



Effects of human capital on revenues: evidence from professional service organizations in Taiwan

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Keywords:

Audit firms

Average partial effects

Human capital

Trans-log revenue function.

JEL Classification:

M41; M42; E24.

Received: 9 June 2023

Revised: 2 January 2024

Accepted: 4 March 2024

Published: 25 March 2024

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Abstract

This paper specifies a trans-log revenue function to estimate the relationship between service revenue outputs and three key human capital inputs, including formal education, work experience, and professional training. Using a Taiwanese pooled cross-sectional sample of 22,875 observations over the period 1992-2021, we divide the total sample into international and non-international audit firms based on their total audit revenues. We find that the average partial effects (APEs) on revenues are much higher for international than for non-international audit firms, suggesting that audit firm size affects audit firms' financial performance. We also find that investments in both formal education and work experience significantly contribute to the growth of service revenues (but if such investments are beyond the optimal level, they may contribute to the reduction of revenues) and that such growth is much larger for international than for non-international audit firms. Although we find that, in our statistical analysis, professional training contributes to the reduction of service revenues, our graphical analysis justifies this intriguing finding, which is attributed to a lagged return on professional training investments. In theory, human capital suggests that professional training is a needed process to raise future service revenues. Overall, our findings shed light on the APEs of human capital inputs on revenue generation and have practical implications for regulators and practitioners to understand how and to what extent human capital can make a positive contribution to the growth of audit firms' revenues.

Funding: This study received no specific financial support.

Institutional Review Board Statement: Not applicable.

Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Data Availability Statement: The corresponding author may provide study data upon reasonable request.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: Designed the study and the conceptual framework, supervised the investigation process, interpreted the results, reviewed the original draft, and gave the advice of articulating the quality of the manuscript and the implication of the results, C-C.Y.; conducted the empirical investigations and tests, performed the finding analyses, developed the visualization of interpreting study results, and wrote the original and the final draft of the manuscript, K-Y.L.; conceptualized the research ideas, supervised the investigation process, reviewed as well as edited the manuscript, and revised the manuscript during the revision process, Y-S.C. All authors have read and agreed to the published version of the manuscript.

1. Introduction

The current audit markets exhibit a dual market structure, with a few large international audit firms and many small audit firms (Bröcheler, Majoor, & Van Witteloostuijn, 2004). These large international audit firms are also referred to as Big N audit firms, including Big 8, Big 6, Big 5, or Big 4. Subsequently, we use international audit firms for consistency. For example, the empirical evidence documents the effects of the dual market structure on competition (Bills & Stephens, 2016) and on audit quality (Eshleman & Guo, 2014; Jiang, Wang, & Wang, 2019; Lawrence, Minutti-Meza, & Zhang, 2011). Also, the literature shows that, unlike non-

Big 8 auditors, Big 8 auditors charge clients an average of 34 percent brand name premium (Craswell, Francis, & Taylor, 1995). Further, Big 4 city-specific industry leaders charge larger audit fees than do non-Big 4 auditors (Basioudis & Francis, 2007) and the audit fee premium is attributable to Big 4 auditors, who charge clients 45 percent higher audit fees (Elliott, Ghosh, & Peltier, 2013). Although existing studies show that international audit firms charge higher audit fees, it is unknown whether higher audit fees have been translated into revenue enhancement. Moreover, for all of the past research on the economic analysis of audit markets, determinants of audit service revenues have rarely been addressed.

In labor economics, human capital refers to the knowledge and skills that workers acquire through three main pillars: formal education, work experience, and professional training (Mankiw, 2021; Mubarik, Chandran, & Devadason, 2018). Human capital accumulation can drive productivity growth (Chang, Chen, Duh, & Li, 2011; Henderson & Russell, 2005), and human capital investments help audit firms enhance their audit quality (Aldhizer III, Miller, & Moraglio, 1995; Cheng, Liu, & Chien, 2009; Meinhardt, Moraglio, & Steinberg, 1987). In short, formal education, work experience, and professional training are three key components of human capital that drive audit quality, which, in turn, boosts service revenues for audit firms. In response to the calls for research into the isolated attributes of technical capabilities related to audit quality (Deis & Giroux, 1992) we attempt to assess the impact of the three key components of human capital on audit firms' performance. Specifically, we examine the relationship between formal education, work experience, and professional training and revenue generation by audit firms.

Audit firms are commonly viewed as knowledge-intensive and professional service organizations where professional knowledge is a key determinant of their financial performance (Alvesson, 1993, 2000; Makani & Marche, 2010; Morris & Empson, 1998; Starbuck, 1992). These firms greatly rely on a workforce that has substantial legitimate and esoteric expertise (Starbuck, 1992; Von Nordenflycht, 2010). The esoteric expertise is usually obtained through formal education, work experience, and professional training (Mubarik et al., 2018; Starbuck, 1992). It is the esoteric expertise that helps audit firms succeed in financial performance (Starbuck, 1992). However, whether having a more well-educated, well-experienced, and well-trained workforce can really help audit firms succeed in building esoteric specialists and in boosting service revenues is still unknown. Hence, the effects of formal education, work experience, and professional training on audit firm revenues warrant further investigation. This motivates us to bridge this knowledge gap.

Revenues contain information about future earnings and cash flows because the information can be immediately reflected in revenues. Further, revenues are more useful in summarizing the performance of firms and in conveying new relevant information to the market (Chandra & Ro, 2008; Gordon, 1989). Following prior studies (e.g., Yang, Chen, and Yang (2021)), we construct a trans-log revenue function to directly explore the average partial effects (APEs) of formal education, work experience, and professional training on audit firms' revenue generation. As the dual market structure exists in Taiwan, we also conduct a pairwise comparison of each APE between international and non-international audit firms.

Relying on a pooled cross-sectional sample of 22,875 observations between 1992-2021, we find that the APEs on service revenues are much higher for international than for non-international audit firms, indicating that audit firm size alone affects audit firms' financial performance in our sample firms.

