The Effects of Endogenous Information Acquisition about Business Risk on Audit Pricing*

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Abstract

This paper examines the pricing of business risk by homogeneous auditors in a two-period model. Incumbent auditors optimally determine the amount of information to acquire about the business risk of a client. They subsequently compete in prices with prospective auditors. In such an environment, we show that there exists differential auditor turnover between high and low risk firms; cross-subsidization of the audit fees of high risk firms by low risk firms; and low-balling by auditors. Moreover, we show how changes in the timing and magnitude of litigation events as well as cyclical changes in the business risk environment affect information acquisition and consequent audit pricing behavior.

Keywords: Business risk, audit pricing, endogenous information acquisition.

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1 Introduction

Auditors have been inundated with shareholder lawsuits. Malpractice-litigation costs of Big Six accounting firms, after insurance recoveries, have substantially increased, and by 1993 amounted to nearly twelve percent of these firms' total accounting and auditing revenue (Lambert 1994). Furthermore, claims against non-Big Six firms rose by two-thirds from 1987 to 1991. In 1990, the seventh largest accounting firm in the United States, Laventhol and Horwath, filed for bankruptcy. The failure of Laventhol and Horwath was mainly attributed to incurred and anticipated litigation costs. The firm's chief executive officer contended that litigation arose, not from inadequacies in its professional performance, but from the perception that the firm had a "deep pocket" (Arthur Andersen, et al. 1992, 3). Similarly, O'Malley (1993, 84-85), chairman and senior partner of Price Waterhouse, claimed that "unwarranted litigation and forced settlements constitute the vast majority of claims against accountants" and that shareholders demand compensation from auditors even if the auditor is not responsible for shareholders' losses.

Against this background of increasing potential liability exposure due to circumstances that are largely outside the auditor's control, it is important to consider the effect of business risk on audit pricing. Business risk, which is the focus of this paper, is defined by the AICPA (1992) as having two components: client's business risk, the risk associated with the client's continued survival and well-being; and auditor's business risk, the risk of potential litigation costs and other expenditure from association with a client irrespective of whether or not an audit failure is asserted. Thus, we interpret business risk as being the residual risk to the auditor of a lawsuit that remains after performing the audit, taking all necessary steps to reduce the risk of litigation, and issuing the appropriate audit opinion. It is often impossible for the auditor to avoid being sued even by exercising due diligence.[1]

An essential feature of the auditing environment is that auditors learn about the business risk associated with a client over the course of the engagement. There are a number of factors that affect business risk that may be known to an incumbent auditor but not to a prospective auditor. Such factors include: management integrity; ambiguous accounting principles that apply to a firm's transactions; asset valuations that necessitate substantial judgment; and nature of the ownership of the company.[2] Knowledge of these factors may provide an incumbent auditor with an informational advantage relative to his competitors; however, acquiring this information may entail

[1] For instance, KPMG Peat Marwick was sued for allegedly performing an inadequate review of the accounts of a bank which was subsequently placed into receivership following substantial losses. The jury found in Peat Marwick's favor, but Peat Marwick nevertheless incurred legal fees of $7 million defending itself. The audit fee was only $15,000 (Berton 1995). This anecdote is consistent with Dye (1995) who notes that auditors have been sued irrespective of whether the audit complied with GAAS.

[2] For additional factors see Brumfield, Elliott and Jacobson (1983), Schuetze (1993), and Pratt and Stice (1994).

costly investigative activities over and above those necessary to perform the audit. Thus, the decision to acquire information about a client's business risk reflects a tradeoff between the advantage of superior information in effectively pricing *future* engagements and the additional costs of obtaining this information.

There appears to be little consensus in the accounting literature as to the appropriate model of auditor competition for client engagements. Areas of minimal agreement are that it is most common for a client, rather than an auditor, to make the appointment decision (Glezen and Elser 1996), and that auditors effectively compete in audit fees (rather than quantities or other strategic variables). Eichenseher and Shields (1983) find that the audit fee is generally the most important choice variable in a firm's auditor selection problem. Similarly, Simunic (1980) and Rubin (1988) find evidence of price competition among auditors in the private and municipal sectors, respectively. Thus, we model competition among auditors as a pricing game. That is, all competing auditors simultaneously submit fee offers for the engagement, and the client selects the lowest.

Utilizing this framework, our paper considers the effect of endogenous information acquisition by incumbent auditors regarding a firm's business risk on audit fee determination in a two-period setting. In such an environment, we show that there exists differential auditor turnover between high and low risk firms; cross-subsidization of the audit fees of high risk firms by low risk firms; and low-balling by auditors. Moreover, we show how changes in the timing and magnitude of litigation events as well as cyclical changes in the business risk environment affect information acquisition and consequent audit pricing behavior. Thus, we obtain a different transmission mechanism from that in the extant audit pricing literature for the earning of information rents by the incumbent auditor and show that low-balling may be attributable, in part, to asymmetric information about business risk and is observable in the absence of technological differences and client switching costs.

Aspects of our model may seem similar to Kanodia and Mukherji (1994). They examine a model in which an incumbent auditor obtains private information about the cost of performing an audit. Specifically, the incumbent auditor is fully informed as to the cost of performing the audit engagement, whereas both the client and all competing auditors are uninformed. However, our paper differs from Kanodia and Mukherji in several key respects.

Kanodia and Mukherji assume the presence of publicly known one-time start-up costs as well as switching costs. In the absence of these costs, in their model, both low-balling and auditor retention vanish. In contrast, our analysis does not require the presence of these frictions for low-balling and differential rates of auditor turnover to occur. Underlying this difference is the nature of the informational asymmetry generating the rents (and hence low-balling) for the incumbent auditor. In Kanodia and Mukherji the central tension occurs in the negotiations between the client and the incumbent auditor. Specifically, the client designs an incentive compatible contract to extract information about the true cost of the audit; naturally, this leads to the incumbent auditor receiving information rents. The prospective auditor plays the role of an outside option in the negotiations between the client and the incumbent auditor. In contrast, we focus on the role of private information in the competition between auditors. Consequently, we are able to dispense with frictions such as switching and start-up costs and still generate low-balling and incumbent auditor retention.

Our paper is related to Engelbrecht-Wiggans, et al. (1983) in that our second period game may entail a dominantly informed bidder competing against others who are less informed. However, unlike Engelbrecht-Wiggans, et al., our model of price competition has the feature that with positive probability, the incumbent auditor's information may be *identical* to that of the prospective auditor; thus the incumbent auditor is only *potentially* dominantly informed. Moreover, this difference in the information structure of the second period game arises as a consequence of the information acquisition decision being determined endogenously rather than being assumed and the dynamic nature of the model, both of which differ from Engelbrecht-Wiggans, et al.

