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Honesty preferences and audit policy

Ruey-Ji Guo[a*], Yenpao Chen[a] and Hung-Shu Fan[b]

[a]*Department of Accounting, Soochow University, Taipei, Taiwan*
[b]*Department of Accounting, Fu Jen Catholic University, New Taipei City, Taiwan*

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A B S T R A C T

This study examines how preferences for honesty affect two-period audit policy. We categorize the audited as either fully honest (i.e. the ethical) or self-interested and rational (i.e. the economic) to deal with the issue of audit policy. As a result, we find the conditional audit policy will be an optimal audit policy only if the incentive for the economic to cheat is sufficiently large and the proportion of the ethical in all audited is relatively moderate,. Otherwise, the conditional audit policy will be dominated by other audit policy. These results suggest that firms are likely able to design a more efficient audit policy if they take into account the honesty preferences of the audited.

1. Introduction

In most of agency structures, information asymmetry keeps being a predominant phenomenon since the agent holds private information that the principal cannot access. To relieve the problem resulting from information asymmetry and reduce the related agency costs, the principal can choose to employ an auditor (another agent) to supervise the audited agent (e.g. the manager). The audit measure becomes one of the prominent management mechanisms inducing the audited agent either to make every effort to behave in the best interest of the principal or to comply with some kind of requirement. Under the variety of settings and assumptions, there are a few papers paving the way for a series of studies on the related issues, (e.g. Antle, 1982; Baron & Besanko, 1984; Demski & Sappington, 1987; Baiman et al., 1987). In the latter study of audit policy, a number of researchers have gradually shifted their interest to the collusion between the auditor and the audited (Tirole, 1986; Baiman et al., 1991; Kofman & Lawarree, 1993; Laffont & Martimort, 1999).

Intuitively, previous audit experience may have some kind of impact on the current audit decision. To reduce audit costs or increase audit benefits, the principal can consider enhancing the probability of

* Corresponding author. Tel: 886-2-23111531 ext. 3405
E-mail addresses: grj@scu.edu.tw (R.J. Guo)

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auditing the agent who has a “poor” (e.g. cheating) audit record in the past. In practice, such as taxation audit, the previous audit result often influences the tax regulator’s current audit action. That phenomenon can arise from a preconception that some people behaving dishonestly in the past are likely to behave the same way in the future. While the inference may be not so unambiguous, the optimal audit decision can be dependent on the prior results for some other reasons.

In the literature concerning conditional audit, there are only a handful of papers, which may be closely related to our work. First of all, Landsberger and Meilijson (1982) propose a dynamic incentive generating penalty system in order to reduce the generation of undesirable externalities at a given cost. Secondly, Greenberg (1984) further proposes an optimal auditing scheme for the tax authorities and classifies individuals into one of three groups. Each group is characterized by two parameters. He claims that there is a combination of these parameters so that in equilibrium the percentage of individuals that cheat is arbitrarily small. However, both of them are involved with some kind of specific conditional audit mechanism under the infinite periods, and disregard the potential effect of different behavioral assumptions related to the audited. Using two-period model, Guo et al. (2005) argue that if the manager’s benefit of under-declaring return is larger than the expected penalty under complete audit so that the manager inevitably choose to under-declare the return, the principal’s optimal audit policy will be implementing complete audit in each period since the expected penalty revenue will outweigh the related audit cost. As a result, they conclude that it is unnecessary to adopt any conditional audit in that situation.

The conclusion of Guo et al. (2005) is actually based on a critical assumption that the behavior of the audited is fully self-interested and rational. Nevertheless, it can be a controversial issue whether all audited agents are self-interested and rational in that the behavioral assumption doesn’t necessarily correspond to the practical situation in the real world. Prior studies have resulted in a wide range of conclusions. While Baiman and Lewis (1989) conclude that preferences for honesty are insignificant in the value of communication, Evans et al. (2001) claim that honesty is relevant and that the reporting environment should be designed to take into consideration all aspects of preferences, both pecuniary and non-pecuniary. Additionally, Evan et al. (2001) find that subjects often sacrifice wealth to make honest or partially honest reports, and they generally do not lie more as the payoff to lying increases. They suggest that the extent of honesty may depend on how the surplus is divided between the manager and the firm. Furthermore, Rankin et al. (2008) find that less slack is created when budget communication requires a factual assertion in the subordinate authority treatment, but not when the superior has final authority. Hence, they note that there is an incremental effect of honesty when the subordinate has final authority.

To examine how honesty preferences influence the principal’s optimal audit policy, we regard the fully honest agent as “the ethical”, and categorize the self-interested and rational agent as “the economic”, who choose to cheat depending on the result of benefit and cost analysis. For simplification, it’s assumed that the incentive for the economic to cheat is sufficiently large so that the behavior of self-interested and rational agent will be equivalent to that of fully dishonest agent.[1] Hence, we can overlook the type of the latter in the analysis without loss of completeness.

In next section, we’ll characterize the basic model used in this paper. The related analyses and results will be presented in section 3. Finally, in the concluding section, we’ll discuss the theoretical implication of this study as well as its effect on the configuration of principal’s audit policy system.

