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The relationship between auditor characteristics with intellectual capital and knowledge-based economy

Abbas Koolivand
Department of Accounting, Kashan Branch, Islamic Azad University,Kashan, Iran
abbas_koolivand2000@yahoo.com

Mahdi Salehi
Department of Economics and Administrative Sciences, Ferdowsi University of Mashhad, Mashhad, Iran.
(Corresponding Author)
Mehdi.salehi@um.ac.ir

Meysam Arabzadeh
Department of Accounting, Kashan Branch, Islamic Azad University, Kashan, Iran
arabzadeh62@yahoo.com

Hassan Ghodrati
Department of Accounting, Kashan Branch, Islamic Azad University, Kashan, Iran
dr.ghodrati42@gmail.com

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ABSTRACT

The current study investigates the relationship between intellectual capital and knowledge-based economy indexes with auditor characteristics.

The knowledge-based economy indexes include innovation, human resources and education, information and communication infrastructure, and economic and institutional regimes. Auditor characteristics include auditor accuracy, auditor specialization in the industry, auditor interlock, and auditors' financial independence. The method of the study is descriptive correlational research. It is based on the companies' information on the Tehran Stock Exchange from 2012 to 2018. The sample consists of 187 companies (1310 observations). The method to test the hypotheses is linear regression using panel data.

The results indicate a positive and significant relationship between intellectual capital and knowledge-based economy indexes with auditor characteristics. Therefore, improving intellectual capital and knowledge-based economy indexes enhances the auditor's characteristics.

This study presents valuable insights concerning the impact of intellectual capital and a knowledge-based economy on auditors' characteristics, especially in Iran's emerging financial market, with serious competition in the audit market.

Keywords: Knowledge-Based Economy, Intellectual Capital, Auditor Independence, Auditor Interlock, Auditor Industry Specialization

1. Introduction

The importance of reporting the intellectual property of knowledge-based companies becomes increasingly evident due to the increased economic tendency towards being more knowledge-based and the improvement and growth of these knowledge-based companies. Audit firms are specific service organizations whose physical assets are less than their intangible assets and are more dependent on the knowledge and skills of specialist auditors. So, their clients' and stakeholders' services are better than other companies and are based on expert knowledge (Hui and Chen, 2019; Kaawaase, Bananuka, Kwizina, and Nabaweesi, 2019). Intellectual capital, especially human capital, is a vital strategic resource in organizations. They play a significant role in competitive markets and are among the necessary elements/items for organizations' survival (Wu Zhanxia, 2011). Organizations must establish a good relationships with people outside the company to maintain the employees' expertise and skills in the business units. They also need to build support systems such as laws, policies, and procedures. Therefore, both necessary factors in fulfilling/realizing human capital values, structural and relational capital, are being provided (Lee and Lin, 2019). Besides professional competence in improving audit quality, auditors must have/possess a high professional code of ethics and values to maintain an independent view. This especially becomes evident when faced with ethical dilemmas and client pressures (Mappanyuki, 2016; Naslmosavi and Jahanzeb, 2017). Auditing is a product that provides professional services for the company. It determines the quality of the information that annual managers report affects the quality of auditors' services. Knowledge-based business units and intellectual capital-based companies provide more precise information.

Earlier studies used different approaches to reveal the importance of intellectual capital and a knowledge-based economy in business success (Chao et al., 2020). Intellectual capital is categorized into human, structural, and relational capital (Marr, 2008; Bernard Marr and Moustaghfir, 2005). Human capital refers to high competencies, expertise, and education-based labour. Structural capital is intangible organizational capital, including innovation and process capital.
It consists of two parts.

The first part includes patents, trademarks, copyright, and goodwill. The second refers to operational procedures, systems, laws, and strategies. Relational capital refers to the relationships with external bodies such as customers, recipients, and rivals. It is reflected in the relations, collaboration, client loyalty, brand value, and corporate reputation (Cagáňová, Hlásniková, Vraňaková, and Chlpeková, 2019; F. Nancy, 2020; Hui and Chen, 2019; Lee and Lin, 2019).

Lee and Lin (2019) showed that intellectual capital and its components profoundly affect the firm's performance. Intellectual capital and the knowledge-based economy restrict and check the personal judgments and behaviours in the business units. They require everyone to act according to the laws to improve quality (Lee and Lin, 2019). Identifying the employees' spiritual resources helps business units to achieve their goals (Porth, McCall, and Bausch, 1999). Spiritual capital affects firm performance (Roosevelt, Malloch, and Naughton, 2010) and improves the performance of intellectual capital components. Spiritual capital also affects the knowledge-based economy's improvement and helps develop a knowledge-based economy (Islami, 2005).