Further analyses of the APEs of these three components indicate that investments in hiring a higher-educated workforce help all audit firms significantly enhance their revenues, and such revenue enhancement is much larger for international audit firms than for non-international audit firms. Similarly, we report a significantly positive impact of the well-experienced workforce investments on audit firm revenue enhancement for international audit firms relative to non-international audit firms. But inconsistent with our expectations, we find that the professional training investment is significantly negatively associated with service revenues and reflects a lagged return on such investments. However, this intriguing finding is consistent with the prediction of human capital theory that the initial gain on training investments is quite low because a large proportion of working time is spent learning rather than producing (Maranto & Rodgers, 1984). Also, this unexpected finding builds evidence for the theory that on-the-job training investment is a needed process for increasing future revenues and coping with a complex, dynamic, and ever-changing environment in the audit markets.

With its findings, this study contributes knowledge to the literature by extending prior research on the role of human capital (Che, Langli, & Svanström, 2018; Cheng et al., 2009). We exclusively and directly examine the relationship between revenues and three key human capital: formal education, work experience, and professional training in audit firms. Our findings confirm a positive association between human capital investments and the performance of audit firms (Mubarik et al., 2018). Specifically, our unexpected finding provides theory-based evidence that professional training investments are a needed process for raising future revenues. The initial productivity from professional training is negative but changes to positive after some turning points (Becker, 1962; Maranto & Rodgers, 1984). In addition, we provide specific attributes of formal education, work experience, and professional training for practitioners to derive their competitive advantages in the complexity and uncertainty of changing audit environments.

The remainder of this paper is organized as follows: Section 2 provides the general background and hypothesis development. We discuss the details of research design in Section 3 and present empirical results in Section 4. We conclude in Section 5.

2. Background and Hypothesis Development

2.1. International Audit Firms

The growth and diversification of an audit firm can be achieved through merging with rivals (Stigler, 1950; Wootton, Wolk, & Normand, 2003). This spate of mergers and acquisitions between international audit firms has caused corporate clients, policymakers, and academics to raise concerns about the implications of these mega-mergers on audit fees (Carson, Simnett, Soo, & Wright, 2012; Iyer & Iyer, 1996). Evidently, Eshleman and Lawson (2017) reveal that audit market concentration is significantly associated with higher audit quality and audit fees. Carson et al. (2012) analyze the change in fee premiums of Big N audit firms over the Big 6, Big 5, and Big 4 periods and find that the consolidation of Big N audit firms causes the increase in the premiums paid by Big N clients. In addition, larger audit firms charge clients higher audit fees than do smaller audit firms (Beatty, 1989; Palmrose, 1986). For example, the brand name premium of Big 8 auditors is 34 percent higher than that of non-Big 8 auditors (Craswell et al., 1995). Elliott et al. (2013) find that the audit fee premium is only attributable to Big 4 auditors, who charge 45 percent higher fees when clients have disagreements or other reportable events, but there is no such fee premium associated with non-Big 4 clients. Basioudis and Francis (2007) find that Big 4 city-specific industry leaders have charged larger fees than do Big 4 non-city leaders and other non-Big 4 auditors. Asthana, Raman, and Xu (2015) find that US-based Big N principal auditors are associated with higher audit fees because these auditors can improve the financial reporting environment by providing higher-quality audited earnings for their US-listed foreign clients. Overall, these empirical studies indicate that clients pay higher audit fees for the services provided by the Big N audit firms and that revenue generation would be higher for Big N than for non-Big N audit firms. These higher revenues would, in turn, translate into the higher APEs on revenue generation for international audit firms than for non-international audit firms in our sample. Hence, we formulate our first alternative hypothesis:

H: Ceteris paribus, APEs on revenue generation are significantly greater for international than for non-international audit firms.

2.2. Human Capital

Human capital is defined as the accumulation of competencies, knowledge, and skills to carry out work that produces economic value (Mubarik et al., 2018). Becker (1993) was the first to modernize the conceptualization of human capital as the knowledge, information, ideas, skills, and health of individuals. Subsequent researchers have taken Becker's initial ideas and applied human capital concepts more broadly across different domains (Nyberg & Wright, 2015). In microeconomics, Yue (2022) finds that human capital expansion (e.g., an increase in the supply of advanced human capital) significantly promotes the improvement of firms' production efficiency and their mark up through the production efficiency channel. Kucharčíková, Mičiak, and Hitka (2018) document that the effectiveness of investment in and utilization of human capital leads to an increase in firms' competitiveness and performance within the context of sustainability. They further argue that investment in human capital helps enterprises not only increase competitiveness and labor productivity, but also improve the quality of production and services. Although the adjustment and upgrading of human capital structures by the labor protection reduces enterprise innovation in China (Guo, Tang, & Jin, 2021), an increase in human capital enhances the technological innovation of Brazil, Russia, India, China, and South Africa (BRICS) and also strengthens the relationship between technological innovation and knowledge spillovers (Hu, 2021).

Human capital inputs can be expected to play a key role in the explanation of audit firm success and failure (Morris & Empson, 1998). Empirical evidence shows that human capital has a significant positive relationship with audit firm performance (Earnest, Chamian, & Saat, 2015) and that international audit firms tend to invest more in human capital (Jiang et al., 2019). In accounting, Cheng et al. (2009) claim that audit firms should invest in human capital and have more well-educated, well-experienced, and well-trained professionals to keep pace with the changing market conditions and enhance audit quality and total revenues. Inspired by the literature, we attempt to assess the impact of each of these three components (e.g., formal education, work experience, and professional training) on audit firms' revenue generation.

2.2.1. Formal Education

Formal academic education builds individuals' general knowledge and their ability to apply theories and concepts in various situations and make sophisticated judgements and decisions (Che et al., 2018). Auditors who choose to pursue a higher education level might have a higher innate ability and more knowledge, hence reflecting their moral reasoning and ethical judgment in rendering services (Che et al., 2018). These highly educated auditors may have more sophisticated cognitive skills and the innate ability to implement more complex auditing procedures (Gul, Wu, & Yang, 2013). Therefore, higher education allows auditors to build their esoteric expertise (Starbuck, 1992) which, in turn, substantially enhances audit firm performance (Bröcheler et al., 2004).

