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The association between auditor quality and human capital

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Abstract

Purpose – Following the high profile collapses of Enron and WorldCom, and the demise of Andersen, human capital (HC) has become a key driver of auditor quality. The purpose of this study is to investigate if there is a positive association between HC and auditor quality in public accounting firms and if the extent of association varies between accounting firms.

Design/methodology/approach – Multiple regression and logistic modeling are applied to examine the association between auditor quality and HC. The sample consists of 4,865 firm-year observations over the period from 1989 to 2004.

Findings – The main findings indicate that higher investments in HC correspond to a higher level of auditor quality. Furthermore, the power of HC on auditor quality has a significant difference between public and non-public audit market firms.

Research limitations/implications – A number of theoretical and measurement limitations are acknowledged that could further increase the statistical power of the tests.

Practical implications – The findings should be of interest to regulators, auditors, audit clients, and academics. The findings also suggest that HC has an impact on overall auditor quality. The audit firms need more well-educated and well-trained professionals with the experience to keep pace with the changing nature of the market and to perform audit tasks.

Originality/value – The findings fill a gap in the literature regarding auditor quality and HC from the perspective of public accounting firms.

Keywords Human capital, Auditors, Public sector accounting, Taiwan

Paper type Research paper

Introduction

Human capital (HC) is the most important asset of public accounting firms. Public accounting firms must make sure they have enough personnel equipped with the required competencies and professional characteristics so that they may perform in accordance with the standards, legal requirements and expectations of the public. To address these expectations, accounting firms should establish a well-planned human resource management process.

When Enron, WorldCom, and Andersen collapsed, the Sarbanes-Oxley Act (SOX) 2002 was passed into law. This led to the formation of the Public Company Accounting Oversight Board (PCAOB), which pays attention to the oversight of quality control of

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each firm. Specifically, PCAOB inspections perform the following tasks: evaluation of the quality of auditing works on specific audits and review of auditors' practices, policies, and procedures related to audit quality. The PCAOB review focuses on the assessment of professional competency of partners, compensation, assignments of responsibility, personnel training programs, compliance with independence standards, client acceptance and retention, and the establishment of policies and procedures. Implied in these PCAOB inspections is the fact that the accounting firm's human resources management is an important determinant of audit quality (PCAOB Standing Advisory Group (SAG), 2004).

In November 2006, the Financial Reporting Council (FRC), United Kingdom's independent regulator for corporate reporting and governance, issued a discussion paper, "Promoting audit quality". The FRC argues that the skills, personal qualities of audit partners and staff, and the training given to audit personnel, are important factors that determine auditor quality. A public accounting firm is a professional service organization, which one would expect would have a high regard for good human resource management. Such a practice would aim to enhance employees' expertise and competency, and in turn, improve auditor quality. Consistent with these arguments, Meinhardt *et al.* (1987), Westort (1990), Aldhizer *et al.* (1995) and Liu (1997) point out that investments in HC – educational attainment of auditors, their work experience, professional certification, and continuing professional development (CPD) – can enhance auditor quality. In the light of recent developments, regulators, academic researchers, and the popular press have observed the importance of auditors' human recourses management on auditor quality (FRC, 2006; SAG, 2004). Arguably, the public has increasingly transferred its concern about auditor quality from audited clients to public accounting firms. This tendency provides the motivation to investigate auditor quality directly within public accounting firms.

This study aims to provide a refined analysis of the association between auditor quality and HC. Specifically, we seek to answer the following questions:

(1) Does investment in HC have an influence on auditor quality?

(2) Does the extent of association between HC and auditor quality vary among accounting firms?

For question (1), we establish a linear regression model to examine the association between auditor quality and HC. For question (2), we perform a comparison analysis of coefficient for each HC factor between public (PAMF) and non-public audit market firms (NONPAMF). Our analysis focuses on 4,865 firm-year observations over the period of 1989-2004. Empirical data are obtained from the "Survey on the business of public accounting firms" by the Financial Supervisory Commission, Taiwan. The public accounting firms are categorized into PAMF and NONPAMF, in that different public accounting firms provide, to some extent, different services to different clients in different districts (Whittington and Pany, 2003; Arens *et al.*, 2005). The main empirical results indicate that educational attainment, work experience, professional certification, and CPD are found to be positively related to auditor quality. Furthermore, we find that investment in HC relates to a higher level of auditor quality. Finally, this study shows that the HC in PAMF and NONPAMF has a different influence in explaining auditor quality.

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Bridging the gap of auditor quality in previous studies, this study has some unique features. First, most previous studies investigate HC through a questionnaire survey, but we test it by using data from an official database. Therefore, the findings we obtained have higher reliability and reflect better real practice. Second, if accounting firms can attract the best, the brightest, and the best-educated personnel, the auditor workforce should be more proficient auditors over time. This proficiency can help accounting firms enhance auditor quality and reduce the possibility of audit failure. Moreover, if accounting firms can keep their well-experienced personnel, encourage them to obtain professional certification, and provide them with well-planed CPD, then these accounting firms would certainly thrive. Finally, our study supports the observations of Deis and Giroux (1992) that HC is related to auditor quality.

The remainder of the paper is organized as follows. The next section presents a literature review and hypothesis devolvement, followed by our methodology, findings, and conclusion.

Literature review and hypothesis development

Auditor quality

Developing and maintaining auditor quality makes it a continuing issue in the public accounting profession. In fact, many researchers have studied the factors affecting auditor quality (Deis and Giroux, 1992; Colbert and Murray, 1998; Lennox, 1999; Francis, 2004). DeAngelo (1981) defines auditor quality as the joint probability for an auditor to:

- discover the breaches or errors in a client's accounting system; and
- report these breaches.