Furthermore, by reviewing the subject literature, we found that so far, the conducted studies on the knowledge-based economy and intellectual capital were largely related to human resource management (Yong et al., 2019), business sustainability (Yusof et al., 2019), sustainable performance (Usliz et al., 2020), environmental performance (Yadiati et al., 2019), and competitive advantage (Kahiono and Hakim, 2020). However, the characteristics of auditors, which play a significant role in the decision-making of users of financial statements, are less considered with intellectual capital. In contrast, Delgado Verde et al. (2014) stated that intellectual capital improves the performance of institutions. Therefore, the present study may have potential implications for audit firms operating in emerging economies/countries. Therefore, it will be vital to check the validity of this research in the context of a developing country, like Iran, with acute political and economic problems and in the shadow of severe economic sanctions. Researchers such as Mulgan (2006) and Basu et al. (2019) argued that intellectual capital and social innovation are vital ways to use the adverse effects of the manufacturing sector, which can increase the social responsibility of

business units. In this regard, Song (2022) also stated that the social performance of companies has led to an increase in the social responsibility of auditing institutions, therefore, it also increases the quality of auditors, so it can be said that intellectual capital also improves the performance of auditors. Since until now, there has been no research on the relationship between intellectual capital and a knowledge-based economy with the characteristics of auditors (such as the auditor's accuracy, auditor's industry expertise, auditor's cooperation, and auditor's financial independence); the present research can fill this research gap to help the development of science and knowledge in this field. Therefore, the main problem of this research is to examine the relationship between intellectual capital and a knowledge-based economy with the audit characteristics of Iranian companies. Since Iran is an emerging market with a developing economy, investigating such a phenomenon can bring useful information to everyone. Because in recent decades in Iran, the problem of the knowledge-based economy and intellectual capital of business units has been at the center of attention. In the following sections, the theoretical foundations and background of the research are discussed, and the methodology, data analysis, discussion, and conclusions are presented in the third to fifth sections.

Intellectual capital and a knowledge-based economy are important because they even affect annual reports and business units' financial reporting. The business units' auditors assess the audit risks of the reports in their contracts. They plan their control and content tests according to these risk assessments. So, intellectual capital affects the audit report process and quality through the auditor's independence and specialization. Therefore, this study's primary concern is analyzing the relationship between intellectual capital and a knowledge-based economy with Iranian firms' audit qualities. This study can provide valuable insights since the Iranian market is an emerging market with a developing economy. Over the past decades, studying the knowledge-based economy and intellectual capital has received special attention in Iran. The following sections include a theoretical foundation. Then the Research method, data analysis, discussion, and conclusions are mentioned.

Theoretical issues and hypothesis development

By emerging the knowledge-based economy and knowledge-based competition, organizations / corporations emphasize organizing the knowledge assets and values. Knowledge, the most significant capital in today's economy, has replaced financial and physical assets. Therefore, knowledge is regarded as the economy's important input and a necessary consequence. During this time, organizations' success depends on earning intangible assets that provide a stable competitive advantage. Intellectual capital is an outcome/the combination of intangible resources and the activities that allow organizations to re-create their financial, material, and human resources. So it has become a significant factor in intelligent development as the most valuable asset and robust competitive resource (Al-Khtib, 2022). Experts consider intellectual capital the firm's intangible and mental resources and assets. Organizations create value and new services by re-producing these assets. In this leading environment, the business units with permanent improvements in intellectual capital will make more progress. The benefits of assessing different intellectual capital aspects are identifying and determining intangible assets, recognizing the organization's knowledge flow patterns, prioritizing the main knowledge topics, accelerating the organizational learning patterns, and creating a practical. While intellectual capital accounting is a future-based procedure that assesses the qualities, financial accounting assessment procedures have past tendencies and assess the quantities. Reporting information about intellectual capital reduces information asymmetry, improves stakeholders' decision-making, and optimally allocates resources. Auditing characteristics such as auditor specialization, financial independence, auditor accuracy, and auditor interlock affect audit qualities. They also affect the reporting and assessment of intellectual capital and knowledge-based economy. Intellectual capital and a knowledge-based economy positively influence business units' financial reporting and help business units in beneficial planning and financial reporting. Studies in auditing indicate that knowledgeable and expert auditors can provide higher-quality services (Cheng, Liu, and Chien, 2009; Naslmosavi and Jahanzeb, 2017; Roosevelt Malloch and Naughton,

