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Journal of Accounting Research, Vol. 28, No. 1 (Spring, 1990), 77-120.

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On Auditors and the Courts in an Adverse Selection Setting

NAHUM D. MELUMAD* AND LYND A THOMAN†

1. Introduction

Most models of auditing in the accounting literature may be classified as agency models or signaling models.¹ The emphasis in an agency model is on a single firm; the auditor is typically modeled as a utility-maximizing player who is hired by a firm's owner to better control a manager as well as to improve their risk-sharing arrangement. A signaling model, on the other hand, includes a larger set of players, and it focuses on the interrelationships among the various players in a market setting. The auditor is usually modeled as a mechanistic monitor; the output (report) of an auditor, and/or the act of hiring an auditor, is used by an informed party (e.g., an owner) to signal its private information (e.g., the firm's risk characteristics) to an uninformed party (e.g., an investor).

In this paper we incorporate a utility-maximizing auditor, as found in agency models, into a simple signaling setting composed of firms of unobservable risk types requiring loans, lenders of capital to the firms, auditors, and a court system. We consider how litigation against auditors affects the prevailing equilibria as well as the resulting welfare of the different participants when the endogenously determined interest rates

* Stanford University; † Purdue University. For helpful suggestions and comments we thank Joseph Bachar, Rajiv Banker, Mary Barth, William Beaver, Linda DeAngelo, Harry Evans, Gerald Feltham, Bengt Holmstrom, David Kreps, Nandu Nagarajan, James Patell, Stefan Reichelstein, Uri Ronnen, Bharat Sarath, Toshi Shibano, Clifford Smith, Peter Wilson, Mark Wolfson, Amir Ziv, and especially William Novshek, Brett Trueman, and two anonymous referees.

¹ Examples of agency models are Antle [1982; 1984], Datar [1985], Baiman, Evans, and Noel [1987], and Baiman, Evans, and Nagarajan [1988]; examples of signaling models are Bar-Yosef and Livnat [1984], Titman and Trueman [1986], and Datar, Feltham, and Hughes [1987]. A related literature concerns strategic testing in auditing (see, e.g., Fellingham and Newman [1985], Fellingham, Kwon, and Newman [1987], and Shibano [1988]).

and audit fee reflect players' expectations regarding future litigation results. This framework enables us to address questions such as: Why do firms hire strategic auditors? What induces auditors to work hard and truthfully report their findings? How does litigation affect the audit process? How do changes in audit fees affect the employment of auditors and firms' welfare?

We adopt a nonmandated auditing framework for three reasons. First, we want to show a demand for auditing not driven by exogenous regulation. Second, the mandated auditing framework is a special case of the nonmandated framework; after analyzing the nonmandated case, we examine the effect of mandating auditing. Third, most firms filing quarterly data with the SEC involve their auditors, even though it is not required.

The large number of strategic choices for the players forces us to adopt highly simplifying assumptions. Specifically, each firm is assumed to have access to a single profitable project; firms, having no resources of their own, turn to the competitive capital market. An adverse selection problem arises from the unobservable (*ex ante*) project risk; while all firms may become insolvent, "good" firms are bankrupt less frequently than "bad" ones. Because a firm recognizes lenders price loans according to their assessments of the probability of being repaid, it may consider hiring an auditor to provide information about its type. Hence firms, good or bad, strategically choose (*i*) whether to hire an auditor at the market-determined flat audit fee and (*ii*) what information to provide the auditor (if one is hired). The auditor then strategically chooses (*i*) how hard to work in investigating the validity of the firm's information and, (*ii*) given the results of the investigation, what public report to issue.

Unless disciplined, the auditor would always choose not to work, making the audit report useless. We thus introduce a court system and let firms and lenders strategically choose whether to sue the auditor for a perceived audit failure. With the threat of litigation, auditors might decide to work and truthfully report their findings to reduce the prospect of paying damages.

A firm's decision to hire an auditor, its message choice, and its litigation strategy depend on the firm's conjectures about the type a lender will believe it to be when it takes a given course of action. That is, the firm makes conjectures about lenders' beliefs about its type for all possible. For this setting, the sequential equilibrium concept of Kreps and Wilson [1982] is appropriate.² The importance of the off-the-equilibrium-path

² A sequential equilibrium consists of a specified strategy for each player plus a system of beliefs which satisfy sequential rationality and consistency. Roughly, sequential rationality requires, given a player's anticipated strategies for the other players and his beliefs at any point in the game, that the player's equilibrium strategy be optimal for the remainder of the game. Consistency means along-the-equilibrium-path beliefs are computed according to Bayes' rule and reflect the actual equilibrium distribution of players' actions.

beliefs to a sequential equilibrium can be seen in the following example. For sufficiently small damage awards, no one would ever sue an auditor, and audit failures would not be punished. Auditors therefore would have no incentive to work and would provide uninformative reports. But an equilibrium in which all firms hire auditors would still exist because of the off-the-equilibrium-path beliefs that a firm which does not hire an auditor is bad. A firm would rather hire an uninformative auditor and be known as an average risk firm than not hire an auditor and be thought a high risk by lenders.

Many combinations of parameter values and off-the-equilibrium-path beliefs support similar equilibria in which auditors are hired despite the fact that they provide useless information; we label this an *ineffective auditing* equilibrium. On the other hand, other sets of parameter values and beliefs support equilibria in which the auditor always works and reports the audit findings truthfully. This second set of equilibria, which we label *effective auditing* equilibria, is the main focus of this paper.

To introduce effective auditing equilibria, we first present a simpler model, called the monitor model, in which the auditor is exogenously assumed to be effective. In this simpler setting where the auditor is nonstrategic, we are able to identify all possible equilibria, including all nondegenerate mixed strategy equilibria. The analysis of the monitor model, however, focuses on the unique equilibrium in which the monitor provides useful information.³ For this equilibrium we first observe that higher monitor fees help separate types. When the monitor fee is sufficiently low, both good and bad firms hire monitors; as the fee increases bad firms gradually leave the market until, at some high fee level, the two types are fully separated. Second, for some parameter values, the good firm is better off in the equilibrium with a high fee than in the equilibrium with free monitoring. Third, the effect of increasing the monitor's market alternative (above some mid-level value) is a Pareto improvement. Finally, we demonstrate circumstances in which all firms are better off without monitors.

Beliefs off-the-equilibrium path (e.g., beliefs about a firm's type if it does not hire an auditor in an equilibrium in which all firms hire) must also be specified and are an integral part of an equilibrium.

³ For each set of parameter values for the monitor model we find *at most* three different equilibria exist: (1) for all parameter values there exists a no-hiring equilibrium in which no firm hires a monitor; (2) as long as monitors are not "too" expensive, there exists a hiring-I equilibrium in which some, possibly all, firms hire monitors; and (3) for a limited set of fees there exists a hiring-II equilibrium in which some good firms, but no bad firm, hire monitors. Our analysis focuses on the hiring-I equilibrium for several reasons. First, no-hiring equilibria do not provide any insights into auditing institutions since no monitor/auditor is employed. Second, while hiring-I equilibria exist for low and moderate levels of the monitor's fee, hiring-II equilibria only exist when the monitor's fee is so large that both good and bad firms are indifferent to all hiring and message choices. Finally, in the hiring-II equilibrium no monitoring/auditing takes place; i.e., the monitor/auditor does not provide any useful information.

Two results distinguish the auditor model from the monitor model. First, fully separating equilibria do not exist in the auditor model, which suggests that conclusions drawn in a nonstrategic setting may not apply to a strategic setting. Second, there exist equilibria, not possible in the monitor model, in which an ineffective auditor is hired. Analogous to the monitor model, however, no-hiring equilibria always exist, and we demonstrate a strong correspondence between the effective auditing equilibria of the auditor model and the above-described equilibrium of the monitor model.

The presence of a court system in the auditor model allows us to address some additional questions, not applicable to the monitor model. In particular, we show that increasing the exogenously specified damages leads to a Pareto improvement in some instances. In addition, we observe, when hiring an auditor is mandated (i.e., in a regulated setting), that increasing the audit fee can never profit either firm type. Increasing the damage award, in contrast, does benefit the good firm; lenders charge the good firm a lower interest rate because they expect to collect a larger portion of their revenues via the court system.

Our monitor model differs from earlier work on signaling in economics and finance (e.g., Spence [1973] and Guasch and Weiss [1981]) because we examine all sequential equilibria rather than just the perfectly separating ones. In fact, we have tried to construct a setting in which opportunities for perfect separation are limited, reflecting what we perceive as reality. The auditor model, by focusing on signaling via a strategic player, further distinguishes our work from the earlier signaling papers. In the accounting literature, studies of litigation against auditors include DeJong [1983] and Nagarajan [1984], who study a two-party game in which the owner's strategic choices are suppressed. Another accounting paper, Sarath and Wolfson [1988], studies strategic auditing in an adverse selection setting involving litigation. The main conceptual difference between our work and Sarath and Wolfson's is our explicit attention to the modeling of the court system, specifically, the strategic use of courts and the welfare consequences of changing the size of damage awards.⁴

Section 2 presents the monitor model and establishes the benchmark results to be contrasted later with those of the auditor model. Section 3 discusses the auditor model and explores both effective and ineffective auditing equilibria. Finally, in section 4, we make some concluding comments. Appendix A provides outlines for the proofs of the main results of the paper; Appendix B summarizes the notation.

⁴ In addition, there are many significant differences in detail; most notable are the differences in (i) the setting—Sarath and Wolfson's (SW) setting is characterized by the "market for lemons" phenomenon and the fact that hiring an auditor facilitates trade, (ii) the court's technology—in SW the courts perfectly observe auditor's private information while in our study the court's technology is imperfect, and (iii) the court's damage awards—SW assume awards are always large enough to guarantee that suits are initiated.

2. The Monitor Model

2.1 ASSUMPTIONS OF THE MONITOR MODEL

We consider a set of firms, each of which wants to borrow funds to undertake a project. Because no firm has its own resources to invest, it must borrow the necessary funds in the competitive debt market if it wants to undertake the project.⁵ The current financial condition of a firm affects the probability the project will bankrupt it; thus, lenders price loans based on their assessment of a firm's bankruptcy risk. To minimize its borrowing costs, a firm strategically decides whether to hire a monitor to provide public information about its financial state.

Specifically, each firm needs N dollars to undertake its project. All successful projects have the same return, R , but the probability of solvency differs. The solvency probability divides firms into two risk classes: fraction t of the firms are "good" (G), i.e., firms that stay solvent with probability p_G , while fraction $(1 - t)$ are "bad" (B), i.e., firms that remain solvent with probability p_B ; $p_B < p_G$. While the distribution of firms across risk classes is common knowledge, only the firm knows its own risk class. We assume firms are risk neutral and the expected return on any project is positive even when a firm is charged the interest rate corresponding to a bad type; thus, all projects are consummated. Alternatively, one might assume that the bad firm could not get a loan if its type were revealed; in that case auditing could play a role in improving social welfare by identifying socially undesirable projects. We believe, however, that the modeling assumption adopted in this paper is more descriptive of most audit work. Only few audit reports result in firms being driven out of business (or denied credit), while for the majority of the firms audit reports affect transaction terms only (e.g., interest rate for a loan).

The fact that the firm has no resources rules out signaling via ownership share (as in Leland and Pyle [1977]). Furthermore, the simple return structure on a project ensures the *nonexistence* of a separating equilibrium even when a lender conditions the contract on a firm's performance.⁶ We

⁵ Because we assume below that there is a single state in which the lender is paid, there is no difference between debt and equity contracts in this model. We thus suppose all contracts are debt contracts with no loss of generality.

⁶ To illustrate the nonexistence of separating contracts, let firms' contracts with lenders specify a pair of payments (X, Y) where X is the payment to be made if the firm is solvent and Y is the payment if the firm is bankrupt. Suppose to the contrary there exist two contracts (X_G, Y_G) and (X_B, Y_B) such that lenders believe a firm offering the first contract was good and a firm offering the second contract (or any contract other than the first) was bad. Given the competitive debt market, lenders expect the same positive return from both contracts or $p_G X_G + (1 - p_G) Y_G = p_B X_B + (1 - p_B) Y_B$. Since Y_i is the payment the firm makes when it is bankrupt, $Y_i \leq 0$, $i = G, B$, implying $X_i > 0$, $i = G, B$. Because $p_G > p_B$, $p_G X_G + (1 - p_G) Y_G > p_B X_G + (1 - p_B) Y_G$. Combining the above inequality and equality yields $p_B X_B + (1 - p_B) Y_B > p_B X_G + (1 - p_B) Y_G$, which indicates the bad firm would choose

therefore introduce nonstrategic monitors, whom firms can employ at the competitively determined flat fee, K , to provide public information about their risk types.⁷ Since a firm has no resources, it must borrow the monitor fee, in addition to N , if a monitor is hired. To minimize the cost of undertaking a project, a firm chooses among three actions: (1) hire a monitor and claim to be a good firm, (2) hire a monitor and claim to be a bad firm, and (3) do not hire a monitor.⁸ While both the act of hiring a monitor and the monitor's report are publicly observable, the communication between the firm and its auditor is not.⁹

Once employed, the monitor tries to verify the firm's claim. Based on the results of this investigation, labeled *findings*, the monitor issues a public report regarding the firm's type. A monitor is assumed to work but may fail to detect a discrepancy between the firm's claim and its true type. Specifically, if the firm has misrepresented its type, the monitor's findings will be identical to the firm's message with probability $(1 - z)$ and will contradict the message with probability z ; but if the firm makes a truthful claim, there is no error to discover, and the monitor's findings will conform to the firm's message. Finally, we assume the monitor is both *truthful* (the report duplicates the findings) and moderately accurate ($z > 1/2$).

the good firm's contract; hence, lenders' beliefs are inconsistent with the players' strategies, implying the nonexistence of a separating sequential equilibrium.