Formal education can be defined as an individual who invests time and money in academic degree attainment, which, in turn, helps the individual earn a position in a firm (Spence, 1973). In general, investment

in education expands and extends knowledge, leading to advances in productivity growth (Weisbrod, 1962). The role of formal education can help reduce the difference between actual and predicted productivity (Stiglitz, 1975) so that educational achievements will guarantee work quality (Hirshleifer, 1973). Accounting professionals with higher academic degrees are assumed to perform their tasks much better because their knowledge and intellectual potential can help them learn and accumulate skills and expertise more efficiently and effectively (Cheng et al., 2009). Higher academic degrees are positively related to the operating performance of audit firms. Further, higher academic degrees exhibit a curvilinear effect on operating performance with a reverse U-shaped relationship for national audit firms and a U-shaped relationship for both regional and local audit firms (Chen, Yang, & Yang, 2020).

Consequently, a high educational level of signing audit partners is significantly and negatively associated with the likelihood of financial misstatements because higher education can enhance the ethics and independence of auditors, thus mitigating the risk of financial misstatements (Du, Yin, & Hou, 2018). Further, auditors with higher educational achievements can help improve the quality of governmental audits (Meinhardt et al., 1987) and are less likely to have audit failure (Li, Qi, Tian, & Zhang, 2017), resulting in increases in audit firm performance (Bröcheler et al., 2004). Taken together, we predict that investments in a well-educated workforce will boost total revenues for audit firms and that the increased revenue will be much higher for international audit firms than for non-international audit firms. This leads to our second set of hypotheses:

H_{2a}: Ceteris paribus, educational level of auditors is positively associated with audit firms' magnitude of revenue enhancement.

H_{2b}: APEs of the auditors' educational level on the magnitude of revenue enhancement are more pronounced for international audit firms than for non-international audit firms.

2.2.2. Work Experience

Work experience has been defined as job-relevant knowledge gained over time (Che et al., 2018; Fiedler, 1970) and is considered relevant for human resource functions (Che et al., 2018). From a pragmatic perspective, most graduates from universities first enter audit firms as assistants to accumulate work experience and continue to learn and gain expertise through learning by doing auditing work. Work experience of auditors is recognized as one of the principal drivers of audit quality (Che et al., 2018). Knowledge can be gained through work experience, and a primary determinant of improved expertise is experience (Bonner & Lewis, 1990). In addition, more experienced auditors outperform less experienced auditors (Bonner & Lewis, 1990) are less likely to be associated with audit failure (Ye, Cheng, & Gao, 2014) and enhance the financial performance of audit firms (Bröcheler et al., 2004) suggesting that experience has a positive effect on knowledge, judgment, and audit performance (Che et al., 2018). Hence, we expect that experienced auditors can provide clients with higher quality audits to earn audit fee premiums, which, in turn, enhance audit revenues. Such revenue enhancement, we predict, is larger for international firms than for non-international firms. This leads to our third set of alternative hypotheses:

H_{3a}: Ceteris paribus, work experience of auditors is positively associated with the audit firms' magnitude of revenue enhancement.

H_{3b}: APEs of the auditors' work experience on the magnitude of revenue enhancement are more pronounced for international audit firms than for non-international audit firms.

2.2.3. Professional Training

The pace of changes in the workplace means that knowledge and skills are likely to evolve through more transitions within tasks and projects. Therefore, ongoing learning and training are needed to maintain and enhance productivity (Lindsay, 2016). Professional training addresses the ongoing learning activities for professionals (Lindsay, 2016; Trentin, 2002) and plays an important role in human resource development (Che et al., 2018). Educational training permanently changes salespeople's knowledge, attitudes, skills, and performances (Noe & Schmitt, 1986). Professional training helps enhance existing knowledge, competence, and skills, thus allowing professionals to provide higher quality service to clients (Cervero, 2001; Thomas, Davis, & Seaman, 1998). Almeida and Carneiro (2009) find that the estimates of the return to professional training are substantial (8.6 percent), suggesting that formal job training is a good investment for audit firms because such an investment yields comparable returns to the investments in physical capital.

Auditors are required to complete certain hours per year of continuing professional education (CPE), which gives auditors direct knowledge and guidance on how to deal with problems related to audit processes. This knowledge may have direct implications for subsequent audit work (Che et al., 2018). In 2005, the US Government Auditing Standards published guidance for CPE which requires that audit work be performed by persons with adequate technical training and proficiency. Wallace and Campbell (1988) argue that reported deficiencies may be attributed to a lower level of professional training, while Cheng et al. (2009) and Elder, Beasley, Hogan, and Arens (2020) find that higher audit quality is positively associated with professional training. The literature also shows that professional training is significantly positively associated with financial performance of audit firms (Chen, Chen, & Lee, 2002; Chen, Chang, & Lee, 2008; Chen, Goan, &

Chen, 2011; Yang, Chen, & Yang, 2013). In all, we expect to observe increased revenues from audit firms that provide employees with professional training to enhance their personnel knowledge and skills. This expectation leads to our fourth set of alternative hypotheses:

H_{4a} : *Ceteris paribus, professional training of auditors is positively associated with the audit firms' magnitude of revenue enhancement.*

H_{4b} : *APEs of auditors' professional training on the magnitude of revenue enhancement are more pronounced for international audit firms than for non-international audit firms.*

3. Research Design

3.1 Sample Selection

We obtain data from the 1992-2021 survey report of audit firms in Taiwan, administered and published by the Financial Supervisory Commission (FSC) (equivalent to the Securities and Exchange Commission (SEC) in the US). The dataset includes quantitative information (e.g., total revenues, expenses, and their compositions) and demographic information (e.g., the number of partners, professionals, and other employees corresponding to their ages, education levels, and years of work experiences). The survey aims to gain insights into the operations of audit firms, analyze macro-economic conditions, and form industrial policies for the FSC. In this respect, the FSC database is superior to US Accounting Today's surveys, which are conducted by a private institution, Arizent. FSC obligates all audit firms to accurately complete the survey by the specified deadline, thus receiving an annual response rate of more than 80 percent and representing the reality of auditing practices in Taiwan.

