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會計師教育程度、審計品質與其法律責任之分析性研究

An Analytical Study of Accounting Education, Audit Quality, and Legal Liability

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當論文進行到此部分，代表碩士生活將接近尾聲。

有句話說「每個人都在自己的命運中尋找平衡」。如果人生的每個遭遇都有其意義，我想讀研究所的這段日子，是要我明白這個道理，並學習與自己的人生命運和解，了解在每一個看似沒有自主權的行動中，其實都是自己心中的選擇。自由、責任與焦慮，是存在的課題。

「因愛誕生」是我心中偷偷為這篇論文下的副標題，雖然偷了蘇絢慧的書名，但也沒光明正大放上封面，應該不算剽竊。生命中總有幾位重要他人——母親、老師、女朋友，即使和這些人的關係因為研究所而變得錯綜複雜，但仍不能否定我心中那份愛。因為「愛」，所以不想看見他們傷心、失望，或是受到傷害，因此才能化愛為動力，將論文完成。這本論文，每一字每一句都是用愛寫出來的，同時，也在字字句句中，看見自己人生那些反覆上演的類似情節裡背後的生命傷痛。

於是我知道，重新找回自己、重新愛自己，是我接下來要學習的。唯有當我成為一個能自我照顧、自我療癒的人時，我才能給我的重要他人一份完整的愛。

謝謝這些人，幫助我看見我生命中的重要學習。研究所這條路是痛苦的，同時，也是有成長的；也謝謝証業出版社的大家，讓我在蛻變的煎熬中得以喘息。

最後，引用存在主義大師尼采的一句話來作結：「那些未能致我於死的一切，讓我更加地強壯」……

摘要

本文參考 Schwartz (1997)的研究架構，提出一理論模型以探討在考慮會計師教育程度之後，在不同法律制度下對審計市場以及投資額的影響。在本模型中，由於投資人可直接觀察會計師教育程度，因此會計師教育程度會透過審計公費對投資人以及會計師本身的決策造成影響。在模糊過失責任的法律制度下，會計師投入的均衡努力程度，接受的均衡教育程度、以及投資人的投資金額皆會永遠偏離社會最適。而在嚴厲法律責任之下，雖然在未考慮投資之前，會計師投入的努力及接受的教育程度皆可達成社會最適，但最後仍會因為超額投資而超過社會最適的水準。研究結果可提供法律制定者做為改善法律制度之參考。

關鍵詞：會計教育、法律制度、審計品質、投資

Abstract

Following the framework in Schwartz (1997), this study examines the effect of accounting education on the audit market and the level of investment conducted under different legal regimes by an analytical model. Since the level of education is observable to the investor, this model shows that it will affect both the investor's and the auditor's decision making through audit fee. Under vague negligence liability rule, the equilibrium combination of audit effort, education, and investment will never achieve social optimum. Although under strict liability rule the audit effort and the education may have a chance to be socially desired, they are still upwardly distorted by excessive investment. These results can be served as reference for law makers to improve the design of auditor liability.

Key words: Accounting education, Legal regime, Audit quality, Investment

Contents

1. Introduction

The issue of auditor liability has always been a popular issue on which numerous researchers show their concerns (e.g., Dye 1993, 1995; Schwartz 1997, 1998; Pae and Yoo 2001; Ganuza and Gomez 2007; Narayanan 1994; Laux and Newman 2010; Liu and Wang 2006; Lennox and Li 2012; Deng et al. 2012; Bigus 2011). Especially after the adoption of Sarbanes-Oxley Act in 2002, it has become an even more controversial debate on the pros and cons of imposing stricter responsibility on auditors. Most of the researchers study how different legal regimes of auditor liability will affect audit fee, audit quality, and the level of investment. However, it seems that researchers have not yet come to a general normative consensus about the optimal rigidity of legal regimes. Some, e.g., Liu and Wang (2006) support a stricter legal regime to encourage more investment projects, while others, like Dye (1995), urges to give auditors free choice to adopt limited legal liability (LLP) for the reason of opening entry for wealthier auditors to boost competition.

This study also aims to analyze the effects of additional accounting education taken by the auditor on the audit market and the amount of investment under different legal regimes. Adopting the analytical framework in Schwartz (1997), this study adds another variable, amount of accounting education into the model. First the socially optimal equilibrium is proposed as the benchmark to compare the degree of efficiency under

different legal regimes, including the vague negligence rule liability and the strict liability rule. Then this study shows distortions under vague negligence liability rule and strict liability rule. Since the damage payments under both legal regimes are dependent on investment, of which may be taken advantage by the investor, the equilibriums are not consistent with social optimum.

In fact, there is a lack of study on the accounting education in the auditing literature, which motivates this paper to incorporate accounting education into the subject of research to contribute to the literature. The study on accounting education by Lee et al. (1999) is the most related to this paper. They examine the consequences of the 150-hour rule, a law that requires auditors complete at least 150 credits of relevant courses before entering audit market, by presenting an economic model. This study is different from their model because the education in this study can freely chosen by the auditor, not bonded by laws in the model by Lee et al. (1999).[1]

The model in this study is different from that by Schwartz (1997) in the following two ways. First, this study presents that the level of education has positive relationships with audit fee owing to the auditor's expectation and the investor's observation that the level of education can be served as a proxy to conjure up audit quality. With the notion

[1] In fact in Taiwan auditors are required to complete undergraduate-level courses before taking the CPA exam. One can also imagine that in this study the auditor has completed required education credits. What he decides in this model about education is whether to take higher (additional) education.

in mind, the investor is willing to pay higher audit fee to the auditor. Second, under certain conditions, audit fee is also positively associated with the level of investment on account of the auditor's anxiety that he may be liable to more damage payout. In sum, audit fee in this study is not only a transfer payout between the auditor and the investor. It can affect all the players' decisions in this model.

The rest of this paper is organized as follows. Section 2 provides a review on related papers in the field of audit quality, legal regimes, and accounting education. Section 3.1 presents the model setting, and socially optimal equilibrium as benchmark is derived in section 3.2. In section 4.1 the deviation from social optimum under vague negligence rule is demonstrated, while in section 4.2 it is revealed that the potential to achieve the socially desired education and audit effort can be spoiled by excessive investment under strict liability. Section 5 concludes this thesis.

2. Prior Literature

2.1 Audit Quality

According to Ittonen (2010), the reasons why demand for auditing arises are based on four theories. One of them is "Theory of Inspired Confidence," which states that stakeholders of a firm demand for accountability from the management, so they need periodic audited financial statements, through which accountability is realized. This theory corresponds to a hypothesis that auditors actually are providers of information for the investors for decision making, which is called "the information hypothesis proposed" by Wallace (1980). In this way, how to measure audit quality becomes a vital issue.

The pioneering definition of audit quality by DeAngelo (1981) is well-known: the "market-assessed" joint probability that an auditor manages to both find errors in the client's accounting information and disclose those errors. Her definition is adopted in this study but the goal of the auditor here is changed to find evidence about the state of nature, not errors in accounting information.

Another research topic: the determinants of audit quality, has been enthusiastically studied for a long time. There is a wide range of papers examining various factors that may have an effect on audit quality, including auditor's reputation (Skinner and Srinivasan 2012; Krishnamurthy et al. 2006; Bigus 2011).

