Iranian Journal of Management Studies (IJMS)
Vol. 7, No. 2, July 2014
pp: 259-283

The Relationship between Intellectual Capital with Economic Value Added and Financial Performance

Mahdi Salehi[1*], Gholamreza Enayati[2], Parisa Javadi[3]
1. Assistant professor of Accounting, Ferdowsi University of Mashhad, Iran
2. Assistant Professor of Management, Islamic Azad University, Mashhad Branch, Mashhad, Iran
3. M.A Holder in Management, Islamic Azad University, Mashhad Branch, Mashhad, Iran
(Received: 8 May 2013 - Revised: 24 December 2013 - Accepted: 7 January)

Abstract

The purpose of the present study is to investigate the relationship between intellectual capital (human capital efficiency, customer capital efficiency, and structural capital efficiency) and economic value added of the listed companies on the Tehran Stock Exchange (TSE). The population includes 39 firms selected through systematic sampling. The data is collected from the audited financial statements of the firms provided by TSE's website from 2007 to 2010. The results of multiple linear regression analysis show that there is a significant relationship between financial performance of firms and intellectual value added, intellectual capital efficiency, relational capital efficiency, human capital efficiency, structural capital efficiency, and economic value added. However, the results of fuzzy regression analysis indicate significant relationships between the financial performance of firms and all the independent variables except structural capital efficiency and economic value added.

Keywords:

Economic value added, Financial performance, Intellectual capital, TSE.

∗ Corresponding Author Tel: +98-9121425323 Email: mehdi.salehi@um.ac.ir

Introduction

In the information age, effective use of intellectual capital is the most important factor in the success or failure of a business (Goh, 2005). For achieving superior performance and competitive advantage, firms have shifted their focus from investment on tangible assets to investment on intangibles. Intellectual capital is one of these intangibles with human capital, structural capital, and customer capital as its components (Chang, 2004). Tangible assets can be easily imitated or purchased in a free market; thus, they cannot be a strategic asset and cannot create competitive advantage for the business. Along with intellectual capital, economic value added is another measure that can help investors with their decision-making. Basically, economic value added (EVA) is the value created in excess of the required return of the firm's investors and can be used for evaluating the performance of firms and developing incentive schemes. This study can be used by investors and shareholders, managers, and members of the Board of Stock Exchange Chemical Listed Companies and Capital Market' Financial Analysts.

Review of Literature

There are various definitions of intellectual capital, some of which are listed here:

- Intellectual capital is the pursuit of effective use of knowledge (finished product) as opposed to information (raw material) (Bontis, 1998).
- Intellectual capital is a group of knowledge assets that are attributed to an organization and most significantly contribute to an improved competitive position of the organization by adding value to the defined key stakeholders (Marr, 2004).

Recently, a consensus is achieved around the components of intellectual capital (IC).

Based on the literature, IC consists of the following components:

Human capital: Human capital is the most important asset of an organization and a source of innovation and strategic renewal. Human capital is a sum of technical expertise, leadership ability, risk-taking, and problem solving ability.

Customer capital: The main theme of customer capital is the knowledge embedded in the marketing channels and customer relationships that an organization develops through the course of conducting business which will enhance its competitive advantage (Bontis, 1998).

Structural capital: Unlike human capital, there is not much consensus on the definition of structural capital. Generally, structural capital includes all the non-human storehouses of knowledge in organizations that include the databases, organizational charts, process manuals, strategies, routines, and anything whose value to the company is higher than its material value. Ghosh and Mondal (2009) argue that structural capital is the infrastructure of human capital and includes buildings, hardware, software, processes, patents, and trademarks. Diez *et al*. (2010) believe that structural capital can comprise internal factors such as infrastructure, processes, and business culture, and at the same time refers to the ability to renovate and improve.

Intellectual capital and the current accounting system

In knowledge-based economy, the growing distance between the market and book value is attributed to intangible assets that cannot be properly measured and reported within the traditional accounting framework. It is also possible for each company to use a different accounting method (Laing *et al*., 2010).