To protect the business information of individual audit firms, the identities of all audit firms are removed from the annual survey data. Therefore, the dataset is a pooled cross-sectional dataset with both cross-sectional and time series information. Prior research employed the pooled cross-sectional technique to exploit the entire available sample (Cowle & Rowe, 2022; Rickmann, 2022). In fact, pooled cross-sectional data permits the consolidated use of the full dataset and thus yields more precise statistical estimates than do the yearly subsample estimates (Finkelstein & Hambrick, 1990; Geletkanycz & Hambrick, 1997). Chandra and Ro (2008) argue that pooled cross-sectional data includes longer sample period and permits researchers to examine differences in the role of revenue in valuing firms across time and in different situations. Our final number of firm-year observations is 22,875, consisting of 137 international audit firms and 22,738 non-international audit firms.

3.2. Theoretical Model

According to Chandra and Ro (2008) revenue may contain information about future earnings and cash flows because the information can be immediately reflected in the revenues. Empirically, they find that, over a longer timeframe, the value relevance of earnings decreased while that of revenue increased. The information conveyed by earnings surprises declines over time, but the incremental information conveyed by revenue surprises remains stable. The usefulness of revenues has been demonstrated in prior research, such as Gordon (1989) which employs revenues as an outcome variable to estimate an aggregated multi output trans-log revenue function for the Canadian cattle industry. Recently, the trans-log revenue function has been intensively used in investigating a variety of topics (Chen & Yang, 2021a, 2021b; Yang et al., 2021; Yang, Chen, & Chen, 2022). Inspired by prior studies above, we utilize audit firms' revenues as our outcome variable and the trans-log revenue function to estimate the parameters of our research variables, formal education, work experience, and professional training. An audit firm's optimal revenue function is expressed as follows:

$$r = r(h_1, h_2, h_3, x, p) \quad (1)$$

Where r is the total revenues and h_1 , h_2 , and h_3 represent the human capital: formal education, work experience, and professional training, respectively. x denotes the number of employees, and p represents the unit price of the services. As our sample period spans three decades, technological advances may cause our revenue function to change over time (Coelli, Prasada Rao, O'Donnell, & Battese, 2005). To account for it, we include a time trend in our model and specify the following trans-log revenue function:

$$\ln r = \alpha_0 + \theta_1 T + \theta_2 T^2 + \sum_{i=1}^3 \alpha_i \ln h_i + \beta_1 \ln x + \gamma_1 \ln p + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \alpha_{ij} \ln h_i \ln h_j + \frac{1}{2} \beta_{11} \ln x^2 + \frac{1}{2} \gamma_{11} \ln p^2 + \sum_{i=1}^3 \delta_i \ln h_i \ln x + \sum_{i=1}^3 \varepsilon_i \ln h_i \ln p + \mu_1 \ln x \ln p \quad (2)$$

Where $\ln r$ is the logarithm of total revenues; T is a time trend; $\theta_1, \theta_2, \alpha_i, \beta_1, \gamma_1, \alpha_{ij}, \beta_{11}, \gamma_{11}, \delta_i, \varepsilon_i$, and μ_1 are unknown parameters to be estimated. Linear homogeneity in output prices suggests that a proportionate increase in output prices must result in the same proportionate increase in total revenue for a given input level. This imposes the following restrictions on Equation 2.

$$\gamma_1 = 1, \gamma_{11} = 0, \mu_1 = 0, \sum_{i=1}^3 \varepsilon_i = 0 \text{ for } i = 1, \dots, 3 \quad (3)$$

Equation 3 represents linear homogeneity, one of the properties of the revenue function to be satisfied, that multiplying all output prices by an amount $k > 0$ will cause a k -fold increase in revenues (e.g., doubling all output prices will double revenues) (Coelli et al., 2005).

3.3. Variable Definitions

3.3.1. Dependent Variable

For the output variable, we are inspired by literature (e.g., (Banker, Chang, & Cunningham, 2003; Chandra & Ro, 2008; Chen & Yang, 2021a, 2021b; Gordon, 1989; Yang et al., 2021)) and use the total revenues as a proxy for the performance of audit firms. We maintain the assumption that audit firms maximize their revenues for any given level of inputs; in a word, the revenue is a function of the output price and input quantities (Yang et al., 2021).

3.3.2. Independent Variables

To compare the performance between international and non-international audit firms, we create an indicator variable, international audit firms (BIGN), which equals 1 if the firm is an international one. The labour economics, which states that workers acquire their knowledge and skills through formal education, work experience, and professional training, serves as our driving force for other variables (Mankiw, 2021). Education (EDU) is defined as the educational level of auditors and measured as the average number of years it takes them to obtain an academic degree. Experience (EXPER) is defined as the average year of an auditor's work experience. Professional training (TRAIN) is defined as the training expenses per auditor. Other inputs are the total number of employees (EMPLOYEE) and the unit price of services (PRICE).

Concerns are voiced about the implicit assumption that the state of technology is constant and that production is basically timeless (Chambers, 1989). Technological advances often cause economic relationships to change over time, suggesting that researchers include a time trend in the model to account for technological change if they have observations over time (Coelli et al., 2005). Hence, we include a time trend, TIME, in the model that makes implicit assumptions about the nature of technological and economic change. TIME is defined as the number of each ordinal year during the 30-year sample period between 1992 and 2021. Table 1 provides the definitions of all variables in our models.

Table 1. Variable definitions.

Theoretical variable	Proxy variable	Definitions
R	REVENUE	Total revenue expressed in new Taiwan (NT) dollars.
h_1	EDU	The average years for auditors to obtain an academic degree.
h_2	EXPER	The average years of auditors' work experience.
h_3	TRAIN	Training expenditures per auditor.
X	EMPLOYEE	Total number of auditors.
P	PRICE	Unit price of audit services.
BIGN		A dummy variable that equals 1 if the firm is an international audit firm, and 0 otherwise.
TIME		Time trend during the 30-year sample period between 1992 and 2021.