Bigus (2011) defines reputation losses as "the present value of lost future rents from auditing and non-auditing services." He also points out that in his analytical model concerns on reputation loss play a beneficial role in inducing auditor's excessive care. As to empirical studies, when auditor's reputation diminished seriously in scandals like ChuoAoyama in Japan in 2006 and Anderson in the U.S. in 2002, Skinner and Srinivasan (2012) find moderate evidence that in Japan their clients will switch to other auditors, whereas Krishnamurthy et al. (2006) state that the stock price of Anderson's clients will experience negative abnormal return at the outbreak of the scandal.

Other works like Titman and Trueman (1986) and Datar et al. (1991) examine that under information asymmetry where the owner of a firm has private information, the entrepreneur is prone to choose the auditor with better quality, hoping to increase the future firm value expected by investors. In this study education is incorporated into analysis for the purpose that higher level of education is often viewed as higher quality of work, which is absent in the papers above.

2.2 Legal Regimes

2.2.1 Analytical studies

In fact, there are a plenty of classic works investigating the outcome of the audit market or investment resulting from different regimes of auditors' liability (Dye 1995; Schwartz 1997; Laux and Newman 2010; Bigus 2012; Deng et al. 2012; Liu and Wang

2006). Dye (1995) models economic changes in the audit market before and after opening free choices to auditors with a continuum of wealth for limited or unlimited legal liability. He points out that after opening choice for assuming limited legal liability, the least wealthy auditors will earn less audit fee and put all their wealth at risk or simply leave the audit market, which means that they are worse off than under unlimited liability. As to the most wealthy auditors, they will incorporate part of their wealth as capital at risk, resulting in concerns for lower audit quality that encourage other people to inspect the quality of the capital incorporated for assuring that investors' legal claim will not be impaired. As such, the legal regime of unlimited liability can be deemed as an entry barrier for wealthier auditors, so it is the limited liability rule for auditors that will promote competition.

The paper by Schwartz (1997) is most directly related to this study. She presents a newly designed damage payment measure that can possibly induce socially desirable investment level. In her model, whether under vague negligence rule or under strict liability rule, traditional out-of-pocket damage measures cause overinvestment.

In the model by Laux and Newman (2010), it is argued that in case of an audit failure, an increase in damage payment to the investor and in litigation cost will result in an increase and a decrease, respectively, in auditors' client acceptance probability. They point out that when legal regime is modified, damage measures and litigation frictions

are usually involved. Therefore, there is a U-shaped relationship between the way legal regime is designed and the probability that an auditor will accept a client, which implies there must exist an optimal legal regime, which minimizes auditors' probability to reject a new client.

Different from common assumption of risk neutrality of auditors, Bigus (2012) assumes the auditor in his model is risk-averse in order to analyze how the auditor will react to ambiguity of legal regime. With vague negligence rule, the auditor will increase his effort to avoid the worst outcome (*certainty effect*), but it is possible that he will lower his effort because he may be lucky enough not to be sued (*futility effect*). Despite low rate of suing, a risk-averse auditor tends to exert excess care when conducting audit case if damage payment is sufficiently large. On the other hand under strict liability, there is no distortion by *certainty effect and futility effect*, so the care exerted is efficient. In spite of auditors' different attitudes toward risk, Bigus (2012) and Schwartz (1997) reach consensus that vague negligence rule is not efficient, so does this study.

Deng et al. (2012) show that adoption of severer laws like Sarbanes-Oxley Act (SOX) indeed helps cut down rate of audit failure and cost of capital for firms; however it also brings about underinvestment if information asymmetry between investors and the firms is too large. In fact at first glance, one may feel curious why the results in Deng et al. (2012) are totally the opposite from that in previous papers like Schwartz

(1997). The underlying reason is that information asymmetry is absent so the level of investment is naturally an increasing function of audit fee and expected auditors' liability. However, with presence of information asymmetry like in Akerlof (1970), if a rule with heavier liability imposed on auditors, they behave more conservatively and thus projects of high-type[2] firms are more likely to be rejected, giving rise to underinvestment.

Liu and Wang (2006) support to impose stricter legal liability on auditors. In their model, effort exerted by the auditor is observable to the court. If the variance[3] between the effort observed by the court and the effort required by the auditing standard is larger, under legal regime that is less rigid the auditor can be tempted to exert higher level of effort. Nonetheless, under stricter legal regime, since the value of audit is perceived higher not only by the entrepreneur but also by the investor, more firms are willing to conduct investment projects regardless of higher audit fee.

Following the research framework in Schwartz (1997), the model in this study strives to study different legal regimes as well, yet it is different from those models above in that in this model education is additionally taken as an endogenous variable, which has seldom been examined, into account. To focus more on searching a socially

[2] The auditor in the model of Deng et al. (2012) aims to distinguish "high type" firms with more cash flows from an investment project from "low type" ones with lower cash flows from its project. On the other hand in Schwartz (1997), the auditor aims to find evidence of state of nature unknown to both the firm and the investor.

[3] It is called "legal error" in the paper.

optimal design of legal liability which is not examined in Deng et al. (2012), there is no lemon problem in the model.

2.2.2 Empirical studies

There are also abundant empirical papers contributing to the literature of legal regime (Choi et al. 2009; Geiger et al. 2006). Choi et al. (2009) provide both theoretical and empirical findings that the audit fee paid by cross-listing companies will be higher than those are not cross-listing, if the legal regime in the mother country of cross-listing companies is stricter than that in foreign legitimacy. Moreover, if foreign legitimacy is similar or even looser than that in mother country, there is a premium in audit fee paid by cross-listing firms only when the legal procedure of scrutiny required for cross listing is more complicated. Finally, such premium will be larger as the discrepancy in the degree of rigidity between local and foreign legal regimes expands

Geiger et al. (2006) use a sample of 649 financially distressed companies which enters into bankruptcy between 1991 and 2001 to study auditors' behavioral changes after the adoption of *Private Securities Litigation Reform Act of 1995*, a law that dramatically reduces the liability exposure of public accounting firms to publically traded clients involved in a lawsuit. They find after the adoption of *Reform Act*, there is a significant decrease in probability that big 6 accounting firms will issue going-concern modified audit reports, yet this effect is not significant for non-big 6 firms. This result

demonstrates that the implementation of such a law relieving auditors from heavy liability has stronger impact on decision-making of the auditors in big accounting firms than those in smaller firms

Although this study does not provide empirical evidences to support the theoretical findings presented by the model, it is optimistic that all the theoretical findings can also be served as valuable references for law makers to think about the possible outcomes of current legal regime in the real world because the model setting is general, not limited to the scope of cross-listing related issues in Choi et al. (2009) or to financially distressed clients in Geiger et al. (2006). Compared with those studies on specific topics above, this study has value of general applicability.

2.3 Accounting Education

Most previous studies on accounting education lay their focuses mainly on the economic consequences effects on the audit market (Lee et al. 1999; Allen and Woodland 2010) or of a policy, especially the 150-hour requirement, which requires auditors complete certain level or degrees of education before they enter the audit market. Lee et al. (1999) extend Dye's (1995) model by assigning accounting education level as another determinant of audit quality to examine the influences of the 150-hour rule in the United States. Contradictory to expectation of enhanced audit quality, the 150-hour rule deteriorates audit quality, and moreover, audit fee is raised for pre-rule

hired auditors. The rule thus makes more pre-rule auditors enter the audit market and all the audit clients worse off, which is Pareto-inferior to pre-rule situation.