Measuring intellectual capital

Although various methods have been proposed for measuring intellectual capital, none of these methods can, in and of itself, satisfy all the needs of an organization for measuring IC. In effect, a combination of these methods must be employed for achieving better results. Some of these methods are listed below:

Balanced Scorecard (BSC): BSC of Kaplan and Norton (1992) is both a strategic approach and a performance management system that allows organizations to translate an organization's vision and strategy into tactical and operational management reality.

Skandia Navigator: This model integrates the assumptions about intellectual capital that reflects the difference between the book and market value of a firm.

Intellectual Capital Index: This index tries to provide dispersed indices into a single index and to link changes in intellectual capital to changes in the market value of firms.

Direct Intellectual Capital Method: The focus of this method is to identify and evaluate each of the components of intellectual capital.

Human Resource Accounting: This method reports the expenditures related to human resources as assets on the balance sheet as opposed to the traditional accounting approach which treats costs related to a company's human resources as expenses on the income statement that reduce profit.

Book-to-Market Ratio: Intellectual capital is often defined as the difference between market and book value of a business.

Tobin's Q: This method has traditionally been used for predicting investment decisions. Tobin's Q is the ratio between the market value and replacement value of the same physical asset.

Value Added Intellectual Coefficient (VAIC^{TM}): This method was introduced by Pulic (1998) as an analytic tool for measuring a firm's performance (Van der Zahn *et al*., 2004). The value of VAIC^{TM} can be compared across different firms and can be reported to external investors.

EVA: EVA is perhaps the most recent method of organizational performance evaluation. Its focus is on maximization of shareholder wealth. In other words, EVA is a measure of whether the intellectual capital of a firm has been effective or not. Obviously, EVA is a substitute metric for intellectual capital and provides accurate information about the effect of IC on firm performance (Ghosh *et al*., 2009).

Janis *et al*. (2005) investigated the relationship between EVA and market added value as well as the effect of economy of such relationship in the US companies. The results indicated that there is a positive meaningful relationship between EVA and GDP (as an economic variable).

Ghanbari (2007) investigated the relationship between EVA and market added value in India Automotive Industry Listed Companies. The results of this study showed that EVA is a strong measure for describing market added value and can be introduced to shareholders as the best domestic measure for evaluating companies' performance.

Yahizade *et al*. (2009) investigated the relationship between EVA and profitability ratios. The results show that EVA is significantly related to stock market value.

Financial Performance

The criteria to measure performance based on accounting concepts are divided into two categories; the first category is based on accounting information and the second category is based upon both accounting and market information (Jahankhani *et al*., 1995).

Carter *et al*. (2003) found that return is considered as an important factor in explaining the company value.

In discussing assets and its relation with companies' intellectual capital, Hemati *et al*. (2010) refer to the industry average, arguing that the model of assets' return is obtained by dividing profit, in a specified period, by the average value of assets at the same time. Yet, the difference between the return on the assets is calculated by the average return on the industry assets and if the observed value becomes zero or negative, the company with intellectual capital will not surpass the industry assets and it is hypothesized that the company intellectual capital is zero.

The first empirical study for measuring intellectual capital was conducted in the mid 1980s by a Swedish association, followed by numerous studies on the topic (Tseng, 2006). Bontis (1998) studied the impact of intellectual capital on business performance. Using ICAP model, the results suggested a valid, reliable, significant, and substantive causal link between dimensions of intellectual capital and business performance.

Chang (2004) studied the relationship between intellectual capital and business performance in the biotechnology industry in Taiwan. This study also focused on whether intellectual capital has any impact on the relationship between innovation capital and business performance. The findings supported the hypothesis.

Baum and Silverman (2004) examined the effect of the components of intellectual capital on venture capital decision firms' decisions and performance. The results indicated a significant effect of the components of intellectual capital on the performance and financial risk of the firms.

Chu *et al*. (2006) studied the relationship between the components of intellectual capital and value with the value/performance of the Industrial Technology Research Institute. They found that intellectual capital is positively associated with performance and that intellectual capital is highly relevant to the value creation process and warrant strategic accumulation for R&D organizations.

