_2

z_1 = high audit signal, z_2 = low audit signal

a_1 = unqualified opinion, a_2 = qualified opinion

TABLE 4

AUDITOR COSTS UNDER STRICT LIABILITY

Play	Expected Cost
$\{A_2, SH_5\}$	$c(A_2 \mid SH_5) = [\sum_{k=2}^{4} D_{nk} \bullet p(t_k \mid s_2, z_1, q_1)] \bullet p(II \mid q_1) + c(I) \bullet p(I \mid q_1) + h(q_1)$
$\{A_2, SH_7\}$	$c(A_2 \mid SH_7) = [D_{n4} \bullet p(t_4 \mid s_2, z_1, q_1)] \bullet p(II \mid q_1) + c(I) \bullet p(I \mid q_1) + h(q_1)$
$\{A_5, SH_5\}$	$c(A_5 \mid SH_5) = \sum_{k=2}^{4} D_{nk} \; p(t_k)$
$\{A_5, SH_7\}$	$c(A_5 \mid SH_7) = D_{n4} \; p(t_4)$
$\{A_6, SH_5\}$	$c(A_6 \mid SH_5) = c(I) \bullet p(I \mid q_2)$
$\{A_6, SH_7\}$	$c(A_6 \mid SH_7) = c(I) \bullet p(I \mid q_2)$

TABLE 5

NORMAL FORM GAME WITH STRICT LIABILITY

Shareholder strategies and share price		Auditor Strategies A_2	A_5	A_6
	t_1	$c(A_2 \mid SH_5)$ 0	$c(A_5 \mid SH_5)$ 0	$c(A_6 \mid SH_5)$ 0
SH_5	$t_{2,3}$	$c(A_2 \mid SH_5)$ $D_2 - w$	$c(A_5 \mid SH_5)$ $D_2 - w$	$c(A_6 \mid SH_5)$ 0
	t_4	$c(A_2 \mid SH_5)$ $D_4 - w$	$c(A_5 \mid SH_5)$ $D_4 - w$	$c(A_6 \mid SH_5)$ 0
	t_1	$c(A_2 \mid SH_7)$ 0	$c(A_5 \mid SH_7)$ 0	$c(A_6 \mid SH_7)$ 0
SH_7	$t_{2,3}$	$c(A_2 \mid SH_7)$ 0	$c(A_5 \mid SH_7)$ 0	$c(A_6 \mid SH_7)$ 0
	t_4	$c(A_2 \mid SH_7)$ $D_4 - w$	$c(A_5 \mid SH_7)$ $D_4 - w$	$c(A_6 \mid SH_7)$ 0

Note: The shareholders' damage awards are given on the bottom row of each box.

TABLE 6

AUDITOR COSTS WITH A NEGLIGENCE DEFENSE

Play	Cost to the Auditor
$\{A_2, SH_5\}$	$c(A_2 \mid SH_5) = c(I) \bullet p(I \mid q_1) + h(q_1)$
$\{A_2, SH_7\}$	$c(A_2 \mid SH_7) = c(I) \bullet p(I \mid q_1) + h(q_1)$
$\{A_5, SH_5\}$	$c(A_5 \mid SH_5) = \sum_{k=2}^{4} D_{nk} \ p(t_k)$
$\{A_5, SH_7\}$	$c(A_5 \mid SH_7) = D_{n4} \ p(t_4)$
$\{A_6, SH_5\}$	$c(A_6 \mid SH_5) = c(I) \bullet p(I \mid q_2)$
$\{A_6, SH_7\}$	$c(A_6 \mid SH_7) = c(I) \bullet p(I \mid q_2)$

TABLE 7

NORMAL FORM GAME WITH NEGLIGENCE DEFENSE

Shareholder strategies and share price		Auditor Strategies A_2	A_5	A_6
SH_5	t_1	$c(A_2 \mid SH_5)$ 0	$c(A_5 \mid SH_5)$ 0	$c(A_6 \mid SH_5)$ 0
	$t_{2,3}$	$c(A_2 \mid SH_5)$ $-w$	$c(A_5 \mid SH_5)$ $D_2 - w$	$c(A_6 \mid SH_5)$ 0
	t_4	$c(A_2 \mid SH_5)$ $-w$	$c(A_5 \mid SH_5)$ $D_4 - w$	$c(A_6 \mid SH_5)$ 0
SH_7	t_1	$c(A_2 \mid SH_7)$ 0	$c(A_5 \mid SH_7)$ 0	$c(A_6 \mid SH_7)$ 0
	$t_{2,3}$	$c(A_2 \mid SH_7)$ 0	$c(A_5 \mid SH_7)$ 0	$c(A_6 \mid SH_7)$ 0
	t_4	$c(A_2 \mid SH_7)$ $-w$	$c(A_5 \mid SH_7)$ $D_4 - w$	$c(A_6 \mid SH_7)$ 0

Note: The shareholders' damage awards are given on the bottom row of each box.