Those predictions above are supported by Allen and Woodland (2010). They conduct an empirical research on audit market in the U.S. during the period 2001 to 2004, and find that firms within the jurisdiction of the 150-hour rule pay audit fee which is estimated 4.5% higher than those without the rule after controlling other factors that may also increase audit fees. In addition, their regression models suggest that such post-rule increase in audit fee is sustainable as time passes.

Other works provide interesting findings on CPA exam-related issues (Boone et al. 2006; Donelan and Philipich 2002). For a study on the CPA exam pass rate, by studying a sample of grades from 43,711 first-time candidates for the exam, Boone et al. (2006) shows that candidates receiving education in area where the 150-rule comes into effect have higher pass rate. On the other hand, there is a significant decline in pass rate during the transition period of the rule presented in regression analysis.

Donelan and Philipich (2002) provide comparisons of satisfaction with learning four different professional skills from CPA exam candidates who chooses different accountancy education programs to meet 150-hour requirement. The results of their questionnaire shows that CPA exam candidates who choose complete additional

undergraduate-level credits are consistently less satisfied in the general, accounting, and information technology skills than those who meet the requirement by completing a master's level accountancy degree program. Thus concerns on redesigning the education programs to help candidate meet the requirement are addressed

This study also studies the economic effect of accounting education but differs from those papers above in three ways. First, in those papers all the auditors must complete legally required credits of curriculums; however the model in this paper gives the auditor opportunities to decide their own desired level of education. Second, various regimes of legal liability are explored in this paper to study if they have different impacts on the auditor's choice of education level. Third, a benchmark of social optimality is also available in this study for the purpose of comparisons between different legal regimes.

3. The Model

3.1 Model Setting

3.1.1 The firm and its shareholder

There are three risk-neutral players: an owner of a firm, a potential investor (shareholder) of the firm, and an auditor, facing one-period problems in this model. A firm has an investment project, and since it doesn't retain any earnings, it has to raising all the capital from a public shareholder.[4] The owner of the firm is assumed to have no private information about the project,[5] and the realization of investment project depends only on the state of nature, which is random and unobservable as capital is raised. The outcome will not be revealed until in the future the project has been conducted. Projects will be successful only at the state of nature "success" with *ex ante* probability s, and the *ex ante* probability of a failed project under the state of nature "failure" is $1-s$. A successful project, denoted by S, is defined as a project with positive net present value; whereas conversely a failed project, denoted by F, is defined as a project with negative net present value.

The initial required funds for the investment project are denoted by I. If the project is successful in the future, the shareholder in the firm can get positive return on the

[4] In this model, shareholders and investors are both referred to the people contributing their fund to the company. They are used interchangeably thereafter.
[5] This is a common assumption in the audit-client model analysis.

project, denoted by $R(I)$; otherwise, the outcome of a failed project brings nothing to the shareholder, that is, $R(I)=0$. The return function $R(I)$ is set to be increasing and concave as initial investment increases: $R'(I)>0$ and $R''(I)<0$. If nobody invests, the return is zero: $R(0)=0$. Since the net return of a successful project is defined to be positive, $R(I)-I$ is also assumed to be positive to make sure that the investor can get positive net return at the state of nature "success".

3.1.2 The auditor and the audit market

The shareholder decides whether he should contribute the funds to the projects in order to maximize the expected return from the investment project. Since he knows nothing about the possibility of the state of nature, so subsequently an auditor is hired to provide professional opinion about the firm's investment project to eliminate uncertainty about the outcome of the project. The auditor decides whether to enter the audit market based on his expected utility from entering the market and his reservation utility, which is normalized to zero in the model. If the auditor expects that there is net increase in his utility after entering the audit market, he will enter the market and then choose certain level of education, H, and incurs relevant cost, $K(H)$, with $K'(H)>0$, $K''(H)>0$, before starting to conduct an audit case. Education level H is observable to all players in the audit market.

For simplicity, it is assumed that once the auditor enters the audit market, he

accepts the client immediately.[6] During the process of auditing, the auditor is subject to another cost. As the auditor exerts the effort e, which is unknown to the investor, audit effort cost $C(e)$, with $C'(e)>0$ and $C''(e)>0$, is incurred. Then he can get information on the future state of nature, on which he will issue audit report either $\hat{S}$ (unqualified report) or $\hat{F}$ (qualified report).

Consistent with the assumption of negligible incorrect rejection in SAS No. 39, ASB (1981), paragraph 12 and 13, the auditor is assumed not to report $\hat{F}$ under state of nature "success".[7] Therefore, once the auditor finds any information supporting good state of nature, he will definitely issue $\hat{S}$ report, that is, $\Pr(\hat{S}|S)=1$.

3.1.3 Audit quality and auditor's liability

Audit quality, $q(e,H)$, is defined as "the probability that an auditor will find evidence supporting bad state of nature and issue report $\hat{F}$ when the state is in fact bad," that is, $q(e,H)= \Pr(\hat{F}|F,e,H)$. Audit quality is an increasing and concave function with effort and education: $q_e(e,H)>0$, $q_{ee}(e,H)<0$, $q_H(e,H)>0$, $q_{HH}(e,H)<0$. Perfect audit quality, $q(e,H)=1$, is impossible because it is too costly, so audit quality is assumed to be strictly smaller than one. Also, if only minimal effort, $\underline{e}$, is exerted, the auditor will by no means find any information concerned about bad state, that is, $q(\underline{e},H)=0$.

[6] For a model considering client acceptance by the auditor, see Laux and Newman (2010).
[7] This is a common assumption made in the literature of analytical study of auditor's liability (Dye 1993, 1995; Schwartz 1997).

The auditor *may*, *not absolutely*, be convicted if he reports $\hat{S}$ about the state of nature, yet the realization turns out to be *F*. Therefore, the auditor's *expected* liability, denoted by Λ, can be de decomposed into two parts: $\Lambda=pD$. The first part, *p*, is the *exogenous* probability that the auditor will be found liable by the court, while the second part, *D*, is the damage payment to the investor.

Independence of the auditor is guaranteed because the auditor will not get higher compensation if he issues an unqualified audit report. Moreover, the legal regime can force the auditor to exert certain amount of effort in order to avoid being subject to the potential liability to the investor when an audit failure happens. To simplify the problem, the auditor cannot hire an attorney to defend for himself if he is accused of issuing false audit report; hence compensation to an attorney does not appear in the model.

The following timetable summarizes the sequence of events in this model:

Stage 1: The firm has an investment project with initial required funds *I*.

Stage 2: The auditor decides if he enters the audit market. If he decides to enter the audit market, he will choose appropriate amount of education; if not, the game ends.

Stage 3: The investor demands for an audit on the project and decides if he will contribute capital to the projects based on the auditor's opinion.

Stage 4: If the auditor enters the market, he issues report on the project and receives audit fee φ. Under an unqualified report $\hat{S}$, the investor will contribute funds. In case of a qualified report $\hat{F}$, the firm's project will not be conducted, and the game also ends.

Stage 5: The result of the project is realized based on the state of nature. The investor will get return $R(I)$ and the auditor is not liable under state of nature "success". Otherwise, the investor will sue the auditor for damage payment.