Tseng (2006) studied the relationship between human capital, innovation capital, and organizational performance companies. The results showed that R&D intensity and the number of patents have significant effects on organizational performance and that the interactive impact between the number of patents and salary per employee is significantly related to organizational performance.

Tan *et al*. (2007) investigated the association between the intellectual capital of companies and their financial performance. The findings show that IC and company performance are positively related; IC is correlated to future company performance, the rate of growth of a company's IC is positively related to the company's performance, and the contribution of IC to company performance differs by industry.

Rudez and Mihalic (2007) studied the effect of the components of IC on the financial performance of the Slovenian hotel industry. The results indicated that there is a positive relationship between the component of IC and financial performance. They also found that end-customer relationships have a strong direct impact on financial results.

Garcia-Meca and Martinez (2007) investigated the disclosure of IC information in a large sample of analysts' results reports. Analyzing 260 financial reports of Spanish companies, they verified a positive relationship between IC information disclosure and corporate profitability.

Richieri *et al*. (2008) studied the effect of intellectual capital on ROE, ROA, and ROS ratios in a sample with data for the 1,000 biggest companies in Brazil. Using static panel data, the authors found the existence of a positive relation between both calculated intangible value and intellectual capital efficiency and the dependent variables ROE, ROA and ROS.

Yang and Kang (2008) investigate the relationship of innovation capital and customer capital with financial performance of firms. The

results demonstrated that the main effects of both innovation and customer capital significantly and positively impact firm performance. Also, a significant interaction effect existed only in the high-technology manufacturing firms.

Ting and Lean (2009) examined the intellectual capital performance and its relationship with financial performance in Malaysia. The results showed that VAIC and ROA are positively related. Moreover, the results revealed that the three components of VAIC are associated with profitability: human capital and capital employed were positively related to profitability, while structural capital was negatively related to profitability.

Hsu and Fang (2009) studied the relationship between intellectual capital and new product development performance. Based on their findings, relational capital was the greatest factor among the three types of intellectual capital in Taiwanese IC design companies, structural capital was second, and human capital was last.

Nogueira *et al*. (2010) carried out a study to verify whether intellectual capital has a positive impact on the profitability of Brazilian companies. The results revealed a significant positive relationship between VAIC^{TM} and profitability.

Zeghal and Maaloul (2010) studied the effect of intellectual capital on economic, financial, and stock market performance of UK companies. The results of multiple regression analysis showed a significant positive relationship between VAIC^{TM} and economic performance and between VAIC^{TM} and financial performance. The relationship between VAIC^{TM} and stock market performance was only significant for hi-tech industries.

De Barros *et al*. (2010) investigated the relationship between intellectual capital and value creation in Brazil. The findings suggested that the intellectual capital of the companies was positively related to value creation.

Longo *et al*. (2011) studied the effect of intellectual capital on employees' job. The results showed that intellectual capital positively affects the job attitudes examined, although differences emerged between the three dimensions of intellectual capital.

Ramezan (2011) investigated the relationship between organizational organic structure and intellectual capital improvement.

The results supported the view that organic structure has a positive impact on intellectual capital.

Wagiciengo and Belal (2012) investigated intellectual capital disclosures by South African companies. They showed that intellectual capital disclosures in South Africa. Out of the three broad categories of intellectual capital disclosures, human capital was reported to be the most popular category.

Li *et al*. (2012) studied the relationship between audit committee characteristics and intellectual capital disclosure. They argued that the association between audit committee characteristics and IC disclosure varies across the IC components (i.e. human capital, structural capital and relational capital).

Abdullah and Sofian (2012) examined the association of the IC with corporate performance of Malaysian public listed companies. Their findings confirmed that all IC components have a significant positive relationship with corporate performance. Furthermore, relational capital was reported as the component that has the strongest relationship with corporate performance.

Costa (2012) examined the relationship between intellectual capital management and corporate performance; they showed that about half of the sample companies had achieved productivity and the rest of the companies had surpassed their competitors in improving IC management.

Jafari Farsani *et al*. (2012) investigated the association between intellectual capital and organizational learning capability. The findings showed significant correlations between the components of IC and organizational learning capability.