TABLE 8

PURE STRATEGY EQUILIBRIA WITH NEGLIGENCE DEFENSE

Auditor Strategies	Shareholder Strategies	Cost Conditions
2	5	Not an equilibrium
2	7	Not an equilibrium
5	5	$c(A_5 \mid SH_5) < c(A_2 \mid SH_5)$ and $c(A_6 \mid SH_5)$; $D_2 > w$
5	7	$c(A_5 \mid SH_7) < c(A_2 \mid SH_7)$ and $c(A_6 \mid SH_7)$; $D_2 < w$
6	5	$c(A_6 \mid SH_5) < c(A_2 \mid SH_5)$ and $c(A_5 \mid SH_5)$
6	7	$c(A_6 \mid SH_7) < c(A_2 \mid SH_7)$ and $c(A_5 \mid SH_7)$

TABLE 9

CROSS-TAB OF PERCENT ZERO PRICE CHANGES DURING ESTIMATION PERIOD AND PARAMETER ESTIMATES FOR OVER THE COUNTER FIRMS.

Estimated Value	Frequency of Zero Changes 0 - .2	.2 - .4	.4 - .6	.6 - .8	(All)
Beta					
(2) - (1.25)	-	-	0.013	-	0.013
(1.25) - (.5)	-	0.013	0.013	-	0.025
(.5) - .25	0.025	0.088	0.100	0.051	0.263
0.25 - 1	0.175	0.113	0.113	0.013	0.413
1 - 1.75	0.113	0.050	-	-	0.163
1.75 - 2.5	0.038	-	0.013	-	0.050
2.5 - 3.25	0.038	0.013	0.013	-	0.063
3.25 - 4	0.013	-	-	-	0.013
Total	0.400	0.275	0.263	0.063	1.000
R-squared					
0 - .1	0.213	0.200	0.250	0.063	.725
.1 - .2	0.150	0.075	0.013	-	.238
.2 - .3	0.038	-	-	-	.038
Total	0.400	0.275	0.263	0.063	1.00

TABLE 10

DESCRIPTIVE STATISTICS

	Mean	Maximum	Minimum	Standard Dev.
All Firms (395) (See also Table 7. Simunic[1980])				
Assets(000's)	554,066	9,854,100	509	1,195,080
Fee	207,283	2,400,000	5,000	277,279
Fee/√assets	13.06	48.32	0.92	8.58
√Subsidiaries	3.17	17.32	0.00	2.67
Diversity	0.90	5.00	0.00	1.23
Utility	0.06	1.00	0.00	0.23
%Current Assets	0.46	1.61	0.01	0.23
%Foreign	0.07	0.67	0.00	0.13
OTC Sample (73 Firms)				
Assets(000's)	85,894	572,370	2,553	111,259
Fee	111,630	700,000	7,000	117,800
Fee/√assets	13.17	48.32	2.12	8.41
√Subsidiaries	2.29	12.41	0.00	1.98
Diversity	0.92	5.00	0.00	1.18
Utility	0.00	0.00	0.00	0.00
%Current Assets	0.48	0.88	0.01	0.20
%Foreign	0.06	0.56	0.00	0.11

TABLE 10--continued

	Mean	Maximum	Minimum	Standard Dev.
	Weekly Sample (173 Firms)			
Assets(000's)	606,555	6,620,880	12,520	1,085,231
Fee	273,196	1,960,000	12,000	307,225
Fee/√assets	14.80	38.62	0.92	8.44
√Subsidiaries	3.82	17.32	0.00	2.82
Diversity	1.01	5.00	0.00	1.26
Utility	0.08	1.00	0.00	0.26
%Current Assets	0.45	0.83	0.01	0.20
%Foreign	0.09	0.50	0.00	0.13
	Monthly Sample (125 Firms)			
Assets(000's)	779,157	6,620,883	32,274	1,204,892
FEE	365,064	2,400,000	35,000	384,337
Fee/√assets	16.30	38.62	1.55	8.94
√Subsidiaries	4.44	17.32	0.00	3.21
Diversity	1.20	5.00	0.00	1.35
Utility	0.08	1.00	0.00	0.27
%Current Assets	0.44	0.83	0.03	0.19
%Foreign	0.12	0.50	0.00	0.14