3.1.4 The relationship among audit fee, education, and investment

Without auditing, the expected value of the project of the firm to the investor is:

$$s \cdot R(I) - I. \tag{1}$$

If the investor can ask an auditor for opinion on the state of nature in the future, he will contribute his funds to the project only when the auditor issues an unqualified report. Once the auditor finds evidence suggesting state of nature "success," the investor will definitely contribute funds to the project, so the probability of investment conditional on "success" is s. On the other hand, the investor will invest at the state of "failure" only when he receives an unqualified report; consequently, the probability conditional on "failure" is $(1-s)[1-q(e,H)]$. Hence, the probability of investment is the sum of two

conditional probabilities: $s+(1-s)[1-q(e,H)]$. Therefore, the expected value of the project to the investor with presence of auditing will be assessed as follows:

$$s \cdot R(I) + (1-s)[1-q(e,H)] \cdot \Lambda - \{s + (1-s)[1-q(e,H)]\} \cdot I. \quad (2)$$

Subtracting audit fee and equation (1) from (2) will yield *NB*, the net benefit of audit:

$$NB = (1-s) \cdot q(e,H) \cdot I + (1-s)[1-q(e,H)] \cdot \Lambda - \varphi.$$

Thus, the audit fee can be rewritten as a function of *H* and *I* as follows:

$$\varphi(H,I) = (1-s) \cdot q(e,H) \cdot I + (1-s)[1-q(e,H)] \cdot \Lambda - NB. \quad (3)$$

Differentiating φ with respect to *H* and *I* will yield the following:

$$\begin{aligned} \varphi_H(H,I) &= (1-s) \cdot q_H(e,H) \cdot I - q_H(e,H)(1-s) \cdot \Lambda \\ &= (1-s) \cdot q_H(e,H) \cdot (I-\Lambda), \\ \varphi_{HH}(H,I) &= (1-s) \cdot q_{HH}(e,H) \cdot (I-\Lambda), \\ \varphi_I(H,I) &= (1-s) \cdot q(e,H) + (1-s)[1-q(e,H)] \cdot \frac{d\Lambda}{dI}. \end{aligned} \quad (4)$$

If *D* is set to be no more than *I*, since the auditor's expected liability, Λ, is calculated as *pD*, it will not exceed *I* because *p* is the probability of being convicted with support [0,1]. Thus $\varphi_H(H, I)$ will be strictly larger than zero and $\varphi_H(H, I)$ will be strictly positive with the assumption of positive $q_H(e, H)$. However, if *D* is set to be more than *I*,[8] on the contrary, it is possible that $\varphi_H(H, I)$ may become weakly negative. It is also intuitive that $d\Lambda/dI$ will be positive, for it is potential that the auditor will have to afford higher

[8] For instance, the damage payment is equal to the profit of other potential investment opportunities forfeited, which may be larger than the initial payout of investment.

damage payment in case of an inappropriate audit opinion as the initial level of investment is higher; thus, $\varphi_I(H, I)>0$.

The auditor's purpose to choose a suitable level education is that in addition to sharpening his profession, under competitive market, education level can be well observed by the investor, who believes that higher audit quality can be induced by higher level of education, so the audit report issued by the auditor with higher level of education is more reliable.[9] The auditor also expects his cost spent on education can be recovered from higher audit fees because the investor perceives higher quality from the auditor's higher education so that the investor is willing to compensate the auditor with higher fee. In fact in the real world, *ceteris paribus*, with several job applicants in the interview list, the employer usually hires one with higher level of education and pays him more salary.

From the perspective of the investor, in a sense like an employer here, under condition of $\Lambda<I$, he perceives better audit quality with higher level education of the auditor, so he will pay more audit fee. For the auditor considering the entry of the audit market, audit fee is perceived as an weakly increasing function of education level, i.e., $\varphi_H(H, I)>0$. Note that $\varphi_H(H, I)=0$ when Λ is equal to I because the marginal benefit of taking additional education is canceled out by the marginal potential assumption of legal

[9] For detailed discussion on signaling in job market, see Spence (1973).

liability as I increases. Yet if the damage payout is larger than I, the auditor may think that it is not worthwhile taking additional education because of higher potential liability beyond his ability to afford. Therefore the marginal effect of education on the audit fee will be negative once the damage payout, D, is large enough to make Λ higher than I.

Interestingly, in order to prevent the auditor from taking unlimited level of education to increase audit fee, there is a self-built mechanism of weakly diminishing marginal increase on audit fee of education, as Λ falls within the support of $[0,I]$, i.e., $\varphi_{HH}(H, I)\leq 0$, with the assumption of $q_{HH}(e, H)<0$. On the other hand, there is also similar properties with large enough D which makes Λ higher than I, $\varphi_{HH}(H, I)>0$.

On top of that, as noted, if higher level of investment is involved in the audit case, the auditor will be afraid that in case of an erroneous audit opinion, he may be forced to afford higher damage payments to the investor. Therefore, audit fee is also positively correlated with the level of investment, formally, $\varphi_I(H, I)>0$.

Observation: (a) Audit fee is a strictly increasing and concave function of education, i.e., $\varphi_H(H, I)>0$, $\varphi_{HH}(H, I)<0$ if the expected liability is smaller than initial investment, i.e., $\Lambda<I$; and

(b) Audit fee is a weakly decreasing and convex function of education, i.e., $\varphi_H(H, I)\leq 0$, $\varphi_{HH}(H, I)\geq 0$ if the expected liability is weakly larger

than initial investment, i.e., $\Lambda \geq I$; and

(c) An increasing function of investment level, i.e., $\varphi_I(H, I) > 0$.

3.2 The socially optimal equilibrium

To derive the most socially efficient equilibrium, this study adopts traditional analysis of social welfare. As in convention, it is assumed that social utility can be seen as the sum of utility of representative players in the model. The social welfare function $\Omega(e, I, H)$ is the aggregation of the auditor's and the investor's utilities, which can be expressed as:

$$\begin{aligned}\Omega(e,I,H) = &[\Pr(\hat{S} \mid e,H) \cdot \Pr(S \mid \hat{S},e,H) \cdot R(I) - \Pr(\hat{S} \mid e,H) \cdot I + \Pr(F \mid \hat{S},e,H) \cdot \Lambda - \varphi(H,I)] \\ &+[\varphi(H,I) - C(e) - \Pr(F \mid \hat{S},e,H) \cdot \Lambda - K(H)].\end{aligned} \tag{5}$$

The first bracket represents the shareholder's utility, while the second one depicts the auditor's. The shareholder will invest I if he receives an unqualified audit report from the auditor and receive return from investment $R(I)$ under the state of nature "success" (S). If the state of nature, on the other hand, is "failure" (F), the shareholder will not be paid off by $R(I)$, instead by Λ, the auditor's expected liability given an unqualified audit report and state of nature "failure." Note that the auditor is not liable in case that he issues a qualified audit report. Finally, the client will have to pay audit fee $\varphi(H,I)$, which is also afforded by the shareholder, to the auditor under the assumption of competitive

audit market.[10]

The auditor's utility is denoted in the second bracket: He receives audit fees from the client and incurs audit effort costs and education cost, finally minus the expected legal liability to the investor under the circumstance of audit failure. Note that the audit fee and expected auditor legal liability are canceled out because they are merely transfer payments between the client and the auditor.