Besharati *et al*. (2012) investigated the relationship of intellectual capital and innovation capital with financial performance and value of the firms. According to the findings, no significant relationship was observed between intellectual capital and firm value; however, there was a significant relationship between intellectual capital and financial performance of the firms. Innovation capital and firm value were not significantly correlated, while a significant positive relationship was observed between innovation capital and financial performance.

AL-Musalli and Ku Ismail (2012) examined the relationship between intellectual capital performance and board characteristics of

GCC banks. The results showed that IC performance of GCC listed banks was low, the number of independent directors had a significant negative relationship with IC performance of GCC listed banks, and all other variables were not associated with IC performance.

Mosavi (2012) examined the relationship between the components of intellectual capital and market value and financial performance. Only one significant relationship was observed between human capital efficiency and financial performance of the firms.

Calabrese *et al*. (2012) investigated the application fuzzy AHP for managing intellectual capital assets in the Italian ICT service industry. The results showed that customer relations improve processes and performance.

Mehralian *et al*. (2013) studied and prioritized the components of intellectual capital in a knowledge-based industry, i.e. the pharmaceutical industry. They expressed their concern about structural capital, investment ratios, and R&D. Meanwhile, relational capital such as customer relations received the greatest attention.

Hypotheses

Chang (2004), Chu *et al*. (2006), Rudez *et al*. (2007), Zeghal *et al*. (2010), and GharoieAhangar (2011) investigated the relationship between Intellectual Added Value Coefficient and financial performance. Findings obtained from studies conducted by Chang (2004), Chu *et al*. (2006), Rudez *et al*. (2007), and Zeghal *et al*. (2010) indicated a positive meaningful relationship between intellectual added value coefficient and companies' financial performance; however, Gharoie Ahangar (2011) did not find any meaningful relationship between these variables.

Also, several scholars such as Yahizadefar *et al*. (2009), Janis *et al*. (2005), and Ghanbari (2007) investigated the relationship between EVA and such dependent variables as market added value, profit per share, equity and so on. The results indicated a strong correlation or relationship between EVA and these dependent variables. So the following hypothesis postulated.

First hypothesis: Value added intellectual coefficient and EVA are significantly associated with firms' financial performance.

Chang (2004), Rudez *et al*. (2007), and Abdullah *et al*. (2012) investigated the relationship between Intellectual Capital Efficiency and financial performance. The findings obtained by Chang (2004); Rudez *et al*. (2007) and Abdullah *et al*. (2012) indicated a positive meaningful relationship between these two variables.

Second hypothesis: Intellectual capital efficiency and EVA are significantly associated with the firms' financial performance.

Rudez *et al*. (2007), Tin *et al*. (2009), Zeghal *et al*. (2010), Abdullah *et al*. (2012) investigated the relationship between communication capital efficiency and financial performance. The results showed a positive meaningful relationship between these two independent and dependent variables.

Third hypothesis: Relational capital efficiency and EVA are significantly associated with the firms' financial performance.

Rudez *et al*. (2007), Tin *et al*. (2009), Zeghal *et al*. (2010), and Abdullah *et al*. (2012) investigated the relationship between communication capital efficiency and financial performance. The results showed a positive meaningful relationship between these two independent and dependent variables.

Fourth hypothesis: Structural capital efficiency and EVA are significantly associated with the firms' financial performance.

Rudez *et al*. (2007), Tin *et al*. (2009), Zeghal *et al*. (2010), and Abdullah *et al*. (2012) investigated the relationship between communication capital efficiency and financial performance. The results revealed a positive meaningful relationship between these two independent and dependent variables.

Fifth hypothesis: Human capital efficiency and EVA are significantly associated with the firms' financial performance.

Methodology

Population and sample

The present research studies two types of industries; the chemical and pharmaceutical listed companies on the TSE. The sample comprises firms that meet the following conditions:

- Firms that have been listed in the stock exchange before 2007;
- Firms whose financial year ends at the end of the Iranian calendar;

- Firms that have no financial year changes;
- Firms that have been operating in TSE during the period of interest;
- Firms that have data available for the period of interest;
- Investment companies are excluded.