⁷ A discussion of the implications of holding the monitor fee constant is provided in section 4. We postpone this discussion so we may consider these implications in both the monitor and auditor models.

⁸ We suppress the strategy for the firm of claiming a type directly to the lender. This strategy is redundant because any prices discriminating between the good and bad message will result in both firm types choosing the same message. The true value of the (seemingly) peculiar strategy of hiring a monitor and claiming to be bad can be assessed only in equilibrium once lenders form their beliefs about the quality of firms given the alternative monitor reports. For example, if lenders believe only a good firm hires an auditor and claims bad, this strategy may be a desirable option. See also n. 15 below.

⁹ Introducing monitors provides additional contracting opportunities; i.e., contracts between firms and lenders could now be conditioned on the monitor's report. Under very special circumstances separation is now possible. Good firms who wish to borrow $(N + K)$

dollars can fully separate themselves by offering to repay $\frac{(1+r)(N+K)}{P_G}$ (where r is the

risk-free interest rate) when the report issued by the monitor is good (and no bankruptcy occurs) and R when the report says bad (and no bankruptcy occurs) *if all of the following conditions are met*: (1) repudiation of a contract is not possible; (2) it is costless to verify the monitor's investigation took place after the contract between the firm and lender was

signed; and (3) R is sufficiently large, i.e., $R > \frac{(1+r)}{z} \left(\frac{N}{P_B} - \frac{(1-z)(N+K)}{P_G} \right)$. Condition

(1) means that a bad firm cannot offer and then repudiate any contract offered by the good firm. If (2) does not hold, bad firms who get good reports would want to offer any contract chosen by a good firm. Finally, (3) guarantees that the separating contract is incentive-compatible. In this section we implicitly assume one of the above three requirements is not met. We stress, however, (i) the existence of separating contracts in the monitor model is conditioned on monitors being present, and (ii) in the auditor model, such full separation is impossible.

We limit monitors to making type II errors for several reasons. First, this assumption seems close to the real-world auditing procedure whereby the firm's financial statements are modified (if at all) only when the auditor discovers a discrepancy between these numbers and his findings.¹⁰ Second, confining the monitor to type II errors makes the auditor model of the following section more tractable. Last, this assumption gives firms the greatest ability to influence the audit reports. (If, for example, the monitor were to make type I and type II errors with equal probability, the probability of a good or bad report would be independent of the firm's message to its monitor.)¹¹

Lenders are risk neutral and operate in a competitive market. They are willing to loan one dollar today for an expected payment of $(1 + r)$ at the end of the period, where r is the risk-free interest rate. Hence, the specific rate charged a firm depends on lenders' assessments of the probability of bankruptcy.

Once firms have made their strategic choices and monitors have investigated the firms' claims, lenders observe three classes of firms—those with a good report, those with a bad report, and those with no report (since they did not hire monitors). For each group lenders form beliefs about the probability that a firm in the given group is good and set the interest rate accordingly. We let g , b , and n represent lenders' probability assessments that a firm is good when it receives a good, bad, and no report, respectively. The interest factor (the price of borrowing one dollar), Q_i , for a firm thought to be good with probability i , $i = b, g, n$, is:

$$Q_i = \frac{1 + r}{p_G i + p_B (1 - i)}. \quad (1)$$

Note that our main objective in studying the monitor model is to understand better the nature of the equilibria when a strategic auditor is effective; we are not interested in making welfare comparisons between the two frameworks. Thus, because litigation threats are not necessary to induce the monitor to work, we do not include courts in the monitor model.¹²

¹⁰ This assumption is consistent with the definition of audit risk adopted by the AICPA: "This definition of audit risk does not include the risk that the auditor might erroneously conclude that the financial statements are materially misstated. In such a situation, he would ordinarily reconsider or extend his auditing procedures. . . . These steps would ordinarily lead the auditor to the correct conclusion" (AICPA [1986, AU§312.02]).

¹¹ Consider the extreme case in which the monitor fails to uncover an error with probability 0.1 and changes a correct message with probability 0.1. Then regardless of whether a firm claimed to be good or bad, the monitor would report a good firm to be good with probability 0.9 and a bad firm to be bad with probability 0.9. Eliminating type I errors, on the other hand, gives firms maximal impact on the audited financial statements.

¹² If we were to introduce a court system into the monitor model, for some parameter values the results would parallel those of the monitor model and, for other values, they would parallel the results of the auditor model.

2.2 EQUILIBRIUM CONCEPT AND SEQUENCE OF PLAY

Our equilibrium concept is the sequential equilibrium, a refinement of the Nash equilibrium, developed by Kreps and Wilson [1982]. A sequential equilibrium, in addition to specifying a strategy for each player, includes a system of beliefs. For the beliefs and strategies to form a sequential equilibrium the following are required:

1. *Sequential rationality*: starting from each information set, the strategy of each player must be optimal for the remainder of the game, assuming the player is evaluating the payoffs according to his beliefs over the nodes in that information set and over his expected strategies for the other players in the game, and
2. *Consistency*: beliefs are consistent with the hypothesized equilibrium strategies and satisfy Bayes' rule whenever it applies.¹³

This concept differs from the familiar Bayesian-Nash equilibrium in that (1) beliefs are defined for every information set, including those that may not be reached along the equilibrium path, and (2) strategies must be optimal starting from *any* information set.

To summarize the monitor model and to indicate how the sequential equilibrium definition is operationalized, the following outline shows the sequence of action in the monitor model:

At the beginning of the period

1. Each firm privately observes its own type.
2. Each firm, correctly anticipating lenders' beliefs for the three groups (and recognizing it cannot influence these beliefs), strategically decides whether to hire a monitor and what message to send (if a monitor is hired).
3. Lenders form their beliefs regarding the probability that a firm is good on the basis of the firm's observed hiring decision and the monitor's public report.
4. Firms borrow N dollars, plus K dollars when a monitor is employed, at an interest rate which reflects the lender's beliefs. The project begins.

At the end of the period

5. Either the firm realizes revenues R and pays its lender or the firm is bankrupt.¹⁴

¹³ The consistency requirement in Kreps and Wilson [1982] includes more technical constraints than the ones described here. In Melumad and Thoman [1986] we show our equilibria satisfy all of those constraints.

¹⁴ More formally, the game proceeds as follows. Firms move first, each making a hiring and message choice. After the monitors issue their reports, risk-neutral lenders bid for loans to firms in each of the three observed groups (firms with good reports, bad reports, and no reports). The bidding process is Bertrand in nature; i.e., each lender specifies an interest rate at which it will make loans to members of that group. A firm chooses the lender offering the lowest interest rate to its group; if more than one lender lists the lowest rate, the firm randomly selects one.

This sequence constitutes a sequential equilibrium only if the resulting distribution of firms is consistent with lenders' initial assessments (i.e., the fractions of firms actually getting good, bad, or no reports are g , b , and n , respectively).

2.3 EQUILIBRIA OF THE MONITOR MODEL

In the monitor model we identify all possible equilibria:¹⁵

PROPOSITION 1. For any value of the monitor fee there exist *at most* three different essentially unique equilibria.¹⁶ Referring to figure 1 and table 1, (a) at all fee levels there exists a *no-hiring* equilibrium in which no firm hires a monitor; (b) for any fee level $K \in [0, K_3]$ there exists an *hiring-I* equilibrium in which some firms employ a monitor; and (c) for any fee level $K \in [K^*, K_3]$ there exists a *hiring-II* equilibrium in which some fraction of the good firms, but no bad firm, hires.¹⁷

The proofs of Proposition 1 and all the following results are provided in Appendix A.

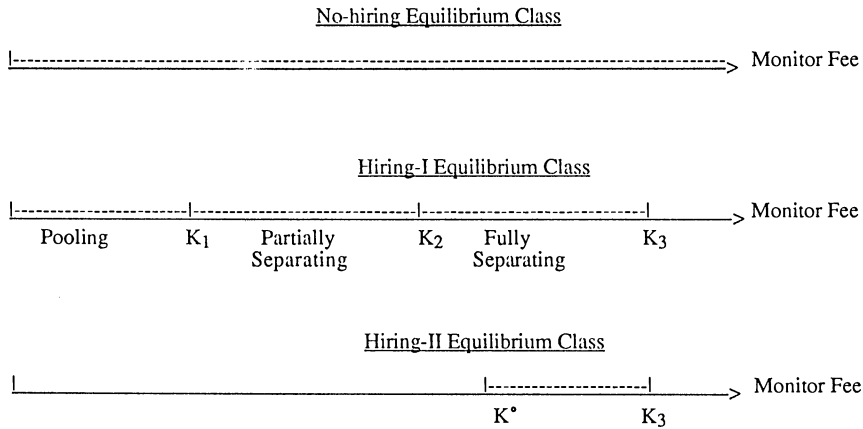
The ubiquitous no-hiring equilibrium, described above, exists at every level of the monitor fee due to the off-the-equilibrium-path beliefs. At low fee levels this equilibrium is supported by lenders' beliefs that hiring a monitor identifies a firm as being truly bad. At high fee levels, however, less extreme beliefs will also support the equilibrium. For example, if the fee is very high, the firm may prefer not to employ a monitor and to be known as average, even if hiring a monitor would have identified the firm as good.

A hiring-II equilibrium exists only at high levels of the monitor fee where all firms are indifferent to hiring, yet this equilibrium can be sustained only if some good firms, but no bad firms, actually hire. Because monitoring is very expensive, good firms are indifferent to being identified as good through payment of the monitor fee and being pooled with firms which do not hire monitors (i.e., all bad firms and possibly some good ones). As the monitor fee increases, this indifference is maintained

¹⁵ When the monitor is not accurate, i.e., $z \leq .5$, there exist additional equilibria. For example, there exist nondegenerate mixed strategy equilibria in which both firm types hire and at least one firm type randomizes on its message choice. All additional equilibria are Pareto dominated by the corresponding no-hiring equilibrium which exists for the same parameter values.

¹⁶ By essentially unique we mean unique on-the-equilibrium-path strategies and payoffs.

¹⁷ Given the multiplicity of sequential equilibria that exist in many models and the "unreasonableness" of some of the beliefs supporting some of the equilibria, a literature has developed which provides criteria for judging the reasonableness of equilibrium beliefs. While the settings in those papers are not identical to ours (we have three strategy choices which are not directly observable while the literature typically assumes two observable strategy choices), in Melumad and Thoman [1986] we apply our interpretation of the Intuitive Criterion of Cho and Kreps [1987] to evaluate the reasonableness of the equilibrium beliefs. We conclude that for mid-range levels of the monitor's fee, the no-hiring equilibrium is based on unreasonable beliefs. (This is consistent with the Cho and Kreps results.) We note, however, that some no-hiring equilibria could be rejected.



$$K_1 = \frac{Nt(1-z)(p_G - p_B)}{tzp_G + (1-z)p_B}$$

$$K_2 = \frac{N(1-z)(p_G - p_B)}{zp_G + (1-z)p_B}$$

$$K_3 = \frac{N(p_G - p_B)}{p_B}$$

$$K^\circ = \frac{N(1-t)(p_G - p_B)}{tp_G + (1-t)p_B}$$

FIG. 1.—Equilibria of the monitor model as a function of the monitor fee. For definitions of variables used in this figure, see Appendix B.

by *increasing* the number of good firms employing monitors. The implied upward-sloping demand for monitors within this class of equilibria seems nondescriptive and unintuitive. We stress, however, that this equilibrium type cannot exist when the monitor fee is at a low or moderate level.¹⁸

Finally, we turn to the hiring-I equilibrium which has more intuitive properties and results in meaningful separation:

COROLLARY 1.1. For any set of parameter values there exists at most a single hiring-I equilibrium.

Referring to figure 1 and table 1, the equilibrium is: (a) a *pooling* equilibrium, where both firm types hire a monitor and claim to be good,

¹⁸ Hiring-II equilibria cannot be eliminated using standard refinements because there is no (observable) action for the firm not taken in equilibrium; hence all beliefs are computed according to Bayes' rule. We also note hiring-II type equilibria are standard features of bivariate signaling models, e.g., Spence's [1973] education model.