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[1] In the real world, there do be some people who are fully dishonest. They behave in irrational way and always choose to cheat as long as there is any possibility (even very low probability) for their dishonest behaviors not to be found and punished.

2. The Model

In the paper, we examine a principal-agent hierarchy consisting of a principal, an auditor and n managers. The principal is the proprietor of the vertical structure with n (homogeneous) operating units; each manager is responsible for his/her individual operating unit with private information about its realized return; the auditor collects information for the principal. Following Tirole (1986), it is assumed that the principal is devoid of either the time or the knowledge necessary to supervise the managers, and that the auditor also lacks either the time or the resources required to run the vertical structure. It is further assumed that all players are risk neutral. Also, the auditor is regarded as independent and won't collude with managers. However, managers are dichotomized into two types. One consists of self-interested and rational managers; the other consists of fully honest managers. Following types models (Koford and Penno 1992), we refer to the former as "the economic", and the latter as "the ethical". While there is still a possibility that a few managers are fully dishonest, we disregard them in that their behavior will be indifferent from the self-interested and rational managers', given the assumption in the paper that the incentive for under-declaration is quite significant. Moreover, it's assumed the proportion of fully honest managers (i.e. the ethical) in all managers is h, and the proportion of self-interested and rational managers (i.e. the economic) is $1-h$. While the value of h is contingent on a few factors, we assume that the principal can acquire the related information on h via past experience or independent investigation.

Nature is assumed to be the only one factor influencing the realized return of the ith operating unit, i.e. high return (R_{iH}) or low return (R_{iL}). It's assumed $R_{iH} = R_H/n$ and $R_{iL} = R_L/n$ for $i=1$ to n, where R_H and R_L denote the maximal and minimal possible returns for all operating units, respectively.[2] Also, in either period one or period two, the principal predicts there are $p \cdot n$ operating units realizing high returns and $(1-p)\cdot n$ operating units realizing low returns. Although every operating unit has the same probability (p) of realizing high return in each period, it may have different realized return in each period (either R_H/n or R_L/n) and the realized return for every operating unit is the unit manager's private information. The principal will be unable to learn the individual manager's (or operating unit's) realized return unless the former undertake an audit action upon the latter. According to some kind of contract or regulation, it's assumed that at the end of each period every manager has to declare the period's return to the principal and transfer a certain portion (α) of the return to the latter. Hence, every manager can reserve only the remaining $1-\alpha$ portion of the return. That transferring mechanism brings about an incentive for a manager to under-declare realized return.

To alleviate the effect of under-declaring returns, the principal can employ an auditor at cost C to audit the return declared by a unit manager when the latter declares a low return. The manager is required to pay a penalty of $\overline{P}$ if the auditor finds the under-declaration of return.[3] Since audit is imperfect, even if the principal accomplishes necessary audit upon an operating unit (at the cost of C), there is only the probability of r (and $0<r<1$) that the auditor can find the under-declaration of return, i.e. the operating unit realizes a high return but the manager declares a low return. Essentially, r reflects the audit capability (or audit quality) of the auditor, and we assume it is the common information of all parties involved. For simplification, we assume that the incentive for the economic to cheat is sufficiently large (i.e. $\alpha(R_H/n - R_L/n) > r\overline{P}$ or $\alpha(R_H - R_L) > nr\overline{P}$) so that the self-interested & rational manager will choose to under-declare the return as the realized return is high.[4] In contrast, the

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[2] In other words, the total returns for all operating units can be between R_L and R_H.

[3] Following Kofman and Lawarree (1993), we assume $\overline{P}$ is an exogenously given number, which may be interpreted as, for instance, a legally specified limit on liability.

[4] If the assumption is changed into $\alpha(R_H - R_L) \le nr\overline{P}$, then the whole analysis will become much more complicated while it allows for the possibility of totally deterring the under-declaration behavior by self-interested manager.

fully honest manager will truthfully declare the realized return regardless of high or low return. In practice, the assumption of strong incentive for under-declaration is not unusual or unreasonable. For instance, the audit quality can be not satisfactory given a certain audit cost due to the complexity of audit environment (resulting in a smaller r), and the penalty can be constrained by legal or other factors.

In a two-period audit scenario, the audit policy for the second period can be dependent on the audit result in the first period, i.e. there exists the possibility of "conditional audit." We assume, at the beginning of period one, the principal first announces a conditional audit policy in the sense that the audit probability for the first period is A if the manager declares low return, but the probability for the second period will depend on the audit result in the first period. If the under-declaration of return in period one is found and revealed by the auditor, the probability for the second period will be enhanced up to A' ($\equiv A+a$) provided the manager declares low return once more in period two. Since the principal is unable to observe the realized return, her audit policy can only depend on the return declared by the manager. The principal will undertake audit only when the manager declares low return. In this paper, it's assumed that there is no existence of blackmail or collusion between the auditor and the manager. Hence, if the realized return is low, the audit result will be also low return.[5] But if the realized return is high, the audit result will be subject to the effect of the audit quality (r) of the auditor. Given the principal takes audit action, there remains a probability of $1-r$ that the auditor cannot find the under-declaration of return.