Given these conditions, 39 firms were selected as sample. It must be noted that among the sample 15 were chemical firms and 24 were pharmaceutical firms.

Since authors believe that intellectual capital and EVA in two Pharmaceutical and Chemical industries can significantly influence companies' financial performance in this turbulent economic world, these two types of companies were chosen.

Variables

Independent variables

The present research uses the model proposed by Pulic (1998) for measuring Intellectual Capital. Intellectual capital comprises human capital and structural capital (Pulic, 2000). Value added intellectual coefficient ($VAIC^{TM}$) can be calculated from the following formula:

$$\mathrm{VAIC}_i = \mathrm{CEE}_i + \mathrm{HCE}_i + \mathrm{SCE}_i$$

The value added of firm i in year t is calculated from the following equation:

$$\mathrm{VA}_i = \mathrm{OP} + \mathrm{EC} + \mathrm{D} + \mathrm{A}$$

where VA is value added, OP is operating profit, EC is employee cost, D denotes depreciation, and A denotes amortization. Relational employed efficiency (CEE_i) can be obtained from the following equation:

$$\mathrm{CEE}_i = \frac{\mathrm{VA}_i}{\mathrm{CE}_i}$$

where VA_i is the value added of firm i and CE_i is the book value of net assets of firm i (book value of total assets minus intangible assets). Human capital efficiency (HCE_i) is obtained from:

$$\mathrm{HCE}_i = \frac{\mathrm{VA}_i}{\mathrm{HC}_i}$$

where HC_i is the human capital of firm i that consist of the total salary cost. As for structural capital efficiency (SCE_i), first we have to calculate structural capital (SC_i):

$$SC_i = VA_i - HC_i$$

Therefore, SCE_i can be calculated from the equation below:

$$SCE_i = \frac{SC_i}{VA_i}$$

Finally, intellectual capital efficiency (ICE) is as follows:

$$ICE = HCE + SCE$$

Economic value added, which provides accurate information about the effect of intellectual capital on corporate performance, can be calculated from the following equation:

$$EVA = NOPAT_t - [(TA_{t-1} - CL_{t-1})] \times WACC_t$$
$$NOPAT_t = OP_t \times \{1 - t\}$$

In the equations above, TA_{t-1} denotes total assets at the beginning of a given financial period, CL_{t-1} is the sum of current liabilities at the beginning of a given period, $NOPAT_t$ is net operating profit after tax for time t, $WACC_t$ denotes weighted average cost of capital for time t, and OP_t is the operating profit for time t.

Dependent variable

The company financial performance can be measured by factors such as Tobin Q, profit, profit growth, return on sales, divided profit, crash flows, profit per share including P/E, ROE, ROA, and ratio of market value to shares' Book Value.

Return on assets is a criterion widely used in previous studies. The return indicating use of assts shows the profit per Rial of the funds invested in the company.

Discussing the return on assets and its relation with the companies' intellectual capital, Hemati *et al*. (2010) refer to the index of industry average arguing that this method provides an approximation of the company intellectual capital suggesting that how this valuable asset influences its profitability.

Carter *et al*. (2003) found that the assets' return is viewed as a significant factor in explaining the company value.

With an overview on national studies it is found that such researchers as Poorzmain *et al*. (2012) used return on assets as criteria to investigate the performance.

Based on the above-mentioned reasons, the present study has

employed the return on tax as a criterion for measuring the company's performance.

$$ROA = \frac{NI}{TA}$$

ROA= Return on assets
NI= Net income
TA= Total assets

Data analysis

Multivariate regression analysis and fuzzy regression analysis were applied at the 5% significance level for testing the hypotheses.