By rearranging equation (1) and substituting $s+(1-s)[1-q(e,H)]$ for the probability of investment, the social welfare function can be further decomposed as follows:

$$\begin{aligned}\Omega(e,I,H) &= \Pr(\hat{S}\mid e,H)\cdot\Pr(S\mid\hat{S},e,H)\cdot R(I)-\Pr(\hat{S}\mid e,H)\cdot I-C(e)-K(H)\\ &= \Pr(S)\cdot R(I)-[\Pr(\hat{S}\mid S,e,H)\Pr(S)+\Pr(\hat{S}\mid F,e,H)\Pr(F)]\cdot I-C(e)-K(H)\\ &= sR(I)-\{s+(1-s)[1-q(e,H)]\}\cdot I-C(e)-K(H).\end{aligned} \tag{6}$$

The socially optimal combination of investment, audit effort, and education which maximizes social welfare function is characterized by the following:

$$\Rightarrow (I^*,e^*,H^*):\begin{cases} R'(I^*)=1+\dfrac{(1-s)[1-q(e^*,H^*)]}{s} \\ C'(e^*)=(1-s)q_e(e^*,H^*)\cdot I^* \\ K'(H^*)=(1-s)q_H(e^*,H^*)\cdot I^*. \end{cases} \tag{7}$$

<u>*Lemma 1*</u>: (I^*, e^*, H^*) that solves the above differential equations is the unique

[10] See other examples in and Lee et al. (1999).

combination of investment, audit effort, and education, which will maximize the social welfare.

Social optimum is the most efficient status in which social welfare is the maximum that can be achieved as if there were an omniscient social planner able to decide everything in this model. This optimal combination of investment, audit effort, and education level is used as a benchmark to compare with the subsequent results under different current legal regimes not considering the effect of education to examine their efficiency in the following sections: vague negligence rule in section 4.1 and strict liability rule in section 4.2.

4. Equilibriums under Different Legal Regimes

4.1 Vague negligence rule

In last section, socially optimal equilibrium is examined. The hypothetical social planner allocates resources most efficiently so that social welfare is maximized. However, the auditor and the investor decide their own strategies from their own instead of the society's perspective. Therefore, the auditor and the investor's strategies are examined in this section too see whether the equilibrium under current legal regime will deviate from social optimum.

In fact, their strategies will be influenced by the way the legal regime is designed: either by the probability the court will convict the auditor, or by how the damage payment is measured. For simplicity, this study assumes the auditor should bear unlimited liability and cannot incorporate their wealth at risk (Dye 1995).

In this section, following Schwartz (1998), the term "vague negligence" is used to depict the legal regime under which the auditor will be accused when the court judges that the effort exerted by the auditor is below the standard level, which is not specified. In this way, the expected liability can be expressed by the probability that the auditor is accused of rendering insufficient care multiplied by the damage payment. Formally,

$$\Lambda = \Lambda_c(I,e) \quad {}^{11}$$
$$= \Pr(e < \rho) \cdot I.$$

$\Lambda_c(I, e)$ is the expected auditor liability under current legal regime of vague negligence and depends on the volume of investment and the effort exerted. In fact, the probability $\Pr(e<\rho)$, with $0<\Pr(e<\rho)<1$, $d\Pr(e<\rho)/de<0$, describes the mechanism of convicting the auditor: If actual effort exerted is claimed less than an unspecified standard level ρ, which cannot be observed both by the auditor and by the investor, then the auditor will be liable for the investor's damage. On the other hand, once the court decides that effort exerted exceeds required unspecified due care, despite an audit failure the auditor will not be responsible for the investor's damage. Therefore, the expected auditor liability under vague negligence legal regime is the probability that the auditor is judged liable multiplied by the damages payment, the initial investment, I.

4.1.1 The auditor's strategy

The auditor chooses his optimal audit effort and education level to maximize his expected profit, π, from the audit *before* entering the audit market:

$$\max_{\{H\}} \pi = \varphi(H,I) - C(e) - (1-s)[1-q(e,H)]\Pr(e<\rho)\cdot I - K(H). \tag{8}$$

The first-order condition for education is:

$$K'(H_{\Lambda_c}) = \varphi_H(H_{\Lambda_c}, I) + (1-s)\cdot q_H(e, H_{\Lambda_c})\cdot \Pr(e<\rho)\cdot I. \tag{9}$$

[11] In this case, $p=\Pr(e<\rho)$, $D=I$

The right-hand side of the equation (9) states the marginal benefit of education, which is equal to the sum of the incremental of audit fee as education level is marginally higher and the marginal decrease of expected liability due to marginally higher audit quality;[12] whereas the left-hand side of the equation (9) is the marginal cost of taking additional unit of education. The equilibrium level of education will balance the expected marginal cost and the marginal benefit before entering the audit market for the auditor. Note that only when π is larger than zero, the normalized reservation utility, the auditor will decide to take part in audit cases.

Substituting the results in equation (4) into (9) will yield:

$$\begin{aligned} K'(H_{\Lambda_c}) &= (1-s)\cdot q_H(e,H_{\Lambda_c})\cdot(I-\Pr(e<\rho)\cdot I)+(1-s)\cdot q_H(e,H_{\Lambda_c})\cdot\Pr(e<\rho)\cdot I \\ &= (1-s)\cdot q_H(e,H_{\Lambda_c})\cdot I. \end{aligned} \tag{10}$$

If π is larger than zero, the auditor is now in the audit market. Subsequently his next problem is to maximize the expected profit from the engagement, Π:[13]

$$\max_{\{e\}} \Pi = \varphi(H_{\Lambda_c}, I) - C(e) - (1-s)[1-q(e,H_{\Lambda_c})]\Pr(e<\rho)\cdot I. \tag{11}$$

Note that $K(H)$ disappears in equation (11) because at the point when the auditor is in the market, $K(H)$ becomes suck cost and not relevant anymore. Thereafter the first-order condition for audit effort is:

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[12] $\because q_H(e,H)>0,\ \therefore (1-s)\cdot q_H(e,H)\cdot\Pr(e<\rho)\cdot I>0$

[13] Don't confuse Π with π. Capital letter Π refers to the expected benefit from accepting client *after* entering the market, whereas π is the auditor's expected benefit of entering the market.

$$C'(e_{\Lambda_c}) = (1-s)[q_e(e_{\Lambda_c}, H_{\Lambda_c}) \Pr(e_{\Lambda_c} < \rho) + q(e_{\Lambda_c}, H_{\Lambda_c}) \Pr'(e_{\Lambda_c} < \rho) - \Pr'(e_{\Lambda_c} < \rho)]I. \quad (12)$$

Obviously, the auditor takes the probability of being liable into consideration when he decides audit effort, and education level. As Schwartz (1997) has noted, the expected auditor liability plays a role of double-edged sword in the process of determining the audit effort level. On one hand, if more effort is exerted, then the probability can be lowed so that it is less likely to be convicted by the court. On the other hand, the vague negligence legal regime has a defect that there exists a possibility for every audit effort level that the auditor may escape from the damage payment because he will be judged innocent. To sum up, the final effect of vague negligence rules on the education is ambiguous without further information on the function form of relevant variables.

As to the education, compare the first-order condition under vague negligence liability rule and that under social optimality, It is obvious that as long as the auditor exerts efficient level of effort and the investor contributes the socially optimal level of investment, socially efficient level of education will be taken since equation (10) is equivalent to the first-order condition in equation (7). Yet one can realize that the equilibrium education under vague negligence legal regime never coincides with that under social optimality, and it will be also excessive because of excessive audit effort rendered by the auditor.