The auditor may only discover these fallacies depending on his/her expertise; in like manner, he/she can report on such problems if independent from clients. Since larger audit firms have more clients, they possess greater aggregate client-specific quasi-rents at stake if a lack of independence or a lower quality audit becomes known. To avoid losing the other quasi-rents, larger audit firms have greater incentives to provide higher quality audit, which indicates that the size of an audit firm is positively related to auditor quality. Francis and Wilson (1988) and DeFond (1992) suggested that auditor size derived from sales is a good proxy since sales revenues are correlated with quasi-rents. Building on this implication, we choose auditor size, a proxy for client-specific quasi-rents, as the first measure of auditor quality.

Francis and Wilson (1988) developed an alternative brand name approach. According to them, audit firms exert efforts to secure the reputation of a brand name and protect quasi-rents arising from it. Reputable firms will then provide a high quality audit to avoid damaging a brand name and loss of future revenues. As a result, auditor quality is a function of brand name reputation. In line with this view, Francis and Wilson (1988) and DeFond (1992) utilized two-way and three-way brand name approaches, respectively, for measuring their auditor quality dependent variable. Hence, we choose a binary brand name classification as the second measure of auditor quality.

Human capital

HC is a public accounting firm's biggest asset. Based on a resource-based view of firms, the sustained competitive advantage and long-term performance of accounting firms

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are contributed by the core resources (Barney, 1991, 2001), which include physical capital resources, HC resources, organizational resources, and financial capital resources (Bush *et al.*, 1997). The core resource of a public accounting firm is HC.

Following series corporate frauds at Enron and WorldCom, and the downfall of Andersen, Congress passed the SOX Act of 2002, which established the PCAOB to oversee accounting industry and public firms. Aimed at protecting investors by improving the accuracy and reliability of corporate disclosures made pursuant to the securities laws and for other purposes, the PCAOB takes on duties with respect to registration, inspection, investigation, and enforcement of external auditors. The PCAOB inspections include the evaluation of the quality of the audit on a specific audit and the review of the auditor's practices, policies, and procedures related to audit quality. PCAOB also oversees quality control of each audit firm and enhances auditor quality through more effective personal management within the public accounting firm. To achieve this purpose, SAG of PCAOB developed in June 2004 the elements of an audit quality control system. The SAG suggested that human resources management within a firm is a determining factor of auditor quality. The SAG also pointed out that public accounting firms should have sufficient personnel equipped with competencies and characteristics required for them to work based on PCAOB standards and applicable regulatory and legal requirements (SAG, 2004). In addition, the FRC issued in November 2006 a challenging paper entitled, "Promoting audit quality". The paper discusses the various factors in auditor quality, adding that accountants' skills, personal qualities of personnel, and CPD of audit personnel are also key determinants of auditor quality.

In view of this, Liu (1997) observes the role played by HC has relatively been ignored in the analysis of the relationship among legal liability, HC investment, and auditor quality. She further argues that investments in HC, education levels, work experience, and professional certification, should also be considered since they were also major factors.

Deis and Giroux (1992) suggested that education, continuing profession education (CPE), and professionalism may affect auditor quality and O'Keefe and Westort (1992) and Westort (1990) proposed that CPE is related to auditor quality. Boynton *et al.* (2001) suggested auditors with pre-employment formal academic education, CPE and experience accumulated by on-the-job training, are qualified to perform audit tasks. In summary, there are four major HC dimensions related to the auditor quality.

The first dimension concerns the educational attainment of auditors. Within a HC framework, the level of education of personnel augments natural abilities subsequently sold in the labor market. The audit is to be performed by a person or persons with adequate technical training and proficiency as an auditor (SAS No. 1, section 210)[1]. The auditor cannot meet the auditing standards without proper education and experience in the appropriate field. Besides, the level of education, an auditor's subsequent work experience is certainly an added advantage. Auditors who have completed higher academic degrees are assumed to perform better given their knowledge plus their intellectual potential to learn and accumulate skills and expertise.

Since most firms want to avoid staff turnover, employers would like to know how to choose the best employees, who, at the same time, are expected to be productive. Moreover, employers provide on-the-job training to improve productivity. Spence (1974a, b) pointed out that higher quality workers assume their level of education can

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earn them places in firms, which measure their personnel's productiveness by their educational attainment. Consistent with these arguments, Hirshleifer (1973) believed that educational achievements guarantee labor quality, while Stiglitz (1975) considered the role of additional education as a method of reducing the difference between actual productivity and predicted productivity. In line with these views, Meinhardt *et al.* (1987) suggested that the educational attainment of auditors can help improve the quality of governmental audits. Therefore, educational level relates to auditor quality positively and the following hypothesis can be advanced:

H1. There exists a positive association between educational level of auditors and auditor quality.

The second dimension is about work experience of auditors. After completing educational requirements, most professionals enter their careers as assistants in audit firms. They keep on learning and gaining expertise through "learning by doing". In general, the average years of experience for partners, managers, seniors or in-charge auditors, and assistants, are over 10 years, 5-10 years, 2-5 years, and 0-2 years, respectively, (Arens and Loebbecke, 2000, p. 27). Thus, as time passes, auditors build HC in the form of individual skills.

According to Libby and Frederick (1990), more experienced auditors detect a greater number of plausible errors and fewer implausible ones than less experienced auditors do. In addition, as an auditor gains more experience, errors in financial statements get fewer. The atypical prompt will have a greater effect than the typical prompt on the cycle of additional errors made by experienced auditors. Neither prompt will affect the cycle of additional errors by inexperienced auditors. Libby and Frederick's (1990) findings are that work experience can broaden and accumulate an auditor's knowledge base of financial statement errors and techniques of audit. Such knowledge can assure any firm a higher quality audit. In support of these views, Booner and Lewis (1990) pointed out more experienced auditors outperform less experienced auditors on average because many audit tasks are knowledge-based and knowledge can be gained through experience. In conclusion, auditors who are more experienced can assure the firm higher auditor quality. This leads to the following hypothesis:

H2. There exists a positive association between work experience of auditors and auditor quality.