TABLE 1
Characteristics of Equilibria in the Monitor Model¹

Class of Equilibria	Strategies	Beliefs ²	Range of Audit Fees Supporting Equilibrium ³	Good Firm's Expected Costs	Bad Firm's Expected Costs
1. No-hiring	G: No hire	$g = 0$	$[0, \infty]$	$p_G \left[\frac{1+r}{tp_G + (1-t)p_B} \right] N$	$p_B \left[\frac{1+r}{tp_G + (1-t)p_B} \right] N$
	B: No hire	$b = 0$ $n = t$			
2. Hiring-I	G: Hire & claim good	$g = \frac{t}{t + (1-t)(1-z)}$	$[0, K_1]$	$p_G \left[\frac{(1+r)[t + (1-t)(1-z)]}{tp_G + (1-t)(1-z)p_B} \right] (N+K)$	$p_B \left\{ (1-z) \left[\frac{(1+r)[t + (1-t)(1-z)]}{tp_G + (1-t)(1-z)p_B} \right] (N+K) \right.$
	B: Hire & claim good	$b = 0$			$\left. + z \left[\frac{1+r}{p_B} \right] (N+K) \right\}$
		$n = 0$			
Partially Separating	G: Hire & claim good	$g = \frac{t}{t + \alpha_B(1-t)(1-z)}$	(K_1, K_2)	$p_G \left[\frac{(1+r)[t + \alpha_B(1-t)(1-z)]}{tp_G + \alpha_B(1-t)(1-z)p_B} \right] (N+K)$	$p_B \left[\frac{1+r}{p_B} \right] N$
	B: Hire & claim good with prob. α_B ; no hire with prob. $(1 - \alpha_B)$	$b = 0$ $n = 0$			
Fully Separating	G: Hire & claim good	$g = 1$	$[K_2, K_3]$	$p_G \left[\frac{1+r}{p_G} \right] (N+K)$	$p_B \left[\frac{1+r}{p_B} \right] N$
	B: No hire	$b = 0$ $n = 0$			
3. Hiring-II: ⁴	G: Hire & claim good with prob. α_G ; no hire with prob. $(1 - \alpha_G)$	$g = 1$ $b = 1$	$[K^0, K_3]$	$p_G \left[\frac{1+r}{p_G} \right] (N+K)$	$p_B \left\{ \frac{(1+r)(1-t\alpha_G)}{t(1-\alpha_G)p_G + (1-t)p_B} \right\} N$
	B: No hire	$n = \frac{t(1-\alpha_G)}{1-t\alpha_G}$			

¹ For definitions of variables used in this table, see Appendix B.
² When the belief is an off-the-equilibrium-path belief, there is a nontrivial range of values (including the specified belief) which is consistent with the equilibrium.
³ K_1 , K_2 , K_3 , and K^0 are defined in figure 1.
⁴ The indicated strategies constitute one of several strategy sets inducing this equilibrium (see Appendix A).

for $K \in [0, K_1]$; (b) a *partially separating* equilibrium, where all good firms, as well as a fraction of the bad firms, hire monitors, for $K \in (K_1, K_2)$; the fraction of bad firms hiring is decreasing in K ; and (c) a *fully separating* equilibrium, where bad firms do not hire while good ones do, for $K \in [K_2, K_3]$.

Corollary 1.1 describes a downward-sloping demand for monitoring within the class of hiring-I equilibria. At very low monitor fees both good and bad firms want to hire a monitor (given the off-the-equilibrium-path beliefs that only a bad firm would not hire a monitor). A good firm will employ a monitor because it knows it will get a good report which will reduce its total interest charges. A bad firm finds it worthwhile to try to masquerade as a good firm since there is a $(1 - z)$ chance of getting a good report and being confused with actual good types.

As the monitor fee increases, the net benefits to each firm type from hiring the monitor decline. Bad firms, however, are the first to become indifferent to employing monitors since the monitor is able to identify some of the high-risk types. With a further increase in the monitor fee some bad firms stop hiring monitors. The smaller number of bad firms employing monitors implies a smaller number of bad firms getting good reports and, in turn, lower interest rates for firms with good reports. For bad firms, the benefits from this lower interest rate just offset the extra cost of the higher monitor fee, keeping bad firms indifferent to hiring. As the fee increases even further, additional bad firms drop out of the monitors' market, thus maintaining this indifference.

When monitor fees are sufficiently high, all bad firms strictly prefer not to employ monitors while good firms continue to hire. In this case, the monitor acts as a perfect signal of a good firm. It is the off-equilibrium threat of a bad report, which lenders associate with a bad firm, that keeps bad firms from hiring monitors. However, only when the monitor works is the threat of a bad report credible. As shown in the next section, the impossibility of making a strategic auditor work when there is a perfect separation of types disallows this equilibrium class in the auditor model. Finally, at extremely high fees, the benefits from the monitor as a signal are outweighed by the audit fees, and thus no firm hires a monitor.

The existence of the two distinct classes of equilibria in which monitors are employed, hiring-I and hiring-II, is due to the endogeneity of the signaling costs in the model. In a hiring-I equilibrium lenders believe a firm which receives a bad report is truly bad; these beliefs may be off-the-equilibrium-path beliefs, as in the fully separating case, or on-the-equilibrium-path beliefs, as in the pooling or partially separating cases. Because monitors provide useful information about firms' types by identifying some of the bad firms, good firms have lower signaling costs than bad firms in a hiring-I equilibrium. On the other hand, in the hiring-II equilibrium lenders believe a firm which receives a bad report is truly good; these beliefs may be off-the-equilibrium-path beliefs or on-the-

equilibrium-path beliefs when the good firms claim to be bad and are the sole employers of monitors. Hence, in a hiring-II equilibrium the monitor provides no information about firms' types, and all firms have the same signaling costs.

By comparing firms' costs, as given in table 1, we establish the following corollaries for the hiring-I class of equilibria; proofs are provided in Appendix A.

COROLLARY 1.2. Within the class of hiring-I equilibria, there exists a range of monitor fees (including the interval $[K_1, K_2]$) in which an improvement in monitoring quality (i.e., an increase in z) reduces the number of firms hiring monitors.

From the definitions in figure 1 it is apparent that, as z increases, both K_1 and K_2 decline while K_3 remains unchanged. Thus, within this equilibrium class, the range of fees over which there is a positive demand for monitoring does not change with an improvement in monitoring technology, but the "demand" for monitoring becomes less elastic. More accurate monitoring reduces the bad firm's benefits from engaging a monitor; therefore, fewer bad firms hire at each fee level.

COROLLARY 1.3. For the partially separating equilibria of the hiring-I class, increasing the monitor fee is a Pareto improvement for the firms.

For the range of fees which support partially separating hiring-I equilibria, the bad firm is indifferent to hiring; hence, increasing the monitor fee does not affect its costs. For the good firm, increasing K has two opposing effects on its expected costs: (1) a direct increase and (2) an indirect decrease since fewer bad firms employ monitors, thus reducing the interest factor Q_g . In equilibrium, the second effect dominates.

COROLLARY 1.4. Within the class of hiring-I equilibria, if the proportion of good firms, t , is "small" and/or the monitors' accuracy, z , is "large" (formally, if and only if $t - (1 - t)z < 0$), then good firms are better off in equilibria which correspond to high monitor fees in the neighborhood of K_2 (i.e., fees that result in little or no hiring by the bad firms) than in equilibria which correspond to any other fee. In particular, good firms are better off with high monitor fees than with costless monitoring.

Roughly, when there are "many" bad firms, the signal implicit in the hiring act itself better separates good and bad firms than the report of the imperfect monitor. A "high degree" of monitoring accuracy is also necessary, however, to ensure that the monitor fee which drives all bad firms out of the market is not excessively high.

We now turn to a comparison across equilibrium classes.

COROLLARY 1.5. For each $K \in [0, K^0)$, i.e., when only hiring-I and no-hiring equilibria exist, while the bad firm is always better off in the no-hiring equilibrium, the good firm is better off in the hiring-I equilibrium as long as $t < 2 - 1/z$. Otherwise, for some nontrivial range of monitor fees, both firm types are better off in the no-hiring equilibrium than in the hiring-I equilibrium.

Bad firms always prefer the no-hiring equilibrium to the hiring-I

equilibrium since they do not have to pay for monitors and are indistinguishable from good firms. The comparison for good firms is more complicated. The interest rate charged in the no-hiring equilibrium is always higher than the rate in the hiring-I equilibrium, but after accounting for the monitor fee, the good firm may be better off in the no-hiring equilibrium. In particular, a good firm is better off being viewed as average risk and saving the monitor fee, as in the no-hiring equilibrium, when the number of good firms, t , is large or monitor accuracy, z , is small.

COROLLARY 1.6. For each $K \in [K^\circ, K_3]$, i.e., when all three equilibrium classes coexist, the no-hiring equilibrium weakly dominates the hiring-II equilibrium, which in turn weakly dominates the hiring-I equilibrium.

The no-hiring equilibrium dominates the hiring-I and hiring-II equilibria because the monitor fee is relatively high; firms are better off not employing the monitor and being thought of as average. The hiring-II equilibrium dominates the hiring-I since fewer firms hire the expensive monitors in the hiring-II equilibrium.¹⁹

We now turn to the auditor model and establish results analogous to the above corollaries of the monitor model.

3. *The Auditor Model*

In this model the auditor is a strategic player who chooses both work intensity and report type to maximize his utility. A court system is also introduced as a disciplining mechanism for auditors. Suit decisions are endogenously made strategic choices determined by equilibrium payoffs. In the first part of this section we concentrate on sets of parameter values inducing, via the litigation process, equilibria in which auditing is said to be “effective”; i.e., the auditor works and reports truthfully. While we find several parallels between the monitor model and the auditor model when auditing is effective, we observe the fully separating hiring-I equilibria of the monitor model cannot coexist with effective auditing. In addition, we examine the role played by the size of the damage awards; in particular, we describe one reason extensive litigation (that is, a large number of lawsuits) against auditors might be desirable. In the second part of the section we study effective auditing equilibria involving limited litigation. We conclude the section by examining ineffective auditing equilibria.

3.1 ASSUMPTIONS OF THE AUDITOR MODEL

In the auditor model, we add to the basic setting of the monitor model the following variants and assumptions. First, the auditor is assumed to be a utility-maximizing, risk-neutral agent who strategically decides

¹⁹ A similar welfare relation exists among no-hiring, hiring-II, and fully separating hiring-I equilibria in standard bivariate signaling models.

whether to work and what type of report to issue. An auditor who works obtains the same findings as a monitor with the same level of accuracy; i.e., a false message will be found with probability z , and a truthful message is never mistaken as incorrect. On the other hand, an auditor who shirks and does not investigate can never find a discrepancy between the firm's message and its true type. The auditor's findings in this last case are defined to be identical to the message. As in the monitor model, the auditor is said to be truthful if he reports his findings.²⁰ Neither the auditor's work choice nor the audit findings are publicly observable.

The auditor's work decision depends on the firm's message and his beliefs that the message came from a good firm; similarly, the auditor's report choice is a function of his revised beliefs about the firm's type, given the investigation. Accordingly, we introduce the belief $g^\circ(b^\circ)$ to represent the auditors' beliefs that a firm which hired an auditor and claimed to be good (bad) is actually good.

Paralleling the monitor model, firms are assumed to be price-takers in the auditing market. The auditor's market alternative is $K - w$, where w is the personal cost of effort. Hence, the auditor works only if he expects to receive K . We postpone the discussion of assuming flat auditor contracts until section 4, after the auditor model and its results have been presented.

In our single-period model, absent reputational effects, an auditor who bears no responsibility for the audit report would always prefer to shirk and report opportunistically. We posit, therefore, a court system in which a lender or firm may sue an auditor if it believes/knows that the auditor's report differs from the firm's true type. In a lawsuit, the court looks for discrepancies between the audit report and the firm's type; we label such a discrepancy an *audit failure*. If an audit failure exists, the courts discover it with probability y , but if the audit report is accurate, there is no audit failure to uncover, and the court's ruling agrees with the report. No moral hazard is assumed on the part of the courts since the proceedings are public; all parties hear the evidence presented and can observe any discrepancy revealed. We have modeled the courts as having a similar technology to the one employed by auditors. The domain of the courts' investigation, however, differs from that of the auditors'; while auditors try to compare the firm's message with its type, the courts compare the auditor's report with the firm's true type.

In this model an audit failure could occur for three possible reasons: (1) the auditor did not work and consequently failed to discover a lie in the firm's message; (2) the auditor did not truthfully report his findings; or (3) although the auditor worked hard and reported truthfully, he failed

²⁰ As long as the auditor works, the use of the terms "findings" and "truthful" seems intuitive. However, when the auditor does not work, our definitions imply that his findings are identical to the firm's message and that a truthful auditor's report repeats the firm's message. While this stretches the commonsense notion of there being "findings" or of the auditor as being "truthful," we nonetheless maintain this semantic convention.

to uncover an error in the firm's message. Courts punish revealed audit failures but are unable to differentiate their sources.²¹

We impose some restrictions on the court's ability to assess damages and try cases. If the court discovers a discrepancy between the audit report and the firm's type, the defendant is assessed a penalty, A , to be paid to the plaintiff as a damage award; if no error is discovered, there are no penalties or awards.²² Because we are interested in studying the effect of varying the size of the damage payment on the resulting equilibria, we assume A is exogenous; in other words, A does *not* reflect the size of the actual damages incurred. Suits involve legal costs, L , which are paid by the loser. We also impose two limitations on the types of suits that can be tried. First, the court's ruling is final; a firm cannot be retried. Second, the court only hears cases in which a party can claim to have been damaged *ex ante* by the auditor's report. Hence, if in equilibrium $Q_g < Q_b$, then (1) a firm with a good report cannot sue its auditor, and (2) a lender to a firm with a bad report cannot sue the auditor.²³

We assume that the lender can sue the auditor but not the firm. This assumption is adopted for two reasons. First, this assumption simplifies the analysis, permitting us to avoid questions of whether the firm can be sued when it is bankrupt and how damage payments are to be divided between a firm and its auditor. In addition, it makes the signaling problem more significant because the court system cannot directly punish a firm for lying. However, since the audit fee is determined competitively, any expected damage payment will be reflected in the fee; thus, *ex ante* the auditor's expected utility does not depend on the way damages are assigned.

A court system introduces several complexities to the model. First, as noted above, because the auditors bear the risk of being sued, their competitively determined fee reflects the expected damage payments. The actual payment to the auditor, denoted by κ , is endogenously determined in equilibrium and, in general, is different from the auditor's market alternative K . Second, if a firm sues its auditor, the court's ruling provides information about a firm's type which lenders can use in determining interest rates. Therefore, letting ij ($i, j = g, b$) represent lenders' beliefs that a firm with an i -report and a j -ruling is good, there exist new prices, Q_{ij} , in addition to the prices Q_i ($i = g, b, n$) charged firms which have not sued their auditors. Last, firms have an additional

²¹ This assumption makes it more difficult to induce auditors to work and report truthfully.

²² The term damage award captures both the restitutive and the punitive aspects of the transfer payment A .