The rest of the paper proceeds as follows: Section two describes a model of audit competition with endogenous information acquisition in the presence of business risk. The audit and litigation environment and the extensive form of the game are formulated. In section three, the incumbent and prospective auditors' problems are defined, and the equilibrium of the game is identified. Auditor turnover, the partial pricing of business risk, and low-balling are shown to arise endogenously in this setting. In section four, we consider the effects of changes in the business risk environment on the information acquisition and pricing decisions of the competing auditors. Section five draws conclusions. All proofs are contained in the appendix.

2 Model

Auditors engage in fee competition in an environment where it is mandatory for the firm's financial statements to be examined by an auditor each period. Since Generally Accepted Auditing Standards place requirements on the nature of the auditor's activities, and the auditor's ultimate responsibility is the issuance of an audit opinion on the fair presentation of the financial statements, it is assumed that audit quality is homogeneous among auditors.[3] Because the focus of this paper is pricing of the risk of potential litigation cost irrespective of whether or not an audit failure is alleged, it is assumed auditors' potential liability arises when some adverse circumstance occurs, such as financial distress, management fraud or some illegal act.

[3] This assumption is consistent with the findings of the AICPA Cohen Commission Report (1978), which note that, "[p]ublic accounting firms go to considerable lengths to develop superior services for their clients, but there is little effective product differentiation from the viewpoint of the present buyer of the service, that is, management of the corporation" (Commission on Auditors Responsibilities 1978, 111).

The audit pricing decision is examined within a two period game which has the following extensive form. In the first period, there are two risk-neutral auditors and an audit client or firm.[4] The client is assumed to know his business risk type.[5] We make the fairly standard assumption that a client's type may not be contracted upon, in contrast to publicly verifiable events, such as bankruptcy, that may be contracted upon.[6] Initially, both auditors are assumed to be symmetrically uninformed about the client's risk type. The competing auditors have common prior beliefs about firm type i, where $i = (L)$ow risk or (H)igh risk. The prior beliefs are $\Pr(i = H) = \lambda > 0$ that the firm is of the high business risk type and $\Pr(i = L) = 1 - \lambda$ that the firm is of the low business risk type. The high type firm has a probability of litigation of $\pi_1 > 0$ in the first period and $\pi_2 > 0$ in the second period. The low type firm has a zero probability of litigation.[7] The probability of litigation is common knowledge.

In both periods, auditors simultaneously choose fees, which is denoted with the variable R, for performance of the audit. This assumption is analytically equivalent to the firm receiving the offers at different times, but not revealing the offers that are submitted. However, even if the client were to disclose the fee offers, competing auditors recognize that the firm has a strategic incentive to under-report fee offers. In addition, the client may choose to re-bid the engagement or otherwise offer the incumbent auditor the right to respond to offers by prospective auditors. However, if, as seems likely, the client cannot commit to truthfully disclose the current "best" offer, then the incumbent auditor will have no incentive to revise his current offer. Thus, the game form remains simultaneous despite sequential firm disclosures or allowing the client to rebid the engagement.

Naturally, the firm chooses the lower of these fee offers; however, if the fee offers are equal, then the firm randomizes between the auditors, giving equal weight

[4] The assumption of two competing auditors is made to facilitate explication and is without loss of generality. As we show later, the analysis extends to the n-auditor case.

[5] The assumption that the client knows its business risk type proves innocuous. If the client is ignorant of its business risk type or knows it only probabilistically, the equilibrium results are unaffected since these are driven entirely by differential information among competing auditors irrespective of the client.

[6] One might be tempted to propose that low-risk clients offer contracts conditional on the event of bankruptcy. That is, a low business risk firm might offer a bond as an indemnity against its being a high type. However, in the event of bankruptcy, debt repayment constraints would preclude payment of the bond; thus, it would be costless for high types to imitate low types in offering such a contract. Naturally, this pooling would undo the original purpose of offering the indemnification contract by low types.

Alternatively, one might also be tempted to invoke the revelation principle and restrict attention to truth-telling equilibria. However, since this setting is one of common agency, it is known that the revelation principle is not generally applicable. (See Martimort and Stole (1993) for additional details.)

[7] Because of risk-neutrality and since the qualitative results of the equilibrium will only depend on the difference between the probabilities of litigation rather than on levels, this assumption is without loss of generality.

to each.[8] The appointed auditor then performs the audit, chooses a probability, α, of successfully determining the client's business risk type at a cost, $c(\alpha)$. Finally, he issues an audit report. The decision regarding the determination of the client's business risk type is known only to the incumbent. Following this, nature determines whether litigation occurs, and this event (or non-event) is publicly observed. If litigation occurs, the appointed auditor incurs an expected liability of B, after which the game ends.[9] If litigation does not occur, the game continues. The prospective auditor updates his prior beliefs as to the firm's type in the usual Bayesian fashion following this event (or non-event). The posterior beliefs formed as a result of this updating process are denoted by λ', the revised probability that the firm is a high risk type. In addition, the prospective auditor forms beliefs, α', about the incumbent's probability of detection.

If no litigation occurs, then in the second period auditors once again compete in price by simultaneously offering fees for the performance of the audit. The simultaneous nature of the strategies chosen by the two firms implies that the fee offered by the incumbent auditor is not observable by the prospective auditor and visa versa. The firm then chooses the auditor with the lower fee; however, in this period, in the case of a tie the client retains the incumbent auditor.[10] At the end of the second period, nature again determines whether litigation occurs and, in this event, the first period auditor incurs an expected liability of B_1, while the second period auditor incurs an expected liability B_2. A key feature of the second period competition is that the incumbent auditor may have private information about the firm's risk type, whereas the prospective auditor only knows the firm's risk type probabilistically.

The time line in Figure 1 summarizes the sequence of events.

[FIGURE 1 HERE]

This model does not consider the effects of the audit opinion on the pricing of business risk. Notice that this is without loss of generality provided that the space of firm risk-types is richer than that of the possible opinions (i.e., going concern modifications and the like) that the auditor may issue. Since the opinion issued by the incumbent auditor is not fully informative of the firm's risk-type, it only mitigates the information asymmetry between the competing auditors without eliminating it. Consequently, the qualitative results which follow remain unaltered.

[8] Long-term contracts are not considered as this may undermine auditor independence as set out in Rule 101 of the AICPA Code of Professional Conduct. In addition, under our assumptions, there are no gains to the firm from acting "strategically" and utilizing a strategy different from merely choosing the lowest price. Thus, the firm is employing a dominant strategy in simply choosing the lowest price offered.

[9] The expected value B is commonly known ex ante by all the auditors. The assumption of risk neutrality enables us to limit attention to the expected value of the litigation lottery rather than considering the specific lottery outcomes in determining the auditor's optimization problem.

[10] This tie breaking rule, which is consistent with Magee and Tseng (1990), is chosen simply because it seems a natural description of the firm's auditor retention decision; however, it does not affect the equilibrium. In particular, an alternative tie-breaking rule, such as giving equal weight to each auditor would yield the same equilibrium strategies.