The third dimension pertains to the professional qualification level of auditors. To grow practice, Christopher (2005) suggested that audit firms have to develop staff, and one of the most important steps in their professional growth is passing the certified public accountant (CPA) exam. Helping staff pass the exam is, in essence, an investment in an audit practice. In addition, Aldhizer *et al.* (1995) argued that auditor quality is positively associated with an in-charge who was a CPA. Liu (1997) supported this statement by arguing that besides the educational attainment and work experience of auditors, their qualification level can also affect higher auditor quality. For instance, an auditor cannot be a CPA without passing the licensure examination for CPAs. Furthermore, a CPA license represents professionalism, proficiency, and competence in practice. Presumably, the greater number of assistant auditors with a CPA license, the higher the auditor quality. This leads to the following hypothesis:

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H3. There exists a positive association between professional qualification level of auditors and auditor quality.

The fourth dimension is concerned with CPD, which refers to training, workshops, and similar activities provided by firms to their employees. Chen *et al.* (2008) argued the most cost-effective way to improve auditor's professional competence and skill is through CPD, which is the core of HC in a public accounting firm. In order for firms to perform better and thus yield better income, they should offer their employees opportunities for growth, so they may perform more competently within their professional environments. In order to do this, human resource officers should establish policies and procedures to assure that all new personnel are qualified and can work competently. Nevertheless, such policies may not be enough, which makes the provision of CPD and professional development activities necessary.

The requirements for CPD are similar in most countries. For example, in November 2006, the FRC, the United Kingdom's independent regulator for corporate reporting and governance, issued a discussion paper, *Promoting Audit Quality*, which states that accounting firms have established requirements relating to CPD. Auditors are required to complete a minimum number hours of CPD each year, allowing them to maintain and extend their professional knowledge and skills and keep them up to date with changes and developments. In addition, in UK and Ireland, holders of the Association of Chartered Certified Accountants practising certificate and holder of insolvency licenses are required to complete at least 35 hours' CPD, 21 hours of which must be for structured CPD and the remaining 14 hours for non-structured CPD[2]. In 2005, Government Auditing Standards (GAS) published Guidance on GAS Requirements for CPE. The published guidance states that each auditor performing work under GAS should complete, every two years, at least 80 hours of CPE. Similarly, in 2005, International Education Standard, IES 7, issued by the International Federation of Accountants, required all of its members to commit to some level of structured CPD. Since then, members have been required to complete a minimum average of 40 hours of CPD every year, compared to the previous requirement of 30 hours, of which at least 20 hours was for structured CPD. These reforms are anchored on the assumption that updating auditors' skill and knowledge make them better auditors, especially in today's competitive climate. In other words, CPD can heighten the expertise and competency of auditors, which improves audit quality.

Akin to these implications, Cervero (2001) suggested that CPE is aimed at helping professionals provide higher quality service to clients by enhancing their existing knowledge, skill, and competence. Wallace and Campbell (1988) argued that deficient practice may be associated with relatively low levels of technical training and Aldhizer *et al.* (1995) indicated auditor quality appeared to be positively associated with CPE. Arens *et al.* (2005) indicated continuing education requirements constitute a critical link connected to other ways to encourage auditors to conduct themselves at a high level. Accordingly, as CPD is expected to be positively related to auditor quality, the following hypothesis can be advanced:

H4. There exists a positive association between CPD of auditors and auditor quality.

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H1-H4 were aimed at the association between auditor quality and individual investments in HC. Based on the above literature, we expect that the overall HC in accounting is positively related to auditor quality, leading then to the following hypothesis:

H5. There exists a positive association between overall human capital and auditor quality.

Segmentation

Market segmentation is based on the premise that most organizations cannot serve total populations, forcing them to disaggregate the population into more homogenous sub-groups to which marketing efforts can be targeted (Pitt *et al.*, 1996). Wind and Cardozo (1974) suggested that industrial market segmentation should proceed by first developing macro-segments, and then micro-segments. Segmentation variables in the macro-stage include size of customer, usage, application of product, standard industry classification code, and geography, while variables in micro-stage was primarily based on key decision making unit characteristics. Likewise, Besanko *et al.* (2000, pp. 428-30) explained that in consumer goods markets, segmentation characteristics consist of demographic, and geographical factors. Still, according to Besanko *et al.* (2000), in industrial goods markets, segmentation variables include the size of the purchasing firm, the consumer type the buyer serves, and quality factors. Whatever type of population is defined, buyers within the group have similar product requirements and tastes, and respond to market mix variables, such as price or advertising, in much the same way, whereas consumers across different types have different needs or marketing responses.

Similarly, market segmentation exists to some extent in the public accounting industry. To examine the relationships among auditor size, auditor quality, and firm's performance in different audit market segmentation, we employ client's firm size as a segmentation variable. The accountancy industry can be divided into PAMF and NONPAMF. The (then) Big 6 were included in the former category.

Since the personnel in large audit firms can acquire a greater degree of expertise, technological knowledge of audit and more CPE than those in small audit firms (Westort, 1990; O'Keefe and Westort, 1992), we expect that when the accountancy industry adopts market segmentation, the impact of overall HC on auditor quality in the PAMF is greater than in the NONPAMF. Accordingly, the following hypothesis can be advanced:

H6. Overall, human capital in the PAMF has greater influence than the NONPAMF in explaining auditor quality.