TABLE 11

ESTIMATED MARKET PARAMETERS

	Mean	Maximum	Minimum	Standard Dev.
OTC Sample				
Beta	0.74	3.75	-1.40	0.89
R^2	0.06	0.27	0.00	0.06
$\sigma(e_i)$	0.07	0.22	0.02	0.04
Weekly Sample				
Beta	1.04	2.53	0.05	0.48
R^2	0.19	0.58	0.00	0.13
$\sigma(e_i)$	0.05	0.19	0.02	0.02
Monthly Sample				
Beta	0.96	2.05	-.10	0.42
R^2	0.38	0.70	0.00	0.15
$\sigma(e_i)$	0.09	0.16	0.04	0.03

TABLE 12

CORRELATION MATRIX OF VARIABLES

Weekly Data (173 Observations)

	Assets	√Subs	Diversity	Utility	Current
Log Assets	1.000				
√Subsidiaries	.433	1.000			
Diversity	.124	.325	1.000		
Utility-dummy	.239	-.219	-.175	1.000	
Current	-.384	.022	.129	-.491	1.000
Foreign	.248	.518	.050	-.204	.208
Beta	-.024	-.108	-.039	-.337	.109
$\sigma(e_i)$	-.503	-.128	-.023	-.312	.362

	Foreign	Beta	$\sigma(e_i)$
Foreign	1.00		
Beta	.134	1.00	
$\sigma(e_i)$	-.077	.385	1.00

Note: Correlations greater than .19 are significant at the .05 level.

TABLE 13

CORRELATION MATRIX OF VARIABLES

Monthly Data (125 Observations)

	Assets	√Subs	Diversity	Utility	Current
Log Assets	1.00				
√Subsidiaries	.434	1.00			
Diversity	.081	.325	1.00		
Utility-dummy	.297	-.245	-.197	1.00	
Current	-.501	.041	.161	-.54	1.00
Foreign	.268	.604	.030	-.248	.242
Beta	-.536	-.297	-.009	-.297	.335
$\sigma(e_i)$	-.392	-.04	-.029	-.422	.296

	Foreign	Beta	$\sigma(e_i)$
Foreign	1.00		
Beta	-.228	1.00	
$\sigma(e_i)$	.038	.609	1.00

Note: Correlations greater than .19 are significant at the .05 level.

TABLE 14

CROSS-TAB OF THE RELATIONSHIP BETWEEN BETA AND $\sigma(e_i)$

$\sigma(e_i)$	Beta					
	<0.3	<0.5	<1	<1.5	<max	(all)
Monthly						
< .03	0	0	0	0	0	0
< .05	0	3	3	0	0	6
< .10	1	10	48	18	3	80
< .15	1	0	5	17	14	38
< .20	0	0	0	0	0	0
(all)	2	13	56	35	17	124
Weekly Sample						
< .03	3	3	5	3	0	14
< .05	5	9	33	26	9	82
< .10	0	4	16	33	12	72
< .15	0	0	2	1	5	8
< .20	0	0	0	0	0	0
(all)	8	16	56	63	26	169

TABLE 15

DIAGNOSTICS - NORMALITY

	Log Model	Square Root Model
	Weekly data (173 obs.)	
Coefficient of Skewness	-.982[1]	.258
Standard Deviation	.184	.184
Coefficient of Excess Kurtosis	2.524[1]	1.204[1]
Standard Deviation	.367	.367
	Weekly Data (169 obs.)	
Coefficient of Skewness	-.289	.425
Standard Deviation	.186	.186[1]
Coefficient of Excess Kurtosis	.299	.798
Standard Deviation	.371	.371[1]

[1] Indicates significance at the .05 level.

Note: Three of the four observations deleted were in the financial industry. The fourth observation was Sun Oil Co.

TABLE 16

DIAGNOSTICS - NORMALITY

	Log Model	Square Root Model
Monthly Data (125 obs.)		
Coefficient of Skewness	-.905[1]	-.004
Standard Deviation	.216	.216
Coefficient of Excess Kurtosis	3.231[1]	1.567[1]
Standard Deviation	.429	.429
Monthly Date (124 obs.)		
Coefficient of Skewness	-.424	.243
Standard Deviation	.217	.217
Coefficient of Excess Kurtosis	1.346[1]	.712
Standard Deviation	.431	.431

[1] Indicates significance at the .05 level.

Note: One observation was deleted. This firm, Sun Oil Company, had an unusually low audit fee, considering the asset base of the company.