3.4. Estimation Model

We use the trans-log function to show the relationship between audit firms' total revenues and three parts of their human capital because it is a flexible functional form that doesn't put any restrictions on substitution elasticities at the start (Joshi, Krishnan, & Lave, 2001). The trans-log revenue function in Equation 2 can be rewritten as follows:

$$\ln(\text{REVENUE}) = \alpha_0 + \alpha_1 \ln \text{EDU} + \alpha_2 \ln \text{EXPER} + \alpha_3 \ln \text{TRAIN} + \beta_1 \ln \text{EMPLOYEE} + \gamma_1 \ln \text{PRICE} + 1/2 [\alpha_{11} (\ln \text{EDU})^2 + \alpha_{22} (\ln \text{EXPER})^2 + \alpha_{33} (\ln \text{TRAIN})^2 + \beta_{11} (\ln \text{EMPLOYEE})^2 + \gamma_{11} (\ln \text{PRICE})^2] + \alpha_{12} (\ln \text{EDU}) * (\ln \text{EXPER}) + \alpha_{13} (\ln \text{EDU}) * (\ln \text{TRAIN}) + \alpha_{23} (\ln \text{EXPER}) * (\ln \text{TRAIN}) + \beta_{11} (\ln \text{EDU}) * (\ln \text{EMPLOYEE}) + \beta_{21} (\ln \text{EXPER}) * (\ln \text{EMPLOYEE}) + \beta_{31} (\ln \text{TRAIN}) * (\ln \text{EMPLOYEE}) + \gamma_{11} (\ln \text{EDU}) * (\ln \text{PRICE}) + \gamma_{21} (\ln \text{EXPER}) * (\ln \text{PRICE}) + \gamma_{31} (\ln \text{TRAIN}) * (\ln \text{PRICE}) + \mu_{11} (\ln \text{EMPLOYEE}) * (\ln \text{PRICE}) + \pi_1 \text{BIGN} + \pi_2 \text{BIGN} * \ln \text{EDU} + \pi_3 \text{BIGN} * \ln \text{EXPER} + \pi_4 \text{BIGN} * \ln \text{TRAIN} + \theta_1 \text{TIME} + \theta_2 \text{TIME}^2 \quad (4)$$

The trans-log revenue function in Equation 4 and the proxy variables of our empirical data enable us to calculate the APEs for our research variables, which are expressed in the following differentiation:

$$\text{APE_BIGN} = \partial \ln \text{REVENUE} / \partial \text{BIGN} = \pi_1 + \theta_2 \overline{\ln \text{EDU}} + \pi_3 \overline{\ln \text{EXPER}} + \pi_4 \overline{\ln \text{TRAIN}} \quad (5)$$

$$\text{APE_EDU} = \partial \ln \text{REVENUE} / \partial \ln \text{EDU} = \alpha_1 + \alpha_{11} \overline{\ln \text{EDU}} + \alpha_{12} \overline{\ln \text{EXPER}} + \alpha_{13} \overline{\ln \text{TRAIN}} + \beta_{11} \overline{\ln \text{EMPLOYEE}} + \gamma_{11} \overline{\ln \text{PRICE}} + \pi_2 \text{BIGN} \quad (6)$$

$$APE_EXPER = \partial \ln REVENUE / \partial \ln EXPER = \alpha_2 + \alpha_{22} \overline{\ln EXPER} + \alpha_{12} \overline{\ln EDU} + \alpha_{23} \overline{\ln TRAIN} + \beta_{21} \overline{\ln EMPLOYEE} + \gamma_{21} \overline{\ln PRICE} + \pi_3 \overline{BIGN} \quad (7)$$

$$APE_TRAIN = \partial \ln REVENUE / \partial \ln TRAIN = \alpha_3 + \alpha_{33} \overline{\ln TRAIN} + \alpha_{13} \overline{\ln EDU} + \alpha_{23} \overline{\ln EXPER} + \beta_{31} \overline{\ln EMPLOYEE} + \gamma_{31} \overline{\ln PRICE} + \pi_4 \overline{BIGN} \quad (8)$$

where \overline{BIGN} , $\overline{\ln EDU}$, $\overline{\ln EXPER}$, $\overline{\ln TRAIN}$, $\overline{\ln EMPLOYEE}$, $\overline{\ln PRICE}$ present the mean value of international audit firms, as well as the mean value of the logarithm of formal education, work experience, professional training, total number of employees, and the price per unit service, respectively. $\partial \ln REVENUE / \partial BIGN$, $\partial \ln REVENUE / \partial \ln EDU$, $\partial \ln REVENUE / \partial \ln EXPER$, $\partial \ln REVENUE / \partial \ln TRAIN$ represent mathematical expressions or partial derivatives showing how changes in international audit firms, formal education, work experience, and professional training affect services revenues when other influences are held constant. Collectively, we use Equations 5, 6, 7, and 8 to calculate the average partial effects (APEs) of international audit firms, formal education, work experience, and professional training, respectively. The results of these APEs are reported in Table 5.

4. Empirical Results

4.1. Descriptive Statistics

Table 2 presents the descriptive statistics of variables used in our analyses for full sample observations. As shown, monetary variables (e.g., REVENUE, TRAIN, and PRICE) have higher means than medians and large standard deviations. These results demonstrate that the data are skewed to the right and that the size of international firms is substantially greater than that of non-international firms. Our untabulated correlation matrix shows that all independent variables, except work experience (EXPER), are significantly positively correlated with REVENUE.

Table 2. Descriptive statistics.

Variables	Mean	Std dev.	Minimum	Median	Maximum
Revenue	26,277,782.36	260,761,238.29	0.00	4,277,984.98	8,240,922,530.67
Edu	15.28	1.16	9.00	15.33	23.00
Exper.	38.99	7.86	25.63	37.50	70.00
Train	5,238.80	24,826.86	0.00	1,016.26	3,103,968.11
Employee	21.34	138.25	1.00	7.00	3,975.00
Price	76,228.21	705,807.76	0.00	43,028.92	49,727,889.58

Note: All monetary variables expressed in NT dollars and deflated to year of 2016.
All variables are defined in Table 1.
Number of observations = 22,875.