²³ In section 3.2.2 we consider an alternative scenario where the lenders can sue only when the firm is bankrupt; this scenario is studied in Melumad and Thoman [1990]. In section 3.2.3 we discuss the effect of an alternative damage-assessment assumption on our results.

strategic choice, and lenders become strategic players. After the auditor's public report is issued, the firm strategically decides whether to sue its auditor. If the firm does sue, it must borrow the legal fees (L); any subsequent payment awarded the firm would reduce its borrowings.²⁴ Similarly, at the end of the period, the lender decides, based on the auditor's report and the solvency position of the firm, whether to sue the auditor.

In summary, the sequence of actions proceeds as follows:

At the beginning of the period

1. Each firm knows its own type.
2. The firm, correctly anticipating lenders' beliefs for the different groups (and recognizing that it cannot influence these beliefs), decides whether to hire an auditor and what message to send (if an auditor is hired).
3. Given the message from the firm and his beliefs about the firm's type, the auditor makes a work choice, completes the investigation, and decides what report to issue.
4. Based on the report, the firm decides whether to sue its auditor. If the auditor is sued and found guilty, he pays damages to the firm.
5. Lenders form beliefs about the probability that a firm is good, conditioned on the firm's hiring decision, the auditor's report, the firm's suit choice, and the court's finding.
6. Firms borrow the necessary funds (i.e., N plus K , if it hires auditor, plus L , if it loses its suit against its auditor, minus A if it wins its suit) at an interest rate which reflects lenders' beliefs and commence production.

At the end of the period

7. Either the firm realizes revenues R and pays the lender or the firm goes bankrupt.
8. Lenders decide whether to sue the auditor.
9. The court conducts its investigation and assesses damage awards.

A sequential equilibrium exists when all parties maximize their expected utilities at each stage of the game, when the resulting distribution of firms' messages is consistent with auditors' beliefs, and when the resulting distribution of firms borrowing funds at the various interest rates is consistent with lenders' beliefs about the quality of firms which obtain loans at those interest rates.

3.2. EQUILIBRIA OF THE AUDITOR MODEL

In the auditor model, as in the monitor model, an equilibrium in which no firm hires an auditor always exists.

²⁴ The alternative assumption, that the firm collects its damage awards at the end of the period, would not qualitatively affect the analysis.

PROPOSITION 2. In the auditor model, a *no-hiring* equilibrium exists for all possible sets of parameter values.

As in the monitor model, these equilibria are supported by off-the-equilibrium-path beliefs that a firm hiring an auditor is truly bad.²⁵

The nature of the equilibrium in which auditors are employed crucially depends on the set of parameter values; in particular, it depends on the size of the damage award. When penalties for audit failures are large enough, auditing is *effective*; i.e., auditors work and truthfully report their findings. Sufficiently small penalties, on the other hand, will not induce effective auditing. We first focus on effective auditing equilibria, looking at two subclasses of this general class. In section 3.2.1 we consider *effective auditing, extensive litigation* equilibria where lenders sue whenever the report is good. In section 3.2.2 we study the *effective auditing, limited litigation* equilibrium class where lenders sue auditors who have issued good reports only when the firm is bankrupt. In section 3.2.3 we turn to *ineffective auditing* equilibria.

We first observe:

PROPOSITION 3. Fully separating equilibria do not exist for any set of parameter values.²⁶

The proof of Proposition 3 is based on the following intuitive argument. If a fully separating equilibrium exists, lenders would no longer sue since they know that any firm with a good report is indeed good and, hence, the lenders cannot win awards. But if lenders do not sue, auditors will not work. Consequently, the benefits from hiring an auditor are identical for both firm types, and all firms would make the same hiring decision, contradicting the existence of a separating equilibrium.²⁷

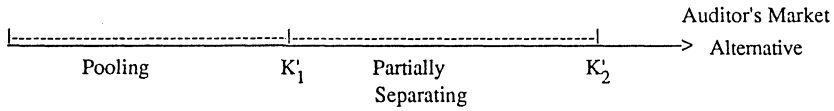
Proposition 3 suggests that conclusions made possible by the existence of auditors, exogenously assumed to be effective, may not be valid in a similar setting where the auditor's effectiveness must be induced in equilibrium. For example, some of the nonstrategic auditing literature focuses on separating equilibria facilitated by information provided by nonstrategic auditors. When the auditor is strategic, separation may not be possible.

3.2.1. Effective auditing, extensive litigation equilibria. In this section, we assume damage awards are sufficiently large that lenders sue whenever the report is good.

²⁵ As in the monitor model, we could apply refinements on beliefs in an attempt to reduce the number of equilibria. The complexity of the model makes operationalizing refinements such as the Intuitive Criterion difficult. We expect, however, an application of standard equilibrium refinements to result in an elimination of no-hiring equilibria for some parameter values (see n. 17 above).

²⁶ The one exception to this proposition is a special case of the hiring-II equilibrium discussed below. For only one value of K ($K = K_3$ as defined in figure 1) there exists an equilibrium in which all good firms hire and send an arbitrary message while all bad firms do not hire. Full separation is then possible since both firm types are indifferent to all three report choices. Note that in this knife-edge case, separation is not beneficial to any party.

²⁷ For a related argument, see Bachar [1989].



$$K'_1 = \frac{N(1-z)t(p_G - p_B)}{zp_G + (1-z)p_B} - \frac{(A+L)y(1-t)(1-z)zp_G}{(1+r)[zp_G + (1-z)p_B]} - \frac{L(1-z)[t+(1-t)(1-z)]p_B}{(1+r)[zp_G + (1-z)p_B]}$$

$$K'_2 = \frac{N(1-z)(p_G - p_B)}{zp_G + (1-z)p_B} - \frac{L(1-z)p_B}{(1+r)[zp_G + (1-z)p_B]}$$

FIG. 2.—Effective auditing, extensive litigation equilibrium class in the auditor model. For definitions of variables used in this figure, see Appendix B.

PROPOSITION 4. In the auditor model, for some parameter values there exists an effective auditing, extensive litigation equilibrium. Referring to figure 2 and table 2, this equilibrium is (a) a *pooling* equilibrium, where both firm types hire an auditor and claim to be good, for any auditors' market alternative $K \in [0, K'_1]$, or (b) a *partially separating* equilibrium in which all good firms, as well some fraction of the bad firms, hire auditors and claim to be good for all $K \in (K'_1, K'_2 - \epsilon]$, where ϵ can be made arbitrarily small; the fraction α_B of bad firms hiring is a decreasing function of K . This equilibrium is the essentially unique effective auditing, extensive litigation equilibrium in which all firms hiring auditors claim to be good.²⁸

Intuition for the types of restrictions that must be imposed on the parameter values to ensure that auditing is effective and litigation extensive is as follows. Suppose equilibrium beliefs support $Q_g < Q_b$; given the restrictions on the types of cases courts will review, a firm can sue its auditor only if the report is bad, and a lender can sue the auditor only if the report is good. Without the threat of *both* suit types the auditor would not always tell the truth, contradicting the assumption of effective auditing. Hence, an initial requirement is that the lender's expected damage award from suing when a firm gets a good report must outweigh the legal costs. Second, since $Q_g < Q_b$, both firm types will claim to be good. If an auditor were subsequently to report a good firm as bad (in an attempt to avoid a lender's lawsuit), the good firm would know it had a good chance of winning a lawsuit. The good firm will want to sue when the auditor reports bad if the expected award exceeds the legal fees involved. Finally, while the auditor cannot avoid paying some damages (since he errs occasionally), he will work hard if the expected reduction

²⁸ We do not attempt to characterize all possible equilibria of the auditor model; in particular, there may exist equilibria in which some firms claim to be bad when they hire auditors and there is effective auditing and extensive litigation.

TABLE 2
Characteristics of Effective Auditing, Extensive Litigation Equilibria in Auditor Model¹

Class of Equilibria	Strategies	Beliefs ²	Range of Audit Fees Supporting Equilibrium ³	Audit Fee	Good Firm's Expected Costs	Bad Firm's Expected Costs
Pooling	<p>G: Hire & claim good; sue when $r = B$</p> <p>B: Hire & claim good</p>	$g = \frac{t}{t + (1-t)(1-z)}$ $b = 0$ $n = 0$	$[0, K_1']$	$K + \frac{(A+L)y(1-t)(1-z)}{(1+r)}$	$p_G \left\{ \frac{(1+r)[t + (1-t)(1-z)]}{tp_G + (1-t)(1-z)p_B} \right\} \cdot (N+K)$	$p_B \left\{ (1-z) \left[\frac{(1+r)[t + (1-t)(1-z)]}{tp_G + (1-t)(1-z)p_B} \right] \right\}$
Partially Separating	<p>Auditor: Truthful; shirk when $m = B$; work when $m = G$</p> <p>Lenders: Sue when $r = G$</p>	$g^0 = t$ $b^0 = 0$	(K_1', K_2')	$K + \frac{(A+L)y(1-t)(1-z)\alpha_B}{(1+r)[t + (1-t)\alpha_B]}$	$- \frac{(A+L)y(1-t)^2(1-z)zp_G}{tp_G + (1-t)(1-z)p_B}$ $+ \frac{L[t + (1-t)(1-z)]p_G}{tp_G + (1-t)(1-z)p_B}$ $+ \frac{p_G \left[\frac{(1+r)[t + (1-t)(1-z)\alpha_B]}{tp_G + (1-t)(1-z)\alpha_B p_B} \right] \cdot (N+K)}{(1+r)[t + (1-t)(1-z)\alpha_B]}$	$+ \frac{(1-z)L[t + (1-t)(1-z)]p_B}{tp_G + (1-t)(1-z)p_B}$ $+ \frac{\left[\frac{1+r}{p_B} \right] (N+K)}{(A+L)y(1-t)(1-z)zp_G}$
Partially Separating	<p>G: Hire & claim good; sue when $r = B$</p> <p>B: Hire and claim good with probability α_B no hire with prob. $(1 - \alpha_B)$</p> <p>Auditor: Truthful; shirk when $m = B$; work when $m = G$</p> <p>Lenders: Sue when $r = G$</p>	$g^0 = \frac{t}{t + \alpha_B(1-t)(1-z)}$ $b = 0$ $n = 0$ $g^0 = \frac{t}{t + \alpha_B(1-t)}$	(K_1', K_2')	$K + \frac{(A+L)y(1-t)(1-z)\alpha_B}{(1+r)[t + (1-t)\alpha_B]}$	$- \frac{(A+L)y(1-t)^2(1-z)zp_G\alpha_B^2}{[tp_G + (1-t)(1-z)\alpha_B p_B][t + (1-t)\alpha_B]}$ $+ \frac{L[t + (1-t)(1-z)]p_G}{tp_G + (1-t)(1-z)\alpha_B p_B}$ $+ \frac{p_G \left[\frac{(1+r)[t + (1-t)(1-z)\alpha_B]}{tp_G + (1-t)(1-z)\alpha_B p_B} \right] \cdot (N+K)}{(1+r)[t + (1-t)\alpha_B]}$	$+ \frac{\left[\frac{1+r}{p_B} \right] N}{(A+L)y(1-t)(1-z)zp_G}$

¹ For definitions of variables used in this table, see Appendix B.

² When the belief is an off-the-equilibrium-path belief, there is a nontrivial range of values (including the specified belief) which is consistent with the equilibrium.

³ K_1' and K_2' are defined in figure 2.

in damage assessments through the investigation outweighs the personal cost of effort. In summary, for an effective auditing, extensive litigation equilibrium to exist, the damage award must be large relative to the legal fees, L , and the personal cost of effort, w .

Corollaries 1.3 through 1.5 of the monitor model have analogues in the auditor model. As in the monitor model, these corollaries are derived by comparing the firms' costs across and within equilibria classes.

First, we find instances in which a higher audit fee is actually beneficial:

COROLLARY 4.1. For any partially separating equilibrium within the class of effective auditing, extensive litigation equilibria (i.e., for any $K \in (K_1', K_2' - \epsilon]$, where ϵ can be made arbitrarily small), increasing K is a Pareto improvement for the firms if and only if:

$$\frac{N(1+r) + zL}{A+L} > \frac{y(zp_G + (1-z)p_B)}{p_G - p_B}.$$

As in the monitor model, for the range of fees supporting partially separating equilibria, the bad firm is indifferent to hiring, and thus an increase in K does not affect its expected costs. The impact of increasing K on a good firm's expected costs is more complex. In addition to the two effects identified in the monitor model—a direct increase via K and a reduction in Q_g due to a revision of lender's beliefs—there is a third effect which increases Q_g because of the reduced expected damage awards collected by lenders. As long as N is large, relative to $(A + L)$, the reduction in Q_g dominates the other two effects.

Second, we observe circumstances in which the auditor better serves as a pure signaling device than as a provider of information:

COROLLARY 4.2. Within the class of effective auditing, extensive litigation equilibria, if the damage award, A , the legal fee, L , and the proportion of good firms, t , are small and auditors are accurate, then good firms are better off in equilibria corresponding to a high market alternative for the auditor than in equilibria corresponding to a zero-valued market alternative for the auditor.

As in the monitor model, when bad firms dominate the population and auditors commit few errors, good firms are better separated via the costly signal implicit in hiring an auditor than via the information content of the auditor's report.

Finally, we observe there exist sets of parameter values for which all firms would be better off without the institution of auditing:

COROLLARY 4.3. For K in the neighborhood of K_1' , there exist some values of the other parameters for which both firm types are better off in the no-hiring equilibrium than in the corresponding effective auditing, extensive litigation equilibrium.