4.1.2 The investor's strategy

Since the investor will not contribute any capital under a report $\hat{F}$, the expected return given a report $\hat{F}$ is zero. When the investor receives a report $\hat{S}$ from the auditor, he tries to maximize his expected return from the investment project, denoted by *ER*, by choosing a suitable investment level:

$$\begin{aligned}\max_{\{I\}} ER &= \Pr(S|\hat{S},e,H)\cdot R(I) + \Pr(F|\hat{S},e,H)\cdot \Pr(e<\rho)\cdot I - \Pr(\hat{S}|e,H)\cdot I - \varphi(H,I) \\ &= \frac{s}{s+(1-s)[1-q(e,H)]}\cdot R(I) + \frac{(1-s)[1-q(e,H)]}{s+(1-s)[1-q(e,H)]}\cdot \Pr(e<\rho)\cdot I \\ &\quad -\{s+(1-s)[1-q(e,H)]\}\cdot I - \varphi(H,I). \end{aligned} \tag{13}$$

That is, if the realization of the state of nature is *S*, the investor can get positive net return from the project; otherwise, it is probable that he may receive damage payment from the auditor for audit failure, yet not definitely.

The first-order condition for the investment is:

$$\begin{aligned}R'(I_{\Lambda_c}) = &\frac{\{s+(1-s)[1-q(e,H)]\}\cdot \varphi_I(H,I_{\Lambda_c}) + \{s+(1-s)[1-q(e,H)]\}^2}{s} \\ &- \frac{(1-s)[1-q(e,H)]\cdot \Pr(e<\rho)}{s}\end{aligned} \tag{14}$$

Substituting equation (4) into (14) will give:

$$\begin{aligned}R'(I_{\Lambda_c}) &= 1 + \frac{(1-s)[1-q(e,H)] + \Pr(e<\rho)\left[(1-s)^2[1-q(e,H)]^2 - (1-s)^2[1-q(e,H)]\right]}{s} \\ &= 1 + \frac{(1-s)[1-q(e,H)] + \Pr(e<\rho)(1-s)^2[1-q(e,H)][1-q(e,H)-1]}{s} \\ &= 1 + \frac{(1-s)[1-q(e,H)] - q(e,H)\cdot(1-s)^2[1-q(e,H)]\cdot \Pr(e<\rho)}{s}. \end{aligned} \tag{15}$$

Compared with the social optimal investment level, it can be seen that $R'(I_{\Lambda_c})$ also incorporates $\varphi_I(H,I_{\Lambda_c})$ and $\Pr(e_{\Lambda_c}<\rho)$, both of which make the equilibrium level of investment under vague negligence liability rule deviate from socially optimal one. There are two underlying reasons: One is that vague negligence legal regime in reality provides fractional insurance to recover their loss, so risks that should be borne by the investor are partially shifted to the auditor, as a result of over investment. The other is that the auditor is afraid of potentially higher liability as the project demands for more investment so that he asks for higher audit fee as compensation for bearing higher litigation risk. Since $q(E,H)(1-s)^2[1-q(H,I)]\Pr(e_{\Lambda_c}<\rho)>0$, $R'(I)>0$, and $R''(I)<0$, the equilibrium investment under vague negligence liability rule is larger than socially optimal level, which implies that the influence of the first effect risk shifting dominates that of the second effect of higher audit fee requested by the auditor that will reduce the level of investment. Hence, the education taken by the auditor exceeds socially desirable amount as well.

The results are summarized in Proposition 1:

Proposition 1: (a) The equilibrium combination of accounting education and investment will exceed the social optimality.

(b) The audit effort exerted will deviate from the social optimum, but its direction is ambiguous.

4.2 Strict liability rule with damage measure depending on investment

Strict liability rule is often deemed as an alternative legal regime besides vague negligence rule. Originally it is applied in the field of product liability, yet nowadays some think that audit report is a joint product by the auditor and the client, so its application in auditor liability cases starts. Under such legal regime, the auditor has to be liable for the damages incurred by the investor when an audit failure happens. Formally, it can be described as:

$$\begin{aligned}\Lambda &= \Lambda_s(I,e) \\ &= I.\end{aligned}$$ [14]

4.2.1 The auditor's strategy

As discussed in 4.1.1, *before* entering the audit market, the auditor maximizes his expected utility from taking participation in audit market by choosing proper level of education. If the auditor falsely issues the report $\hat{S}$ in case of realization of state of nature "failure", this time he has to afford all the investor's damage, I. Therefore,

$$\max_{\{H\}} \varphi(H,I) - C(e) - (1-s)\cdot[1-q(e,H)]\cdot I - K(H). \tag{16}$$

The first-order conditions are the following:

$$K'(H_{\Lambda_s}) = \varphi_H(H_{\Lambda_s}, I) + (1-s)\cdot q_H(e_{\Lambda_s}, H_{\Lambda_s})\cdot I$$

Note that in the observation in section 3.1.4, the marginal increase in audit fee with

[14] In the strict liability rule with damage measure depending on investment, $p=1$, $D=$I.

additional level of education is equal to zero when Λ is set to be I, that is, the strict liability rule. Thus the first-order condition for education can be reduced to:

$$K'(H_{\Lambda_s}) = (1-s)\cdot q_H(e_{\Lambda_s}, H_{\Lambda_s})\cdot I \tag{17}$$

Compared with the socially optimal equilibrium combination in equation (7), it is apparent that under strict liability legal regime, except the expected incremental audit fee by marginal level of education, the first-order condition for education is almost equivalent. This implies that strict liability legal regime may induce the auditor to take the most optimal level of education once the levels of effort exerted and investment conducted are efficient as well.

If the auditor expects that utility from entering the audit market is larger than his normalized-to-zero reservation utility, he now determines appropriate effort rendered to maximize expected utility from an audit case. Formally,

$$\max_{\{e\}} \Pi = \varphi(H_{\Lambda_s}, I) - C(e) - (1-s)[1-q(e, H_{\Lambda_s})]\cdot I. \tag{18}$$

The first-order condition for audit effort is:

$$C'(e_{\Lambda_s}) = (1-s)\cdot q_e(e_{\Lambda_s}, H_{\Lambda_s})\cdot I. \tag{19}$$

Equation (17) also looks just the same as the first-order condition for audit effort under social optimality. Similar to the results in Schwartz (1997), it is guaranteed that

the auditor will definitely render socially optimal level of effort and take efficient level of education, as long as the level of investment can reach social optimality. The results are presented in Lemma 2.

Lemma 2: (a) Under strict liability rule, the auditor takes socially optimal level of education;

(b) The auditor will exert socially desired effort, if the investment level is also socially desired; and

(c) Both effort rendered and education taken will exceed socially desired level if the investment also exceeds social desirable level.