4.2. Pairwise Comparisons to Test Differences between International and Non-international Audit Firms

Table 3 shows that the mean of the output variable (REVENUE) and of all input variables, except for EXPER, is considerably larger for international audit firms than for non-international audit firms. EXPER shows that the mean of international firms is less than that of non-international firms. This reverse direction seemingly echoes the unique ownership structure of non-international audit firms whose owners are well-experienced auditors. Overall, these results indicate that a striking difference between international and non-international audit firms makes the comparison of revenue generations between these audit firms necessary. In addition, the difference between international and non-international audit firms is also confirmed by our untabulated Chow test results¹.

Table 3. Comparisons of research variables between international and non-international firms.

	Revenue	Edu.	Exper.	Train	Employee	Price
International firms	2,698,228,999.96	16.28	31.20	14,000.00	1,500.39	194,734.15
Non-international firms	10,178,859.11	15.28	39.04	5,186.01	12.42	75,514.20
Difference	2,688,050,140.85	1.00	-7.84	8,814.26	1,488.96	119,219.95
t-statistic	198.47	10.07	-11.67	4.14	225.44	1.97

Note: All monetary variables are expressed in NT dollars and deflated to the year of 2016. All variables are defined in Table 1.

¹ We obtain the F-statistics of 9.236 and the probability of 0.000 from the Chow test and thus reject the null hypothesis. This result suggests that the difference does exist in the relation between international and non-international audit firms and that the investigations of the different performance between these audit firms is still an empirical issue.

4.3. Empirical Results

4.3.1. Tests of APEs on Revenues of International Audit Firms

Instead of the simpler Cobb-Douglas (log-linear) form, we employ the more flexible trans-log functional form and assess whether the following conditions on Equation 4 are satisfied:

$$\alpha_{ij} = \beta_{i1} = \gamma_{i1} = \mu_{11} = 0(9)$$

Equation 9 is used to test the suitability of the trans-log function in this study. The test result (F-statistic=210.467; p=0.000) rejects the null hypothesis of log-linear specification, suggesting that the trans-log model is more suitable than the Cobb-Douglas model for analyzing the revenue function of our sample firms.

We report the parameter estimates and test results for the revenue function in Table 4, which shows that our explanatory variables (e.g., EDU, EXPER, and TRAIN) appear in three terms, including interaction and quadratic terms. In econometrics, both interaction and quadratic terms should be considered in determining the relationship between these pivotal explanatory variables and the outcome variable. Therefore, we use coefficient estimates from the regression results to calculate the APEs of the human capital inputs, formal education (EDU), work experience (EXPER), and professional training (TRAIN).

Table 4. Performance comparisons between international and non-international firms.

Variables	Estimates	P-value
Intercept	-1.7405	0.7901
lnEDU	-4.0513	0.2231
lnEXPER	5.7561	0.0001
lnTRAIN	-0.0859	0.1408
lnEMPLOYEE	-2.0831	0.0000
lnPRICE	1.9716	0.0000
1/2(lnEDU) ²	-4.6117	0.0000
1/2(lnEXPER) ²	-2.5462	0.0000
1/2(lnTRAIN) ²	0.0240	0.0000
1/2(lnEMPLOYEE) ²	-0.2027	0.0000
1/2(ln PRICE) ²	-0.0305	0.0000
(lnEDU)(lnEXPER)	2.9722	0.0000
(lnEDU)(lnTRAIN)	0.1005	0.0000
(lnEXPER)(lnTRAIN)	-0.0225	0.0020
(lnEDU)(lnEMPLOYEE)	1.6663	0.0000
(lnEXPER)(lnEMPLOYEE)	0.0803	0.0875
(lnTRAIN)(lnEMPLOYEE)	-0.0029	0.1304
(lnEDU)(lnPRICE)	0.1948	0.0002
(lnEXPER)(ln PRICE)	-0.4276	0.0000
(lnTRAIN)(ln PRICE)	-0.0170	0.0000
(lnEMPLOYEE)(ln PRICE)	-0.0934	0.0000
BIGN	-43.8243	0.0004
BIGN(lnEDU)	11.7604	0.0064
BIGN(lnEXPER)	3.4144	0.0311
BIGN(lnTRAIN)	-0.0317	0.4489
TIME	-0.00117	0.0000
TIME ²	0.0005	0.0000
Adjusted R ²	0.8016	
N	22,875	
Test of log-linear specification (H ₀ : α _{ij} = β _{i1} = γ _{i1} = μ ₁₁ = 0)		
F-statistic	210.4674	

The APEs are summarized in Table 5. As shown, compared to non-international firms, international firms (BIGN) have significantly positive APE_{BIGN} (1.3242, p<0.01). It suggests that the audit firm size affects the financial performance of audit firms and thus that APEs on audit firms' revenues are greater for international audit firms than for non-international audit firms. Hence, H1 is supported. The results are consistent with prior studies showing that audit firm size is positively associated with audit pricing (Niemi, 2004) that Big 4 audit firms, as industrial leaders, earn a significantly high fee premium from audits (Kharuddin & Basioudis, 2018). In addition, international audit firms succeed in differentiating their products and services from those of non-international firms, which allows them to charge higher audit fees than do others (Moizer, 1997). Moreover, we also report the APEs of formal education (APE_{EDU}), work experience (APE_{EXPER}), and professional training (APE_{TRAIN}) on the revenues of international and non-international audit firms in Table 5.

Table 5. Average partial effects (APEs): International versus non-international firms.

APEs	Mean	P-value
APE_BIGN	1.3242	0.0000
APE_EDU		
International firms	11.9325	0.0000
Non-international firms	0.1721	0.0000
Difference	11.7604	0.0064
APE_EXPER		
International firms	3.6293	0.0000
Non-international firms	0.2149	0.0000
Difference	3.4144	0.0311
APE_TRAIN		
International firms	-0.0178	0.0000
Non-international firms	0.0139	0.0000
Difference	-0.0317	0.4489

4.3.2. Tests of Formal Education on Revenues

As shown in Table 5, the APEs of formal education (APE_EDU) are significantly positive. When BIG N equals 1 and 0, their means are 11.9325 and 0.1721, respectively. These results indicate that both international and non-international firms obtain positive returns on their investments in formal education. Further comparisons indicate that the returns are much larger for international firms than for non-international firms ($p < 0.01$). H2a and H2b are supported. Findings above are consistent with the notion that knowledge is a key determinant of the audit firm performance (Morris & Empson, 1998) and the success of audit firms greatly relies on a workforce with substantial expertise acquired from formal education (Von Nordenflycht, 2010). Findings are also consistent with Chen et al. (2020) finding that international audit firms experience an increase in their operating performance as auditors' levels of education increase. Further, our results confirm that education level of auditors is positively associated with audit fees (Niemi, 2004) and echo that auditors with a master's degree exert more effort than those with a bachelor's degree (Che et al., 2018). Unlike undergraduate courses, courses in the master program fully equip students with in-depth theoretical knowledge about audit processes, auditing standards, authority regulation, taxation, and valuation and further develop students' ability to critically reflect on ethical dilemmas.