Methodology

Empirical models

To examine the association between auditor quality and HC, we establish the following four empirical models. Of the four models, Models 1 and 3 are used to test *H1-H4*; while Models 2 and 4 are used to test *H5*:

$$\text{QUAL} = b_0 + b_1\text{EDU} + b_2\text{STAF35} + b_3\text{LICENSE} + b_4\text{TRAINING} + e_1, \quad (1)$$

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$$\mathrm{QUAL} = b_0 + b_1\mathrm{HC} + e_2, \tag{2}$$

$$\mathrm{BRAND} = \mathrm{logit}\,(b_0 + b_1\mathrm{EDU} + b_2\mathrm{STAF35} + b_3\mathrm{LICENSE} + b_4\mathrm{TRAINING}) + e_3, \tag{3}$$

$$\mathrm{BRAND} = \mathrm{logit}\,(b_0 + b_1\mathrm{HC}) + e_4,$$

where QUAL, the measure of auditor quality, measured by the natural log of revenues in the audit firms; BRAND, the measure of auditor quality, when audit firms are large assign 1, otherwise 0; EDU, education level of auditors; STAF35, work experience of auditors; LICENSE, professional qualification level of auditors; TRAINING, natural log of expenditures of CPD; HC, the principal components linear combination of the four HC measures; e, error team.

Definitions of variables

Dependent variable. Based on the DeFond (1992) and Francis and Wilson (1988) research design, we employ both the auditor size and the brand name approaches for measuring auditor quality. The former approach defines auditor size as the nature logarithm of revenues of audit firms (QUAL)[3]. Ordinary least squares (OLS) regression is used for models 1 and 2. In the latter approach, we adopt a two-way brand name category, distinguishing the following two groups in expected brand name reputation rank order – large and non-large audit firms (BRAND). In that a dichotomous dependent variable violated OLS regression assumption, binominal logistic regression is used for models 3 and 4.

Independent variables. There are five independent variables in our study. The first variable is education level – or educational attainment – of auditors (EDU), which is defined as the average years to obtain a degree in auditing (or accounting), and then calculated as follows: (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/year-end number of auditors[4].

The second variable is work experience of auditors (STAF35), which is defined as the proportion calculated by number of auditors older than 35 years, divided by the year-end number of practicing CPAs partners. The third variable is professional qualification level of auditors (LICENSE), measured by the number of auditors with a CPA license divided by the year-end number of practising CPAs. The forth variable–CPD (TRAINING) – is defined as the natural logarithm of expenditures of CPD. Lastly, we employ the technique of principal of components analysis to combine the four variables and extract a common factor to capture the overall level of HC.

Sample selection

The empirical data employed in this study are collected from the "Survey on the Business of Public Accounting Firms" undertaken by the Financial Supervisory Commission, Executive Yuan, Taiwan (ROC). The survey has been conducted mandatorily by Ministry of Finance, Executive Yuan, since 1989 and has published the Survey Report annually except in 1991. The content of the survey includes candidate profile, number of personnel, educational background, average age, job ranking,

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job category, years of service, components of revenue, expense and operational assets, difficulty of operation, and future operational strategy. To secure the secrecy of business transactions for public accounting firms, the Ministry of Finance provides no specific information about an individual firm each year. Consequently, we test our hypotheses by using cross sectional data instead of panel data. After eliminating unqualified and incomplete observations for related variables, we arrive at 4,865 firm-year observations for the period of 15 years (1989-2004)[5].

To examine the association between auditor quality and HC in a different segmentation audit market, we utilize client's firm size, measured by whether public accounting firms engage in financial statement audit, as a segmentation variable (Wind and Cardozo, 1974; Besanko *et al.*, 2000). As Figure 1 shows, the accountancy industry is divided into PAMF and NONPAMF.[6] Big 8/6/5/4 firms were included in the former category. The clients of PAMF and NONPAMF firms are listed firms and non-listed firms, respectively.

Table I summarizes the distribution of the samples. As shown in Table I, total observations are of two categories: PAMF and NONPAMF. Firms without enough information to calculate the related variables are excluded. The final sample includes 4,865 firm-year observations over the period of 1989-2004 excluding 1991. Of the 4,865 samples, there are 728 PAMF and 4,137 NONPAMF, respectively.

Empirical results

Descriptive statistics

Panel A of Table II shows descriptive statistics for the 4,865 samples. The average of auditor quality is 30.40 and the median of auditor quality is 15.56. Mean and median education levels of auditors (EDU) are 14.73 and 14.75 years, respectively. Mean number of work experience of auditors (STAF35) is 5.87 employees, while median number of auditors with CPA license per practicing CPA (LICENSE) is 1. As to the mean and median expenditure of CPD (TRAINING), both of them are 10.13.

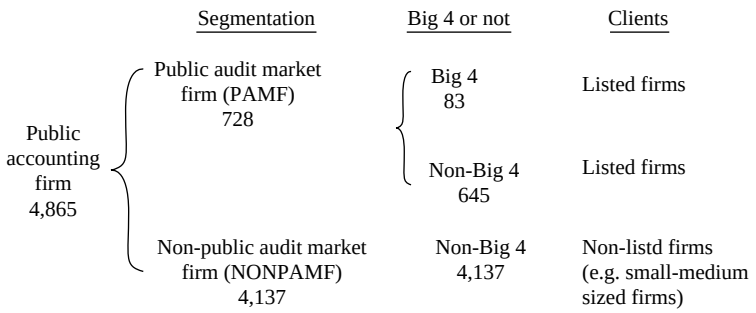

Figure 1.
Sample category

Year	89	90	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
PAMF	33	35	37	40	41	48	57	53	58	52	67	55	55	51	46	728
NONPAMF	116	113	180	221	236	257	346	322	309	337	379	383	356	341	241	4,137
Total	149	148	217	261	277	305	403	375	367	389	446	438	411	392	287	4,865