4.2.2 The investor's strategy

As noted previously, under strict liability legal regime, the audit is required to bear certain amount of damages, which is set the initial amount of investment here, incurred by the investor, once improper opinion is issued. Firstly the damage measure of initial investment is investigated. The investor faces no uncertainty under such damage measure because when state of nature is realized as "success", he can receive return $R(I)$, and at state of nature "failure" the auditor will cover all the damages, I, for the investor. Therefore the investor retrieves initial funds I back, with no losses incurred at all. Formally, the investor still tries to maximize expected return from the project:

$$\max_{\{I\}} ER = \frac{s}{s+(1-s)[1-q(e,H)]} \cdot R(I) + \frac{(1-s)[1-q(e,H)]}{s+(1-s)[1-q(e,H)]} \cdot I - \{s+(1-s)[1-q(e,H)]\} \cdot I - \varphi(H,I), \tag{20}$$

and the first-order condition for investment is as follows:

$$R'(I_{\Lambda_s}) = \frac{(1-s)[1-q(e,H)]}{s} + \frac{\{s+(1-s)[1-q(e,H)]\}^2}{s} + \frac{\{s+(1-s)[1-q(e,H)]\} \cdot \varphi_I(H, I_{\Lambda_s})}{s}.$$

Again, using the observation in 3.1.4, the first-order condition can be reduced to:

$$R'(I_{\Lambda_s}) = 1 + \frac{(1-s) \cdot [1-q(e,H)][1-q(e,H)+s \cdot q(e,H)]}{s}. \tag{21}$$

There are two effects of opposite directions on the level of investment: One is the result in Schwartz (1997) that all the risks under state of nature "failure" are shifted to the auditor, so the shareholder will overly invest in the firm's project, resulting in overinvestment. Even though the investor faces no uncertainty of losses from the project, unlike the investor in Schwartz (1997), he does not maximize expected net return from investment as if the realization of state of nature would be "success" undoubtedly as long as he receives a report $\hat{S}$ from the auditor. This is because of another distorting effect of marginal audit fee, which is not considered by the investor in her model. Since the auditor expects stricter penalty, he will charge more audit fee as compensation for bearing additional risks from the investor. Yet this effect of audit fee is still dominated by the benefit that the investor expects to transfer all the risks, so the level of investment

exceeds social optimum in strict liability rule. The results are presented in Proposition 2.

Proposition 2: Under strict liability rule with damage measure of initial amount of investment, overinvestment will always occur, despite any level of audit effort exerted and education taken by the auditor, i.e., $I_{\Lambda_s} > I^*$, $\forall e, H$.

In summary, Lemma 2 implies that the strict liability rule dominates vague negligence liability rule because the former can possibly induce socially efficient effort exerted and education taken, whereas all the variables deviate from social optimality from the beginning. However, as summarized in Proposition 2, since investment is overly undertaken, audit effort will be excessively rendered and education will also be excessively taken by the auditor.

5. Conclusions

5.1 Summary for findings in the model

The purpose of this study is to examine the effect of accounting education on the audit market and the level of investment under different legal regimes. First, there exists association between audit fee and accounting education. If the damage payout is set under the initial capital contribution by the investor, audit fee will be weakly increasing as the auditor receives more education. This is because the auditor expects higher audit fee from the client because the client perceives higher level of education as better audit quality. On the other hand, this association will be reversed conditionally on sufficiently large damage payout that makes expected liability exceed the initial investment. This is because taking additional education makes the auditor assume more potential liability. Such unwanted risk dominates the marginal benefit of the increase in audit effort, so the auditor will take less education even with an increase in audit fee.

Second, under vague negligence liability rule, audit effort exerted, education level, and the investment conducted will deviate from social optimum. Under this regime, it is the unknown probability of being sued that causes deviation. For audit effort, this probability makes him exert more effort to avoid being convicted, yet it also makes him render less effort because he may not be liable once the judge determines that the effort auditor renders surpass an unspecified level.

As to investment level, the effect of shifting risks from the investor to the auditor, which will increase investment, dominates the effect of higher audit fee resulting from potential damage payment from the auditor, which will decrease investment; therefore, the final net effect causes the level of investment under vague negligence rule upwardly biased from optimality. With the problem of overinvestment, the auditor also takes excessive amount of accounting education. In sum, social optimum is totally prevented under vague negligence liability rule.

Finally, under strict liability rule, there are chances that the effort rendered and the education taken may reach socially desirable level. However as presented in Proposition 2, with overinvestment under this regime, the equilibrium effort rendered and education taken will surpass social optimum. Overinvestment is caused on the grounds that the investor expects a sure damage payment when the state of nature “failure” realizes, which dominates the effect of higher audit fee as compensation asked from the auditor.

It is urged that the strict liability rule instead of vague negligence liability rule should be adopted because the equilibrium under this regime is very close to social optimality and it only needs some modifications to elicit social optimum. Also, the marginal effect of audit fee induced by accounting education should not be neglected, for that it causes distortion. The conclusions should be taken into consideration by the law maker when the regulations have to be modified next time.

5.2 Suggestions for further researches

This study only does not consider auditor's reputation and integrity. One may extend this model by letting the auditor decide which type, good or bad, he wants to be. Also, researchers can add cost of searching auditors into the model and extend the game into infinite periods like in Kiyotaki and Wright (1993) and let the auditors change their type freely in each period. This is an interesting extension because it results in dynamic flows within the auditors.

Another extension is to allow the entrepreneur to partially invest in his own project since in this model the firm owner is assumed to raise capital completely from outsiders. As in Leland and Pyle (1977), it is possible for the entrepreneur to signal better quality of investment project by self-investing more shares in the project. It will be interesting to add the reaction of the entrepreneur into the model.

Appendix A: Summary for Notations

States of Nature and Audit Reports	
F	State of nature "failure"
S	State of nature "success"
s	Probability of realization of state of nature "success"
$\hat{F}$	Qualified audit opinion (Failure opinion)
$\hat{S}$	Unqualified audit opinion (Success opinion)
The Investor and the Project	
I	Initial volume of investment
$R(I)$	Return from investment project
ER	Investor's expected return from the investment project
The Auditor, Audit Cost, and Education	
e	Audit effort exerted
$\underline{e}$	Minimum audit effort required to make audit quality bigger than 1
$C(e)$	Cost function of audit effort
H	Education volume of accountants
$K(H)$	Cost function of education
$q(e, H)$	Audit quality
$\varphi(I, H)$	Audit fee
π	Auditor's expected benefit from entering the audit market
Π	Auditor's expected benefit from engaging audit case
Legal Regime	
Λ	Auditor's expected liability given an audit failure
p	Probability that the auditor will be found liable
D	Damage payment by the auditor to the investor
Λ_c	Auditor's expected liability under vague negligence rule
ρ	Unspecified required effort rendered under vague negligence rule
Λ_s	Auditor's expected liability under strict liability rule
Others	
$\Omega(e, I, H)$	Social welfare function
NB	Net benefit of audit

Appendix B: Proofs

Proof of Lemma 1

As in expression (3), the first-order conditions for social optimality are:

$$\Rightarrow (I^*, e^*, H^*): \begin{cases} R'(I^*) = 1 + \dfrac{(1-s)[1-q(e^*, H^*)]}{s} \\ C'(e^*) = (1-s) q_e(e^*, H^*) \cdot I^* \\ K'(H^*) = (1-s) q_H(e^*, H^*) \cdot I^*. \end{cases}$$

(a) Partially differentiating the first-order condition of I^* with respect to e and H will yield:

$$R''(I^*) \cdot \frac{\partial I^*}{\partial e} = \frac{(1-s)[-q_e(e,H)]}{s},$$
$$R''(I^*) \cdot \frac{\partial I^*}{\partial H} = \frac{(1-s)[-q_H(e,H)]}{s}.$$

Therefore,

$$\frac{\partial I^*}{\partial e} = \frac{(1-s)[-q_e(e,H)]}{s \cdot R''(I^*)} \Rightarrow \frac{\partial^2 I^*}{\partial e^2} = \frac{(1-s)[-q_{ee}(e,H)]}{s \cdot R''(I^*)};$$
$$\frac{\partial I^*}{\partial H} = \frac{(1-s)[-q_H(e,H)]}{s \cdot R''(I^*)} \Rightarrow \frac{\partial^2 I^*}{\partial H^2} = \frac{(1-s)[-q_{HH}(e,H)]}{s \cdot R''(I^*)}.$$

Since $q_{ee}(e,H)<0$, $q_{HH}(e,H)<0$, $R''(I)<0$, and $1-s>0$, it is concluded that

$$\frac{\partial I^*}{\partial e} > 0, \frac{\partial^2 I^*}{\partial e^2} < 0; \frac{\partial I^*}{\partial H} > 0, \frac{\partial^2 I^*}{\partial H^2} < 0.$$

This shows that I^* is a monotonic increasing and concave function of both e and H.