In addition, we plot the relationship between formal education and revenues for international and non-international audit firms, as shown in Figure 1. Overall, the curvilinear relationship is a concave pattern. In Figure 1 (a), the slightly concave pattern indicates that revenues of international firms increase at a nearly fixed rate as the auditors' educational level increases. This positive revenue elasticity with respect to formal education indicates that international audit firms are advised to hire more well-educated auditors to generate service revenues. In Figure 1 (b), the concave pattern also shows that when non-international firms hire more well-educated auditors, revenues increase sharply before the turning point and then decrease sharply after. These results show that non-international audit firms may consider hiring more well-educated employees to enhance service revenues, but if such investment goes beyond the optimal level, negative returns will appear.

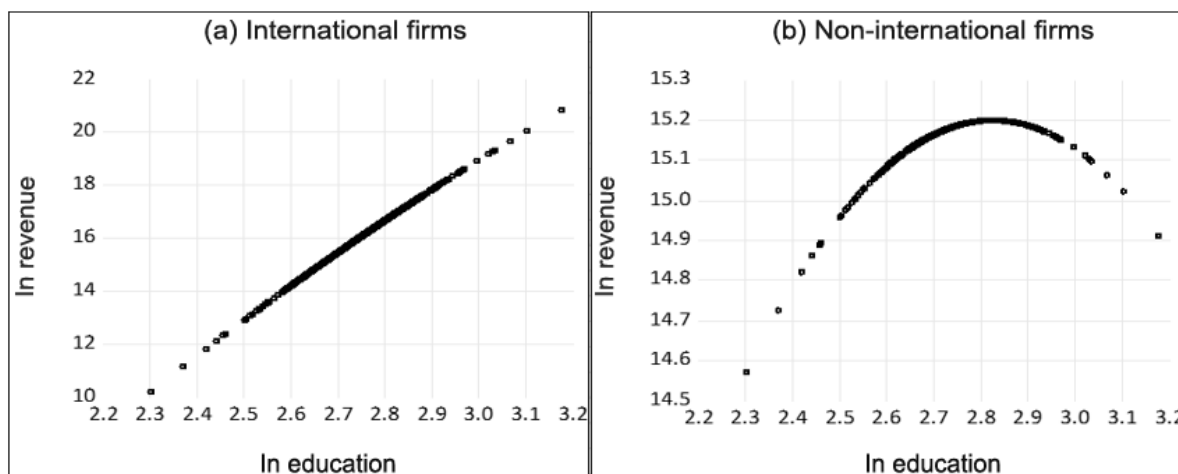


Figure 1. Graph of curvilinear relationship between formal education and revenues.

4.3.3. Tests of Work Experience on Revenues

Table 5 indicates that the APE of work experience (APE_EXPER) is significantly positive for international firms (3.6293, $p < 0.01$) and non-international firms (0.2149, $p < 0.01$), with a significant difference between

them (3.4144, $p < 0.05$). These results suggest that investments in an experienced workforce help enhance total revenues for audit firms and that such revenue enhancement is larger for international firms. H3a and H3b receive support. Our results are consistent with the extant literature that higher work experience is positively associated with audit quality, audit fees, and audit firm performance (Bröcheler et al., 2004; Cheng et al., 2009; Niemi, 2004). This positive relationship indicates that work experience can broaden and accumulate an auditors' knowledge base of auditing techniques, which ensures high-quality audits (Libby & Frederick, 1990) and leads to higher audit firms' revenues.

Figure 2 plots the relationship between work experience and revenues for international and non-international audit firms. Figure 2 (a) shows a concave pattern that, as international audit firms hire a well-experienced workforce, their revenues increase at a nearly fixed rate and then decrease. Hence, international audit firms are advised to hire well-experienced auditors to boost revenues. In Figure 2 (b), the curvilinear is concave downward and has an inflection point as well. Particularly, when non-international audit firms invest more in experienced auditors, revenues sharply increase and sharply decrease after reaching the optimal point of work experience. In a word, investments in an experienced workforce may help non-international audit firms enhance total revenues, but if these investments are beyond the optimal level, they will obtain negative returns.

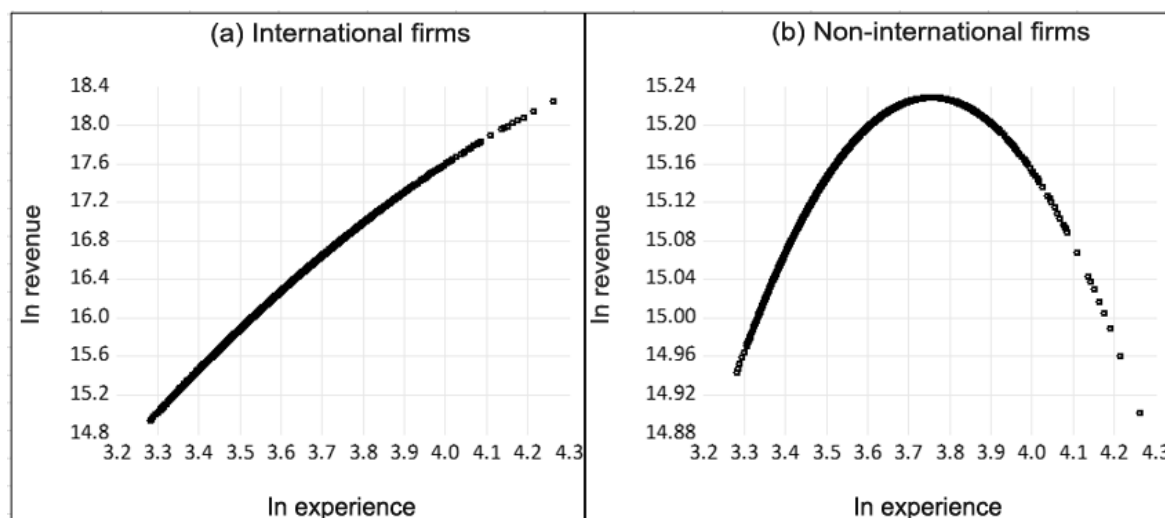


Figure 2. Graph of curvilinear relationship between work experience and revenues.