The auditor model also enables us to analyze the impact of increases in the damage award. If all bad firms hire auditors at the original award level, some sufficiently large increase in the award would make bad firms indifferent to hiring. Analyzing the impact of increasing A beyond the level of indifference is complicated by the possibility that the suing

decision could be affected—increasing A may drive some bad firms out of the market, reducing the likelihood a lender will win his case; the combined effect of a higher damage award with a lower probability of winning damages on the lenders' and firms' equilibrium suing strategies is not immediately clear. In the proof to the following corollary we show that for effective auditing, extensive litigation equilibria increasing A does not affect the players' suing strategies. Simple, yet cumbersome, computations show this increase in this damage award reduces the proportion of bad firms employing auditors while reducing the good firms' expected costs.

COROLLARY 4.4. Within the class of effective auditing, extensive litigation equilibria, increasing the size of the damage award (weakly) reduces the number of bad firms employing auditors. For the subclass of partially separating equilibria, the number of bad firms hiring, as well as the good firms' expected costs, *strictly decreases* as the damage award increases. Consequently, for this equilibrium subclass, increasing the damage award is a Pareto improvement for the firms.

In contrast to Corollary 4.1, we note that this Pareto improvement is independent of the parameter values.

All of the above results assume an unregulated environment. If auditing were mandated, then the signal provided by firms' hiring choices would be lost. Assuming litigation awards were sufficiently high to induce effective auditing, firms' costs would be the same as in the pooling hiring equilibrium (given in table 2). Clearly, in a regulated setting, increasing the auditor's market alternative cannot improve separation; it merely increases all firms' borrowing costs. From table 2 it is apparent, however, that increasing the damage award would reduce the good firms' costs at the expense of the bad firm. Intuitively, raising the damage awards increases the equilibrium-expected damage awards collected by the lenders; as a result lenders reduce the price for a loan associated with a good report (but not the price corresponding to a bad report). To summarize:

COROLLARY 4.5. In a setting with mandatory auditing, there exist equilibria in which auditing is effective and litigation is extensive. For those equilibria, an increase in the auditor's damage payment raises the bad firms' expected borrowing costs while reducing the good firms' expected costs, even though auditors charge both firm types the same fee.

Thus, while separation cannot be improved by increasing the damage awards in a regulated environment, costs are more appropriately assigned (relative to perfect observability).

Finally, we consider the impact of changes in level of auditor accuracy, z :

COROLLARY 4.6. Consider equilibria in which litigation is extensive and auditing is effective and mandatory. When A is large and z is close to one, an increase in z *raises* the good firm's expected costs and *lowers* the bad firm's expected costs.

The implication of the corollary, from the perspective of the good firms, is that auditors in a regulated environment can be *too* accurate. The intuition for this result is the following. Changing z affects a good firm's expected costs in three ways: (1) the interest factor corresponding to a good report is directly reduced as more bad types are detected; (2) the interest factor corresponding to a good report is indirectly increased as lenders' expected damage collections decline; and (3) the audit fee, charged all firms, is reduced due to fewer successful suits. When z is close to one, a further increase in z reduces by a large percentage the number of bad firms with good reports, causing effect (2) to dominate the combined impact of (1) and (3).

3.2.2. Effective auditing, limited litigation equilibria. The prior section assumed the parameter values induced lenders to sue whenever the report was good. The extensive litigation feature of the derived equilibria might be regarded as undescriptive as well as "undesirable" because it involves large deadweight legal costs. However, there exist effective auditing equilibria when litigation is "limited," i.e., where lenders sue only when the report is good and the firm is bankrupt. This will happen when award levels are too small to induce extensive litigation, yet sufficiently large to induce limited litigation.

PROPOSITION 5. For some parameter values, in particular small damage awards, there exists an equilibrium similar to the equilibrium described in Proposition 4 with the exception that lenders sue *only* when the report is good *and* the firm is bankrupt. This equilibrium is the essentially unique effective auditing, limited litigation equilibrium in which all firms hiring auditors claim to be good.

We stress that extensive litigation equilibria and limited litigation equilibria cannot coexist for the same parameter values. Nevertheless, in evaluating the equilibria as to their descriptiveness or "desirability," we note the following. First, the label "limited litigation" refers to suing *behavior* and not to the *number* of cases litigated. In fact, for the same parameter values (other than the damage awards), there may be more legal cases in a limited litigation equilibrium than in an extensive litigation equilibrium because the larger awards in the latter drive many bad firms out of the auditor market. Second, in the limited litigation equilibria, we trade improved separation for (possibly) reduced litigation. Because the damage awards in the limited litigation case have to be relatively small—to guarantee a lender will not find it worthwhile to sue when the firm is not bankrupt—the separation between types is limited.

Finally, we consider an alternative setting in which limited litigation is exogenously imposed via legal strictures requiring the existence of ex post damages before a case can be tried; specifically, lenders can sue only if the firm was bankrupt after it had gotten a good report. In this case, we get qualitatively similar existence and comparative static results corresponding to the effective auditing, extensive litigation case.

3.3.3. Ineffective auditing equilibria. We consider parameter values

for which litigation threats are insufficient to induce the auditor to work. This can occur if the auditor's personal cost of working, w , exceeds the incremental expected damages for shirking or if firms' or lenders' expected legal costs exceed the total expected damage collections—thus they would never sue. (Note that total expected damage collections are small when the damage award, A , is relatively small, as well as when few bad firms hire.)

When auditing is ineffective, the auditor functions as a monitor who has no detective ability, i.e., a monitor with $z = 0$. In this case, there exist pooling and partially separating hiring-I as well as hiring-II equilibrium classes, although the monitor provides no information. At the same time, we observe:

PROPOSITION 6. Any ineffective auditing equilibrium is strictly Pareto dominated by the no-hiring equilibrium corresponding to the same set of parameter values.

As long as the ineffective auditing equilibrium is due to the small level of the damage award, A , and/or a high personal cost of effort, w , ineffective auditing equilibria and effective auditing equilibria cannot coexist for the same parameter values. But if the ineffective auditing equilibrium is a consequence of the fact that no bad firms hire (as in a hiring-II equilibrium), it is possible ineffective and effective auditing equilibria will coexist for the same parameter values. However, as long as auditing is moderately accurate, an equilibrium involving effective auditing and a hiring-II equilibrium cannot coexist for the same parameter values.²⁹

Before concluding, we wish to comment on a potential similarity between ineffective auditing and one common interpretation of a rational court system. Some legal researchers argue damage awards should restore a “wronged” party to his economic position had the wrong not occurred. Consider now an extreme case of a “rational” court system that attempts to bring the plaintiff back to his *ex ante* position. In our model, a bankruptcy does not imply the lender has been damaged, since in equilibrium the lender always receives a payment which accurately reflects his probability of being repaid. He accepted a known fair bet but was unlucky and lost. Since our “rational” court would not rule any award to lenders, lenders would not sue and auditors would not work. Hence a “rational” court system, in the context of our model, provides a special case of ineffective auditing, and all equilibria in which auditors are employed would be dominated by equilibria without auditors.³⁰

4. Discussion

In this section, we address the issue of hiring courts (instead of auditors) to signal types and discuss the limitations of the flat fee assumption.

²⁹ A sufficient condition is $z > t$ because it guarantees that $K_2' < K^\circ$.

³⁰ For a related discussion of *ex ante* versus *ex post* damages, see Patell, Weil, and Wolfson [1982].

4.1 WHY HAVE AUDITORS?

A legitimate concern is whether auditors serve any purpose once a court system is introduced. Indeed, in our model, only when a firm engages an auditor will the lender “consider” charging it a reduced price. However, an alternative market arrangement would allow firms to make public claims about their types and let lenders strategically sue firms based on the firms’ messages. Thus, what is the rationale for introducing the intermediate party—the auditor?

We present two possible reasons. First, auditors reduce the extent of litigation in equilibrium. In the absence of auditing, all firms would issue the same message; hence, when awards are large enough, the lenders would sue every firm. In the auditor model, even in a case of extensive litigation, as described in Proposition 4, some bad firms are screened out by the auditors, and no suits are initiated by lenders with respect to these firms.

A second rationale for introducing the auditors is the “insurance” role they play given the firms’ limited ability to pay damage awards. A firm can pay damages up to its net return (after borrowing costs), but even this amount is conditioned on solvency. Auditors, on the other hand, are assumed to have deep pockets and thus provide finer separation compared to a model in which lenders sue the firms directly.

4.2 OPTIMAL AUDIT CONTRACTS

We have assumed that a firm cannot design an audit contract in which payment is a function of the observable variables. We justify these assumptions on several grounds. First, we are interested in studying strategic auditing in a market setting. A flat audit contract assumption facilitates the analysis in our complex market setting while reflecting reality. Second, introducing more elaborate contracts would necessitate the introduction of lenders’ and auditors’ beliefs about firms which offer those contracts. This would be a game different than the one analyzed in this paper; however, if we were to identify *all* sequential equilibria of the new game, not only the fully separating ones, the equilibria of this paper would *also* be equilibria of the new game for appropriately defined beliefs about parties who offer nonconstant contracts. As contracts could only be judged as “optimal” within the context of a given equilibrium set of lenders’ and auditors’ beliefs, the constant contracts of this paper would still be “optimal” for an appropriately defined set of beliefs. In Melumad and Thoman [1990] we study the question of optimal contingent audit contracts in a setting similar to the one of this paper. Finally, our intent is to study the equilibria of a market setting when there are limits on firms’ abilities to separate themselves. Imposing flat contracts, although not essential, enables us to achieve this objective more easily. Much of the signaling literature studies combinations of contracting arrangements and public information sets which result in perfect separation for some parameter values; the analysis typically concentrates on

such fully separating equilibria. We have taken a different tack by restricting the signaling opportunities and studying all possible sequential equilibria. We believe this approach reflects the real world where firm characteristics are sufficiently complex—compared to the limited number of observable variables on which contracts can be written—to preclude full separation, and hence other equilibrium types prevail. Assuming all audit contracts are flat allows us to study the various equilibrium forms. In addition, while for some parameter values contingent contracts would produce in the monitor model a fully separating equilibrium (along with other sequential equilibria), fully separating sequential equilibria cannot exist in the auditor model.

APPENDIX A

Outline of Proofs

PROPOSITION 1 AND COROLLARY 1.1. Let α_i be the probability a firm of type i , $i = B, G$, picks the action hire and claim to be good; let β_i be the probability a firm of type i , $i = B, G$, picks the action hire and claim to be bad. By default, $1 - \alpha_i - \beta_i$ is the probability a firm of type i , $i = B, G$, does not hire a monitor. The following chart indicates all potential equilibria of the monitor model:

					$\alpha_G \in (0, 1)$	$\alpha_G \in (0, 1)$	
	$\alpha_G = 1$	$\alpha_G = 0$	$\alpha_G = 0$	$\alpha_G \in (0, 1)$	$\alpha_G = 0$	$\beta_G \in (0, 1)$	$\beta_G \in (0, 1)$
	$\beta_G = 0$	$\beta_G = 1$	$\beta_G = 0$	$\beta_G = 0$	$\beta_G \in (0, 1)$	$\alpha_G + \beta_G = 1$	$\alpha_G + \beta_G < 1$
$\alpha_B = 1, \beta_B = 0$	A	B	C	D	E	F	G
$\alpha_B = 0, \beta_B = 1$	H	I	J	K	L	M	N
$\alpha_B = 0, \beta_B = 0$	O	P	Q	R	S	T	U
$\alpha_B \in (0, 1), \beta_B = 0$	V	W	X	Y	Z	AA	BB
$\alpha_B = 0, \beta_B \in (0, 1)$	CC	DD	EE	FF	GG	HH	II
$\alpha_B \in (0, 1), \beta_B \in (0, 1)$	JJ	KK	LL	MM	NN	OO	PP
$\alpha_B + \beta_B = 1$							
$\alpha_B \in (0, 1), \beta_B \in (0, 1)$	QQ	RR	SS	TT	UU	VV	WW
$\alpha_B + \beta_B < 1$							

Given the beliefs g , b , and n and the interest factor associated with each belief, as given by equation (1), the expected costs for each firm type for each of the three pure strategies are:

Action	Good firm's expected costs	Bad firm's expected costs
$\alpha_i = 1, \beta_i = 0$	$p_G Q_g (N + K)$	$p_B [(1 - z) Q_g + z Q_b] (N + K)$
$\alpha_i = 0, \beta_i = 1$	$p_G [z Q_g + (1 - z) Q_b] (N + K)$	$p_B Q_b (N + K)$
$\alpha_i = 0, \beta_i = 0$	$p_G Q_n N$	$p_B Q_n N$

Finally, if beliefs follow Bayes' Rule, *on* the equilibrium path they are defined as follows:

$$g = \frac{t(\alpha_G + \beta_G z)}{t(\alpha_G + \beta_G z) + (1 - t)\alpha_B(1 - z)}, \tag{A1}$$

$$b = \frac{t\beta_G(1-z)}{t\beta_G(1-z) + (1-t)(\alpha_B z + \beta_B)}, \quad \text{and} \quad (\text{A2})$$

$$n = \frac{t(1-\alpha_G-\beta_G)}{t(1-\alpha_G-\beta_G) + (1-t)(1-\alpha_B-\beta_B)}. \quad (\text{A3})$$

Beliefs off-the-equilibrium path must satisfy the consistency condition as specified in Kreps and Wilson [1982].

To compute if a particular potential equilibrium is sustainable, one computes consistent beliefs and the expected costs for the indicated potential equilibrium actions. Then one confirms that costs cannot be reduced by choosing one of the three pure strategies. If costs cannot be reduced by choosing one of the three pure strategies, they clearly cannot be reduced by choosing a mixed strategy.