Table I.
Sample distribution

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Panel A: descriptive statistics (N = 4865)

	Mean	*SD*	*Maximum*	*Median*	*Minimum*
QUAL	15.69	1.31	22.09	15.56	9.41
EDU	14.73	0.87	19.79	14.75	11.20
STAF35	5.87	16.86	370	3	0
LICENSE	1.12	0.45	9	1	1
TRAINING	10.13	1.66	18.29	10.13	2.64

Panel B: correlation matrix (N = 4865)

	QUAL	*BRAND*	*EDU*	*STAF35*	*LICENSE*	TRAINING
QUAL	1					
BRAND	0.56*	1				
EDU	0.21*	0.32*	1			
STAF35	0.63*	0.48*	0.11*	1		
LICENSE	0.37*	0.41*	0.23*	0.29*	1	
TRAINING	0.48*	0.35*	0.15*	0.28*	0.25*	1

Notes: *p values < 0.01; variables definition: QUAL, auditor quality, measured by the natural log of revenues in the audit firms; BRAND, auditor quality. Based on brand name, when audit firms are Large assign 1, otherwise 0; EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9) /(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development; QUAL and TRAINING are deflated by consumer price index of the base year, 1989, and expressed in new Taiwan dollars

Table II.
Descriptive statistics and correlation matrix

Panel B of Table II provides the Spearman rank correlation between dependent and independent variables. As shown, auditor quality measured by either auditor size (QUAL) or brand name (BRAND) is significantly correlated to EDU, STAF35, LICENSE, and TRAINING. The measures of HC are also significantly correlated. Spearman rank correlation coefficients range from 0.11 to 0.29 with p-values smaller than 0.001, which loosely does not indicate the presence of collinearity.

Human capital index

Based on the theory and literature, we select four related indicators – educational attainment (or level of education), experience, certification, and training – to capture the same underlying concept: the HC index. Nevertheless, these indicators cannot perfectly measure HC. Therefore, considering the measures as a group may provide more information on HC than considering them individually. Hence, we employ the technique of principal components analysis (PCA) with no rotation to combine the four variables and extract common factors from a set of variables. The common factor is utilized in *H5* as an overall measure of HC.

The factor score coefficients generated by PCA were 0.23 for EDU, 0.41 for STAF35, 0.40 for LICENCE, and 0.37 for TRAINING. The procedure produced only one significant common factor named HC index, with an eigenvalue of 1.92, indicating that 47.95 percent of the variance is explained by the resulting factor. The distribution of the scores indicates that each variable is relatively important in contributing to the explanation of the overall variance[7]. Notationally, the combined dependent variable is formed as follows:

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$$HC = 0.23EDU + 0.41STAF35 + 0.40LICENSE + 0.37TRAINING_1. \quad (5)$$

The result for factor loadings suggests a positive association between original variables and common factor (HC)[8]. Work experience of auditors (with 0.80) has the greatest influence on HC, whereas a CPA certification and CPD have more influence on HC (0.77 and 0.71, respectively). EDU is also found to be important on HC (0.68).

Results of univariate analysis

Table III reports the results of univariate analysis. The table shows mean and median individual and overall investments in HC and auditor quality for PAMF and NONPAMF. The differences obtained from subtracting the means and medians of PAMF from those of NONPAMF are in the last two columns, along with the results of the *t*-test and Wilcoxon two-sample test of the differences between the two samples. As shown in Table III, there is a statistical difference in EDU, STAF35, LICENSE, TRAINING, and HC, whereas the mean and median of them in the PAMF are higher than NONPAMF. Furthermore, the mean and median auditor quality (QUAL) is significantly higher in PAMF than in NONPAMF at 0.01 levels. The results of the univariate analysis appear to imply that the bigger the auditor size, the higher investments in HC, thus the higher auditor quality. To examine the association between auditor quality and HC, besides adopting the univariate analysis, we further perform regression analysis before drawing any conclusion.

Diagnostic procedures. Collinearity is considered by analyzing of variance inflation factors (VIF). Table IV provides the diagnostic results of collinearity. As Table IV shows, no severe problems were noted, since all the VIFs for independent variables were below 10, ranging from 1.01 to 2.12. Following diagnostic procedures, we found

	Mean		Median		Difference	
	PAMF ($n = 728$)	NONPAMF ($n = 4137$)	PAMF ($n = 728$)	NONPAMF ($n = 4137$)	*t*-statistics	*Z*-statistics
QUAL	17.68	15.34	17.42	15.37	2.34* (57.86)	2.05* (39.31)
EDU	15.33	14.63	15.37	14.67	0.7* (20.90)	0.7* (22.13)
STAF35	21.01	3.21	9	2	17.79* (28.35)	7* (33.36)
LICENSE	1.42	1.07	1.08	1	0.35* (19.93)	0.08* (28.60)
TRAINING	11.69	9.86	11.38	9.91	1.83* (29.79)	1.47* (24.31)
HC	1.17	−0.21	0.57	−0.22	1.38* (39.26)	0.79* (32.13)

Notes: *Significant at 0.01 level, two-tailed test; PAMF and NONPAMF represent public audit market firms and non-public audit market firms, respectively; *t*-statistics tests difference in means, while Wilcoxon *Z* tests difference in medians; observations of PAMF and NONPAMF are 728 and 4137, respectively; QUAL and TRAINING are deflated by consumer price index of the base year, 1989, and expressed in new Taiwan dollars; since the values of HC are the standardized measure (mean = 0, standard = 1), negative values are reasonably expected; QUAL, auditor quality, measured by the natural log of revenues in the audit firms; EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development; HC, the principal components linear combination of the four human capital indicators

Table III.
Univariate test

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	Total sample VIF	PAMF VIF	NONPAMF VIF
EDU	1.06	1.26	1
STAF35	1.43	1.75	1.02
LICENSE	1.36	2.03	1
TRAINING	1.25	2.12	1.02
Observations	4,865	728	4,137

Notes: PAMF and NONPAMF represent public audit market firms and non-public audit market firms, respectively; VIF represents variance inflation factors. When the value exceed 10, it shows that collinearity is severe; EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development

Table IV.
Collinearity diagnosis

that no collinearity exists among independent variables, and the regression model can be interpreted.