4.3.4. Tests of Professional Training on Revenues

In Table 5, the APE of professional training (APE_TRAIN) is significantly negative for international audit firms (-0.0178, $p < 0.01$) but significantly positive for non-international firms (0.0139, $p < 0.01$). This indicates that investments in professional training generate negative revenues for international audit firms but positive revenue for non-international firms, which means that H4a and H4b are not supported. Results above are inconsistent with the prior research (Che et al., 2018; Yang et al., 2013). Reasons, according to practitioners, behind this unexpected result is that investment in professional training brings no immediate returns to audit firms but future returns instead.

The relationship between professional training and revenues is plotted for international and non-international audit firms in Figure 3. As shown, Figure 3 (a) is a convex pattern, which means that when international audit firms invest in professional training, their revenues decrease to a turning point and then increase afterwards. Similarly, Figure 3 (b) indicates that, when non-international audit firms invest in professional training, their revenues decrease first and then increase after reaching the lowest point of professional training. Furthermore, the increases in revenues are sharper for international firms than for non-international firms.

These curvilinear relations show that, before the turning point, a negative relationship between professional training and revenues lends no support to H4a and H4b. However, after the turning point, the positive relationship between professional training and revenues does lend full support to H4a and H4b. Our partial support for H4a and H4b suggests that audit firms need sufficient time to properly train their auditors to respond to their audit clients. This partial effect is supported by the human capital theory, which predicts that the initial gain in productivity from on-the-job training is quite low (e.g., less than 50 percent of cost recovery) because a large proportion of working time is spent learning rather than producing (Maranto & Rodgers, 1984) and that on-the-job training is a process that raises future productivity (Becker, 1962).

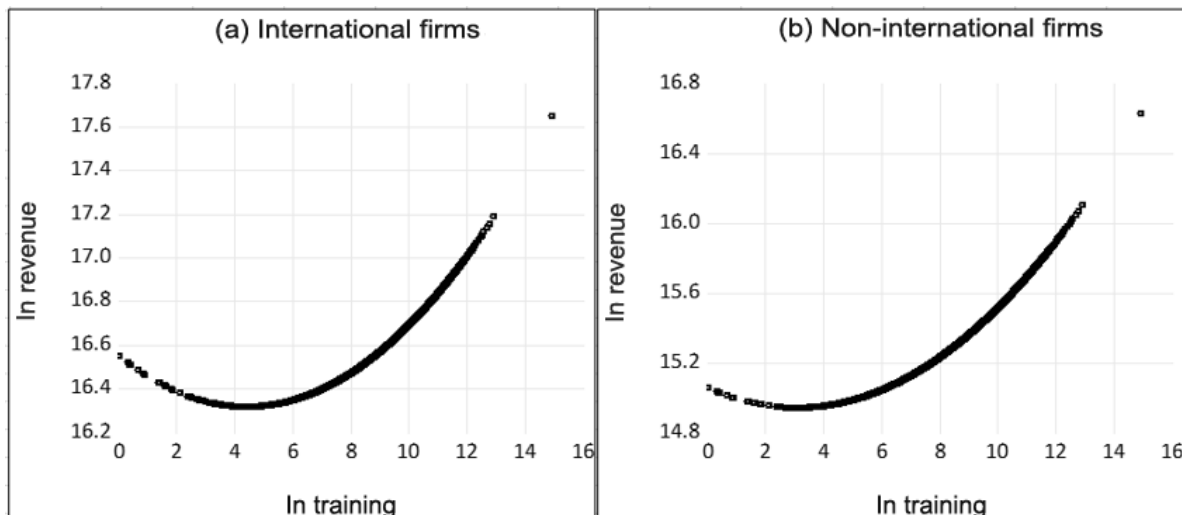


Figure 3. Graph of curvilinear relationship between professional training and revenues.

In summary, our results indicate that the investments in formal education and work experience of auditors help audit firms enhance service revenues substantially and that the revenue enhancement is much larger for international audit firms than for non-international audit firms. These results suggest that audit firms may consider investing more in auditors' formal education and work experience to benefit the growth of service revenues, especially international audit firms, which benefit the most from the investments. However, audit firms may need to consider the possibility that, after some optimal level of investment in formal education and work experience, there may be diminishing marginal returns on such investments. In addition, investments in professional training are needed to accumulate auditors' esoteric expertise for the growth of future productivity and profits.

5. Conclusion

5.1. Findings

This paper aims to examine the role of formal education, work experience, and professional training in the revenue enhancement of audit firms. Our results show that investments in a higher-educated and well-experienced workforce help audit firms significantly enhance their revenues. Such a revenue enhancement is much larger for international audit firms than for non-international audit firms. However, audit firms may need to consider the possibility that, after some optimal level of investment in formal education and work experience, there may be diminishing marginal returns on such investments. We also find a lagged return on professional training investments because audit firms initially obtain significantly negative revenues and then subsequently gain significantly positive revenues from the investments.

5.2. Practical Implications and Future Study

Our finding of a lagged return on professional training investments indicates that, to cope with the ever-changing business environment, professional training is a needed process to raise future revenues. Although the initial investment in professional training brings about a negative return, audit firms will be rewarded with a positive return after some periods of time. Dual market structure exists in Taiwan, which includes a few international audit firms and many non-international firms. Non-international firms account for over 99% of the audit firms and include proprietorship and partnership firms. By market segmentation, future studies are advised to divide non-international firms into national, regional, and local firms to explore the relationship between human capital and revenues.

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