Multivariate regression

The regression model proposed in the present research is as follows:

$$\mathrm{ROA} = \widetilde{A}_0 + \widetilde{A}_1\mathrm{EVA} + \widetilde{A}_2\mathrm{VAIC} + \widetilde{A}_3\mathrm{ICE} + \widetilde{A}_4\mathrm{CEE} + \widetilde{A}_5\mathrm{HCE} + \widetilde{A}_6\mathrm{SCE} + £\mathrm{i}$$

where ROA is return on assets, EVA is economic value added, VAIC is value added intellectual coefficient, ICE is intellectual capital efficiency, CEE is capital employed efficiency, HCE is human capital efficiency, and SCE is structural capital efficiency.

Findings

Descriptive and inferential (multivariate and fuzzy regression analyses) analyses are used for testing the hypotheses of the research.

Descriptive statistics

The data is collected from 39 samples firms listed in Tehran Stock Exchange for the period from 2007 to 2010. Table 1 provides mean, median, standard deviation, maximum, and minimum values for the research variables.

Table 1. Descriptive statistics of the variables

Statistics	ROA	EVA	VAIC	ICE	CEE	HCE	SCE
Mean	0.1604	0.0615	5.2318	4.7784	0.4314	4.0200	0.7279
Median	0.1400	0.0618	4.5135	4.0798	0.4105	3.3760	0.7111
SD	0.11590	0.07293	2.34119	2.26765	0.15835	2.05473	0.11261
Minimum	-0.03	-0.11	2.55	2.34	0.17	2.00	0.50
Maximum	0.53	0.25	15.67	15.05	0.90	13.39	0.99

Inferential statistics

In the regression model, the effect of the independent variables (EVA, CEE, HCE, SCE, ICE, and VAIC) on the financial performance of the sample firms is examined. A multivariate linear regression model is used at the 5% significance level for testing the hypotheses. If there is no relationship between the independent variables and the dependent variable, all the coefficients in the regression model must be equal to zero. Thus, we can test the significance of the regression model, which is often done using F test. If the obtained F-statistic is less than the Table value of F at the 95% confidence level, the regression model will be significant. The results of F-test are provided in Table 2 ($P<0.05$).

Table 2. Analysis of variance

Model	Sum of Squares	df	Mean Squares	F	Sig.
Regression	18.945	6	3.158	3.920	0.001[a]
Residual	138.546	172	0.805		
Total	157.491	178			

Notes: a. Predictors: constant, EVA, CEE, SCE, HCE, VAIC, and ICE
b. Dependent variable: ROA

The results of estimating the regression model at the 5% significance level are provided in Table 3.

Table 3. The results of estimating the regression model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Result
	B coefficient	Std. Error	Beta			
Constant	-5.293	0.826	-	-6.409	0.000	
EVA	-1.108	1.038	-0.084	-1.067	0.287	Rejected
VAIC	-0.722	0.381	-1.573	-1.895	0.060	Rejected
ICE	1.892	1.019	4.000	1.856	0.065	Rejected
CEE	1.481	0.683	0.247	2.170	0.031	Accepted
HCE	-1.442	0.949	-2.915	-1.520	0.130	Rejected
SCE	4.881	1.817	0.483	.686	0.008	Accepted

Dependent variable: ROA

Fuzzy regression

Simple Linear Regression defined based on probability distributio, is always confronted with some limitations due to the hypotheses inflexibility. On the other hand, the statistical regression models are used only when the observations' distribution is done based on a

statistical model. However, the fuzzy regression models, in addition to their flexibility in adaptation to natural conditions, is an efficient instrument for explaining the effects of those variables with the same features.

Time fuzzy regression is employed when the variables or the observations are imprecise and vague, and when the relationship between variables is imprecise, as well as when the hypotheses' accuracy is uncertain (in small samples).

Fuzzy regression is divided into three categories:

1. The first category is used when the relationship between the fuzzy variables is hypothesized; in the other words, the regression coefficients are viewed as fuzzy; fuzzy regression when the variables (or the observations related to the variables) are imprecise and fuzzy.
2. When all variables and the model coefficients are considered to be fuzzy: it is worth mentioning that the variety in the fuzzy regression is not limited to the above conditions, but, the methods proposed per condition (methods for establishing model, parameters, goodness of fit criteria) have created a variety of fuzzy regression methods. The present study examines the regression model with fuzzy coefficients.
3. The regression models provide some patterns based on which the relationship between a set of variables can be investigated: such variables include dependent and independent ones. In these models, based on some observations related to the dependent and independent variables, a function is built to predict and control the dependent variable.