(b) Partially differentiating the first-order conditions of e^* with respect to I will yield:

$$C''(e^*) \cdot \frac{de^*}{dI} = (1-s) q_{ee}(e^*, H) \cdot \frac{de^*}{dI} \cdot I + (1-s) q_e(e^*, H).$$

Therefore,

$$\frac{de^*}{dI}=\frac{(1-s)\cdot q_e(e^*,H)}{C''(e^*)-(1-s)q_{ee}(e^*,H)\cdot I},\ \frac{d^2e^*}{dI^2}=\frac{(1-s)^2\cdot q_e(e^*,H)\cdot q_{ee}(e^*,H)}{\left[C''(e^*)-(1-s)q_{ee}(e^*,H)\cdot I\right]^2}.$$

Given assumptions of $q_e(e,H)>0$, $q_{ee}(e,H)<0$, $C'(e)>0$, and $1-s>0$, the following conclusions can also be made:

$$\frac{de^*}{dI}>0,\frac{d^2e^*}{dI^2}<0.$$

On the similar grounds, with $q_H(e,H)>0$, $q_{HH}(e,H)<0$, $K'(H)>0$, and $1-s>0$

$$\frac{dH^*}{dI}=\frac{(1-s)\cdot q_H(e,H^*)}{K''(H^*)-(1-s)q_{HH}(e,H^*)\cdot I}>0,\ \frac{d^2H^*}{dI^2}=\frac{(1-s)^2\cdot q_H(e,H^*)\cdot q_{HH}(e,H^*)}{\left[C''(e^*)-(1-s)q_{HH}(e,H^*)\cdot I\right]^2}<0.$$

One can see that both e and I are monotonic increasing and concave functions of I. Also, if no investment is made, that is, I=0, there is no need for the auditor to take any education or to exert any effort, i.e., $e(I=0)=H(I=0)=0$.

(c) From (a) and (b), one can see that if a solution combination to (3) exists, it is unique.

Proof of Proposition 1

As in equations (10), (12), and (15) the first-order conditions under vague negligence liability rule are the following:

$$\begin{aligned}K'(H_{\Lambda_c})&=(1-s)\cdot q_H(e,H_{\Lambda_c})\cdot(I-\Pr(e<\rho)\cdot I)+(1-s)\cdot q_H(e,H_{\Lambda_c})\cdot\Pr(e<\rho)\cdot I\\&=(1-s)\cdot q_H(e,H_{\Lambda_c})\cdot I,\end{aligned}$$

$$C'(e_{\Lambda_c})=(1-s)[q_e(e_{\Lambda_c},H_{\Lambda_c})\Pr(e_{\Lambda_c}<\rho)+q(e_{\Lambda_c},H_{\Lambda_c})\Pr'(e_{\Lambda_c}<\rho)-\Pr'(e_{\Lambda_c}<\rho)]I,$$

$$R'(I_{\Lambda_c})=1+\frac{(1-s)[1-q(e,H)]-q(e,H)\cdot(1-s)^2\left[1-q(e,H)\right]\cdot\Pr(e<\rho)}{s}.$$

It is obvious that $q(e,H)(1-s)^2[1-q(e,H)]\Pr(e<\rho)$ in the second term of the first-order

condition for investment is positive; therefore, $R'(I_{\Lambda_c})$ is smaller than $R'(I^*)$. With the assumptions that return is a increasing and concave function of investment, i.e., $R'(I)>0$, $R''(I)<0$, one can conclude that the equilibrium level of investment is in excess of that in socially optimal condition. Additionally, since the first-order condition for education under vague negligence liability rule corresponds to equation (7), with overinvestment present, the level of education will be also too much.

Proof of Lemma 2

(a) From expression (17) and (19), the first-order conditions for education and audit effort are identical to the equation (4). Therefore, under strict liability measure, the equilibrium combination of audit effort and education is exactly socially desirable.

(b) Differentiating H in equation (17) e in and (19) with respect to I will establish:

$$K''(H)\cdot\frac{dH_{\Lambda_s}}{dI}=(1-s)\cdot q_{HH}(e,H)\cdot\frac{dH_{\Lambda_s}}{dI}\cdot I+(1-s)\cdot q_H(e,H),$$
$$\frac{dH_{\Lambda_s}}{dI}=\frac{(1-s)\cdot q_H(e,H)}{K''(H)-q_{HH}(e,H)(1-s)\cdot I};$$

and

$$C''(e)\cdot\frac{de_{\Lambda_s}}{dI}=(1-s)\cdot q_{ee}(e,H)\cdot\frac{de_{\Lambda_s}}{dI}\cdot I+(1-s)\cdot q_e(e,H),$$
$$\frac{de_{\Lambda_s}}{dI}=\frac{(1-s)\cdot q_e(e,H)}{C''(e)-q_{ee}(e,H)(1-s)\cdot I}.$$

From proof of Lemma 1, one can see:

$$\frac{dH_{\Lambda_s}}{dI} = \frac{(1-s)\cdot q_H(e,H)}{K''(H) - q_{HH}(e,H)(1-s)\cdot I} > 0,$$
$$\frac{de_{\Lambda_s}}{dI} = \frac{(1-s)\cdot q_e(e,H)}{C''(e) - q_{ee}(e,H)(1-s)\cdot I} > 0.$$

Therefore, under strict liability rule, if the level of investment exceeds socially desired level, audit effort and education level will also be excessive, since both e_{Λ_s} and H_{Λ_s} are increasing function of *I*.

Proof of Proposition 2

From equation (21), the first-order condition for investment under strict liability rule is:

$$\begin{aligned} R'(I_{\Lambda_s}) &= 1 + \frac{s(1-s)\left[1-q(e,H)\right] - (1-s)^2\left[1-q(e,H)\right]^2}{s} \\ &= 1 + \frac{(1-s)\left[1-q(e,H)\right]\left\{s + (1-s)\left[1-q(e,H)\right]\right\}}{s} \\ &= 1 + \frac{(1-s)\left[1-q(e,H)\right]\left[1-q(e,H) + s\cdot q(e,H)\right]}{s}. \end{aligned}$$

Since $1+sq(e,H)-q(e,H)$ are smaller than one, the second term of $R'(I_{\Lambda_s})$ to be less than $\frac{(1-s)\left[1-q(e,H)\right]}{s}$. Therefore, one can see that

$$R'(I_{\Lambda_s}) < R'(I^*). \qquad \text{(p.1)}$$

With the assumption of diminishing return from investment, $R''(I)<0$, one can conclude the level of investment under strict liability rule is always larger socially desired level, for any effort exerted and education taken:

$$I_{\Lambda_s} > I^*. \qquad \text{(p.2)}$$

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