However, is "conditional audit" necessary to raise the principal's expected payoff (or utility)? Does "preferences for honesty" have any effect on the optimal audit policy? Both of them are the key issues that this paper intends to address.

To summarize, the timing on the relevant events is presented as follows:

(1) The principal and the managers achieve an agreement that the latter will transfer a portion (α) of the return to the former. Meanwhile, the principal announces a audit policy with a normal audit probability, A, and a punitive audit probability, A', where $A \le A'$.
(2) Nature determines the realized return of individual operating unit in period one. There are $p \cdot n$ operating units with high return (R_H/n) and $(1-p)\cdot n$ operating units with low return (R_L/n).
(3) The manager of the ith operating unit declares the return in period one, $\hat{R}_{i1}$, and will transfer $\alpha \cdot \hat{R}_{i1}$ to the principal, where $\hat{R}_{i1} = R_H/n$ or R_L/n.
(4) The principal sends the auditor at cost C with probability A if the ith manager declares low return in period one (i.e. $\hat{R}_{i1} = R_L/n$.)
(5) The auditor presents an audit report. If the under-declaration of return is disclosed, the manager involved will have to pay the principal a penalty of $\overline{P}$.[6] Also, the principal will keep a dishonest record on the manager.
(6) Transfer for period one takes place.
(7) Nature determines the realized return of individual operating unit in period two once again. There remain $p \cdot n$ operating units with high return (R_H/n) and $(1-p)\cdot n$ operating units with low return (R_L/n).
(8) The manager of the ith operating unit declares the return in period two, $\hat{R}_{i2}$, and will transfer $\alpha \cdot \hat{R}_{i2}$ to the principal, where $\hat{R}_{i2} = R_H/n$ or R_L/n.

Additionally, by further analysis, it seems that the new assumption won't change the trend and direction of optimal audit policy or the effect of h on the related policy.

[5] It's assumed that the auditor has to present some evidence to support his audit report on under-declared return, and that the evidence cannot be falsified.

[6] $\overline{P}$ is assumed to be larger than $\alpha(R_H - R_L)/n$ for compensation and punishment.

(9) The principal sends the auditor at cost C with probability A if the ith manager was not found under-declaring the return in period one and declares low return in period two (i.e. $\hat{R}_{i2} = R_L/n$.), but with probability A' if the ith manager was found under-declaring the return in period one and declares low return in period two.
(10) The auditor presents an audit report, and the manager will have to pay the principal a penalty of $\overline{P}$ if the under-declaration of return is disclosed.
(11) Transfer for period two takes place.

For simplification, all payoffs are evaluated at the end of period one by using a present value factor of d.

3. The Analyses

Since this paper divides the managers into two types, i.e. the ethical (or fully honest managers) and the economic (or self-interested and rational managers), we need to understand the possible declaration behaviors by both types of managers. First of all, if the realized return in period one or period two is low, either the ethical or the economic will consistently declare low return to the principal. However, if the realized return in either period one or period two is high, while the ethical will honestly declare high return, the economic will under-declare the return in consideration of the significant economic incentive (i.e. $\alpha(R_H/n - R_L/n) > r\overline{P}$ or $\alpha\Delta R > nr\overline{P}$ where $\Delta R \equiv R_H - R_L$).

After understanding the possible actions that will be taken by the manager, the next step is to analyze the principal's optimal audit policy given the choice of manager's declaration. Fundamentally, it is a precondition for the principal to consider employing the auditor that the expected payoff exceeds the audit cost. Otherwise, the audit mechanism will never be activated. In the latter analysis, we find the relative ratio of the ethical to the economic in managers essentially plays a critical role in audit decision made by the principal, and has a prominent impact on the cost-benefit analysis of audit policy. The effect of honesty preferences on the principal's optimal audit policy will be shown in the following propositions.

Proposition 1:

As the incentive for the economic to under-declare is quite large (i.e. $\alpha\Delta R > nr\overline{P}$), if the proportion of the ethical in all managers is considerably low (i.e. $h \le h_1$), then the principal's optimal audit policy will be uniformly complete audit, i.e. $A^* = A'^* = 1$, where $h_1 \equiv [(1+d-drp)(rp\overline{P}-C)]/[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C]$. In that situation, the conditional audit will be inapplicable, and the principal will obtain a maximal expected payoff of $\pi_P^* = (1+d)\alpha R_L + (1+d)hp\alpha\Delta R - (1+d)(1-p)hnC + (1+d)(1-h)(rp\overline{P}-C)n$.

[Proof] See the Appendix A.