LEMMA 1. Given the assumptions of the monitor model, any potential equilibrium in which some of both firm types hire monitors *and* some of at least one type claim to be bad cannot be sustained; i.e., *B, E, F, G, H, I, K, L, M, N, W, Z, AA, BB, CC, DD, FF, GG, HH, II, JJ, KK, MM, NN, OO, PP, QQ, RR, TT, UU, VV, and WW* are not equilibria.

Proof. Given that both firm types hire, g and b are defined by equations (A1) and (A2) above. Either firm type will send the bad message only if $g \leq b$. Substituting (A1) and (A2) into $g \leq b$ gives:

$$z \leq \frac{\alpha_B\beta_G - \alpha_G\beta_B}{2\alpha_B\beta_G + \alpha_G\alpha_B + \beta_G\beta_B}. \quad (\text{A4})$$

The right-hand side of (A4) is less than or equal to .5 implying $z \leq .5$, which contradicts an assumption of the monitor model. *Q.E.D.*

LEMMA 2. Given the assumptions of the monitor model, any potential equilibrium in which the good firm mixes between (1) not hiring and (2) hiring and claiming good and the bad firm picks any action other than the pure action of not hiring cannot be sustained; i.e., *D, K, Y, FF, MM, TT* are not equilibria.

Proof. The good firm mixes between (1) not hiring and (2) hiring and claiming to be good only if it is indifferent to the payments it makes under the two actions when it is solvent. The bad firm's payment when it does not hire and is solvent is the same as the good firm's costs when the good firm does not hire, but the bad firm's payment when it hires and is solvent is strictly greater than the good firm's since, regardless of the message it sends, it will sometimes get a bad report which consistent lenders' beliefs will identify with a truly bad firm. Hence, the bad firm would not hire a monitor. *Q.E.D.*

LEMMA 3. Given the assumptions of the monitor model, any potential equilibrium in which the good firm does not hire and the bad firm picks an action other than the pure action of not hiring cannot be sustained; i.e., *C, J, X, EE, LL, SS* are not equilibria.

Proof. Any bad firm hiring, independent of its message, will be thought to be a bad firm; any bad firm not hiring will be thought to be good with some positive probability; hence, not hiring is a strictly preferred action. *Q.E.D.*

All remaining potential equilibria (A and O through V) are equilibria of the model for some parameter values. Category A represents *pooling* equilibria, one subclass of the *hiring-I* equilibria. The beliefs g and b can be computed from equations (A1) and (A2), respectively:

$$g = \frac{t}{t + (1-t)(1-z)} \quad \text{and} \quad b = 0.$$

Note that n is an off-the-equilibrium-path belief; letting $n = 0$ (among other values) satisfies the consistency condition. Clearly, both firm types strictly prefer claiming good over bad. In addition, if bad prefers or is indifferent to hiring, good strictly prefers to hire since the bad will sometimes be revealed as bad when it hires. Bad prefers or is indifferent to hiring when:

$$p_B[Q_g(1-z) + Q_bz](N+K) \leq p_B Q_n N. \quad (\text{A5})$$

After making the appropriate substitutions, the above inequality holds when:

$$K \leq \frac{N(1-z)t(p_G - p_B)}{tzp_G + (1-z)p_B} \equiv K_1. \quad (\text{A6})$$

Category V is the *partially separating* equilibria, the second subclass of the *hiring-I* equilibria. In this case g , b , and n are all three computed from equations (A1), (A2) and (A3), respectively:

$$g = \frac{t}{t + \alpha_B(1-t)(1-z)}, \quad b = 0, \quad \text{and} \quad n = 0.$$

Again, it is clear both firm types prefer claiming good to bad, and the good firm strictly prefers hiring when the bad firm is indifferent. The bad firm is indifferent when inequality (A5) holds with equality or, after making the appropriate substitutions, when:

$$K = \frac{N(1-z)t(p_G - p_B)}{t[p_B(1-z) + p_Gz] + \alpha_B(1-t)(1-z)p_B}. \quad (\text{A7})$$

It is apparent that K and α_B are inversely related; hence, the number of bad firms hiring decreases as K increases. This equilibrium type exists for $K \in (K_1, K_2)$ where K_1 is computed from (A7) with $\alpha_B = 1$ and is defined above in (A6), and K_2 is computed from (A7) with $\alpha_B = 0$:

$$K_2 \equiv \frac{N(1-z)(p_G - p_B)}{zp_G + (1-z)p_B}. \quad (\text{A8})$$

Category O corresponds to the *fully separating* equilibria, the third class of the *hiring-I* equilibria. Beliefs g and n are computed from (A1)

and (A3): $g = 1$ and $n = 0$. Belief b is an off-the-equilibrium-path belief; $b = 0$ is a consistent belief. Given these beliefs, good strictly prefers claiming good. Bad will not want to hire when the inequality in (A5) is reversed or when $K \geq K_2$, where K_2 is defined above in (A8). Good will want to hire as long as:

$$Q_g(N + K) \leq Q_n N, \tag{A9}$$

or, after making the appropriate substitutions, as long as:

$$K \leq \frac{N(p_G - p_B)}{p_B} \equiv K_3. \tag{A10}$$

Category Q corresponds to the *no-hiring* equilibria of the model. From equation (A3) we get $n = t$. Beliefs b and g are both off-the-equilibrium-path beliefs; consistent beliefs are $b = 0$ and $g = 0$. Given these beliefs, clearly neither firm would want to hire a monitor.

Finally, P , R , S , T , and U correspond to the *hiring-II* equilibria of the monitor model. For R , one can compute:

$$g = 1 \quad \text{and} \quad n = \frac{(1 - \alpha_G)t}{(1 - \alpha_G)t + (1 - t)};$$

$b = 0$ is a consistent belief. Given these beliefs, any firm which hires prefers to say good over bad, and if the good firm is indifferent to hiring, the bad firm would strictly prefer not to hire. The good firm is indifferent to hiring when (A9) holds with equality or:

$$K = \frac{(1 - t)(p_G - p_B)N}{(1 - \alpha_G)tp_G + (1 - t)p_B}. \tag{A11}$$

Clearly, K and α_G are directly related; hence as K increases more good firms employ monitors. This equilibrium class exists for $K \in [K^\circ, K_3]$, where K° is computed from (A11) with $\alpha_G = 0$:

$$K^\circ = \frac{(1 - t)(p_G - p_B)N}{tp_G + (1 - t)p_B},$$

and K_3 is computed from (A11) for $\alpha_G = 1$ and is defined in (A10) above. At S , the equilibria are similar to R except:

$$b = 1, \quad n = \frac{(1 - \beta_G)t}{(1 - \beta_G)t + (1 - t)}, \quad \text{and} \quad g = 1,$$

and the bad firm is indifferent to not hiring as opposed to strictly preferring not to hire as in R . Category U is likewise similar to R except:

$$b = 1, \quad n = \frac{(1 - \alpha_G - \beta_G)t}{(1 - \alpha_G - \beta_G)t + (1 - t)}, \quad \text{and} \quad g = 1,$$

and the bad firm is indifferent to not hiring. For both P and T , an equilibrium exists only at K_3 . Both firm types are indifferent to all three

actions, but only good firms hire. Equilibrium beliefs are $g = 1$, $b = 1$, and $n = 0$; note all beliefs reflect actions taken in equilibrium.

The equilibria described in this proof are essentially unique. While there are off-the-equilibrium-path beliefs, other than those specified, which also satisfy the consistency condition, they are part of an equilibrium with identical on-the-equilibrium-path strategies and beliefs (and hence payoffs) to one of the equilibria identified.

COROLLARY 1.2. $\frac{\partial K_1}{\partial z}, \frac{\partial K_2}{\partial z} < 0$ follow immediately from the definitions of K_1 and K_2 (provided in expressions (A6) and (A7) above).

COROLLARY 1.3. From table 1, a bad firm's expected costs are constant in the partially separating equilibria of the hiring-I class. In this equilibrium class, bad firms are indifferent to hiring; hence:

$$p_B Q_b^* N = p_B [(1 - z) Q_g + z Q_b^*] (N + K) \quad \text{or}$$

$$Q_g = \frac{Q_b^* N - z Q_b^* (N + K)}{(1 - z)(N + K)}.$$

The good firm's expected costs are thus:

$$p_G Q_g (N + K) = p_G \frac{Q_b^* N - z Q_b^* (N + K)}{(1 - z)}.$$

Clearly this expression is strictly decreasing in K .

COROLLARY 1.4. From the expression for a good firm's costs in the hiring-I equilibria, as given in table 1, it is apparent a good firm's expected costs are strictly increasing over the interval $[0, K_1]$; from Corollary 1.3 it is apparent expected costs are strictly decreasing over the interval $[K_1, K_2]$. A good firm's expected costs for $K = 0$ are:

$$p_G \frac{(1 + r)[t + (1 - t)(1 - z)]}{tp_G + (1 - t)(1 - z)p_B} N. \tag{A12}$$

A good firm's expected costs for $K = K_2$ (and $\alpha_B = 0$) are:

$$p_G \frac{1 + r}{p_G} \left[N + \frac{N(1 - z)(p_G - p_B)}{zp_G + (1 - z)p_B} \right]. \tag{A13}$$

The expression in (A13) is strictly less than the expression in (A12) if and only if $t - (1 - t)z < 0$.

COROLLARY 1.5. From table 1 it is clear the bad firm's expected costs are smallest in a no-hiring equilibrium. From prior corollaries it is apparent that the good firm's expected costs are increasing (decreasing) on $[0, K_1]$ ($[K_1, K_2]$); from table 1 we observe that the expected costs are increasing on $[K_2, K_3]$. Thus along $[0, K^\circ]$ the good firm's expected costs have at most two local maxima, K_1 (if $K_1 < K^\circ$) and K° . For $K = K_1$, a

good firm's expected costs in the hiring-I equilibrium are:

$$p_G \frac{(1+r)[t+(1-t)(1-z)]}{tp_G+(1-t)(1-z)p_B} \left[N + \frac{Nt(1-z)(p_G-p_B)}{tzp_G+(1-z)p_B} \right]. \quad (A14)$$

By comparing expression (A14) to the good firm's expected costs in the no-hiring equilibrium, as given in table 1, we see that the good firm is strictly better off in the hiring-I equilibrium at K_1 if $t < 2 - 1/z$. The inequality $t < 2 - 1/z$ implies $z > t$, and hence $K^\circ > K_2$. For any $K > K_2$, the good firm's expected costs in the hiring-I and the hiring-II equilibria are the same; by definition of K° , therefore, the good firm has the same costs in the hiring-I equilibrium as in the no-hiring equilibrium for $K = K^\circ$. Hence, when $t < 2 - 1/z$, the good firm is strictly better off in the hiring-I equilibrium for all $K \in [0, K^\circ]$. If $t > 2 - 1/z$, then the good firm is better off in the no-hiring equilibrium in some neighborhood of either K° or K_1 .

COROLLARY 1.6. From table 1, it is immediately clear that a bad firm is weakly better off in the no-hiring than in the hiring-II equilibrium when they coexist. The same holds for the good firm since the good firm is indifferent to hiring in the hiring-II equilibrium or:

$$p_G \frac{1+r}{p_G} (N+K) = p_G \frac{(1+r)(1-t\alpha_G)}{t(1-\alpha_G)p_G+(1-t)p_B} N \geq p_G \frac{1+r}{tp_G+(1-t)p_B} N.$$

In hiring-II equilibria both good and bad firms are indifferent to hiring the monitor and paying Q_g^* for the loan and not hiring the monitor. In all hiring-I equilibria, the good firm hires the monitor and pays at least Q_g^* ; hence, a good firm is weakly better off in the hiring-II equilibrium. From table 1 it is evident that the bad firm is better off in the hiring-II equilibrium than in the hiring-I equilibrium when the hiring-I equilibrium is partially separating or fully separating. If the hiring-I equilibrium is pooling, the bad firm hires the monitor and pays more than Q_g^* ; hence, the bad firm is better off in the hiring-II equilibrium.

PROPOSITION 2. The proof is immediate.

PROPOSITION 3. The proof follows the argument in the text.

PROPOSITION 4. The proof proceeds in five steps. In step 1 we derive the bounds on the auditor's market alternative separating the two classes of equilibria. In step 2 we establish the restrictions on the parameters (conditions (A)-(D)) required to generate the two equilibrium classes. In step 3 we demonstrate that these conditions can be simultaneously satisfied for some positive parameter values for all $\alpha_B \in [\epsilon, 1]$, where ϵ is arbitrarily small. In step 4 we show K and α_B are inversely related. Finally, in step 5 we argue the equilibrium is essentially unique among

the class of effective auditing, extensive litigation equilibria in which all firms claim to be good.

STEP 1

The bounds on the auditor's market alternative are given in figure 2 and repeated here for reference:

$$K_1' \equiv \frac{N(1-z)t(p_G - p_B)}{tzp_G + (1-z)p_B} - \frac{(A+L)y(1-t)t(1-z)zp_G}{(1+r)[tzp_G + (1-z)p_B]} \quad (\text{A15})$$

$$- \frac{L(1-z)[t + (1-t)(1-z)]p_B}{(1+r)[tzp_G + (1-z)p_B]}.$$

$$K_2' \equiv \frac{N(1-z)(p_G - p_B)}{zp_G + (1-z)p_B} - \frac{L(1-z)p_B}{(1+r)[zp_G + (1-z)p_B]}. \quad (\text{A16})$$

Note $K_1' < K_2'$ since the first term of K_1' is strictly less than the first term of K_2' , the third term of K_1' is strictly larger than the second term of K_2' , and the second term of K_1' is positive.