Regression results

To examine the hypothesis that investments in HC are a factor in auditor quality, we used OLS and logistic regression analysis to test "size" and "brand name" model, respectively. Table V shows the results of estimation of OLS regression models 1 and 2 for the test of *H1-H4* and auditor size is used to proxy auditor quality. Panel A of Table V reports the influences of individual investments in HC on auditor quality. As shown, the regression results from model 1 among samples are consistent. All variables are significant at 0.01 levels and have a predicted sign. Also, model 1 for the full sample and two sub-samples has significant *F*-statistics with *p*-value less than 0.0, implying a good fitness of models. Besides, adjusted R^2 lies between 31 and 74 percent, which indicates a moderate explanatory power of models[9]. More importantly, the results support *H1-H4*; the variables of EDU, STAF35, LICENCE, and TRAINING have significant positive coefficients as predicted. The positive coefficients of EDU, STAF35, LICENCE, and TRAINING, imply that there is a higher auditor quality if firms invest more in education, work experience, professional certification, and CPD of their auditors.

Panel B of Table V presents the influences of overall investments in HC on auditor quality. We use PCA to extract the overall investments in HC from EDU, STAF35, LICENCE, and TRAINING. As shown, the adjusted R^2 of model 2 for all sample firms, PAMF, and NONPAMF are 42, 71, and 12 percent, respectively. *F*-statistics show that the OLS regression model is valid. In addition, HC is significantly associated with auditor quality among full samples and two sub-samples, which supports *H5*, that is, the more investments in HC for auditors, the higher the auditor quality.

Comparison of coefficient between groups

Table VI presents the difference analysis of parameters between PAMF and NONPAMF. Pane A shows the test results of coefficients b_1-b_4. The coefficients b_1 for PAMF and NONPAMF are 0.17 and 0.02, respectively. The test of the difference provides evidence that *ceteris paribus* (i.e. b_2-b_4 are all fixed), there is a significant

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	Total sample Coefficient (*t*-statistics)	PAMF Coefficient (*t*-statistics)	NONPAMF Coefficient (*t*-statistics)
Panel A: QUAL $= b_0 + b_1 EDU + b_2 STAF35 + b_3 LICENSE + b_4 TRAINING(1)$			
Intercept	10.01* (41.08)	11.26* (16.95)	12.48* (55.34)
EDU	0.14* (8.62)	0.17* (3.83)	0.02 (1.41)
STAF35	0.03* (25.96)	0.01* (14.93)	0.12* (31.46)
LICENSE	0.24* (6.66)	0.25* (6.28)	0.14* (3.34)
TRAINING	0.32* (34.29)	0.27* (14.63)	0.21* (24.13)
Observations	4,865	728	4137
Adjusted R^2	0.46	0.74	0.31
Model *F*-statistic (*p*-value)	1053.81* (0.00)	512.68* (0.00)	458.09* (0.00)
Panel B: QUAL $= b_0 + b_1 HC(2)$			
Intercept	15.69* (1100.96)	17.05* (583.37)	15.47* (1036.51)
HC	0.85* (59.62)	0.65* (24.01)	0.56* (42.47)
Observations	4,865	728	4,137
Adjusted R^2	0.42	0.71	0.12
Model *F*-statistic (*p*-value)	3554.45* (0.00)	1803.28* (0.00)	576.66* (0.00)

Notes: *Significant at 0.01 level, two-tailed test; PAMF and NONPAMF represent public audit market firms and non-public audit market firms, respectively; variable definition: EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development; HC, the principal components linear combination of the four human capital indicators

Table V.
OLS regression for "Size" models

difference between parameters (0.15, $t = 4.07$), which shows that the education level of auditors in PAMF has greater influence than in NONPAMF in explaining auditor quality. Similarly, the professional certificate of auditors and CPDs in PAMF, respectively, have greater influence than in NONPAMF in explaining auditor quality. Nevertheless, the work experience of auditors (STAF35) in NONPAMF makes a greater contribution to auditor quality than those in PAMF.

Panel B reports the results of coefficient b_5. As shown, the difference of regression coefficient b_5 is significant at 1 percent (0.09, $t = 3.25$), implying HC in PAMF has greater influence than HC in NONPAMF in explaining auditor quality. As a whole, the results support the *H6*.