A significant incentive for the economic to under-declare implies that the economic manager's benefit of under-declaring return by far outweighs the expected penalty even if the principal takes uniformly complete audit (i.e. $A = A' = 1$). In that situation, the self-interested and rational manager will necessarily choose to declare low return when the realized return is high, and it becomes the principal's optimal audit policy to take a complete audit action as long as the proportion of the ethical in all managers is sufficiently low (i.e. $h \le h_1$). Otherwise, if the proportion of the ethical in all managers becomes relatively significant, there will be a possibility that some kind of "conditional audit" becomes an optimal audit policy. The related result is characterized in the following *Proposition 2*.

Proposition 2:

As the incentive for the economic to under-declare is quite large (i.e. $\alpha\Delta R > nr\overline{P}$), if the proportion of the ethical in all managers is relatively moderate (i.e. $h_1 < h < h_2$), then the principal will take a conditional audit policy to maximize the expected net return. That is, the principal will use a normal audit probability of $A^* = A_1$ and a punitive audit probability of $A'^* = 1$, where

$h_1 \equiv \left[(1+d-drp)(rp\overline{P}-C)\right]/\left[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C\right]$,

$h_2 \equiv \left[(1+d+drp)(rp\overline{P}-C)\right]/\left[(1+d+drp)(rp\overline{P}-C)+(1+d)(1-p)C\right]$,

$A_1 \equiv (1/2)+\{(1+d)[(1-h)(rp\overline{P}-C)-hC(1-p)]\}/\left[2drp(1-h)(rp\overline{P}-C)\right]$.

Meanwhile, the principal will have a maximal expected payoff of

$\pi_P^* = (1+d)\alpha R_L + (1+d)hp\alpha\Delta R - (1+d)(1-p)hA_1 nC + (1-h)[(1+d)A_1 + dA_1(1-A_1)rp](rp\overline{P}-C)n$.

[Proof] See the Appendix B.

According to *Proposition 2*, it is shown that the honesty preferences of the audited have a significant effect on whether the principal should adopt a conditional audit policy. If the proportion of the ethical in all managers is relatively moderate (neither too high nor too low), using conditional audit will likely become an optimal audit policy. In that case, the principal can undertake a random audit with an audit probability of A_1 (and $0 < A_1 < 1$) when the manager declares a low return in period one. Then, in period two, the audit probability will be kept at A_1 if the manager was not found under-declaring the return in period one and declares a low return once more in period two. But if the manager was found under-declaring the return in period one and declares a low return in period two, the principal will take a complete audit action (i.e. $A' = 1$). The audit policy is referred to as "conditional audit" policy in the paper.

However, as the proportion of the ethical in all managers becomes much higher, the value of audit will vanish and the no audit policy will be optimal. The related result is presented in *Proposition 3*.

Proposition 3:

As the incentive for the economic to under-declare is quite large (i.e. $\alpha\Delta R > nr\overline{P}$), if the proportion of the ethical in all managers is sufficiently high (i.e. $h \geq h_2$), then "no audit" action will be the principal's optimal audit policy, i.e. $A^* = 0$ and A' is inapplicable, where $h_2 \equiv \left[(1+d+drp)(rp\overline{P}-C)\right]/\left[(1+d+drp)(rp\overline{P}-C)+(1+d)(1-p)C\right]$.

Hence, in that situation, audit is worthless and the principal's expected payoff will become $\pi_P^* = (1+d)\alpha R_L + (1+d)hp\alpha\Delta R$.

[Proof] See the Appendix C.

As shown in *Proposition 3*, if the proportion of the ethical in all managers is sufficiently large (i.e. $h \geq h_2$), then audit will become worthless. The main reason is that the benefit of undertaking audit will be less than the audit cost since most of the audited managers are the ethical and never cheating. Nevertheless, since the threshold of no audit (h_2) is increasing in the audit quality (r), unless the audit quality is relatively too low so that h will never be less than h_2, some kind of audit remains to be worth undertaking.

Lemma 1:

Following the denotation in *Proposition 2*, the precondition of $h_1 < h < h_2$ implies that $C_1 < C < C_2$. Meanwhile, we have $C_1 < rp\overline{P}(1-h)/(1-ph) < C_2 < rp\overline{P}$, where

$C_1 \equiv \left[(1+d-drp)(1-h)rp\overline{P}\right]/\left[(1+d-drp)-(1+d-dr)ph\right]$ and

$C_2 \equiv \left[(1+d+drp)(1-h)rp\overline{P}\right] / \left[(1+d+drp)-(1+d+dr)ph\right]$.

[Proof] See the Appendix D.

As shown in *Lemma 1*, the precondition for conditional audit to be desirable, i.e. the proportion of the ethical in all managers is relatively moderate (i.e. $h_1 < h < h_2$), can be changed into the one that the audit cost is relatively adequate (i.e. $C_1 < C < C_2$). Hence, analyzing the proportion of the ethical in all managers is actually involved with a comparison of the audit cost with the audit benefit. If the audit period of interest is only single one, the precondition for audit action to be worthwhile will be $C < \left[(p-ph)/(1-ph)\right]r\overline{P}$. In that case, the threshold of audit cost for triggering audit action is $rp\overline{P}(1-h)/(1-ph)$, and it will be $rp\overline{P}$ if there is no fully honest manager (i.e. $h = 0$). Nevertheless, in a two-period audit scenario, the threshold of audit cost can be relaxed (enhanced) to be C_2, where $rp\overline{P}(1-h)/(1-ph) < C_2 < rp\overline{P}$ provided there exist the ethical managers (i.e. $h > 0$). The main reason is that the principal can implement some kind of conditional audit in two-period audit, but it is impossible to do that in single period. Hence, conditional audit indeed increases the possibility of using audit action.