However, in many cases, one or more hypotheses may be rejected or due to the sample size the hypothesis cannot be supported. In such cases, the common models do not have the required reliability and performance. The next alternative method is fuzzy regression. This kind of regression can be employed when the variables or the relevant observations are imprecise and vague; also when the relationship between the variables is imprecise; or when the hypotheses are not certainly true (particularly, when the sample is small). The current study employs the fuzzy regression with fuzzy coefficients to examine the model.

Given the regression model

$$\mathrm{ROA} = \widetilde{\mathrm{A}}_0 + \widetilde{\mathrm{A}}_1\mathrm{EVA} + \widetilde{\mathrm{A}}_2\mathrm{VAIC} + \widetilde{\mathrm{A}}_3\mathrm{ICE} + \widetilde{\mathrm{A}}_4\mathrm{CEE} + \widetilde{\mathrm{A}}_5\mathrm{HCE} + \widetilde{\mathrm{A}}_6\mathrm{SCE} + £\mathrm{i}$$

Assuming that

$$\mathrm{Y} = \mathrm{ROA}\,, \mathrm{X}_6 = \mathrm{SCE}, \mathrm{X}_5 = \mathrm{HCE}, \mathrm{X}_4 = \mathrm{CEE}, \mathrm{X}_3 = \mathrm{ICE}, \mathrm{X}_2 = \mathrm{VAIC}, \mathrm{X}_1 = \mathrm{EVA}$$

and

$$\widetilde{\mathrm{A}}_i = (\mathrm{a}_i, \mathrm{s}_i), \quad i = 0,1,\dots,6$$

The objective function is expressed as follows:

$$\mathrm{Z} = 2 \times 80\mathrm{S}_0 + 2\mathrm{S}_1 \sum_{j=1}^{80} |\mathrm{X}_{1j}| + 2\mathrm{S}_2 \sum_{j=1}^{80} |\mathrm{X}_{2j}| + 2\mathrm{S}_3 \sum_{j=1}^{80} |\mathrm{X}_{3j}| + 2\mathrm{S}_4 \sum_{j=1}^{80} |\mathrm{X}_{4j}| + 2\mathrm{S}_5 \sum_{j=1}^{80} |\mathrm{X}_{5j}| + 2\mathrm{S}_6 \sum_{j=1}^{80} |\mathrm{X}_{6j}|$$

Two constraints are defined for each observation with a total of 416 constraints. For instance, the first two constraints are as follows:

$$\begin{aligned}(1-h)\mathrm{S}_0 + (1-h)\mathrm{S}_1|0.268171081| + (1-h)\mathrm{S}_2|88.31303| \\ + (1-h)\mathrm{S}_3|87.9974| + (1-h)\mathrm{S}_4|0.31561| \\ + (1-h)\mathrm{S}_5|87.00891| + (1-h)\mathrm{S}_6|0.98851| - \mathrm{a}_0 \\ - \mathrm{a}_1|0.26871081| - \mathrm{a}_2|88.31303| - \mathrm{a}_3|87.9974| \\ - \mathrm{a}_4|0.31561| - \mathrm{a}_5|87.089| - \mathrm{a}_6|0.98851| \geq -(0.082420)\end{aligned}$$

Minimizing the objective function (Z) with respect to the 416 constraints as well as $\mathrm{S}_0 \geq$ for $i = 0,1,\dots,6$ and a_i for $i = 0,1,\dots,6$ is a problem in linear programming that is solved by Lingo software. Solving the problem for $h \in (0,1)$ leads to the data provided in Table4.