The respective auditor's problem in the two-period game may be formalizing as follows: If the incumbent auditor learns the client's business risk type in the first period, his problem is expressed as:

If the firm is a high type then,

$$\max_{R_H} E\left(W_H^2\right) = \left(R_H - \pi_2 B_2\right) \Pr\left(R_H \leq R_P\right) - \pi_2 B_1 \tag{1}$$

If the firm is a low type then,

$$\max_{R_L} E\left(W_L^2\right) = R_L \Pr\left(R_L \leq R_P\right) \tag{2}$$

If, on the other hand, the incumbent auditor does not learn the client's business risk type in the first period, then his problem is expressed as:

$$\max_{R_U} E\left(W_U^2\right) = \left(R_U - \lambda' \pi_2 B_2\right) \Pr\left(R_U \leq R_P\right) - \lambda' \pi_2 B_1 \tag{3}$$

where

R_i is the incumbent auditor's second period fee offered to the i type firm, $i \in \{H, L\} \cup U$, where U denotes a firm of unknown type.

R_P denotes the prospective auditor's second period fee;

$\Pr\left(R_i \leq R_P\right)$ is the probability that the incumbent auditor offers a lower fee than the prospective auditor.

The prospective auditor's problem, given beliefs α' that the incumbent auditor has learned the client's type, is represented as:

$$\begin{aligned} \max_{R_P} E\left(W_P^2; \alpha'\right) &= \alpha' \left(\lambda' \left(R_P - \pi_2 B_2\right) \Pr\left(R_P < R_H\right) + \left(1 - \lambda'\right) R_P \Pr\left(R_P < R_L\right)\right) + \\ & \quad \left(1 - \alpha'\right) \left(R_P - \lambda' \pi_2 B_2\right) \Pr\left(R_P < R_U\right) \end{aligned} \tag{4}$$

where

$\Pr(R_P < R_i)$ is the probability that the prospective auditor submits a lower offer than the incumbent auditor and thereby obtains appointment; and

α' denotes the prospective auditor's beliefs about the probability that the incumbent auditor learned the client's business risk type.

The posterior beliefs are updated based on the publicly observable litigation state and are determined by Bayes' Rule as follows:

$$\lambda' = \frac{\left(1 - \pi_1\right) \lambda}{1 - \pi_1 \lambda} \tag{5}$$

Prior to the possible litigation event in the first period, the incumbent auditor chooses the level of effort to expend in determining the client's business risk type given the beliefs held by the prospective auditor about the incumbent's choice. This problem is represented as follows:

$$\begin{aligned}\max_{\alpha\in[0,1]} \mathcal{C}(\alpha;\alpha') &= \alpha\left((1-\lambda)E\left(W_L^2\right)+\lambda(1-\pi_1)E\left(W_H^2\right)-\lambda\pi_1 B\right)+ \\ &\quad (1-\alpha)\left((1-\lambda\pi_1)E\left(W_U^2\right)-\lambda\pi_1 B\right)-c(\alpha) \qquad (6)\end{aligned}$$

To ensure an interior solution, we make the following standard assumptions: $c(0)=0$, $c'\geq 0$, $c''>0$, $c'(0)=0$, and $c'(1)=\infty$.

Differentiating

$$\left((1-\lambda)E\left(W_L^2\right)+\lambda(1-\pi_1)E\left(W_H^2\right)-\lambda\pi_1 B\right)-\left((1-\lambda\pi_1)E\left(W_U^2\right)-\lambda\pi_1 B\right)-c'(\alpha)=0 \qquad (7)$$

Let $\alpha^*(\alpha')$ denote the unique solution to the above problem.

Lemma 1 *There exists a unique solution* $\alpha^*(\alpha^*)$.

Finally, auditor 1's (resp. 2) problem in the first period is formalized as:

Choose R_1 such that:

$$\begin{aligned}\max_{R_1} E(W_1) &= \left(\Pr(R_1<R_2)+\frac{1}{2}\Pr(R_1=R_2)\right)\left(R_1+\mathcal{C}\left(\alpha^*(\alpha');\alpha'\right)\right)+ \qquad (8)\\ &\quad \left(\Pr(R_1<R_2)+\frac{1}{2}\Pr(R_1=R_2)\right)E_1\left(E\left(W_P^2\right)\right)\end{aligned}$$

where

R_1, R_2 denote the audit fees offered by auditor 1 and auditor 2, respectively; and

$E_1(E(W_P^2))$is the expected profit (loss) earned by the prospective auditor in the second period evaluated using the auditor's prior beliefs as they existed in the first period.

3 Analysis

Before characterizing the unique Perfect Bayesian Equilibrium of the game in Theorem 1, let $F_P(R)$ denote the cumulative distribution of audit fees, R_P, charged by the prospective auditor.[11] Similarly, let $F_i(R)$ represent the cumulative distribution function for the informed incumbent auditor's fee, R_i, conditional on the firm's known business risk type i. Finally, let $F_U(R)$ represent the cumulative distribution function for the uninformed incumbent auditor's fee, R_U.

[11] While the equilibrium was derived assuming there are two competing auditors, the qualitative results are largely unchanged by assuming that there are n competing auditors. Since the prospective auditors are symmetrically informed in the second period, the symmetric strategy profile, $G(R)$, for each of the $n-1$ prospective auditors is determined as follows:

$$\begin{aligned}F_P(R) &= \Pr\left(\min(R_2,R_3,...,R_n)<R\right)\\ &= 1-\Pr\left({}_2,R_3,...,R_n>R\right)\end{aligned}$$

Theorem 1 *The unique Perfect Bayesian Equilibrium for the two period game is given by:*

A prospective auditor randomizes his bid according to:

$$F_P(R) = \begin{cases} 0 & \text{where} \quad -\infty < R < \lambda'\pi_2 B_2 \\ 1 - \frac{\lambda'\pi_2 B_2}{R} & \text{where} \quad \lambda'\pi_2 B_2 \leq R \leq \frac{\lambda'\pi_2 B_2}{1-\alpha^*+\alpha^*\lambda'} \\ 1 - \frac{\lambda'\pi_2 B_2 \alpha^*(1-\lambda')}{R-\lambda'\pi_2 B_2} & \text{where} \quad \frac{\lambda'\pi_2 B_2}{1-\alpha^*+\alpha^*\lambda'} \leq R < \pi_2 B_2 \\ 1 & \text{otherwise} \end{cases}$$

and earns zero expected profits.