Since $a\,(= A' - A = 1 - A)$ corresponds to the punitive effect of conditional audit policy, a larger a implies the principal can conduct a random audit in period one with a lower audit probability, and then implement a complete audit in period two when the manager has a under-reporting record and declares a low return once more. In the following proposition, we further examine the impacts of the proportion of the ethical in all managers and the audit cost on the punitive effect of conditional audit policy.

Proposition 4:

If conditional audit is the principal's optimal audit policy (as characterized in Proposition 3), then, ceteris paribus, a higher proportion of the ethical in all managers or more costly audit (given a certain level of audit quality) will lead to a larger punitive effect in conditional audit policy.

[Proof] See the Appendix E.

In terms of the *Proposition 4*, if the optimal audit policy is to implement some kind of conditional audit, the punitive effect (i.e. the difference between punitive and normal audit probabilities) will be positively correlated with the proportion of the ethical in all managers (h) and the audit cost (C). Given the punitive audit probability is a constant (i.e. $A' = 1$), *Proposition 4* implies that a higher proportion of the ethical in all managers or more costly audit will lead to a lower normal audit probability. Essentially, audit quality is highly related to audit cost. If it needs more expenditure in audit cost to attain a certain level of audit quality, the related audit will be regarded as more costly. In contrast, subject to a constraint of audit expenditure budget, if we can obtain a higher level of audit quality, then the audit action will be considered less costly. According to *Proposition 4*, more (less) costly audit will induce the principal to use a lower (higher) audit probability in period one to locate the self-interested managers (the economic), provided conditional audit is desirable, and result in a larger (smaller) punitive effect.

4. Conclusion

In audit literature, it is generally assumed that the audited is self-interested, and will undertake cost and benefit analysis to determine whether to be honest (or in compliance). However, there is a possibility in real world that the audited is fully honest or ethical, at least in a certain audit scenario. For instance, some people with highly religious belief will always honestly declare their income taxes and never consider the benefits from avoiding tax. In general, the portion of people in compliance in some society can be dependent upon the society's income, education, religion, or culture level.

The paper relaxes the behavioral assumption related to the audited managers, and allows for the coexistence of both the ethical (fully honest managers) and the economic (self-interested and rational managers). We find that, as the incentive for the economic to under-declare is considerably large, the conditional audit policy can become an optimal audit policy as long as the proportion of the ethical in all managers is up to a significant but not extremely high level. Otherwise, when the proportion of the ethical in all managers becomes quite large, any audit action will be uneconomical and the value of audit will vanish. In contrast, if the proportion becomes pretty low, it will be worth implementing a comprehensive audit. Hence, the argument of Guo et al. (2005) can be regarded as a specific case in that they assume the proportion of the ethical in all managers is just equal to zero (extremely low) and conclude a complete audit policy is adequate.

We also argue that, as the conditional audit becomes the principal's optimal policy, the difference between punitive and normal audit probabilities (i.e. the punitive effect) will be positively correlated with the proportion of the ethical in all managers and the audit cost. Given that the punitive audit probability is invariably set to be one, the result implies that a higher proportion of the ethical in all managers or more costly audit will lead to a lower normal audit probability. Hence, in a highly developed country or in a society with highly religious belief, the punitive effect of conditional audit will likely be much more evident than other areas in the world in that the former can has more the ethical and fewer the economic. Similarly, in a more complicated (and more costly) audit situation, the punitive effect of conditional audit will be more significant as well. Both of them will trigger a lower (normal) audit probability in earlier audit period for locating the economic and bring about a larger punitive effect while using conditional audit policy.

Additionally, audit quality can have some kind of relationship with audit cost. If it needs more expenditure in audit cost to attain a certain level of audit quality, the audit is regarded as more costly. In contrast, if we can obtain a higher level of audit quality given some audit cost, then the audit action will be considered less costly. Hence, subject to a constraint of audit expenditure budget, if the conditional audit is a desirable policy but the audit quality is not so satisfactory, the principal will likely employ a lower normal audit probability to enlarge the difference between punitive and normal audit probabilities. In terms of the results of the paper, it is interesting that the behavioral assumption concerning the audited indeed plays a vital role in the analysis of audit policy.