2010). Auditors with a professional code of ethics provide more objective opinions (Saputra, 2015) and more credible information for the public (Cheng et al., 2009). Therefore, training talented and knowledgeable employees will improve auditing and financial reporting (Earnest, Chamian, and Saat, 2015). Ni, Huang, and Liu (2019) showed that the following factors significantly affect audit quality. The factors include education, expertise, age, experience, and learning ability. They mentioned that the companies' tendency to investigate personnel training for improving human capital also enhances audit quality. Since industry specialization helps auditors obtain sufficient evidence for checking accounts, corporations with more industry specialization also apply knowledge and professional skills more effectively to perform auditing activities (Yen, Lim, Wang, and Hsu, 2018). Since Knowledge-based economy and intellectual capital identify and prevent the manager's and business units' earnings management, they also affect audit quality (Balsam, Krishnan, and Yang, 2003; Chin and Chi, 2009; Fleming, Hee, and N. Romanus, 2014). Finally, industry specialization is affected by the business units' intellectual capital and knowledge capital. Rapid technology improvements have altered customer-relationships ways and economic activities. It has also updated the business units' processes and accelerated information exchange. Businesses compete over intellectual capital and a knowledge-based economy that emphasizes knowledge. Since the following factors are good audit quality indicators, audit pricing policies must also significantly affect audit quality. Such factors are audit fees, auditor industry specialization, and financial independence (Simunic, 1980; DiAngelo, 1981). Higher quality services usually have higher prices (Rahmina and Agoes, 2014; Suseno, 2013). Reputable companies typically pay insurance premiums to enhance the quality of their services. The customer's amount of work determines the service pricing and the corporate's reputation. The following factors depend on the business units responsible for their audit complexities. These factors are audit quality, fees, auditor's financial independence, industry specialization, and accuracy. Chao et al. (2020) showed a significant positive relationship between intellectual capital and audit quality in Chinese firms based on auditors' focus. They showed that intellectual capital improves the quality of auditing and its services.

Samimi, M., Mirjomehri, A., & Ghorbani, R. (2022) also showed that intellectual capital and a knowledge-based economy lead to increased innovation and performance of business units. Al-Khatib (2022) showed a positive and significant relationship between intellectual capital and its components with companies' innovation performance. In this way, intellectual capital strengthens the innovation of companies. Ali et al. (2022) showed that intellectual capital has a positive and significant effect on the performance of institutions. Ali et al. (2021) also found that human capital, structural capital, and relational capital significantly affect human resource management. Ali and Anwar (2021) showed that intellectual capital and its components lead to value creation for institutions. Yeh et al. (2018) state that there is a positive and significant relationship between audit fees and audit quality.

Accordingly, the research hypotheses are as follows:

H1: There is a significant relationship between intellectual capital and auditor characteristics.

H2: There is a positive relationship between the knowledge-based economy and auditor characteristics.

Research Methodology

This research is of causal correlation type. Its methodology is quasi-experimental and post-event type. This study is in the field of positive accounting research done with real information/data. In terms of nature and goals, this is applied research. Applied research aims to develop applied knowledge in a specific field. At the same time, this research is causal-correlational regarding data collection and analysis methods.

Statistical Population

This research's Statistical Populations include all the listed companies on the Tehran Stock Exchange from 2012 to 2018.

Data Collection Methods

Systematic removal sampling is used for data collection. The following conditions obtain the final statistical sample:

1) To have been listed on the Tehran stock exchange by the end of 2011
2) To fully provide the required financial data for this study during the research period.

3) Not to be part of the following companies: the banks, investment, insurance, and financial intermediation companies.

The final sample is presented in table (1) based on the collected data at the end of 2018

Data Collection Methods and Instruments

Data for the research literature and theoretical topics will be collected from library sources such as Persian and Latin books, publications, and websites. Information about companies (balance sheet and profit and loss statement) has been used as a research instrument. The required data for testing the **hypotheses** are collected from the following sources. The Tehran Stock Exchange database includes Tadbir Pardaz and Rahavard Novin, the Tehran Stock Exchange Organization report, and other required sources. These reports are collected through direct access (by analyzing the disclosed reports on the Codal website and then manually collecting them). The issued reports are presented as a CD by the Tehran Stock Exchange and on the rdis.ir site.

Data analysis and method

The data analysis method is cross-sectional. The Multivariate Linear Regression method has been used to test the research hypotheses. Descriptive and inferential statistical methods have been used to analyze the obtained data. Thus, to describe the data, the frequency distribution table is used. The following tests are used to test the research hypotheses at the inferential level. These tests are the F-Limer test, Hausman test, normality test, and Multiple Linear Regression test.