An informed incumbent auditor who knows that the firm is a low business-risk type randomizes his bid according to:

$$F_L(R) = \begin{cases} 0 & \text{where} \quad -\infty < R < \lambda'\pi_2 B_2 \\ \frac{R-\lambda'\pi_2 B_2}{\alpha^*(1-\lambda')R} & \text{where} \quad \lambda'\pi_2 B_2 \leq R \leq \frac{\lambda'\pi_2 B_2}{1-\alpha^*+\alpha^*\lambda'} \\ 1 & \text{otherwise} \end{cases}$$

and earns expected second period profits of

$$E\left(W_L^2\right) = \lambda'\pi_2 B_2$$

An informed incumbent auditor who knows that the firm is a high business-risk type bids:

$$R_H = \pi_2 B_2$$

and earns expected second period profits (losses) of

$$E\left(W_H^2\right) = -\pi_2 B_1$$

And an uninformed incumbent auditor randomizes his bid according to:

$$F_U(R) = \begin{cases} 0 & \text{where} \quad -\infty < R < \frac{\lambda'\pi_2 B_2}{1+\alpha^*+\alpha^*\lambda'} \\ \frac{R(1-\alpha^*+\alpha^*\lambda')-\lambda'\pi_2 B_2}{(1-\alpha^*)(R-\lambda'\pi_2 B_2)} & \text{where} \quad \frac{\lambda'\pi_2 B_2}{1+\alpha^*+\alpha^*\lambda'} \leq R \leq \pi_2 B_2 \\ 1 & \text{otherwise} \end{cases}$$

and earns expected second period profits of

$$E\left(W_U^2\right) = \lambda'\pi_2\left(B_2\alpha^*\left(1-\lambda'\right) - B_1\right)$$

$$= \quad 1 - (1 - G(R))^{n-1}$$

Thus, $G(R) = (1 - F_P(R))^{\frac{1}{n-1}}$.

Note however, that while equilibrium payoffs are still uniquely determined, there exist a continuum of equilibrium strategies supporting these payoffs.

Moreover, the beliefs held by the prospective auditor and the effort level employed by the incumbent auditor in the first period are given by α^*.

Finally, in the first period the competing auditors bid:

$$R_1 = -\mathcal{C}(\alpha^*; \alpha^*).$$

The nature of the equilibrium strategies arises largely from the need for the prospective auditor to avoid the adverse selection problem inherent to his disadvantaged position. Specifically, the prospective auditor is faced with a "lemons" problem in deciding what fee to charge. In the event that he follows some pure strategy of pricing above the expected costs of unknown types, but less than the expected cost of a high type firm, it is clear that he will be undercut in the case where the client is a unknown or low-risk type and left with only high risk firms. Likewise, the case where the prospective auditor prices above zero but below the expected costs of unknown types, leads to an adverse selection problem where prospective auditors end up solely with unprofitable high and unknown types. Thus, the prospective auditor mixes to avoid this undesirable outcome.

Auditor Switching

An important feature of the equilibrium is that, with some probability, auditor turnover is observed for both types of firms. In particular, low risk firms are less likely to change auditors than high risk firms. This relationship is stated in Proposition 1, where the unconditional probability of a switch is denoted $\Pr(s)$, and the probability of a switch given an i type firm is defined as $\Pr(s|i)$ where $i \in \{H, L\}$.

Proposition 1 *Given the strategies stated in Theorem 1, then*

$$\Pr(s|H) - \Pr(s|L) > 0.$$

The higher probability of auditor switching for high risk firms than for low risk firms, or the probability of auditor switching increasing with business risk, is consistent with the empirical observations of Schwartz and Menon (1985). They find that firms experiencing financial distress are more likely to switch auditors; moreover, the likelihood of switching increases as the firm approaches bankruptcy.

It is interesting to note that the switching differential, $\Pr(s|H) - \Pr(s|L)$, is non-monotonic in the incumbent auditor's effort to acquire information. Specifically, differential switching rates are largest for intermediate values of α. As a consequence, changes in switching differentials are ambiguous with respect to changes in the business risk environment. Specifically, the effect of changes in the business risk environment depend on whether or not the current equilibrium entails a low level of information acquisition, $\alpha^* \leq \frac{1}{1+\lambda}$.

Cross-Subsidization

A further consequence of the equilibrium fee strategy profiles set out in Theorem 1 is that the audit fees offered to high risk firms, $E(R|H)$, are higher on average than those offered to low risk firms, $E(R|L)$. Nevertheless, the risk premium or difference between the fees offered to the high and low risk firms is less than the difference between the expected cost of servicing the high risk type and that of servicing the low risk type firm. These observations are formalized in Proposition 2.

Proposition 2 *Given the strategy profiles stated in Theorem 1, then*

$$0 < E(R|H) - E(R|L) < \pi_2 B_2$$

From Proposition 2 it follows that, in equilibrium, the expected litigation costs of high risk firms are subsidized by the low risk firms. To be precise, since uninformed incumbent and prospective auditors are charging prices above the cost of servicing low business risk firms, but below the cost of servicing high type firms, then profits from low type firms are, in effect, subsidizing the added cost of servicing high type firms. Of course, informed auditors price high types appropriately, but still reap profits on low types due to their informationally advantaged position in the market. This incomplete pass-through of expected litigation costs to high risk firms is consistent with practitioners' claims that competitive pricing prevents them from fully adjusting audit fees to reflect business risk.

Notice that the expected fee offered to the high risk firm, $E(R|H)$, is less than the expected litigation cost, $\pi_2 B_2$, associated with auditing that firm in the second period. Thus, in the second period, low-balling by prospective auditors is observed for high risk type firms. We note that the prospective auditor's low-balling occurs not because of rents anticipated from future periods, but rather from probabilistic intra-period rents anticipated by the prospective auditor from low type clients in the second period.

In the event that costs are low enough to induce the incumbent auditor to always learn a firm's business risk type, then some algebra yields the result that average audit fees in the second period are increasing in average business risk, $\lambda' \pi_2$, faced by a prospective auditor. Thus, the model accords well with empirical findings about audit pricing and business risk. In particular, Bell et al. (1994) find that audit fees are higher for high risk clients, but business risk may not be fully priced.

Dynamic Pricing

We now turn to the first period to consider the impact of endogenous effort and business risk on the initial pricing problem faced by auditors. From Theorem 1, it follows that the incumbent auditor earns expected continuation payoffs of:

$$\begin{aligned}\mathcal{C}(\alpha^*; \alpha^*) &= \alpha^* \left((1-\lambda) E\left(W_L^2\right) + \lambda (1-\pi_1) E\left(W_H^2\right) - \lambda \pi_1 B\right) + \\ &\quad (1-\alpha^*) \left((1-\lambda\pi_1) E\left(W_U^2\right) - \lambda \pi_1 B\right) - c(\alpha^*)\end{aligned}$$

$$= \alpha^* \left((1-\lambda) \lambda' \pi_2 B_2 - \lambda \left((1-\pi_1) \pi_2 B_1 + \pi_1 B \right) \right) + (1-\alpha^*) \left((1-\lambda\pi_1) \left(\lambda' \pi_2 \left(B_2 \alpha^* (1-\lambda') - B_1 \right) \right) - \lambda \pi_1 B \right) - c(\alpha^*) \quad (9)$$