TABLE 17

CHI-SQUARE TEST FOR HETEROSCEDASTICITY

	Test	Df	Signif
Monthly Data - Log Model			
Breusch-Pagan-Godfrey	3.949	8	.86
Harvey	10.531	8	.23
Monthly Date - Square Root Model			
Breusch-Pagan-Godfrey	15.794	7	.03
Harvey	14.677	7	.04
Weekly Data - Log Model			
Breusch-Pagan-Godfrey	3.911	8	.86
Harvey	8.21	8	.41
Weekly Date - Square Root Model			
Breusch-Pagan-Godfrey	24.394	7	.01
Harvey	20.834	7	.01

TABLE 18

RAMSEY RESET SPECIFICATION TESTS
USING POWERS OF YHAT F TEST

	Test	Df1	Df2	Signif
Monthly - Log Model				
Reset(2)	1.89	1	114	.17
Reset(3)	1.71	2	113	.19
Reset(4)	1.26	3	112	.29
Monthly - Square Root Model				
Reset(2)	.91	1	115	.34
Reset(3)	.93	2	114	.40
Reset(4)	.71	3	113	.54
Weekly - Log Model				
Reset(2)	2.35	1	159	.13
Reset(3)	3.15	2	158	.05
Reset(4)	2.09	3	157	.11
Weekly - Square Root Model				
Reset(2)	.023	1	160	.87
Reset(3)	1.02	2	159	.36
Reset(4)	.68	3	158	.57

TABLE 19

Z-SCORE

D	$\sigma(r_m)$	Log Model Coef.	Log Model T	Square Root Model Coef.	Square Root Model T
		Weekly Sample			
0.000	0.100	0.206	0.690	4.501	1.163
0.000	0.200	0.571	1.373	9.396	1.777
0.000	0.300	1.089	2.017	16.433	2.468
-0.250	0.100	0.226	2.151	3.088	2.504
-0.250	0.200	0.337	2.721	4.589	3.206
-0.250	0.300	0.407	2.991	5.688	3.609
-0.500	0.100	0.148	2.397	1.977	2.775
-0.500	0.200	0.203	2.878	2.756	3.401
-0.500	0.300	0.234	3.069	3.259	3.689
-0.750	0.100	0.108	2.492	1.442	2.885
-0.750	0.200	0.145	2.933	1.958	3.470
-0.750	0.300	0.164	3.095	2.276	3.712
		Monthly Sample			
0.000	0.100	-0.056	-0.163	0.140	0.029
0.000	0.200	0.074	0.160	2.353	0.366
0.000	0.300	0.305	0.506	5.852	0.729
-0.250	0.100	0.061	0.545	1.095	0.761
-0.250	0.200	0.111	0.828	1.805	1.077
-0.250	0.300	0.163	1.039	2.495	1.302
-0.500	0.100	0.044	0.669	0.738	0.893
-0.500	0.200	0.071	0.925	1.122	1.180
-0.500	0.300	0.098	1.103	1.474	1.362
-0.750	0.100	0.033	0.718	0.548	0.946
-0.750	0.200	0.052	0.963	0.809	1.220
-0.750	0.300	0.070	1.127	1.043	1.383

T values of 1.96 are significant at the .05 level

TABLE 20

PROBABILITY OF LOSS

		Log Model		Square Root Model	
D	$\sigma(r_m)$	Coef.	T	Coef.	T
		Weekly Sample			
0.000	0.100	0.553	0.663	13.087	1.191
0.000	0.200	1.495	1.332	25.647	1.778
0.000	0.300	2.841	1.988	43.728	2.463
-0.250	0.100	0.936	1.857	16.731	2.584
-0.250	0.200	1.292	2.437	21.005	3.203
-0.250	0.300	1.531	2.864	23.883	3.679
-0.500	0.100	1.216	1.997	23.250	2.919
-0.500	0.200	1.391	2.370	24.850	3.317
-0.500	0.300	1.505	2.779	25.357	3.693
-0.750	0.100	1.916	2.106	37.632	3.230
-0.750	0.200	1.904	2.267	36.151	3.381
-0.750	0.300	1.881	2.586	33.593	3.565
		Monthly Sample			
0.000	0.100	-0.245	-0.250	-0.115	-0.008
0.000	0.200	0.115	0.090	5.888	0.329
0.000	0.300	0.752	0.463	15.271	0.701
-0.250	0.100	-0.033	-0.047	4.241	0.443
-0.250	0.200	0.287	0.414	7.721	0.843
-0.250	0.300	0.571	0.835	10.361	1.193
-0.500	0.100	-0.096	-0.077	6.461	0.368
-0.500	0.200	0.349	0.343	10.809	0.796
-0.500	0.300	0.629	0.779	12.509	1.209
-0.750	0.100	0.398	0.126	22.882	0.502
-0.750	0.200	0.912	0.426	25.426	0.881
-0.750	0.300	1.037	0.763	21.935	1.268