Research model

Model (1) is used to test the first research hypothesis as follows:

Model (1)

$$\begin{aligned} AIS_{it} = a_0 &+ a_1 lnis_{it} + a_2 lnes_{it} + a_3 lneir_{it} \\ &+ a_4 lniacl_{it} + a_5 INCAP_{it} \\ &+ a_6 lnafee_{it} + a_7 BIG1_{it} \\ &+ a_8 age_{it} + a_9 loss_{it} + a_{10} ROA_{it} \\ &+ a_{11} LEV_{it} + a_{12} MODIF_{it} \\ &+ a_{13} size_{it} + a_{14} rest_{it} \\ &+ a_{15} BIND_{it} + a_{16} BUSY_{it} \\ &+ a_{17} mchange_{it} \\ &+ a_{18} mtenure_{it} + a_{19} msf_{it} \\ &+ a_{20} msi_{it} + a_{21} bsf_{it} + a_{22} bsi_{it} \\ &+ a_{23} Year_{it} + a_{24} Industry_{it} \\ &+ \varepsilon_{it} \end{aligned}$$

Model (2) is used to test the second research hypothesis as follows:

Model (2)

$$\begin{aligned} Audit.Acc_{it} = a_0 &+ a_1 lnis_{it} + a_2 lnes_{it} + a_3 lneir_{it} \\ &+ a_4 lniacl_{it} + a_5 INCAP_{it} \\ &+ a_6 lnafee_{it} + a_7 BIG1_{it} \\ &+ a_8 age_{it} + a_9 loss_{it} + a_{10} ROA_{it} \\ &+ a_{11} LEV_{it} + a_{12} MODIF_{it} \\ &+ a_{13} size_{it} + a_{14} rest_{it} \\ &+ a_{15} BIND_{it} + a_{16} BUSY_{it} \\ &+ a_{17} mchange_{it} \\ &+ a_{18} mtenure_{it} + a_{19} msf_{it} \\ &+ a_{20} msi_{it} + a_{21} bsf_{it} + a_{22} bsi_{it} \\ &+ a_{23} Year_{it} + a_{24} Industry_{it} \\ &+ \varepsilon_{it} \end{aligned}$$

Model (3) is used to test the third research hypothesis as follows:

Model (3)

$$\begin{aligned} ainter_{it} = a_0 &+ a_1 lnis_{it} + a_2 lnes_{it} + a_3 lneir_{it} \\ &+ a_4 lniacl_{it} + a_5 INCAP_{it} \\ &+ a_6 lnafee_{it} + a_7 BIG1_{it} \\ &+ a_8 age_{it} + a_9 loss_{it} + a_{10} ROA_{it} \\ &+ a_{11} LEV_{it} + a_{12} MODIF_{it} \\ &+ a_{13} size_{it} + a_{14} rest_{it} \\ &+ a_{15} BIND_{it} + a_{16} BUSY_{it} \\ &+ a_{17} mchange_{it} \\ &+ a_{18} mtenure_{it} + a_{19} msf_{it} \\ &+ a_{20} msi_{it} + a_{21} bsf_{it} + a_{22} bsi_{it} \\ &+ a_{23} Year_{it} + a_{24} Industry_{it} \\ &+ \varepsilon_{it} \end{aligned}$$

Model (4) is used to test the fourth research hypothesis as follows:

Model (4)

$$\begin{aligned}\text{aind}_{it} = a_0 &+ a_1 lnis_{it} + a_2 lnes_{it} + a_3 lneir_{it} \\ &+ a_4 lniacl_{it} + a_5 INCAP_{it} \\ &+ a_6 lnafee_{it} + a_7 BIG1_{it} \\ &+ a_8 age_{it} + a_9 loss_{it} + a_{10} ROA_{it} \\ &+ a_{11} LEV_{it} + a_{12} MODIF_{it} \\ &+ a_{13} size_{it} + a_{14} rest_{it} \\ &+ a_{15} BIND_{it} + a_{16} BUSY_{it} \\ &+ a_{17} mchange_{it} \\ &+ a_{18} mtenure_{it} + a_{19} msf_{it} \\ &+ a_{20} msi_{it} + a_{21} bsf_{it} + a_{22} bsi_{it} \\ &+ a_{23} Year_{it} + a_{24} Industry_{it} \\ &+ \varepsilon_{it}\end{aligned}$$

Dependent variables

1) **Auditor financial independence (A. Ind):** This equals the sum of the fees received by each auditing firm each year from every employee divided by the sum of all fees received by the auditors in each industry. If this ratio is more than 0.5, it is zero and shows a lack of independence, and if it is less than 0.5, it equals one and shows the auditor's financial independence.
2) **Auditor Industry Specialization (A. In):** The auditor's industry specialization is i in year t. Since this study shows the industry's priority over other auditors, the market share is considered an indicator of auditor industry specialization. The higher the auditor's market share, the higher his/her industry specialization and experience are compared to other auditors. Auditors' market share is calculated as below:

   Equation (1)

   Total assets of all employees/owners of each specific auditing firm in a particular industry

   Total assets of all employees/owners in a particular industry

In this study, the industry specialization institutions are the institutions with market share, i.e., a ratio of more than 1.2 [1.2 * (the number of all the companies of existing companies / 1)]. If the audit institution's market share is higher than the above equation, it is an industry expert. Hence, if the audit institution is an expert in the industry, it equals one and zero otherwise (Habib and Bihoyan, 2011).