Notice that the expected costs of auditing a firm in the first period are

$$\kappa = \lambda \left(\pi_1 B + (1-\pi_1) \pi_2 B_1 \right) \quad (10)$$

Low-balling is traditionally defined as setting the initial audit fee below first period expected cost (DeAngelo 1981a, b). Formally, the amount of the low-ball, $\mathcal{L}$, is given by:

$$\mathcal{L} = \kappa - R_1 \quad (11)$$

Since $R_1 = -\mathcal{C}(\alpha^*; \alpha^*)$, we then have the following proposition:

Proposition 3 *Auditors bid below expected costs in the amount*

$$\mathcal{L} = \alpha^* \pi_2 B_2 \left((1-\lambda) \lambda' (2-\alpha^*) \right) - c(\alpha^*) > 0$$

The fee offered in the first period is set recognizing that the incumbent auditor benefits from knowing the firm's type when bidding for appointment as the firm's auditor in the second period. Since the competing auditors are symmetrically uninformed in the first period, it follows from Bertrand competition that the two period expected profit must be zero.

Thus, the anticipation of expected profits in the second period induces auditors to offer a fee lower than the first period expected audit liability in the hope of being appointed auditor. Appointment allows the auditor to potentially learn the client's type and thereby offer differential audit prices in the second period. In short, the auditor has an incentive to low-ball. Since entry is free and firms are assumed to have no fixed costs, this condition is consistent with the audit market being in long-run equilibrium.

One can show that the amount of low-balling is increasing in the amount of the second period expected liability, B_2, which arises in the event of litigation. That is, the heightened prospect of adverse court outcomes in the event of litigation actually increases low-balling by auditors. Thus, our model has the testable implication that the recent changes in the litigation environment should lead to a decline in the amount of the low-ball, $\mathcal{L}$, relative to the amounts observed by Simon and Francis (1988) and Ettredge and Greenberg (1990). This prediction arises since many of the earlier changes in the law that had facilitated legal actions against auditors, (see Kothari, et al. 1988; Lys and Watts 1994), have since been reversed. First, the 1983 New Jersey court's decision in *H. Rosenblum v. Adler*, which substantially increased auditor's expected liability by holding them to the foreseeable privity standard was overruled by the New Jersey legislature in 1995.[12] This state has adopted the less severe,

[12] 444 A. 2d 66 (N. J. 1982), 461 A. 2d 138 (N. J. 1983).

strict privity standard (AICPA 1995). Second, in 1993, the U. S. Supreme Court held in *Reves et al. v. Ernst & Young* that since auditors do not participate in the management of an enterprise, they are not subject to the Racketeer Influenced and Corrupt Organizations (RICO) Act of 1970.[13] Finally, the recently passed Securities Litigation Reform Act of 1995 provides protection to auditors by adopting modified proportionate liability for defendants who do not knowingly engage in fraud and including provisions to prevent abusive litigation practices (AICPA 1996).

4 Information Acquisition and Business Risk

In this section we consider how changes in the business risk environment affect information acquisition and profits of competing auditors. In particular, we examine filing delays, changes in liability laws, as well as how cyclical changes in the economic environment affect audit pricing.

Filing Delays

Suppose that filing delays reduce the first-period probability of shareholders of a high-risk firm filing a lawsuit in which the incumbent auditor is the defendant. In this case, there is a reduction in the informational "leakage" arising from the publicly observable litigation event. Consequently, the value to the incumbent of acquiring information about the business risk of the client is increased, and hence, more information acquisition is undertaken. Moreover, as a result of increased information acquisition combined with greater uncertainty in the second period business risk environment, profits of incumbent auditors increase in equilibrium. This has the collateral effect of then increasing observed low-balling in the first period.

More formally,

Remark 1 *Suppose that $\lambda \leq \frac{1}{2}$ and $B_1 = B_2 > 0$, then a small decrease in π_1 results in increased information acquisition and higher profits for both informed incumbents with low business risk firms as well as uninformed incumbent auditors.*

Of course, profits of prospective auditors and informed incumbents with high risk firms are unchanged by filing delays.

Legal Reform

Now consider how changes in liability laws might affect the audit pricing environment. Suppose that reform is anticipated in period two and results in a reduction in B_2. As a consequence of the decreased downside associated with business risk, the incumbent auditor's incentives to obtain additional information are reduced; hence, equilibrium information acquisition levels decrease. In this case, the adverse selection

[13] 113 S. Ct. 1163, March 3, 1993.

problem faced by the prospective auditor is reduced while the informational advantage of the incumbent is also diminished. Thus, profits accruing to both informed auditors with low type firms as well as uninformed incumbents are reduced. Notice that there are two separate effects accounting for these profit reductions: in the case of informed incumbents with low type firms, reduced profits arise purely from more aggressive bidding by prospective auditors due to the reduction in adverse selection. For uninformed auditors, there is an additional profit reducing effect due to the reduction in levels of information acquisition. This reduces the favorable information externalities accruing to uninformed incumbents, hence also resulting in their decreased profit levels.

Formally,

Remark 2 *A small decrease in B_2 decreases information acquisition as well as the expected profits of uninformed incumbents and informed incumbents with low type firms.*

Next consider that case in which the liability of prior auditors in the event of a litigation increases; that is, consider an increase in B_1. Since such a reform has no impact on the business risk environment faced by the *prospective* auditor, it then has no effect on information acquisition, nor on the profits of informed incumbents with low types. However, for informed incumbents with high risk types and uninformed incumbents, the downside of being an *incumbent* auditor has increased and consequently, expected second period profits decrease.

Remark 3 *A small increase in B_1 has no effect on information acquisition or the expected profits of informed incumbents with low type firms. Expected profits of uninformed incumbents and informed incumbents with high type firms decrease.*

Cyclical Business Risk Effects

Finally, consider the effects of an increase in the overall business risk environment faced by auditors; that is, consider an increase in λ. Suppose that low business risk firms are more numerous than high type firms. In this case, as prior beliefs about firm types becomes more diffuse, the value of obtaining information about business risk increases. Consequently, information acquisition efforts by incumbents increase. Naturally, this leads to greater profits for informed incumbents with low type firms (through adverse selection only). Profits for uninformed incumbents are ambiguous. While positive information externalities and adverse selection lead to less aggressive bidding on the part of prospective auditors and hence increase profits for uninformed incumbents; on the other hand, the costs of being a first period auditor have also increased for uninformed types. This latter effect may outweigh the former; hence profits are ambiguous. Nonetheless, in the absence of prior period liability, i.e. when $B_1 = 0$, then profits to uninformed types increase.