Both K_1' and K_2' are computed directly from the following equation expressing the bad firm's indifference to hiring:

$$[zQ_b^* + (1-z)Q_g](N + \kappa) = Q_b^*N, \quad (\text{A17})$$

where Q_b^* is the perfect observability interest factor for the bad firm, and Q_g is the interest factor for a good report in a partially separating equilibrium. The interest factor Q_g gives competitive lenders their market alternative when lenders know they will incur court costs and receive damage awards:

$$(1+r)(N + \kappa) = (gp_G + (1-g)p_B)Q_g(N + \kappa) - L + (1-g)(A+L)y, \quad \text{or}$$

$$Q_g = \frac{(1+r)(N + \kappa) - (1-g)y(A+L) + L}{(N + \kappa)(gp_G + (1-g)p_B)}$$

where $g = \frac{t}{t + (1-t)(1-z)\alpha_B}$, and the audit fee, κ , equals the auditor's market alternative when he works, K , plus the discounted value of the expected damage payment times the probability the auditor gives a bad firm a good report and the error is discovered by the courts:

$$\kappa = K + \frac{g^\circ(1-g)y(A+L)}{g(1+r)} \quad (\text{A18})$$

where $g^\circ = \frac{t}{t + (1-t)\alpha_B}$. To compute K_1' let $\alpha_B = 1$ in equation (A17) and solve for K ; to compute K_2' let $\alpha_B = 0$. Note that equilibria of the proposition exist only if K_2' is positive. The following condition, calcu-

lated from equation (A16), guarantees K_2' is strictly positive:

$$N(1 + r)(p_G - p_B) > p_B L. \tag{A19}$$

STEP 2

Here we demonstrate that the equilibria described by Proposition 4 exist when conditions (A) through (D) (derived below) are satisfied.

Assume $Q_g < Q_b$ in equilibrium (to be verified later); by the assumption that a firm can sue only if it has been damaged, a firm cannot sue its auditor if he issued a good report. The costs relevant to a firm's suit decision when the report is bad are:

Firm's Suit Decision (given a bad report)

Firm Type	Expected Costs If Go to Court	Expected Costs If Do Not Go to Court
Good firm	$p_G[yQ_{bg}(N + K - A) + (1 - y)Q_{bb}(N + K + L)]$	$p_GQ_b(N + K)$
Bad firm	$p_BQ_{bb}(N + K + L)$	$p_BQ_b(N + K)$

Any time the court's findings differ from the report, the firm's type is revealed with certainty; hence, $Q_{bg} = Q_g^*$ (where Q_j^* is the perfect observability interest factor corresponding to type j). Suppose in equilibrium a lender's beliefs are such that $Q_b = Q_b^*$ and $Q_{bb} = Q_b^*$ (to be verified as consistent with the equilibrium), then the bad firm would never sue its auditor. On the other hand, given these values for Q_b , Q_{bg} , and Q_{bb} , the good firm sues when:

$$p_G[yQ_g^*(N + K - A) + (1 - y)Q_b^*(N + K + L)] \leq p_GQ_b^*(N + K), \text{ or}$$

$$A \geq \frac{L(1 - y)Q_b^* - y(Q_b^* - Q_g^*)(N + K)}{yQ_g^*}. \tag{Condition A}$$

Next, consider lenders' suing choices. If $Q_g < Q_b$, lenders face a decision about suing only when the report is good since courts will only try a case in which the lender is damaged. However, suing can be conditioned on bankruptcy. The relevant costs for the lender's decision are given in the following chart:

Lender's Suit Decision (given a good report)

Bankruptcy Position	Expected Awards from Suing	Costs If Sue
Bankrupt	$\left[\frac{(1 - g)(1 - p_B)}{(1 - g)(1 - p_B) + g(1 - p_G)} \right] y(A + L)$	L
Solvent	$\left[\frac{(1 - g)p_B}{(1 - g)p_B + gp_G} \right] y(A + L)$	L

The expected awards from suing are the product of (1) the probability that the firm is bad given that it got a good report and given its financial

position at the end of the period, (2) the probability that the court will discover the audit failure, and (3) the legal fees and awards that are paid when an audit failure is discovered.

By comparing the expected awards from suing when the firm is bankrupt to the awards when the firm is solvent, as given in the above chart, it can readily be verified that the expected award when the firm is bankrupt is larger than the award when it is not. Hence lenders will *always* sue when the report is good if:

$$\frac{(1 - g)p_{BY}(A + L)}{(1 - g)p_B + gp_G} \geq L, \text{ or}$$

$$A \geq \frac{L[gp_G + (1 - g)(1 - y)p_B]}{(1 - g)p_{BY}}. \quad (\text{Condition } B)$$

Given that only good firms sue when the report is bad and lenders always sue when the report is good, consider the auditor's decisions about working and reporting. If the auditor's findings differ from the message delivered by the firm, the auditor knows the firm's type with certainty. In these cases the auditor loses nothing by telling the truth. However, when the findings agree with the message, the auditor cannot be sure his findings are correct. The costs relevant to an auditor's reporting decision when the message and audit findings coincide are:

Auditor's Reporting Decision (given lenders sue when the report is good and good firms sue when the report is bad)

Message and Findings	Expected Costs If Truthful	Expected Costs If Lie
Good	$\frac{(1 - g^\circ)(1 - z)y(A + L)}{(1 + r)(1 - g^\circ)(1 - z) + g^\circ} + w$	$\frac{g^\circ y(A + L)}{(1 - g^\circ)(1 - z) + g^\circ} + w$
—if works:		
—if does not work:	$\frac{(1 - g^\circ)y(A + L)}{1 + r}$	$g^\circ y(A + L)$
Bad	$\frac{b^\circ(1 - z)y(A + L)}{b^\circ(1 - z) + (1 - b^\circ)} + w$	$\frac{(1 - b^\circ)y(A + L)}{(1 + r)[b^\circ(1 - z) + (1 - b^\circ)]} + w$
—if works:		
—if does not work:	$b^\circ y(A + L)$	$\frac{(1 - b^\circ)y(A + L)}{1 + r}$

Comparing the above costs, it is clear that if $g^\circ \geq (1 - g^\circ)$ in equilibrium or:

$$g^\circ \geq .5 \quad (\text{Condition } C)$$

and $b^\circ = 0$ (to be verified), then the auditor is better off reporting his findings truthfully regardless of his work decision.

Would the auditor want to work hard given that he is truthful? The

costs relevant to this decision are:

Auditor’s Work Decision (given the auditor is truthful, lenders sue when the report is good, and good firms sue when the report is bad)

Message	Expected Costs If Work	Expected Costs If Shirk
Good	$\frac{(1 - g^\circ)(1 - z)y(A + L)}{1 + r} + w$	$\frac{(1 - g^\circ)y(A + L)}{1 + r}$
Bad	$b^\circ(1 - z)y(A + L) + w$	$b^\circ y(A + L)$

For $b^\circ = 0$, it is clear that the auditor will not work when the message states the firm is bad. On the other hand, when the message is good, the auditor works if:

$$\frac{(1 - g^\circ)(1 - z)y(A + L)}{1 + r} + w \leq \frac{(1 - g^\circ)y(A + L)}{1 + r}, \text{ or}$$

$$w \leq \frac{zy(1 - g^\circ)(A + L)}{1 + r}. \quad (\text{Condition } D)$$

Given the above reporting, working, and suing choices, one can show, in a manner similar to that employed in the proof of Proposition 1, that the firm’s hiring and message choices listed in Proposition 4 are optimal for the indicated ranges of auditor’s market alternatives.

Finally, we need to verify that the assumed specifications— $Q_g < Q_b$, $Q_b = Q_b^*$, $Q_{bb} = Q_b^*$, and $b^\circ = 0$ —are consistent with the equilibria. In all of the equilibrium classes of the proposition $Q_b = Q_b^*$ since only a bad firm can get a bad report from an auditor who works and reports truthfully when all firms are claiming to be good. Furthermore, $Q_g < Q_b^*$, since in equilibrium all good firms get good reports, and lenders take this information into account when forming Q_g . Also, given the equilibrium systems, both b° and Q_{bb} pertain to off-equilibrium events; hence, we can set $b^\circ = 0$ and $Q_{bb} = Q_b^*$ while meeting the equilibrium conditions as well as the consistency requirement of sequential equilibrium.

STEP 3

In this step we verify that all four conditions can be simultaneously satisfied. We proceed by first identifying sufficient conditions for conditions (A)–(D). Since $Q_b^* > Q_g^*$, a sufficient condition for condition (A) is:

$$A \geq \frac{L(1 - y)Q_b^*}{yQ_g^*} = \frac{L(1 - y)p_G}{yp_B}, \text{ or}$$

$$L \leq \frac{Ap_By}{(1 - y)p_G}. \quad (\text{SC-A})$$

Since $[gp_G + (1 - g)(1 - y)p_B] < 1$, a sufficient condition for condition (B) is:

$$L \leq Ap_By(1 - g). \tag{SC-B}$$

Note $g^\circ \equiv \frac{t}{t + (1 - t)\alpha_B} \geq t$ for all $\alpha_B \in (0, 1]$; hence:

$$t \geq .5 \tag{SC-C}$$

implies condition (C). Finally, since $L \geq 0$, a sufficient condition for condition (D) is:

$$w \leq \frac{A(1 - g^\circ)zy}{1 + r}. \tag{SC-D}$$

For $L = 0$ and $w = 0$, and appropriate values for the other parameters, it is trivial to show that all four sufficient conditions are satisfied for all $\alpha_B \in (0, 1]$. We wish to verify that, for some $L > 0$ and $w > 0$, and appropriate positive values for the other parameters, all four conditions can be met for all $\alpha_B \in [\epsilon, 1]$, where ϵ is arbitrarily small. Note when $\alpha_B < 1$, the bad firm is indifferent to hiring, or equation (A17) must hold. When α_B changes, another variable must also change to maintain this indifference; in the proposition choose K to be the compensating variable.

While (SC-A) and (SC-C) set exogenous restrictions on the parameters, both (SC-B) and (SC-D) are endogenously determined since beliefs g and g° are functions of α_B . Condition (SC-C) is readily satisfied. We note (SC-B) implies (SC-A) since the right-hand side of (SC-B) is less than the right-hand side of (SC-A). In addition, observing $g^\circ = g \cdot$ [probability the report is good given a good message sent] and thus $A(1 - g^\circ) \geq A(1 - g)$, satisfaction of (SC-B) for positive L implies that (SC-D) is satisfied for some positive w . Thus, satisfaction of (SC-B) guarantees the ability to construct a set of positive parameter values satisfying (SC-B), (SC-A), and (SC-D). By setting A sufficiently large it is possible to satisfy (SC-B) for all $\alpha_B \in [\epsilon, 1]$.

STEP 4

In this step we demonstrate $\frac{\partial K}{\partial \alpha_B} < 0$. Note that step 3 has demonstrated that $\frac{\partial K}{\partial \alpha_B}$ is well defined for $\alpha_B \in [\epsilon, 1]$ where ϵ depends on the parameters of the problem. Equation (A17) can be rewritten as follows:

$$\begin{aligned} z \frac{1 + r}{p_B} \left[N + K + \frac{(A + L)y(1 - g)n}{1 + r} \right] \\ + (1 - z) \frac{(1 + r)(N + K) - (A + L)y(1 - g)(1 - n) + L}{m} \\ = N \frac{1 + r}{p_B} \end{aligned} \tag{A17a}$$

where:

$$m = gp_G + (1 - g)p_B = \frac{tp_G + \alpha_B(1 - z)(1 - t)p_B}{t + \alpha_B(1 - z)(1 - t)} \quad \text{and}$$

$$n = \frac{g^\circ}{g} = \frac{t + \alpha_B(1 - z)(1 - t)}{t + \alpha_B(1 - t)}.$$

From (A17a) we get:

$$\begin{aligned} \frac{\partial K}{\partial \alpha_B} = & \left[Q_g(N + \kappa) \left(\frac{1 - z}{m} \right) \frac{\partial m}{\partial \alpha_B} \right. \\ & + (A + L)y \left\{ \left[\frac{zn}{p_B} - \frac{(1 - z)(1 - n)}{m} \right] \frac{\partial g}{\partial \alpha_B} \right. \\ & \left. \left. - (1 - g) \left[\frac{z}{p_B} + \frac{(1 - z)}{m} \right] \frac{\partial n}{\partial \alpha_B} \right\} \right] / \\ & \left[(1 + r) \left[\frac{z}{p_B} + \frac{(1 - z)}{m} \right] \right] \end{aligned} \quad (\text{A20})$$

where:

$$Q_g(N + \kappa) = \frac{(1 + r)(N + K) - (A + L)y(1 - g)(1 - n) + L}{m} > 0.$$

We can readily verify:

$$\frac{\partial g}{\partial \alpha_B} = \frac{-t(1 - t)(1 - z)}{[t + \alpha_B(1 - t)(1 - z)]^2} < 0,$$

$$\frac{\partial m}{\partial \alpha_B} = (p_G - p_B) \frac{\partial g}{\partial \alpha_B} < 0, \quad \text{and}$$

$$\frac{\partial n}{\partial \alpha_B} = \frac{-zt(1 - t)}{[t + \alpha_B(1 - t)]^2} < 0.$$

Finally, since $m > p_B$, the term in braces in (A20) is smaller than:

$$\begin{aligned} \left(\frac{1}{p_B} \right) \left\{ [zn - (1 - z)(1 - n)] \frac{\partial g}{\partial \alpha_B} - (1 - g) \frac{\partial n}{\partial \alpha_B} \right\} \\ = \frac{-t(1 - t)z(1 - z)[t^2 - (1 - t)^2(1 - z)\alpha_B^2]}{p_B[t + \alpha_B(1 - t)(1 - z)]^2[t + \alpha_B(1 - t)]^2}, \end{aligned}$$

which is negative for $t > .5$. Thus, for $t > .5$, $\frac{\partial K}{\partial \alpha_B} < 0$.