3) **Auditor accuracy (Audit.Acc):** This variable equals one; otherwise, zero if, According to Altman Z-Score, the company is subject to discontinuance, but the auditor has not mentioned it in the report, or he/she has not mentioned the financial balance.
4) **Auditor interlock (A. Inter):** If the audit institution/organization has analyzed another company this year, it equals one and otherwise zero.

Independent Variables

1) Intellectual Capital (INCP): Pulic Model (2000) and its modified version by Chang (2007) for the coefficient of intellectual capital value added is used to calculate intellectual capital.

According to the Palic model, value-added results from the difference between outputs and inputs.

VA = OUT - IN[۱]

The value added = outputs – inputs

In this model, the salary and wage costs are not included in the input due to human resources' active role in the value creation process. Therefore, the employees' expenses are not considered as costs but as investments.

VA = OP + EC + D + A[۲]

Value Added = Operating Profit + Labor cost + Depreciation of fixed assets + Depreciation of intangible assets

Human Capital Efficiency (HCE)

According to the Chang model, human capital efficiency is calculated as follows: how much-added value is gained from one rial for wage and salary expenses.

HC = IHR[۳])

Human Capital = Human Capital Investment

HCE = VA ÷ HC[٤])

Human capital Efficiency = value Added ÷ Human Capital

Human capital includes the following expenses: direct and indirect wage expenses, sales, marketing, and administrative expenses.

2) structural capital efficiency (SCE)

This coefficient represents/shows the company's structure and process value-added. It shows what percent of the value-added is from structural capital (Chang, 2007). Pulic stated that there is a proportional inverse relationship between structural capital and human capital. Hence, the structural capital and its efficiency are calculated by the following equation:

SC = VA – HC[5])

Structural Capital= Value-Added – Human Capital

SCE = SC ÷ VA[6])

Structural Capital Efficiency= Structural Capital ÷ Value-Added

Nazari (2010), by applying Edinson and Malone's model (1997), states that structural capital consists of two elements, including Client capital and Organizational capital. Hence, structural capital efficiency is client and organisational capital efficiency. It is calculated as follows:

SCE = (CC ÷ VA) + (OC ÷ VA)[7])

Structural Capital Efficiency= (Client Capital ÷Value-Added) + (Organizational Capital ÷Value-Added)

The two following equations are used to calculate client capital and organizational capital:

OC = D&S[8])

Organizational capital =Advertising and marketing expense/cost

CC = SC – OC[9])

Organizational capital= structural capital – client capital

CCE = CE ÷ VA [10])

Communication Capital Efficiency= Communication Capital÷ Value-Added

3) Knowledge-Based Economics: The world bank's index of the Knowledge-based economy is the most significant in the knowledge-based economy. Since some parts of this data are unavailable in Iran, only the accessible sections are used. This index was introduced by the world bank in (1998), with five sub-fields. Later in (2008), it was introduced as a knowledge-based economy with four indexes by eliminating the performance indicator. Winchuk et al. (2014) modified the components (in an essay) using information technology standards and high-tech products. The present study has considered Winchuk et al.'s (2014) components for institutional regimes and innovation systems indexes. However, in the Human Resources Index section, due to the lack of access to the data used in the study of Winchuk et al. (2014), the components of human education of the World Bank will be used. Since various studies used the education costs/expenses basics, this index applies the knowledge-based economy expenditures. In this study, due to the unavailability of personal computer component data, instead of the five components of Winchuk et al. (2014), four elements are used:

Indexes of Innovation Systems (InIS)

Residents Patent Application

This is society's application for new products, processes, modes of operation, modern solutions, or solving previous problems. A 20-year exclusive advantage is also provided. This variable unit is a number, and the world bank is its source.

Non-resident (patent) Application

Non-resident patent applications are applications made by non-citizens in that community. It has similar advantages and definitions as resident patent applications, and its source is also the World Bank.

Research and Development Scholars

Several scholars and professionals present or develop modern concepts, tools, and theories. Hence, it includes basic, applied, and experimental research. Its source is also the world bank.

Scientific and technical articles

This variable includes all the published articles in Physics, Chemistry, Mathematics, Medicine, Environment, Bio-medicine, Engineering, Technology, and Earth and Space Sciences. Its source is also the world bank.