T values of 1.96 are significant at the .05 level

TABLE 21

TESTS ON BETA AND $\sigma(e_i)$
USING WEEKLY DATA AND THE LOG MODEL

Sub-sample	Beta			$\sigma(e_i)$		
	Coef.	T-value	Sig.	Coef.	T-value	Sig.
All obs. 160 df	.130	1.78	.08	2.19	1.34	.18
Beta only	.17	2.58	.01			
$\sigma(e_i)$ only				3.41	2.29	.02
Low 25% $\sigma(e_i)$ 32 df	.25	1.33	.19	36.68	2.18	.05
Low 35% 47 df	.25	1.4	.16	33.02	2.41	.02
High 25% 33 df	.043	.38	.7	4.07	1.47	.15
High 35% 50 df	.026	.27	.8	2.66	1.23	.20

TABLE 22

TESTS ON BETA AND $\sigma(e_i)$ USING
WEEKLY DATA AND THE SQUARE ROOT MODEL

Sub-sample	Beta			$\sigma(e_i)$		
	Coef.	T-value	Sig.	Coef.	T-value	Sig.
All obs. 161 df	1.50	1.43	.14	49.67	2.40	.01
Beta only	2.38	2.57	.01			
$\sigma(e_i)$ only				61.12	3.41	.001
Low 25% 33 df	3.31	2.49	.18	138.0	1.20	.22
Low 35% 48 df	4.13	2.25	.03	229.2	2.01	.05
High 25% 34 df	.46	.292	.78	99.9	2.92	.01
High 35% 51 df	-.13	-.08	.94	70.02	2.90	.01

TABLE 23

TEST FOR CHANGE OF BETA SLOPE COEFFICIENT[1].

Sample	Coef. on Beta Indicator	df	T-value	Signif.
Log Model				
Low 25% and High 25%	.31	72	2.2	.02
Low 35% and High 35%	.19	104	1.68	.10
Square Root Model				
Low 25% and High 25%	3.63	73	3.01	.01
Low 35% and High 35%	2.24	105	1.68	.10

[1] This is a test of the difference between the beta coefficients estimated using a dummy variable to indicate the low and high samples in a single pooled regression. It is equivalent to a Chow test.

TABLE 24

TESTS ON BETA AND $\sigma(e_i)$
USING MONTHLY DATA AND THE LOG MODEL

Sub-sample	Beta			$\sigma(e_i)$		
	Coef.	T-value	Sig.	Coef.	T-value	Sig.
all 115 df	.184	1.61	.11	-1.10	-.67	
Beta only	.14	1.49	.14			
$\sigma(e_i)$				.33	.24	
Low 25% 22 df	.017	.03		15.61	1.32	
Low 35% 33 df	.36	.86		3.66	.42	
High 25% 23	.029	.19		5.00	1.36	
High 35% 35 df	.052	.03		2.11	.56	

TABLE 25

TESTS ON BETA AND $\sigma(e_i)$
USING MONTHLY DATA AND THE SQUARE ROOT MODEL

Sub-sample	Beta			$\sigma(e_i)$		
	Coef.	T-value	Sig.	Coef.	T-value	Sig.
all[1] 116 df	2.56	1.68	.09	-8.23	-.36	
Beta only	2.23	1.82	.07			
$\sigma(e_i)$ only				13.00	.69	
Low 25% 23 df	4.13	1.14	.26	27.46	.33	
Low 35% 34 df	5.14	1.61	.12	-5.36	-.06	
High 25% 24 df	3.09	1.54	.14	79.21	1.17	
High 35% 36 df	3.1	1.69	.1	46.47	.78	

[1] Since there is some evidence of heteroscedasticity in the square root model the coefficients are estimated using White's Heteroscedasticity-consistent covariance matrix. Which is an appropriate diagnostic for unknown sources of heteroscedasticity. See Judge et. al.

TABLE 26

TEST FOR CHANGE OF BETA SLOPE COEFFICIENT[1].

Sample	Coef. on Beta Indicator	df	T-value	Signif.
Log Model				
Low 25% and High 25%	.39	52	1.46	.15
Low 35% and High 35%	.31	75	1.47	.14
Square Root Model				
Low 25% and High 25%	3.77	53	1.08	.28
Low 35% and High 35%	4.61	76	1.59	.12

[1] This is a test of the difference between the beta coefficients estimated using a dummy variable to indicate the low and high samples within a single pooled regression. It is equivalent to a Chow test.