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Appendix A (*Proof of Proposition 1*)

Since $\alpha\Delta R > nr\overline{P}$, the principal's audit action won't prevent the self-interested and rational manager from under-declaring the return even if $A = 1$. Hence, the principal's expected payoff in the situation is

$$\begin{aligned}
\pi_p &= hpn[\alpha R_H/n + dp\alpha R_H/n + d(1-p)(\alpha R_L/n - AC)] \\
&\quad + h(1-p)n[\alpha R_L/n - AC + dp\alpha R_H/n + d(1-p)(\alpha R_L/n - AC)] \\
&\quad + (1-h)pn\{\alpha R_L/n + A(r\overline{P} - C) + dp[\alpha R_L/n + Ar(A+a)(r\overline{P} - C) + (1-Ar)A(r\overline{P} - C)] \\
&\qquad + d(1-p)[\alpha R_L/n - Ar(A+a)C - (1-Ar)AC]\} \\
&\quad + (1-h)(1-p)n\{\alpha R_L/n - AC + dp[\alpha R_L/n + A(r\overline{P} - C)] + d(1-p)(\alpha R_L/n - AC)\} \\
&= hp[\alpha R_H + dp\alpha R_H + d(1-p)(\alpha R_L - AnC)] \\
&\quad + h(1-p)[\alpha R_L - AnC + dp\alpha R_H + d(1-p)(\alpha R_L - AnC)] \\
&\quad + (1-h)p\{\alpha R_L + A(nr\overline{P} - nC) + dp[\alpha R_L + Ar(A+a)(nr\overline{P} - nC) + (1-Ar)A(nr\overline{P} - nC)] \\
&\qquad + d(1-p)[\alpha R_L - Ar(A+a)nC - (1-Ar)AnC]\} \\
&\quad + (1-h)(1-p)\{\alpha R_L - AnC + dp[\alpha R_L + A(nr\overline{P} - nC)] + d(1-p)(\alpha R_L - AnC)\} \\
&= h(1+d)[p\alpha R_H + (1-p)(\alpha R_L - AnC)] + (1-h)[(1+d)\alpha R_L + (A + dA + dAarp)(rp\overline{P} - C)n] \\
&= h(1+d)[p\alpha R_H + (1-p)(\alpha R_L - AnC)] + (1-h)(1+d)\alpha R_L + (1-h)[(1+d)A + dAarp](rp\overline{P} - C)n
\end{aligned}$$

To maximize π_p subject to $0 \le A \le 1$, $0 \le a < 1$, and $0 \le A + a \le 1$, we let the related Lagrangian function be

$$\begin{aligned}
Z &= h(1+d)[p\alpha R_H + (1-p)(\alpha R_L - AnC)] + (1-h)(1+d)\alpha R_L + (1-h)[(1+d)A + dAarp](rp\overline{P} - C)n \\
&\quad + \lambda(1 - A - a).
\end{aligned}$$

Meanwhile, Kuhn-Tucker conditions require

$\partial Z/\partial A \le 0$, $A \ge 0$, $(\partial Z/\partial A)\cdot A = 0$,

$\partial Z/\partial a \le 0$, $a \ge 0$, $(\partial Z/\partial a)\cdot a = 0$,

and $\partial Z/\partial \lambda \ge 0$, $\lambda \ge 0$, $(\partial Z/\partial \lambda)\cdot \lambda = 0$.

In *Proposition 1*, we first consider the situation that the optimal policy is using complete audit (i.e. $A=1$ and $a=0$). Hence, for the audit policy to maximize π_p, the related conditions, including $\partial Z(A=1,a=0)/\partial A = 0$, $\partial Z(A=1,a=0)/\partial a \le 0$ and $\lambda \ge 0$, need to be satisfied.

That implies $\lambda = -h(1+d)(1-p)nC + (1-h)(1+d)(rp\overline{P} - C)n \ge 0$ and $(1-h)drpn(rp\overline{P}-C) - \lambda = (1-h)drpn(rp\overline{P}-C) + h(1+d)(1-p)nC - (1-h)(1+d)(rp\overline{P}-C)n \le 0$ need to hold. Thus, by the first inequality, we need $h \le (rp\overline{P}-C)/(rp\overline{P}-pC)$; and by the second inequality, we need $h \le [(1+d-drp)(rp\overline{P}-C)]/[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C] \equiv h_1$.

Since $0 < [(1+d-drp)(rp\overline{P}-C)]/[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C] < (rp\overline{P}-C)/(rp\overline{P}-pC) < 1$, there exists possible proportion of the ethical in all managers for $A=1$ and $a=0$ to be the optimal solution.

Hence, as $h \le h_1$, if $A^*=1$ and $a^*=0$ (i.e. $A^* = A'^* = 1$), the principal will have the maximal expected payoff of π^*_P, where

$$\pi^*_p = h(1+d)[p\alpha R_H + (1-p)(\alpha R_L - A^* nC)] + (1-h)(1+d)\alpha R_L + (1-h)[(1+d)A^* + dA^* a^* rp](rp\overline{P}-C)n$$
$$= (1+d)\alpha R_L + (1+d)hp\alpha\Delta R - (1+d)(1-p)hnC + (1+d)(1-h)(rp\overline{P}-C)n$$

and $h_1 \equiv [(1+d-drp)(rp\overline{P}-C)]/[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C]$.