Research and development expenditure

This equals the percentage of Gross domestic product (GDP): GDP consists of the capital and current expenditures in the four following sections: corporate, government, higher, and informal and private education. This variable is a percentage of GDP, and the world bank is its resource.

Gross Domestic Expenditure on Research and Development (GERD)

The unit of this variable is the dollar's purchasing power, and uis.unesco.org is its source.

Hi-Tec manufactured products

These are the products from extensive research and development. The world bank is its source.

Hi-Tec goods for export

These are the products from extensive research and development. The world bank is its source.

Export of ICT Goods

This variable means Information and communication technology goods exports. The world bank is its source.

indexes of Education and Human Resources (Ines)

High school Enrollment

It equals the number of people who enrolled in high school, regardless of age. It is considered relative to the total population in percent. Its source is also the world bank.

Enrollment in the third period/year of high school

It is the same as the previous index, and it is also regardless of the age of the people. Its source is also the world bank.

Education Expenditure

This index equals the Government Expenditure in the education sector in percentage. Its source is the world bank.

Adult Literacy Rate

This variable is the percentage of people over 15 years with a minimum literacy who can read and write a brief, simple statement on their everyday life. Its source is the world bank.

The infrastructure of Information and Communication Indicators indexes (lniacl)

Fixed Broadband

A fixed broadband subscription includes fixed subscriptions to high-speed access to the public Internet. It is kilo-bite per second, and its source is the world bank.

Telephone lines

This variable includes active landlines and public telephones. Its unit is per 100 people, and its source is the World Bank.

Mobile subscriptions

It refers to active mobile phones. Its unit is per hundred people, and the world bank is its source.

Internet users

It refers to the number of users in/during the past 12 months. Its source is the world bank, and its unit is per hundred people.

Indicators of Economic and Institutional Regimes (lneir)

Government effectiveness index

It refers to the following factors. The factors are perceptions of the quality of public and civil services and their independence from political pressures.

Other factors include the policy planning and implementation quality and the validity of the government's commitment to such policies. Its unit is a score between 2.5 negative and 2.5 positive. The World Bank's good governance site is its source.

Corruption control index

Different cultural, social, legal, and economic factors cause financial corruption. Financial corruption limits economic freedom due to insecurity and uncertainty in economic relations. A checklist is used to analyze the components in calculating this index. Such components include bribery, the appointment of relatives in important administrative jobs, extortion, and embezzlement. There is always a direct relationship between government interference in economic activities and the amount of corruption. Transparency is a powerful weapon against corruption. Transparency in the regulatory processes is a quick and effective cure against corruption. The scale/score of this index varies from 0 to 100.

The Rule of the Law Index

This index shows the Perceptions about the trust degree to the society’s rules, especially the rules concerning the quality of the following issues. Such issues refer to contract enforcement, property rights, the police and the courts, and the possibility of crime and violence. This variable's unit is the score ranging from - 2.5 to + 2.5, and its source is the World Bank good governance site variable.

The index of the quality of the law

This variable refers to the perceptions of governments' ability to implement the correct/ policies and rules that promote the private sector's development. This variable's unit is the score ranging from - 2.5 to + 2.5, and its source is the World Bank good governance site variable.

Index of Economic Freedom

This index is a combination of the following barriers. These barriers are the absence of tariff and non-tariff barriers to importing and exporting goods and services. The *trade-weighted average tariff* rate and non-tariff restrictions are considered to calculate this index. Restrictions include import and export taxes, various tariffs, and legal barriers. Non-tariff barriers range from 0 to 20 points. Zero indicates no restrictions on international trade, and 20 indicates the highest level of restriction.

Control variables

LEV: Financial leverage equals the ratio of the total debts to total assets of the company in the year under review/ within the mentioned year

Age equals the time since it was established to the year under review.

SIZE: the logarithm of the company's total assets

ROE: the result of dividing net income by the book value of the shareholders' equity

Loss: loss in the current year; if the firm is at a loss this year, it equals one; otherwise, zero.

BUSY: If the fiscal year corresponds to March 20, it equals one; otherwise, zero.

REST: if the unit re-states the last year's financial statements in the current year/year under review, it equals one; otherwise, zero.

MODIF: if the audit opinion is unmodified, it equals one; otherwise, zero.

Bind: This is the ratio of irresponsible board members to the total board members

M-change: if the manager was changed over/during the mentioned year, it equals one; otherwise, zero.

M-tenure: this was when the manager was in charge permanently until the year under review.

MSF: if the manager has a degree relevant to one of the financial majors, it equals one; otherwise, zero.

MSI: Managers specialization in the industry; if the manager has a degree relevant to the mentioned industry, it equals one; otherwise, zero.

BSF: if at least one board member has a relevant degree in one of the financial majors, it equals one; otherwise, zero.