Remark 4 *Suppose $\lambda < \frac{1}{2}$,then a small increase in λ increases information acquisition and the expected profits of informed incumbents with low type firms. Expected profits of informed incumbents with high type firms decrease. Expected profits for uninformed types are ambiguous.*

Summary

It is convenient to summarize the equilibrium comparative static effects in the following matrix:

	α^*	$E(W_L^2)$	$E(W_H^2)$	$E(W_U^2)$	$E(W_P^2)$	$\mathcal{L}$
B	0	0	0	0	0	0
B_1	0	0	$-$	$-$	0	0
B_2	$+$	$+$	0	$+$	0	$+$
π_1^a	$-$	$-$	0	$-$	0	$-$
π_2	$+$	$+$	$-$	$+^c$	0	$+$
λ^b	$+$	$+$	0	$+^c$	0	$+$

where the row headings denote the comparative static parameters, the column headings denote the relevant equilibrium effects, and the symbols $\{0, -, +\}$ denote (resp.) no change, decrease, and increase.[14]

a denotes $\lambda \leq \frac{1}{2}$, $B_1 = B_2 > 0$.

b denotes $\lambda \leq \frac{1}{2}$.

c denotes B_1 small.

5 Conclusion

Auditing arises in an environment characterized by endogenously determined levels of incomplete information. Consequently, it seems natural that the information asymmetry concerning the business risk of an audit client should affect the pricing of audit services. We find that differential auditor turnover, incomplete pass through of business risk, the established empirical regularity of pricing an initial audit below the expected cost of performing that audit, or low-balling, arise in our model as a consequence of price competition among auditors who determine strategically the degree of information asymmetry. Our paper shows that transaction costs, technological differences between auditors, and operating efficiencies which arise through repeated performance of an audit are *not* required to explain these phenomena.

Our analysis has a number of testable empirical relations. Auditor turnover should be observed for both low and high business risk type firms with high risk firms being more likely to change auditors than low risk firms. Further, we hypothesize that although audit fees increase with business risk, high business risk firms on average

[14] Routine computation of equilibrium comparative statics are obtained after lengthy and tedious calculations; details are available from the authors.

are not fully charged with the expected cost of litigation arising from the audit service. Thus, we would expect that cross-subsidization between the high and low business risk firms would be observed. Finally, low-balling and audit fees are shown to be positively correlated with litigation liability exposure.

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A Appendix

Proof of Lemma 1:

Substituting for the second period equilibrium payoffs and simplifying yields:

$$(1-\pi_1)\lambda\pi_2 B_2 \frac{(1-\alpha')(1-\lambda)}{1-\pi_1\lambda} - c'(\alpha) = 0$$

Then, using the implicit function theorem:

$$\frac{\partial\alpha^*}{\partial\alpha'} = -\frac{(1-\lambda\pi_1)(\lambda'\pi_2(B_2(1-\lambda')))}{c''(\alpha)} \tag{12}$$

which is everywhere negative.

Combining the monotonicity results of equation (12)with the endpoint conditions implied by our cost function assumptions yields that there is a unique α^* such that the beliefs of the prospective auditor are correct in the second period game. ■

Proof of Theorem 1:

We begin by considering the strategies in the second period. Since it is not difficult to show that an equilibrium in pure strategies for the actions in the second period does not exist, we will consider the equilibrium in non-degenerate behavioral strategies only.

First, consider the expected payoff of the prospective auditor given the strategy adopted by the incumbent auditor. The expected payoff is

$$\begin{aligned} E\left(W_P^2\right) &= \alpha^*\left(\lambda'(R_p - \pi_2 B_2)(1 - F_H(R_p)) + (1-\lambda') R_p (1 - F_L(R_P))\right) + \\ &\quad (1-\alpha^*)(R_P - \lambda'\pi_2 B_2)(1 - F_U(R_P)). \end{aligned}$$

If $R_P < \pi_2 B_2$, then $F_H(R_P) = 0$. Consider the equilibrium payoffs over the non-degenerate support of $F_L(R_P)$. Notice that on this support $F_U(R_p) = 0$. Thus

$$\begin{aligned} E\left(W_P^2(R_P)\right) &= \alpha^*\left(\lambda'(R_p - \pi_2 B_2) + (1-\lambda') R_p \left(1 - \frac{R_P - \lambda'\pi_2 B_2}{\alpha^*(1-\lambda') R_P}\right)\right) + \\ &\quad (1-\alpha^*)(R_P - \lambda'\pi_2 B_2) \\ &= 0 \end{aligned}$$

after some simplification.

Similarly, equilibrium payoffs over the non-degenerate support of $F_U(R_P)$ where $F_L(R_p) = 1$ are

$$\begin{aligned} E\left(W_P^2(R_P)\right) &= \alpha^*\lambda'(R_p - \pi_2 B_2) + (1-\alpha^*)(R_P - \lambda'\pi_2 B_2)(1 - F_U(R_P)) \\ &= \alpha^*\lambda'(R_p - \pi_2 B_2) + \\ &\quad (1-\alpha^*)(R_P - \lambda'\pi_2 B_2)\left(1 - \frac{R(1-\alpha^* + \alpha^*\lambda') - \lambda'\pi_2 B_2}{(1-\alpha^*)(R - \lambda'\pi_2 B_2)}\right) \\ &= 0 \end{aligned}$$

Consider deviations outside the non-degenerate strategy support by the prospective auditor:

Suppose $R_P < \lambda' \pi_2 B_2$, then $E\left(W_P^2\left(R_P\right)\right) = R_p - \pi_2 B_2 < 0$. Suppose now that $R_P > \pi_2 B_2$, then $E\left(W_P^2\left(R_P\right)\right) = 0$.

Therefore the prospective auditor has no incentive to deviate outside the support specified in Theorem 1.

Second, consider the expected payoff of the informed incumbent auditor given the strategy of the prospective auditor. Suppose that the client is a low-type firm. The expected payoff to the incumbent auditor for $R_L \in \left[\lambda' \pi_2 B_2, \frac{\lambda' \pi_2 B_2}{1-\alpha^* + \alpha^* \lambda'}\right]$ is

$$
\begin{aligned}
E\left(W_L^2\left(R_L\right)\right) &= R_L\left(1 - F_P\left(R_L\right)\right) \\
&= R_L\left(\frac{\lambda' \pi_2 B_2}{R_L}\right) \\
&= \lambda' \pi_2 B_2
\end{aligned}
$$

Consider deviations by the informed incumbent outside the non-degenerate support. Suppose $R_L < \lambda' \pi_2 B_2$, then $E\left(W_L^2\left(R_L\right)\right) = R_L < \lambda' \pi_2 B_2$. Next, consider the case where $\pi_2 B_2 \geq R_L > \frac{\lambda' \pi_2 B_2}{1-\alpha^* + \alpha^* \lambda'}$, then $E\left(W_L^2\left(R_L\right)\right) = R_L\left(\frac{\lambda' \pi_2 B_2 \alpha^*\left(1-\lambda'\right)}{R_L - \lambda' \pi_2 B_2}\right) < \lambda' \pi_2 B_2$ since $R_L > \frac{\lambda' \pi_2 B_2}{1-\alpha^* + \alpha^* \lambda'}$. Finally, where $R_L > \pi_2 B_2$ then profits are zero. Thus, the incumbent auditor remains indifferent between payoffs generated by fees on the support $R_L \in \left[\lambda' \pi_2 B_2, \frac{\lambda' \pi_2 B_2}{1-\alpha^* + \alpha^* \lambda'}\right]$ which are strictly preferred to payoffs outside this support.