STEP 5

By definition of effective auditing and extensive litigation, the auditor always works and tells the truth, and the lender always sues when the report is good. Among the equilibria in which all firms claim to be good and bb and b° are off-the-equilibrium-path beliefs, Q_{bb} and b° can take on values other than Q_b^* and 0, respectively, as long as they do not alter the equilibrium decisions. Next suppose Q_{bb} reflects on-the-equilibrium-path behavior. As long as all firms claim to be good, Q_{bb} must equal Q_b^* . However, if $Q_{bb} = Q_b^*$, we know no bad firm would sue, which contradicts the assumption that Q_{bb} reflects on-the-equilibrium-path behavior. Limiting firms to claiming good implies b° is always an off-the-equilibrium-path belief. Hence, on-the-equilibrium-path, the auditor functions as a monitor who provides useful information, and, as in the proof of Proposition 1, we can show the only possible effective auditing, extensive litigation equilibria (in which all firms claim to be good) are pooling and partially separating equilibria.

COROLLARY 4.1. The indifference equation (A17a) can be solved for K in terms of α_B (and the other parameters). Substituting this into the expression for κ in table 2 and differentiating with respect to α_B , we get:

$$\frac{\partial \kappa}{\partial \alpha_B} = [(1 - z)^2(1 - t)p_{Bt}\{(A + L)y[zp_G + (1 - z)p_B] - (p_G - p_B)[(1 + r)N + zL]\}] / [(1 + r)[ztp_G + (1 - z)(t + \alpha_B(1 - t))p_B]^2].$$

This derivative is negative under the condition stated in the corollary.

From step 4 of Proposition 4 we know $\frac{\partial K}{\partial \alpha_B} < 0$, thus $\frac{\partial \kappa}{\partial K} > 0$. Similarly to the argument in Collary 1.3, the good firm's expected costs for a partially separating equilibrium are $p_G Q_G(N + \kappa) = p_G \frac{Q_b^* N - zQ_b^*(N + \kappa)}{(1 - z)}$. Therefore, the good firm's expected costs and κ are inversely related.

COROLLARY 4.2. At $K = 0$, the good firm's expected costs in the hiring equilibrium are computed by substituting $K = 0$ into the good firm's expected costs in the pooling equilibrium as given in table 2. As $K \rightarrow K_2'$, the good firm's expected costs in the hiring equilibrium approach the limit:

$$(1 + r)N + \frac{(1 + r)(p_G - p_B)N - L(1 - z)p_B}{zp_G + (1 - z)p_B}.$$

The good firm's costs are lower as $K \rightarrow K_2'$ than at $K = 0$ when:

$$\begin{aligned} & N(1 + r)(1 - z)(p_G - p_B)p_G[(1 - t)z - t] \\ & + L\{[t + (1 - t)(1 - z)][zp_G + (1 - z)p_B]p_G \\ & + (1 - z)[tp_G + (1 - t)(1 - z)p_B]p_B\} \\ & > (A + L)y(1 - t)^2(1 - z)z[zp_G + (1 - z)p_B]p_G. \end{aligned}$$

COROLLARY 4.3. At $K = K_1'$, the good firm's expected costs in the hiring equilibrium are computed by substituting K_1' into the good firm's expected costs in the pooling equilibrium as given in table 2. For the no-hiring equilibrium the good firm's expected costs are:

$$\frac{p_G(1+r)N}{tp_G + (1-t)p_B}.$$

The good firm's expected costs in the hiring equilibrium at K_1' are greater than its costs in the no-hiring equilibrium when:

$$\frac{N(1+r)(p_G - p_B)t(1 + zt - 2z)}{tp_G + (1-t)p_B} - (A + L)y(1-t)(1-z)z + L[t + (1-t)(1-z)]z > 0.$$

COROLLARY 4.4. First, we establish, for a fixed set of parameters, effective auditing, extensive litigation equilibria exist and the derivative $\frac{\partial A}{\partial \alpha_B}$ is well defined for all $\alpha_B \in (0, 1]$. By the argument in Proposition 4, if (SC-B) is satisfied, then we can find strictly positive parameters which support an effective auditing, extensive litigation equilibrium. In the range of pooling equilibria, g is constant; hence, by raising A one can increase $A(1-g)$. However, increasing A also augments the auditor's fee, κ , and if A is made sufficiently large, bad firms become indifferent to hiring. In the range of partially separating equilibria, changing A affects the number of bad firms hiring, α_B , and hence g . Let $A(\alpha_B)(1-g(\alpha_B))$ represent the value of $A(1-g)$ as a function of α_B . Then:

LEMMA 4. In the range of partially separating equilibria, $A(\alpha_B)(1-g(\alpha_B))$ is minimized either at $\alpha_B = 1$ or as α_B approaches zero.

Proof. Equation (A17) holds when the bad firm is indifferent to hiring, as in the range of partially separating equilibria. Equation (A17) can be rewritten as follows:

$$\begin{aligned} A(\alpha_B)(1-g(\alpha_B)) &= \{\alpha_B^2[p_B(1-t)^2(1-z)[-K(1+r) - L(1-z)]] \\ &+ \alpha_B[t(1-t)\{(1+r)[N(1-z)(p_G - p_B) - K(zp_G + 2(1-z)p_B)] \\ &- L(1-z)[zyp_G + (2-z)p_B]\}] + [t^2\{(1+r)[N(1-z)(p_G - p_B) \\ &- K(zp_G + (1-z)p_B)] - L(1-z)p_B\}]/ \\ &\{\alpha_B[t(1-t)z(1-z)yp_G] + t^2zyp_G\}. \end{aligned} \quad (\text{A17b})$$

Hence, $A(\alpha_B)(1-g(\alpha_B))$ is a quadratic function of α_B divided by a linear function of α_B . Since the coefficient of the α_B^2 term in the numerator is negative and the denominator is positive, the right-hand side of equation (A17b) can be rewritten as a negatively sloped line plus a hyperbola, where the hyperbola is:

$$\frac{t\{-N(1+r)(1-z)(p_G - p_B) + L(1-z)yp_G + K(1+r)z(p_G - p_B)\}}{(1-z)yp_G\{t + \alpha_B(1-t)(1-z)\}}$$

As the hyperbola is convex for $\alpha_B \in (0, 1]$, independently of its slope, $A(\alpha_B)(1 - g(\alpha_B))$ is minimized at $\alpha_B = 1$ or as α_B approaches zero. *Q.E.D.*

Evaluating equation (A17b) at $\alpha_B = 1$ gives:

$$A(1)(1 - g(1)) = \frac{\{Nt(1 + r)(1 - z)(p_G - p_B) - K(1 + r)[ztp_G + (1 - z)p_B] - L(1 - z)[p_B(t + (1 - t)(1 - z)) + p_Gt(1 - t)zy]\}}{\{tzy p_G[t + (1 - t)(1 - z)]\}} \quad (\text{A17c})$$

As α_B approaches zero:

$$A(1 - g) \rightarrow \frac{(1 + r)[zp_G + (1 - z)p_B]}{zyp_G} \cdot \left(\frac{N(1 - z)(p_G - p_B)}{zp_G + (1 - z)p_B} - \frac{L(1 - z)p_B}{(1 + r)(zp_G + (1 - z)p_B)} - K \right) \quad (\text{A17d})$$

$$= \frac{(1 + r)[zp_G + (1 - z)p_B](K_2' - K)}{zyp_G}$$

By selecting appropriate parameter values (in particular small L and K relative to N), we can make the right-hand side of (A17c) or (A17d) arbitrarily large. Hence where $A(\alpha_B)(1 - g(\alpha_B))$ attains its minimum, we can readily construct sets of parameter values which satisfy all four sufficient conditions. The above results imply that the same sets of parameter values will satisfy all four sufficient conditions for $\alpha_B \in (0, 1]$ and $A = A(\alpha_B)$.

Differentiating equation (A17a) with respect to A and α_B gives:

$$\frac{\partial A}{\partial \alpha_B} = \left[Q_g(N + \kappa) \left(\frac{1 - z}{m} \right) \frac{\partial m}{\partial \alpha_B} + (A + L)y \left\{ \left[\frac{zn}{p_B} - \frac{(1 - z)(1 - n)}{m} \right] \frac{\partial g}{\partial \alpha_B} - (1 - g) \left[\frac{z}{p_B} + \frac{(1 - z)}{m} \right] \frac{\partial n}{\partial \alpha_B} \right\} \right] / \left[\frac{zy(1 - g)n}{p_B} - \frac{(1 - z)y(1 - g)(1 - n)}{m} \right]$$

In step 4 of the proof of Proposition 4, we demonstrated the numerator of the above expression is negative when $t > .5$. By making the appropriate substitutions, the denominator equals:

$$\frac{y(1 - g)ztp_G}{p_B m [t + \alpha_B(1 - t)]} > 0,$$

hence $\frac{\partial A}{\partial \alpha_B} < 0$. From table 2 we observe for $K \in (K_1', K_2')$ that the bad firm's costs are constant. In the range of partially separating equilibria the average cost per firm is:

$$(1+r)\{N + K(t + \alpha_B(1-t))\} + L[t + \alpha_B(1-t)(1-z)]$$

which is clearly declining with α_B . Since the bad firm's costs are constant, the good firm's expected costs must be declining with α_B .

COROLLARY 4.5. The proof immediately follows from the definition of the good firm's expected costs in table 2.

COROLLARY 4.6. When auditing is mandatory, the good firm's costs are the same as in the pooling case. Differentiate the good firm's expected costs given in table 2 with respect to z :

$$\begin{aligned} \frac{\partial EC_G}{\partial z} = & [p_G(1-t) \{-(p_G - p_B)t[(1+r)(N+K) + L] \\ & + (A+L)y(1-t)[(2z-1)tp_G - (1-t)(1-z)^2p_B\}]/ \\ & [tp_G + (1-t)(1-z)p_B]^2. \end{aligned}$$

It is readily verified that when $z \rightarrow 0$ and A is large, the derivative is positive. Because average costs are unchanged, the bad firm's expected costs go down.

PROPOSITION 5. The suing behavior in this proposition takes place when (1) the inequality in condition (B) of the proof of Proposition 4 is reversed (ensuring no suits if the firm is solvent):

$$A < \frac{L\{gp_G + (1-g)(1-y)p_B\}}{(1-g)p_By} \quad (\text{Condition B1})$$

and (2) the following restriction is added (ensuring suits take place when the firm is bankrupt):

$$A > \frac{L\{g(1-p_G) + (1-g)(1-y)(1-p_B)\}}{(1-g)(1-p_B)y}. \quad (\text{Condition B2})$$

Clearly, for each $\alpha_B \in (0, 1]$ (letting K adjust, when $\alpha_B < 1$, so that equation (A17) is satisfied), there exist $A, L, w > 0$ such that conditions (A), (C), and (D) established in the proof of Proposition 4 and (B1) and (B2) are satisfied.

Essential uniqueness is established in a fashion similar to the proof of Proposition 4.

PROPOSITION 6. Since the auditor provides no information all firms have identical preferences over actions. Suppose in equilibrium both firm types strictly prefer to hire auditors; then they pay the "average" interest rate, the same interest rate as in the no-hiring equilibrium, in addition to the audit fee. Next suppose both firm types are indifferent to hiring in equilibrium. Let $P_h(P_n)$ reflect the equilibrium probability of solvency for a firm which hires (does not hire). Since firms are indifferent to

hiring, then $\frac{(1+r)(N+K)}{P_h} = \frac{(1+r)N}{P_n}$, implying $P_h > P_n$. Thus, $P_h > tp_G + (1-t)p_B > P_n$, implying $\frac{(1+r)N}{P_n} > \frac{(1+r)N}{tp_G + (1-t)p_B}$, where the last expression is the no-hiring equilibrium costs for any firm given it is solvent.

APPENDIX B

Summary of Notation

General:

N = the dollars required for a firm to begin the project.

R = revenues the firm earns if it completes the project and remains solvent.

G = the good (low-risk) firm.

B = the bad (high-risk) firm.

p_G = probability for the good firm of *not* going bankrupt.

p_B = probability for the bad firm of *not* going bankrupt.

t = the fraction of good firms in the population.

r = the risk-free interest rate.

z = probability that the monitor correctly detects a lie in the firm's message.

y = probability that the courts detect an audit failure.

K = the market alternative for the monitor and for the auditor when he works.

κ = equilibrium audit fee in the auditor model.

α_B = the fraction of bad firms which hire monitors/auditors.

α_G = the fraction of good firms which hire monitors/auditors.

w = auditor's personal cost of effort.

L = legal fee required to bring a suit.

A = damages paid by a defendant to a plaintiff when the defendant is found guilty.

Beliefs:

Lenders:

g = prob (firm is good | firm hired an auditor and the report is good).

b = prob (firm is good | firm hired an auditor and the report is bad).

n = prob (firm is good | firm did not hire an auditor).

ij = prob (firm is good | firm got report i , sued its auditor got a j -ruling), $i = B, G; j = B, G$.

Auditors:

g° = prob (firm is good | firm's message was good).

b° = prob (firm is good | firm's message was bad).

Interest factors (the price of borrowing one dollar):

Q_i = interest factor for a firm thought to be good with probability i ,
 $i = b, g, n$.

Q_g^* = the perfect observability interest factor for a good firm; i.e.,

$$\frac{1+r}{p_G}$$

Q_b^* = the perfect observability interest factor for a bad firm; i.e.,

$$\frac{1+r}{p_B}$$

Abbreviations for equilibrium classes:

No-hiring = an equilibrium in which no firm hires an auditor.

Hiring-I = an equilibrium in which all good firms and some bad firms hire auditors.

Hiring-II = an equilibrium in which some good firms but no bad firms hire auditors.

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