Bsi: if at least one board member has a relevant degree in the mentioned industry, it equals one; otherwise zero.

Year: The dummy year variable.

Industry: The dummy industry variable.

Data analysis

This study applied four models to analyze the effect of intellectual capital and knowledge-based economy over auditor characteristics., i.e., (auditor industry specialization, auditor's financial independence, auditor interlock, and auditing accuracy). The study also included the panel data method, including 187 Iranian companies. The following variables are used for model evaluation. The variables include intellectual capital, social capital, the type of auditor opinion, audit report lag, and auditing quality.

Unit Root Test

By examining the unit root test for all the variables, they all are stationary. The LM statistics for each variable are reported in Table 3.

Collinearity Test

The variables do not have collinearity, according to Table 4, and they are independent of each other.

As shown in the above table, there is no alignment between any of the model variables and according to the obtained VIF statistic.

Sensitivity Test

This test examines the relationship between variables in pairs; its output is the above matrix. The matrix's diameter always equals one indicating a complete correlation because it examines the correlation between the variable and itself. Hence, the closer these numbers are to one, the higher the correlation is, and the closer they are to zero, the more unrelated they will be. The range of correlation varies from/between + 1 and _ 1. The negative numbers indicate a reverse correlation, and the positive numbers indicate a direct correlation.

Research model analysis

The F-Limer test uses panel data or pooled to evaluate the research model. The null hypothesis indicates that data are panel, and hypothesis 1 indicates that they are pooled if hypothesis 0 is rejected after the F- test. It should be determined whether Fixed-Effect or Random-Effects Model should analyze the model. The Hausman test determines it. According to the integration test results in Table 6, the null hypothesis that the data are integrated at the level of 99% confidence is rejected. Hence, the pooled model is used to evaluate the coefficients of the research model. Table (6) shows the Hausman statistic is 0.000, with a probability level of 59.17. Table (6) shows that the null hypothesis is rejected. Finally, the Fixed-Effect Model was selected as a more proper research model.
Table (6) shows a positive and significant relationship between the following variables and the auditor's specialization in the industry. The variables include intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. Their p-value is 0.000, 0.009, 0.025, 0,000, and 0,0000, which is lower than the significance level of 5%. Their coefficients are positive numbers 0.025, 0.029, 0.002, 0.056, and 0.153, showing a positive relationship between these variables and the industry specialization.

According to the integration test results presented in Table 7, the null hypothesis indicating that the data are integrated at the level of 99% confidence for the second research model is also rejected. Therefore, the panel data model should be used to estimate the coefficients of the research model. According to Table 7, the Hausman test statistic based on the research model's estimation is 75.03 with a probability level of 0.000; the null hypothesis is rejected. Therefore, the fixed effects model has been selected as the most suitable model (2).

Table 7 shows a positive and significant relationship between the following variables and the auditor's accuracy. The variables include intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. Their p-value is accordingly 0.002, 0.028, 0.045, 0.034, and 0.0000, which is lower than the significance level of 5%. Their coefficients are positive numbers 0.069, 0.057, 0.005, 0.045, and 0.216, showing a positive relationship between these variables and the auditor's accuracy.

According to the integration test results presented in Table 8, the null hypothesis indicating that the data are integrated at the level of 99% confidence for the third research model is also rejected. Therefore, the panel data model should be used to estimate the coefficients of the research model. According to Table 8, the Hausman test statistic based on the estimation for the research model is 37.71, with a probability level of 0.0197; the null hypothesis is rejected. Therefore, the fixed effects model has been selected as the most suitable model (3).

Table 8 shows a positive and significant relationship between the following variables and the auditor's interlock. The variables include intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. Their p-value is accordingly 0.004, 0.008, 0.018, 0.000, and 0.012, which is lower than the significance level of 5%. Their coefficients are positive numbers 0.026, 0.069, 0.027, 0.039, and 0.089, showing a positive relationship between these variables and auditors' interlock.

According to the integration test results presented in Table 9, the null hypothesis indicating that the data are integrated at the level of 99% confidence for the fourth research model is also rejected. Therefore, the panel data model should be used to estimate the coefficients of the research model. According to Table 9, the Hausman test statistic based on the research model's estimation is 43.54 with a probability level of 0.0040; the null hypothesis is rejected. Therefore, the fixed effects model has been selected as the most suitable model (4).

Table (8) shows a positive and significant relationship between the following variables and the auditor's financial independence. The variables include intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. Their p-value is accordingly 0.036, 0.000, 0.000, 0.010, and 0.045, which is lower than the significance level of 5%. Their coefficients are positive numbers 0.062, 0.033, 0.004, 0.120, and 0.146, showing a positive relationship between these variables and the auditor's financial independence.