Sensitivity analysis

We perform several additional tests to ensure the robustness of our results. First, we add brand name as a proxy for auditor quality and run a logistic regression analysis. The results using the brand name surrogate are presented in Table VII. The pseudo-R^2 of models 3 and 4 are 53 and 39 percent, respectively. The χ^2-statistic is significant, implying a good fitness of the models. Also, the regression coefficients for both models are statistically significant at 0.01 levels, indicating that the more individual or overall investment in HC, the higher auditor quality. Our robustness check thereby supports *H1-H5*. Second, we use natural log total number of staff per year in public accounting

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Variables	Estimated parameter PAMF (A)	NONPAMF (B)	Difference (A-B)	Absolute *t*-statistics
Panel A: QUAL $= b_0 + b_1 EDU + b_2 STAF35 + b_3 LICENSE + b_4 TRAINING$				
EDU	0.17	0.02	0.15^{**}	4.07
STAF35	0.01	0.12	-0.11^{**}	27.35
LICENSE	0.25	0.14	0.11^{*}	1.50
TRAINING	0.27	0.21	0.06^{**}	3.63
Panel B: QUAL $= b_0 + b_1 HC$				
HC	0.65	0.56	0.09^{**}	3.25

Notes: Null hypothesis is that some two model parameters are equal in the population; critical values for difference between parameters are 2.33, 1.65, and 1.28 at 1, 5, and 10 percent significant level. Significant at *0.1 and **0.01 levels, respectively PAMF and NONPAMF represent public audit market firms and non-public audit market firms, respectively; EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development; HC, the principal components linear combination of the four human capital indicators

Table VI.
Comparison of coefficient between PAMF and NONPAMF

firm to proxy auditor quality. The results of study show that coefficient estimates and significance levels for the explanatory variables are similar to those reported in Table V (not reported here). Third, we additionally perform a univariate analysis to examine whether there are differences in the investment of HC between Big 4 and Non-Big 4

Variables	Model (3) Coefficient	*p*-values	Model (4) Coefficient	*p*-values
Intercept	−23.29	0.00	−2.15	0.00
EDU	0.95	0.00		
STAF35	0.28	0.00		
LICENSE	0.45	0.00		
TRAINING	0.51	0.00		
HC			2.44	0.00
Observations	4,865		4,865	
Pseudo-R^2	0.53		0.39	
Model chi-square	31.55		30.85	
Chi-square significance	0.00		0.00	

$$BRAND = \text{logit}(b_0 + b_1 EDU + b_2 STAF35 + b_3 LICENSE + b_4 TRAINING) \quad (3)$$

$$BRAND = \text{logit}(b_0 + b_1 HC_{it}) \quad (4)$$

Notes: BRAND, auditor quality. Based on brand name, when audit firms are large assign 1, otherwise 0; EDU, (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35, (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development; HC, the principal components linear combination of the four human capital indicators

Table VII.
Logistic regression for "Brand Name" models

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within PAMF; between Big 4 of PAMF and Non-Big 4 of NONPAMF and to see whether this differences lead variations in auditor quality. The univariate analysis suggests that there is a significant difference in the investment of HC between Big 4 and Non-Big 4 within PAMF; between Big 4 of PAMF and Non-Big 4 of NONPAMF (not reported here).

The former investments of HC are more than the latter. The univariate analysis also suggests that the auditor quality in Big 4 is significantly more than Non-Big 4 of PAMF and Non-Big 4 of NONPAMF (not reported here). Our variables continue to be significant after dividing our sample to size quartiles within PAMF. Finally, cross-sectional regression equations are run by year so as to mitigate potential overstated problems of repeating observations (firm). Table VIII reports the results of cross-sectional regression run by year. Of the 15 regression equations, estimated coefficients STAF35 and TRAINING are all positive and significant (p-statistics < 0.01); estimated coefficients EDU are all positive, but only nine years are significant; and estimated coefficients LINCENSE are mixed (only nine years are positive and only three years are significant). One possible explanation is that repeating observations affect estimated results. Nevertheless, a more likely explanation may be that the Uniform CPA Examination pass rates have traditionally remained much lower. According to the Ministry of Examination, the examination is given once each year, in December, and passed status requires the candidate to achieve 100 percent on all eight subjects during 1989-2000. Statistics over the past decade show that only about 0.13-19.90 percent candidates pass all parts of the CPA examination[10]. The range of annual pass rates was a bit wide, which indirectly influences the value of LICENSE and the results of multivariate regression. In all cases, our results were qualitatively unchanged.

Conclusion, managerial implications, and future research

This study aims to investigate whether there is a positive association between HC and auditor quality; whether there is any auditor-quality difference in the accounting firms; and whether the extent of association between HC and auditor quality varies between accounting firms. Empirical results indicate that auditor quality is positively related to HC, implying the firm's investments in HC determine the quality of audits that it delivers to clients. We also find an interesting phenomenon – that the overall investments in HC for PAMF have greater influence than do NONPAMF in explaining audit quality; however, individual investment in HC does not have the same results. Additionally, auditors' level of education, license, and CPD for PAMF all have greater influence than NONPAMF in explaining audit quality. Nevertheless, the marginal contributions of working experience of auditors of NONPAMF are significantly higher than those of PAMF. This may be due to different human structured between PAMF and NONPAMF.

This study contributes to the literature on auditor quality in a number of ways. First, we support Deis and Giroux's (1992) conjectures that education, CPD, and professionalism of auditors may affect auditor quality. Second, we further explain why auditor size is related to auditor quality. Finally, from a management perspective, the increase and enrichment of the pool of HC in the audit firm can improve auditor quality. An accounting firm can enhance auditor quality and avoid audit failure by hiring well-educated personnel, providing them with well-planed CPD, encouraging them to acquire professional certificates, and maintaining them

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Table VIII.
Sensitivity analysis