Now, suppose that the client is a high-type firm. The expected payoff to the incumbent auditor is

$$
E\left(W_H^2\left(R_H\right)\right)\left(R_H - \pi_2 B_2\right)\left(1 - F_P\left(R_H\right)\right) - \pi_2 B_1
$$

Since the incumbent auditor sets $R_H = \pi_2 B_2$ with probability one, $F_P\left(\pi_2 B_2\right) = 1$, and the expected payoff $E\left(W_H^2\left(R_H\right)\right) = -\pi_2 B_1$. Notice that all deviations yield payoffs that are either lower (for the case where $R_H < \pi_2 B_2$ or the same $R_H > \pi_2 B_2$ as those obtained in equilibrium.

Third, consider the expected payoff of the uninformed incumbent auditor given the strategy of the prospective auditor. The uninformed incumbent's equilibrium payoff for all $R_U \in \left[\frac{\lambda' \pi_2 B_2}{1+\alpha^* + \alpha^* \lambda'}, \pi_2 B_2\right]$ is

$$
\begin{aligned}
E\left(W_U^2\left(R_U\right)\right) &= \left(R_U - \lambda' \pi_2 B_2\right)\left(1 - F_P\left(R_U\right)\right) - \lambda' \pi_2 B_1 \\
&= \lambda' \pi_2\left(B_2 \alpha^*\left(1 - \lambda'\right) - B_1\right)
\end{aligned}
$$

Analogous to the previous cases, it is routine to verify that deviations outside $R_U \in \left[\frac{\lambda' \pi_2 B_2}{1+\alpha^* + \alpha^* \lambda'}, \pi_2 B_2\right]$ are not strictly profitable.

The solution to α^* given by Lemma 1 is necessary for Perfect Bayesian equilibrium (hereafter PBE). Finally, first period pricing follows from Bertrand arguments.

It remains to show uniqueness of the equilibrium payoffs. We begin by considering the second period auction. By Bertrand arguments, equilibrium prices must be less than or equal to $\pi_2 B_2$.

Define the non-degenerate supports of the bidding strategies of each of the bidder types as $\mathcal{S}_H, \mathcal{S}_L, \mathcal{S}_P, \mathcal{S}_U$. Using standard arguments (see Engelbrecht-Wiggans, et al. and Amann and Leininger (1995)), the supports of any set of equilibrium bidding strategies:

1. Connected and atomless except possibly at upper endpoints;
2. $\mathcal{S}_H \cup \mathcal{S}_L \cup \mathcal{S}_U$ is connected;
3. $(\mathcal{S}_H \cup \mathcal{S}_L \cup \mathcal{S}_U) \diagdown \mathcal{S}_P = \emptyset$.

It is also useful to recall that, since for all i, $\mathcal{S}_i$ is the support of some cumulative distribution function over a bounded interval, then $\mathcal{S}_i$ is a closed set.

Claim: In any equilibrium $E(W_P^2) = 0$.

Proof. Since the prospective auditor loses the auction with certainty by pricing at $\sup(\mathcal{S}_P)$,and since by closedness $\sup(\mathcal{S}_P) \in \mathcal{S}_P$ then expected profits from the strategy $R_P = \sup(\mathcal{S}_P)$ are zero. By definition of equilibrium, then for all $R_P \in \mathcal{S}_P$, expected profits are zero. ■

Claim: In any equilibrium $\inf(\mathcal{S}_P) = \lambda' \pi_2 B_2$.

Proof. $\inf(\mathcal{S}_P) = \sup(\mathcal{S}_P)$ can only happen in a pure strategy equilibrium, which we ruled out earlier. Thus, $\inf(\mathcal{S}_P) < \sup(\mathcal{S}_P)$. But since by playing $R_p = \inf(\mathcal{S}_P)$ the prospective auditor wins with certainty, then $\inf(\mathcal{S}_P) = \lambda' \pi_2 B_2$ for zero expected profits to hold. ■

Claim: In any equilibrium, $\sup(\mathcal{S}_H) = \inf(\mathcal{S}_H) = \sup(\mathcal{S}_P)$.

Proof. Clearly, in no equilibrium would informed incumbents win with positive probability for any $R_H < \pi_2 B_2$. Since $\sup(\mathcal{S}_P) \leq \pi_2 B_2$, then if $\inf(\mathcal{S}_H) < \sup(\mathcal{S}_P)$, we have a contradiction. Likewise, for $\sup(\mathcal{S}_H) < \sup(\mathcal{S}_P)$. Combining these contradictory conditions with $(\mathcal{S}_H \cup \mathcal{S}_L \cup \mathcal{S}_U) \diagdown \mathcal{S}_P = \emptyset$ yields the result. ■

Claim: Given some interval $[a, b] \subseteq [\lambda' \pi_2 B_2, \pi_2 B_2]$ and an endpoint condition $F_P(a) = k$, then there exists a unique bidding function $F_P(R)$ played by the prospective auditor which keeps a low (resp. uninformed, prospective) type indifferent over $[a, b]$. Moreover, the solution to $F_P(\cdot)$ differs depending on the type of player being made indifferent.

Proof. Consider the case of a low type. For low types to remain indifferent over $[a, b]$ requires for all $R_L \in [a, b]$

$$R_L(1 - F_P(R_L)) \equiv z$$

where z is some constant. Differentiating with respect to R_L,

$$\left(1 - F_P\left(R_L\right) - R_L \frac{d}{dR_L}\left(F_p\left(R_L\right)\right)\right) = 0 \tag{13}$$

which is a first-order linear differential equation. Combined with an endpoint condition and the fact that the range of $F_P(\cdot)$ is convex, we know that $F_P(\cdot)$ is unique. An analogous argument holds for uninformed types

$$\left(1 - F_P\left(R_U\right) - \left(R_U - \lambda' \pi_2 B_2\right) \frac{d}{dR_L}\left(F_p\left(R_U\right)\right)\right) = 0 \tag{14}$$

and it is clear that for a fixed endpoint, the solutions to equations (13) and (14)are different. The proof for a prospective type is identical. ■

CLAIM: There exists no interval $[a, b]$, $a < b$, such that $\mathcal{S}_L \cap \mathcal{S}_U = [a, b]$. Moreover, for any interval $[a, b]$ over which uninformed types are indifferent, $a \succ_L b$. Likewise, or any interval $[a, b]$ over which low types are indifferent $b \succ_U a$, where the relation $\succ_i$denotes strict preference by type $i \in \{L, U\}$.