Robustness tests

The research hypotheses have been tested by Random Effect Model and Liner Method to achieve better results and confirm the study results. The results are as follows:

To confirm the model's results (1), the relationship between the following variables and the auditor's specialization in the industry was analyzed by applying Random effects and the Liner method. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional regimes. Table 10 shows a significant relationship between the following variables and the auditor's specialization in the industry. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional regimes. This relationship follows the main results and confirms them. Also, according to the random effects method, there is a positive and significant relationship between these variables and the auditor's specialization in the industry. It is accepted at the significance level of 90%. Because their p-value is higher than the significance level of 5%, at the level of 99%, it is less than the significance level of 10%. Hence, it is rejected at the significance level of 99% but confirmed at the significance level of 90%. Accordingly, the results of this method also confirm the main research method. Therefore, the following positive and significant relationships can be stated more confidently. The relationship is the relationship between the following variables and the auditor's specialization in the industry. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional.

Also, to confirm the model's results (2), the random effects and Liner methods examined the model. Table 11 shows a positive and significant relationship between the following variables and the auditor's accuracy. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional regimes. Still, they are significant at a 90% confidence level. The coefficients of the variables in both methods are positive and significant. These results confirm the main results of the research.

Also, to confirm the results of model (2), the model was examined by the random effects and Liner methods. According to Table 12, based on both random-effects and Liner methods, there is a positive and significant relationship between the following variables and the auditor's interlock. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional regimes. The results follow the main methods of the study results. So, the results are reliable because two other methods also confirm the results of the main method.

The random effects and Liner methods examined the model to confirm the model's results (2). According to Table 13, and based on both Random-effects and Liner methods, there is a positive and significant relationship between the following variables and the auditor's independence. The variables are intellectual capital and innovation indexes, education and human resources, information and communication infrastructure, and economic and institutional regimes.

The results confirm the main methods of the study results. Both named methods have the same results as the main research results.

Discussion and Results

Intangible assets such as intellectual capital have become a competitive advantage for companies in the current era of the knowledge economy (Chang and Chen, 2012; Gupta and Raman, 2021). Apart from reducing costs and creating differentiation in their products, organizations have learned that emphasis on human capital is important for developing and maintaining competitive advantage (Olaraju and Masoumi, 2021). A considerable body of empirical research is available on intellectual capital, its determinants, and its consequences (Baima et al., 2020; Gupta and Raman, 2021). Moreover, the review of the literature on the consequences of intellectual capital shows that it can lead to social capital and innovation and improve the performance of institutions (Kasoga, 2020). This can ultimately help organizations gain a strong and sustainable competitive advantage in their business (Kasoga, 2020; Al-Khatib, 2022; Samimi et al., 2022). These findings provide a basis for the development of the intellectual capital model, which is particularly important for organizations.

Hence, the present study analyzed the relationship between intellectual capital and knowledge-based economy indexes with auditor characteristics. The knowledge-based economy indexes are innovation, human resources and education, information and communication infrastructure, and economic and institutional regimes.

Auditor characteristics include auditor accuracy, auditor specialization in the industry, auditor interlock, and auditors' financial independence. The hypotheses test results revealed a significant positive relationship between intellectual capital and knowledge-based economy indexes with auditor characteristics.

The knowledge-based economy indexes are innovation, human resources and education, information and communication infrastructure, and economic and institutional regimes. Auditor characteristics include auditor accuracy, auditor specialization in the industry, auditor interlock, and auditors' financial independence. Therefore, the following variables also increase the industry specialization, auditor accuracy, auditor interlock, and auditors' financial independence. The variables are intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. One way to enhance an auditor's essential characteristics that significantly affect audit quality is to increase the following factors. Such factors include intellectual capital, innovation indexes, education, human resources, information and communication infrastructure, and economic and institutional regimes. So considering these factors also improves audit quality and the position of this profession in society. This result is in line with the research results of Chao et al. (2020); Ni, Huang, and Liu (2019); Yen, Lim, Wang, and Hsu (2018); Balsam, Krishnan, and Yang (2003); and Hee and N. Romanus (2014). They showed that intellectual capital significantly affects audit quality (auditor's specialization in the industry and financial independence). This element's best application is vital since knowledge today has considerable importance worldwide for countries, especially businesses. A knowledge-based economy significantly improves business units to achieve power and more capital. The volume and impact of applying knowledge in various fields are evident to anyone, such as business units. They attempt to apply it to improve their performance. Hence, business units and countries are trying to use their economic sectors' knowledge and improve their performance. The research results generally show that economies based on knowledge, expertise, ethics, culture and values, laws, structures and characteristics of the company's relationship with customers are all factors that affect the auditor's characteristics.

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