Appendix B (*Proof of Proposition 2*)

Following the proof of *Proposition 1*, we further consider the situation allowing for conditional audit (i.e. $0<A<1$ and $0 \le a < 1$). Since the combination of $0<A<1$ and $a=0$ cannot satisfy all the Kuhn-Tucker conditions, it leaves the combination of $0<A<1$ and $0<a<1$ to be a possible optimal solution. In the case, we find the optimal values of A and a (i.e. A^* and a^*) to maximize π_p. Hence, both $\partial Z(A^*, a^*)/\partial A = 0$ and $\partial Z(A^*, a^*)/\partial a = 0$ need to be satisfied.

That means both $\lambda = \lambda_1 \equiv -h(1+d)(1-p)nC + (1-h)(1+d+da^* rp)(rp\overline{P}-C)n$ and $\lambda = \lambda_2 \equiv (1-h)dA^* nrp(rp\overline{P}-C)$ need to be satisfied simultaneously. Since $\lambda = \lambda_2$ will lead to $\lambda > 0$, $\partial Z(A^*, a^*)/\partial\lambda = 0$ needs to hold, implying $A^* + a^* = 1$.

Hence, by $\lambda = \lambda_1 = \lambda_2$ and $A^* = 1 - a^*$, we have

$$-h(1+d)(1-p)C + (1-h)(1+d)(rp\overline{P}-C) + (1-h)drp(rp\overline{P}-C)a^* = (1-h)drp(rp\overline{P}-C)(1-a^*)$$
$$\Leftrightarrow 2(1-h)drp(rp\overline{P}-C)a^* = h(1+d)(1-p)C - (1-h)(1+d)(rp\overline{P}-C) + (1-h)drp(rp\overline{P}-C)$$
$$\Leftrightarrow a^* = 1/2 + \{(1+d)[h(1-p)C - (1-h)(rp\overline{P}-C)]/2(1-h)drp(rp\overline{P}-C)\} \equiv a_1$$

and $A^* = 1 - a^* = 1/2 - \{(1+d)[h(1-p)C - (1-h)(rp\overline{P}-C)]/2(1-h)drp(rp\overline{P}-C)\} \equiv A_1$

Also, to let $0 < A^* < 1$ and $0 < a^* < 1$ hold, we need

$$-1/2 < (1+d)[h(1-p)C - (1-h)(rp\overline{P}-C)]/2(1-h)drp(rp\overline{P}-C) < 1/2$$
$$\Leftrightarrow -(1-h)drp(rp\overline{P}-C) < (1+d)[h(1-p)C - (1-h)(rp\overline{P}-C)] < (1-h)drp(rp\overline{P}-C)$$
$$\Leftrightarrow (1+d-drp)(rp\overline{P}-C)(1-h) < (1+d)(1-p)Ch < (1+d+drp)(rp\overline{P}-C)(1-h)$$
$$\Leftrightarrow h > [(1+d-drp)(rp\overline{P}-C)]/[(1+d-drp)(rp\overline{P}-C)+(1+d)(1-p)C] \equiv h_1$$

and $h < [(1+d+drp)(rp\overline{P}-C)]/[(1+d+drp)(rp\overline{P}-C)+(1+d)(1-p)C] \equiv h_2$.

Hence, as $h_1 < h < h_2$, we have $A^* = A_1 (<1)$ and $A'^* = A^* + a^* = 1$ to satisfy all the Kuhn-Tucker conditions, and obtain a maximal expected payoff of π^*_P, where

$$\pi_p^* = h(1+d)[p\alpha R_H + (1-p)(\alpha R_L - A_1 nC)] + (1-h)(1+d)\alpha R_L + (1-h)[(1+d)A_1 + dA_1 a_1 rp](rp\overline{P} - C)n$$
$$= (1+d)\alpha R_L + (1+d)hp\alpha\Delta R - (1+d)(1-p)hA_1 nC + (1-h)[(1+d)A_1 + dA_1(1-A_1)rp](rp\overline{P} - C)n \, .$$

Appendix C (*Proof of Proposition 3*)

To maximize π_p subject to $0 \le A \le 1$, $0 \le a < 1$, and $0 \le A + a \le 1$, we have considered two possible optimal combinations in *Propositions 1* and *2*. Finally, we'll search for the condition that the no audit policy (i.e. $A = 0$) becomes the optimal solution.

Following the proof of *Proposition 1*, if $A = 0$ (for $0 \le a < 1$) is an optimal combination for maximizing π_p, we need $\partial Z(A = 0)/\partial A \le 0$ and $\lambda = 0$ to satisfy all the Kuhn-Tucker conditions. That is,

$$\partial Z(A = 0, \lambda = 0)/\partial A = -h(1+d)(1-p)nC + (1-h)(1+d+darp)(rp\overline{P} - C)n \le 0$$
$$\Leftrightarrow (1-h)(1+d+darp)(rp\overline{P} - C) \le h(1+d)(1-p)C$$
$$\Leftrightarrow h \ge [(1+d+drp)(rp\overline{P} - C)]/[(1+d+drp)(rp\overline{P} - C) + (1+d)(1-p)C] \equiv h_2 \, .$$