Proof. The first part of the claim follows directly from the uniqueness of F_P. The second part follows from uniqueness combined with the absence of profitable deviations for each of the types given in the existence proof above. ■

It then follows that $\inf(\mathcal{S}_P) = \inf(\mathcal{S}_L) = \lambda' \pi_2 B_2$. And, by the definition of a cdf, $F_P(\lambda' \pi_2 B_2) = F_L(\lambda' \pi_2 B_2) = 0$. Using uniqueness of the solution to the differential equation generating indifference, we then reproduce the strategies given in Theorem 1. Uniqueness of α^* follows from Lemma 1 and the uniqueness of first period strategies follows from Bertrand pricing arguments. ■

Proof of Proposition 1: Note that $\Pr(s|L) = \alpha^* \Pr(R_P < R_L) + (1 - \alpha^*) \Pr(R_P < R_U)$. Since $F_P(R)$, $F_L(R)$, and $F_U(R)$ are mixed strategies, R_p, R_L, and R_U are independent random variables. Therefore, $\Pr(R_P < R_L)$ may be expressed as a convolution of $F_P(R)$ and $F_L(R)$. Also, define $f_j(R) = \frac{\partial}{\partial R} F_j(R)$ for $j \in \{H, L, U, P\}$. Thus,

$$\begin{aligned} \Pr(s|L) &= \alpha^* \Pr(R_P < R_L) + (1 - \alpha^*) \Pr(R_P < R_U) \\ &= \alpha^* \int_{-\infty}^{\infty} F_P(R) f_L(R)\, dR + (1 - \alpha^*) \int_{-\infty}^{\infty} F_P(R) f_U(R)\, dR \end{aligned}$$

Then using Theorem 1,

$$\begin{aligned} \Pr(s|L) &= \alpha^* \int_{\lambda' \pi_2 B_2}^{\frac{\lambda' \pi_2 B_2}{1 - \alpha^* + \alpha^* \lambda'}} \left(1 - \frac{\lambda' \pi_2 B_2}{R}\right) \left(\frac{\lambda' \pi_2 B_2}{\alpha^* (1 - \lambda') R^2}\right) dR + (1 - \alpha^*) \int_{-\infty}^{\infty} F_P(R) f_U(R)\, dR \\ & \frac{1}{2}(1 - \lambda')(\alpha^*)^2 + (1 - \alpha^*) \int_{-\infty}^{\infty} F_P(R) f_U(R)\, dR \end{aligned}$$

Now consider turnover among high types, by similar reasoning

$$\begin{aligned}\Pr(s|H) &= \alpha^* \Pr(R_P < R_H) + (1-\alpha^*)\Pr(R_P < R_U) \\ &= \alpha^* \int_{-\infty}^{\infty} F_P(R) f_H(R)\, dR + (1-\alpha^*) \int_{-\infty}^{\infty} F_P(R) f_U(R)\, dR\end{aligned}$$

Then using Theorem 1,

$$\Pr(s|H) = \alpha^*(1-\lambda'\alpha^*) + (1-\alpha^*)\int_{-\infty}^{\infty} F_P(R) f_U(R)\, dR$$

Differencing

$$\begin{aligned}\Pr(s|H) - \Pr(s|L) &= \alpha^*(1-\lambda'\alpha^*) - \frac{1}{2}(1-\lambda')(\alpha^*)^2 \\ &= \frac{1}{2}\alpha^*(2-\alpha^*\lambda'-\alpha^*) \\ &> 0 \blacksquare\end{aligned}$$

Proof of Proposition 2:

Recall that

$$\begin{aligned}E(R|L) &= \alpha E\left(R|\bar{L}\right) + (1-\alpha)E(R|U) \\ E(R|H) &= \alpha E\left(R|\bar{H}\right) + (1-\alpha)E(R|U)\end{aligned}$$

where $\bar{L}$ (resp. $\bar{H}$) denotes that the incumbent auditor has successfully learned the firm's type, while U again denotes the type of firm being unknown to the incumbent.

Differencing

$$E(R|H) - E(R|L) = \alpha\left(E\left(R|\bar{H}\right) - E\left(R|\bar{L}\right)\right)$$

Define $G(R|i)$ to be the distribution of the minimum order statistic of the pair $\left(\tilde{R}_P, \tilde{R}_i\right)$ $i \in \{H, L\}$,and let $g(R|i)$ be the associated density. Observe that when $i = H$, then for all $R > \pi_2 B_2$, $g(R|H) = 0$; hence $E\left(R|\bar{H}\right) \leq \pi_2 B_2$. Similarly, observe that for all $R < \lambda'\pi_2 B_2$, $g(R|L) = 0$;hence $E\left(R|\bar{L}\right) \geq \lambda'\pi_2 B_2$. Combining these inequalities yields $E\left(R|\bar{H}\right) - E\left(R|\bar{L}\right) < \pi_2 B_2$.

Next, observe that the $F_H(R)$ first order stochastically dominates $F_P(R)$ which first order stochastically dominates $F_L(R)$. Consequently, $G(R|H)$ first order stochastically dominates $G(R|L)$; hence $E\left(R|\bar{H}\right) - E\left(R|\bar{L}\right) > 0$. $\blacksquare$

Proof of Proposition 3:

Notice that $\kappa + \mathcal{C}(0;\alpha') \geq 0$ for all α' with strict inequality for all $\alpha' > 0$. Moreover, $\kappa + \mathcal{C}(\cdot;\alpha')$ is strictly concave, and by our assumptions on $c(\cdot)$, a PBE choice of α is interior. Thus, $\kappa + \mathcal{C}(\alpha^*;\alpha^*) > 0$.

To obtain the expression for the low-ball amount: rewrite $\kappa + \mathcal{C}(\alpha^*; \alpha^*)$:

$$\begin{aligned}
\kappa + \mathcal{C}(\alpha^*; \alpha^*) &= \lambda(\pi_1 B + (1-\pi_1)\pi_2 B_1) + \\
&\quad \alpha^*((1-\lambda)\lambda' \pi_2 B_2 - \lambda((1-\pi_1)\pi_2 B_1 + \pi_1 B)) + \\
&\quad (1-\alpha^*)((1-\lambda\pi_1)(\lambda'\pi_2(B_2\alpha^*(1-\lambda') - B_1)) - \lambda\pi_1 B) - c(\alpha^*)
\end{aligned}$$

Simplifying:

$$\begin{aligned}
\kappa + \mathcal{C}(\alpha^*; \alpha^*) &= \alpha^* \pi_2 B_2((1-\lambda)\lambda' + (1-\alpha^*)(1-\pi_1)\lambda(1-\lambda')) - c(\alpha^*) \\
&= \alpha^* \pi_2 B_2((1-\lambda)\lambda'(2-\alpha^*)) - c(\alpha^*) \blacksquare
\end{aligned}$$