TABLE 27

DESCRIPTIVE STATISTICS USING WEEKLY DATA
FOR ALL, LOW, AND HIGH SAMPLES

Variable	Mean	Std. Dev.	Minimum	Maximum
	Total Sample (169 obs.)			
log assets	19.16	1.44	16.34	22.61
√subsidiaries	3.82	2.74	0	17.32
Current Assets	.45	.20	.03	.83
Beta	1.04	.49	.055	2.53
$\sigma(e_i)$	.054	.024	.0155	.19
	Lowest 25% (42 obs.)			
log assets	20.16	1.34	17.31	22.61
√subsidiaries	4.09	3.04	0	11.79
Current Assets	.34	.20	.05	.76
Beta	.79	.43	.20	1.97
$\sigma(e_i)$	.031	.005	.0155	.036
	Highest 25% (57 obs.)			
Log assets	18.23	1.13	16.39	21.28
√subsidiaries	3.07	1.58	0	7.21
Current Assets	.54	.17	.06	.83
Beta	1.30	.54	.31	2.53
$\sigma(e_i)$	.09	.022	.07	.19

TABLE 28

DESCRIPTIVE STATISTICS USING MONTHLY DATA
FOR ALL, LOW, AND HIGH SAMPLES

Variable	Mean	Std. Dev.	Minimum	Maximum
	Total Sample (124)			
Log assets	19.63	1.27	17.29	22.61
√subsidiaries	4.44	3.23	0	17.32
Current Assets	.43	.19	.03	.50
Beta	.96	.42	-.12	2.05
$\sigma(e_i)$	.09	.028	.036	.16
	Low 25% (31 obs.)			
log assets	20.20	1.36	17.93	22.61
√subsidiaries	4.24	3.36	0	11.53
Current Assets	.35	.22	.05	.76
Beta	.68	.18	.34	.98
$\sigma(e_i)$	.06	.03	.04	.07
	High 25% (43 obs.)			
Log assets	18.99	1.18	17.34	22.09
√subsidiaries	4.45	3.37	0	17.32
Current Assets	.50	.20	.04	.83
Beta	1.34	.45	-.1	2.05
$\sigma(e_i)$	.13	.01	.11	.16

TABLE 29

CONDITIONAL EXPECTED NEGATIVE RETURN

D	$\sigma(r_m)$	Log Model Coef.	Log Model T	Square Root Model Coef.	Square Root Model T
Weekly Sample					
0.000	0.100	-0.622	-2.304	-11.154	-3.435
0.000	0.200	-0.670	-2.588	-11.652	-3.750
0.000	0.300	-0.647	-2.782	-11.038	-3.846
-0.250	0.100	-0.658	-2.320	-11.870	-3.486
-0.250	0.200	-0.697	-2.585	-12.213	-3.765
-0.250	0.300	-0.667	-2.770	-11.442	-3.838
-0.500	0.100	-0.707	-2.319	-12.880	-3.518
-0.500	0.200	-0.739	-2.566	-13.082	-3.765
-0.500	0.300	-0.701	-2.745	-12.126	-3.822
-0.750	0.100	-0.765	-2.315	-14.056	-3.537
-0.750	0.200	-0.791	-2.545	-14.130	-3.759
-0.750	0.300	-0.744	-2.717	-12.975	-3.802
Monthly Sample					
0.000	0.100	-0.137	-0.256	-5.054	-0.700
0.000	0.200	-0.298	-0.625	-6.590	-1.063
0.000	0.300	-0.371	-0.943	-6.816	-1.376
-0.250	0.100	-0.157	-0.269	-5.680	-0.721
-0.250	0.200	-0.323	-0.631	-7.143	-1.076
-0.250	0.300	-0.391	-0.945	-7.214	-1.384
-0.500	0.100	-0.180	-0.273	-6.521	-0.730
-0.500	0.200	-0.358	-0.632	-7.983	-1.083
-0.500	0.300	-0.424	-0.943	-7.873	-1.391
-0.750	0.100	-0.209	-0.278	-7.522	-0.737
-0.750	0.200	-0.402	-0.633	-9.009	-1.090
-0.750	0.300	-0.465	-0.941	-8.696	-1.397