Hence, we conclude that, as $h \ge h_2$, the no audit policy (i.e. $A = 0$) is an optimal solution. Meanwhile, the principal's maximal expected payoff is

$$\pi_p^* = h(1+d)[p\alpha R_H + (1-p)\alpha R_L] + (1-h)(1+d)\alpha R_L$$
$$= (1+d)\alpha R_L + (1+d)hp\alpha\Delta R \, .$$

Appendix D (*Proof of Lemma 1*)

$$h > h_1$$
$$\Leftrightarrow h > [(1+d-drp)(rp\overline{P} - C)]/[(1+d-drp)(rp\overline{P} - C) + (1+d)(1-p)C]$$
$$\Leftrightarrow (1+d-drp)(rp\overline{P} - C)h + (1+d)(1-p)Ch > (1+d-drp)(rp\overline{P} - C)$$
$$\Leftrightarrow [(1+d-drp) - (1+d-dr)ph]C > (1+d-drp)(1-h)rp\overline{P}$$
$$\Leftrightarrow C > [(1+d-drp)(1-h)rp\overline{P}]/[(1+d-drp) - (1+d-dr)ph] \equiv C_1 \, ,$$
$$h < h_2$$
$$\Leftrightarrow h < [(1+d+drp)(rp\overline{P} - C)]/[(1+d+drp)(rp\overline{P} - C) + (1+d)(1-p)C]$$
$$\Leftrightarrow (1+d+drp)(rp\overline{P} - C)h + (1+d)(1-p)Ch < (1+d+drp)(rp\overline{P} - C)$$
$$\Leftrightarrow [(1+d+drp) - (1+d+dr)ph]C < (1+d+drp)(1-h)rp\overline{P}$$
$$\Leftrightarrow C < [(1+d+drp)(1-h)rp\overline{P}]/[(1+d+drp) - (1+d+dr)ph] \equiv C_2 \, ,$$
$$C_1 < rp\overline{P}(1-h)/(1-ph)$$
$$\Leftrightarrow (1+d-drp)(1-ph) < (1+d-drp) - (1+d-dr)ph$$
$$\Leftrightarrow -ph - dph + drp^2 h < -ph - dph + drph$$
$$\Leftrightarrow p < 1 \, ,$$
$$rp\overline{P}(1-h)/(1-ph) < C_2$$
$$\Leftrightarrow (1+d+drp) - (1+d+dr)ph < (1+d+drp)(1-ph)$$
$$\Leftrightarrow -ph - dph - drph < -ph - dph - drp^2 h$$
$$\Leftrightarrow p < 1 \, ,$$

and

$$C_2 < rp\overline{P}$$
$$\Leftrightarrow (1+d+drp)(1-h) < (1+d+drp) - (1+d+dr)ph$$
$$\Leftrightarrow ph + dph + drph < h + dh + drph$$
$$\Leftrightarrow h(1-p) + dh(1-p) > 0 \, .$$

Appendix E (*Proof of Proposition 4*)

By *Proposition 2*, as $\alpha\Delta R > r\overline{P}$ and $h_1 \le h < h_2$, the optimal "conditional audit" policy will be $A^* = A_1$ and $A'^* = 1$. Hence, $A'^* - A^* = 1 - A_1 = a_1$; meanwhile,

$$\begin{aligned}
\partial a_1/\partial h &= \frac{(1+d)\left[2drp(1-h)(rp\overline{P}-C)(rp\overline{P}-pC)\right] - 2drp(1+d)\left[(1-h)(rp\overline{P}-C) - hC(1-p)\right](rp\overline{P}-C)}{\left[2drp(1-h)(rp\overline{P}-C)\right]^2} \\
&= \frac{(1+d)\left[(1-h)(rp\overline{P}-C)(1-p)C + hC(1-p)(rp\overline{P}-C)\right]}{2drp(1-h)^2(rp\overline{P}-C)^2} \\
&= \frac{(1+d)(1-p)C}{2drp(1-h)^2(rp\overline{P}-C)} > 0
\end{aligned}$$

and

$$\begin{aligned}
\partial a_1/\partial C &= \frac{(1+d)\left[2drp(1-h)(rp\overline{P}-C)(1-hp)\right] - 2drp(1+d)\left[(1-h)(rp\overline{P}-C) - hC(1-p)\right](1-h)}{\left[2drp(1-h)(rp\overline{P}-C)\right]^2} \\
&= \frac{(1+d)\left[(1-h)(rp\overline{P}-C)(1-hp) - (1-h)^2(rp\overline{P}-C) + hC(1-p)(1-h)\right]}{2drp(1-h)^2(rp\overline{P}-C)^2} \\
&= \frac{(1+d)\left[(1-h)(rp\overline{P}-C)(1-p)h + hC(1-p)(1-h)\right]}{2drp(1-h)^2(rp\overline{P}-C)^2} \\
&= \frac{(1+d)(1-h)(1-p)hrp\overline{P}}{2drp(1-h)^2(rp\overline{P}-C)^2} > 0\,.
\end{aligned}$$