	1989	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Number of positive & significance
Intercept	8.33***	7.51***	11.47***	11.33***	9.47***	10.29***	11.79***	11.34***	11.93***	9.69***	10.76***	10.6***	11.58***	10.36***	10.53***	
	(6.67)	(6.02)	(9.15)	(11.17)	(9.38)	(10.52)	(15.68)	(13.63)	(12.54)	(9.96)	(12.33)	(12.87)	(14.02)	(11.20)	(7.04)	*15*
EDU	0.26***	0.30***	0.04	0.04	0.18**	0.13*	0.03	0.10*	0.04	0.17***	0.14***	0.13**	0.05	0.12***	0.10	
	(2.88)	(3.39)	(0.55)	(0.63)	(2.62)	(1.94)	(0.59)	(1.76)	(0.68)	(2.66)	(2.49)	(2.44)	(0.97)	(2.05)	(1.01)	*9*
STAF35	0.08***	0.05***	0.08***	0.06***	0.03***	0.07***	0.04***	0.06***	0.03***	0.02***	0.03***	0.03***	0.03***	0.03***	0.02***	
	(7.17)	(4.76)	(6.04)	(5.63)	(5.15)	(6.52)	(6.76)	(9.68)	(7.01)	(5.01)	(7.21)	(9.04)	(8.64)	(8.85)	(8.55)	*15*
LICENSE	0.11	0.00	0.00	0.27	0.66***	−0.08	−0.06	−0.27**	−0.20	0.15	0.06	0.34**	0.10	0.19	0.24***	
	(0.61)	(−0.02)	(−0.02)	(1.51)	(4.91)	(−0.51)	(−0.33)	(−2.05)	(−1.06)	(0.41)	(0.77)	(2.65)	(0.46)	(0.46)	(2.11)	*3*
TRAINING	0.27***	0.33***	0.29***	0.30***	0.26***	0.32***	0.33***	0.28***	0.32***	0.32***	0.27***	0.26***	0.30***	0.31***	0.35***	
	(4.71)	(5.38)	(5.97)	(7.27)	(6.95)	(8.55)	(10.16)	(8.60)	(9.29)	(9.26)	(8.98)	(9.20)	(10.12)	(10.36)	(9.78)	*15*
N	149	148	217	261	277	305	403	375	367	389	446	438	411	392	287	
Adjusted-R^2	0.53	0.55	0.48	0.49	0.48	0.49	0.47	0.54	0.48	0.44	0.45	0.46	0.48	0.5	0.54	

Notes: Significant at the *10, **5 and ***1 percent levels, respectively; variables definition: EDU (number of auditors with doctorates × 23 + number of auditors with master's degrees × 18 + number of auditors with bachelor's degrees × 16 + number of employee with senior high school diploma × 12 + number of employees with other education levels × 9)/(year-end number of auditors); STAF35 = (number of auditors over 35 years old)/(number of practicing CPAs); LICENSE, (number of auditors with CPA license)/(number of practicing CPAs); TRAINING, natural log of expenditures of continuing professional development

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within the work environment so that the "best people stay in the profession." In conclusion, to ensure its viability and flexibility and its ability to meet the needs of investors, the audit firm needs to continue to attract, develop, educate, and train auditors at all levels that are prepared to perform high quality audits in this dynamic environment.

Further research would be necessary to find out what other factors motivate accounting firms to provide audits of different quality be undertaken. Further research would also perform additional analysis by examining proxies for auditor quality such as abnormal accruals and financial restatements.

Notes

1. AU section 210 training and proficiency of the independent auditor.
2. The Chartered Certified Accountant's Practicing Regulator provide for three types of the Association of Chartered Certified Accountants practicing certificate: audit, general practise, and accounting and consultancy. Structured CPD can be defined as an attendance at classroom-based courses or a participation in online and video training courses, while non-structured CPD is defined as any form of self-study or practical exercise aimed at improving skills which do not form part of day-to-day working duties.
3. We measure the "QUAL" of each audit firm in terms of its natural log total revenue generated from two sources: Accounting and Auditing (A&A) and Tax Services (TAX), excluding Management Advisory Services (MAS). A&A includes compilations, special reports, and audits/reviews of historical financial information. TAX includes tax research, planning and preparation work. MAS includes consulting service, systems development, integration of Enterprise Resource Planning, and any other management assistance.
4. For instance, a doctor degree will take about 23 years, that is, six years in elementary school, three years in junior high school, three years in high school, four years in college, two years in a master program, and five more years for the doctor program.
5. The survey has been conducted annually by the Department of Statistics, Ministry of Finance, Taiwan, ROC since 1989. In 1991, the survey was included in the census of commercial and service industry administered by the General Accounting Office. Thus, the data of 1991 are excluded due to data availability. The survey of public accounting firms has been conducted by the Financial Supervisory Commission, Executive Yuan, Taiwan, ROC since 2003.
6. From the practical perspective, public company's size is generally larger than non-public company. Besides, according to the related raw, the former financial statements must be audited by independent auditors, the latter are not. Therefore, whether public accounting firm engage in financial statement audit can represent client's size.
7. Eigenvalues of factor 1-4 are 1.92, 0.90, 0.68, and 0.50, respectively. Our important factors are those which contribute most to the total variance of the variables; those factors having eigenvalues greater 1.0 describe more of the data than any single variable and examined most closely. Remaining factors (having eigenvalues less than 1.0) will be obscure and more difficult to identify; such factors are not reported in the results.
8. A factor loading is interpreted as the Pearson correlation coefficient of an original variable with a factor. Factor loadings of EDU, STAF35, LICENSE, and TRAINING are 0.43, 0.80, 0.77, and 0.71, respectively.
9. Model 1 for large audit firms has greater explanatory power than medium and small audit firms, with an adjusted R^2 of 0.89 compared to 0.57 for medium audit firms and 0.32 for small audit firms. Model 1 for medium firms has somewhat greater than small firms.

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10. According to the statistics of the Ministry of Examination (available at: www.moex.gov.tw), annual pass rates from 1989 to 2000 were 19.90, 16.49, 4.12, 14.27, 6.39, 14.43, 11.37, 14.47, 6.63, 12.88, 5.05, 12.33, and 0.13 percent, respectively. In 2001, the Ministry of Examination allowed the existence of "conditional eligibility requirements". Candidates attaining a conditional status are successful on at least one part but are not regarded to have passed the examination and must repeat the failed section within three years.

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