T values of 1.96 are significant at the .05 level

TABLE 30

EXPECTED NEGATIVE RETURN

D	$\sigma(r_m)$	Log Model Coef.	Log Model T	Square Root Model Coef.	Square Root Model T
		Weekly Sample			
0.000	0.100	-1.223	-2.066	-22.795	-3.157
0.000	0.200	-1.387	-2.407	-24.713	-3.573
0.000	0.300	-1.408	-2.689	-24.381	-3.827
-0.250	0.100	-1.182	-2.102	-22.169	-3.227
-0.250	0.200	-1.320	-2.433	-23.617	-3.614
-0.250	0.300	-1.335	-2.715	-23.094	-3.848
-0.500	0.100	-1.244	-2.103	-24.136	-3.312
-0.500	0.200	-1.305	-2.348	-24.311	-3.578
-0.500	0.300	-1.290	-2.632	-22.977	-3.775
-0.750	0.100	-1.494	-2.098	-29.670	-3.305
-0.750	0.200	-1.454	-2.218	-28.292	-3.462
-0.750	0.300	-1.370	-2.447	-25.461	-3.600
		Monthly Sample			
0.000	0.100	0.015	0.012	-7.500	-0.429
0.000	0.200	-0.479	-0.423	-12.908	-0.856
0.000	0.300	-0.765	-0.827	-14.823	-1.259
-0.250	0.100	0.029	0.024	-7.634	-0.452
-0.250	0.200	-0.447	-0.421	-12.307	-0.873
-0.250	0.300	-0.712	-0.831	-13.802	-1.266
-0.500	0.100	0.027	0.016	-9.870	-0.415
-0.500	0.200	-0.500	-0.388	-14.581	-0.846
-0.500	0.300	-0.731	-0.794	-14.830	-1.263
-0.750	0.100	-0.566	-0.171	-25.796	-0.542
-0.750	0.200	-1.001	-0.465	-26.831	-0.923
-0.750	0.300	-0.997	-0.782	-21.124	-1.302

T values of 1.96 are significant at the .05 level

TABLE 31

STATISTICS OF RISK MEASURES[1]

Means:	Weekly	Monthly
Z-score	-2.02	-2.31
Probability of Loss	.0448	.0256
Conditional Ex. Negative Return (CNR)	-.961	-.9108
Unconditional Ex. Negative Return (UNR)	-.0487	-.0256

Correlation Matrices

Weekly Sample.

	Z	Pr.Loss	CNR	UNR
Z score	1.0			
Pr. Loss	.784	1.0		
CNR	-.837	-.917	1.0	
UNR	-.719	-.985	.979	1.0

Monthly Sample.

	Z	P.Loss	CNR	UNR
Z score	1.0			
Pr. Loss	.803	1.0		
CNR	-.899	-.98	1.0	
UNR	-.781	-.99	.97	1.0

[1]These statistics are based upon D being set to -.75 and $\sigma(r_m)$ being set to .3.

TABLE 32

EXAMPLES OF THE RELATIONSHIP AMONG RISK MEASURES[1]

Sample Values of Related Measures

BETA	$\sigma(e_i)$	Z-score	Pr.LOSS	CNR	UNR
0.9926	0.7174	-0.8726	0.2726	-0.9105	-0.1743
0.8553	0.7035	-0.8838	0.27	-0.8975	-0.1691
1.2358	0.6932	-0.9057	0.2647	-0.9007	-0.1644
1.0617	0.3931	-1.4644	0.1365	-0.6984	-0.05
0.7528	0.4051	-1.464	0.1366	-0.6919	-0.0495
0.7283	0.4021	-1.4754	0.1343	-0.6892	-0.0483
1.2129	0.1485	-2.3379	0.0259	-0.5961	-0.0058
1.3716	0.0717	-2.3843	0.0233	-0.5945	-0.0051
0.5153	0.2259	-2.4812	0.0184	-0.5806	-0.0038

Relative Values of Related Risk Measures

BETA	$\sigma(e_i)$	Z-score	Pr.LOSS	CNR	UNR
High	High	Large	Large	Small	Small
High	Low	?	?	?	?
Low	High	?	?	?	?
Low	Low	Small	Small	Large	Large

[1]These were calculated with the following parameter values: $D = -.50$, $E(r_m) = .15$, $r_f = .08$, and $\sigma(r_m) = .20$

TABLE 33

SUMMARY OF RESULTS ON PROXY RISK MEASURES

Model	Weekly		Monthly	
	Log Model	Sq. rt. Model	Log Model	Sq. rt Model
z-score	s	s	c	c
Pr. Loss	s	s	c	c
CNR	s	s	c	c
UNR	s	s	c	c

s... indicates significant results
c... indicates consistent results with H2.

Appendix 1

Numerical Examples of Share price Determination

Let *ex ante* share prices be determined by one of the following functions (it is assumed that everyone knows which):

$$t'(\theta_i, s_j) = 5\ (\theta_1 + s_1)$$

$$t''(\theta_i, s_j) = 12 - 3 \bullet (2 - \theta_1)\ (2 - s_1)$$

where,

$$\theta_i = \begin{cases} 1 \text{ if good event} \\ 0 \text{ if bad event} \end{cases} \quad \text{and} \quad s_j = \begin{cases} 1 \text{ if fs are fair} \\ 0 \text{ if fs are not fair} \end{cases}$$

Assume the following probabilities are assessed over the states:

$$p(\theta_1) = 1 - p(\theta_2) = .5$$

$$p(s_1) = 1 - p(s_2) = .8$$

Let shareholders assess the following joint distribution:

	Fair	Not Fair	
Accept (unqualified)	.72	.08	.8
Not Accept (qualified)	.08	.12	.2
	.80	.20	

The revised posterior beliefs over the fairness of the financial statements are:

$$p(F \mid A) = .9 \qquad p(F \mid NA) = .4$$

$$p(NF \mid A) = .1 \qquad p(NF \mid NA) = .6$$

and the *ex ante* and *ex post* stock prices are:

$$t_0'(A) = 7.0 \qquad t_0'(NA) = 4.5$$

$$t_0''(A) = 7.05 \qquad t_0''(NA) = 4.8$$

and

$$t_1' = 10, \quad t_2' = 5, \quad t_3' = 5, \quad t_4' = 0$$

$$t_1'' = 9, \quad t_2'' = 6, \quad t_3'' = 6, \quad t_4'' = 0$$

The shareholder losses are given by:

$L_{1a}' = 0$	$L_{1r}' = 0$	$L_{1a}'' = 0$	$L_{1r}'' = 0$
$L_{2a}' = 2.0$	$L_{2r}' = 0$	$L_{2a}'' = 2.05$	$L_{2r}'' = 0$
$L_{3a}' = 2.0$	$L_{3r}' = 0$	$L_{3a}'' = 2.05$	$L_{3r}'' = 0$
$L_{4a}' = 7.0$	$L_{4r}' = 4.5$	$L_{4a}'' = 7.05$	$L_{4b}'' = 4.8$

Appendix 2

Mixed Equilibrium in the Negligence Regime

In this appendix a mixed equilibrium is calculated for the case when the auditor has a negligence defense. It is assumed that the cost conditions are such that the auditor would like to use the high audit intensity, but as shown in the text, this is not a pure strategy equilibrium. The auditor is assumed to randomize between A_2 and A_5. The shareholder randomizes between SH_5 and SH_7. Let $p(A_2) = 1 - p(A_5)$ and $p(SH_5) = 1 - p(SH_7)$ be the probabilities that the players play a given pure strategy. Also note that the shareholders' randomization is equivalent to always suing when t_4 occurs, never suing when t_1 occurs and randomizing over t_2 and t_3. The auditor has the following minimization problem:

$$\min_{p(A_2)} \quad p(A_2)\, [\, c(I)\, p(s_1 | z_2, q_1) + h(q_1)\,] + (1 - p(A_2)) \Big[p(SH_5)\, (D_2\, (p(t_2) + p(t_3)) + D_4\, p(t_4) \Big]$$

The first order condition yields the following result:

$$p(SH_5) = \frac{c(I)\, p(s_1 | z_2, q_1) + h(q_1) - D_4\, p(t_4)}{D_2\, p(t_2) + D_3\, p(t_3)}$$

The shareholders have the following maximization problem conditional upon observing t_2 or t_3 :

$$\max_{p(SH_5)} \quad p(SH_5) \Big[(D_2 - w)\, p(A_5) - w\, p(A_2) \Big]$$

The first order condition yields:

$$p(A_2) = (D_2 - w) / D_2$$

Substituting these equilibrium values into the auditor's cost function yields the expected cost of the mixed strategy which is equal to:

$$c(I)\ p(s_1 | z_2, q_1) + h(q_1)$$

It is interesting to note that the auditor achieves an expected cost which is equal to the cost of the high audit intensity, but that it is done through a mixed strategy.

Appendix 3

Calculating Conditional Expected Losses

Assuming the return is distributed normally, $n(Er_i, \sigma(r_i))$, then the expected loss equals:

$$\frac{1}{\sigma(r_i)\ (2\pi)^{.5}} \int_{-\infty}^{D} r_i \bullet \exp - \frac{1}{2} \left[\frac{r_i - Er_i}{\sigma(r_i)} \right]^2 dr_i \qquad \text{A1.)}$$

Let x_i be defined as:

$$x_i = (r_i - Er_i) / \sigma(r_i)$$

then A1.) is equivalent to:

$$k\ (2\pi)^{-.5} \int_{-\infty}^{D'} x_i \bullet \exp -(\tfrac{1}{2} \bullet x_i^2)\ dx_i \qquad \text{A2.)}$$

where $D' = (D - Er_i) / \sigma(r_i)$ and k, a normalizing constant, is equal to $1 / (N(D) - N(-\infty))$. Noting that $N(\bullet)$ is the normal cumulative density function. This function is easily integrated.

The result is:

$$-k\ m(x_i) \Big|_{-\infty}^{D'} = - m(D') / N(D) \qquad \text{A3.)}$$

where m indicates a standard normal density function, and $N(-\infty)$ is set to zero.

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