Table 4. Estimating the objective function based on different membership degrees

h	S_0	Z
0.1	0.3790585	78.84416
0.2	0.42644	88.6996
0.3	0.48736	101.3711
0.4	0.56858	118.2662
0.5	0.2368	141.9195
0.6	0.85288	177.3994
0.7	1.137175	236.5325
0.8	1.705763	354.7987
0.9	3.411526	709.5974

Considering the above Table, we will have the following calculations for all the h values:

$S_1 = S_2 = S_3 = S_4 = S_5 = a_6 = 0$

$a_0 = 0.16489 \quad a_1 = 0.2094728 \quad a_2 = 0.0091978$

$a_3 = 0.105577 \quad a_4 = 0.092495 \quad a_5 = 0.12196 \quad a_6 = 0$

By replacing the coefficients obtained in the regression model, for certain values of independent variables the output is fuzzy and in the form of symmetric triangular fuzzy numbers. Therefore, we defuzzify the output using Center of Area (COA) in MATLAB. Finally, the MSE of the model can be obtained by comparing the estimated model with real values. In this case, the final regression model is the one with the lowest MSE. The output of MATLAB is provided in Table 5.

Table 5. Estimating the objective function based on real value

h	A_0	MSE
0.1	0.1666	0.0318
0.2	0.1732	0.0311
0.3	0.1657	0.0316
0.4	0.1666	0.0318
0.5	0.1657	0.0316
0.6	0.1652	0.0315
0.7	0.1641	0.0313
0.8	0.1648	0.0314
0.9	0.0708	0.0216

Considering the Table above, the lowest MSE occurs when $h = 0.9$. Therefore, the fuzzy regression model is:

$$\tilde{y} = (0.16489,3.411526) + (0.2094728,0)X_1 + (0.0091978,0)X_2 + (0.105577,0)X_3 + (0.092495,0)X_4 + (-0.12196,0)X_5 + (0,0)X_6$$

Defuzzification gives the following model:

$$y = 0.0708 + 0.2094728X_1 + 0.0091978X_2 + 0.105577X_3 + 0.09495X_4 - 0.12196X_5$$

Hypothesis 1

According to the first hypothesis, VAIC and EVA are significantly associated with financial performance. Based on the results of multivariate regression model (Table 6), EVA has a beta coefficient of -1.108 and p-value of 0.287. Moreover, VAIC has a beta coefficient of -0.722 and a p-value of 0.060. Therefore, there is no significant relationship between EVA, VAIC, and financial performance at 5% significance level.

Based on the results of fuzzy regression, there is a significant

relationship between EVA, VAIC, and financial performance and the first hypothesis is accepted.

Table 6. Results of testing the first hypothesis with multivariate regression analysis

Variable	Beta	Sig.	Result
VAIC	-0.722	0.060	Rejected
EVA	-1.108	0.287	Rejected
Notes: Dependent variable: ROA			

Hypothesis 2

Based on the second hypothesis, ICE and EVA are significantly associated with financial performance. The results of multivariate regression analysis in Table 7 indicate that ICE has a beta coefficient of 1.892 and a p-value of 0.065, and EVA has a beta coefficient of -1.108 and a p-value of 0.287. Thus, the second hypothesis is rejected, i.e. there is no significant relationship between EVA, ICE, and financial performance.

Table 7. Testing the second hypothesis with multivariate regression analysis

Variable	Beta	Sig.	Result
ICE	1.892	0.065	Rejected
EVA	-1.108	0.287	Rejected
Notes: Dependent variable: ROA			

Based on the results of fuzzy regression analysis, there is a significant relationship between ICE, EVA, and financial performance and the second hypothesis.

Hypothesis 3

According to the third hypothesis, CEE and EVA are significantly associated with financial performance. Based on the results of multivariate regression analysis (Table 8), CEE has a beta coefficient of 1.481 and a p-value of 0.031, and EVA has a beta coefficient of -1.108 and a p-value of 0.287. Thus, there is a significant relationship between CEE and financial performance at 5% significance level. However, the hypothesis is rejected, since both independent variables must be associated with financial performance.

Table 8. Testing the third hypothesis with multivariate regression analysis

Variable	Beta	Sig.	Result
CEE	0.031	1.481	Rejected
EVA	-1.108	0.287	Rejected
Notes: Dependent variable: ROA			

Based on the results of fuzzy regression analysis, there is a significant relationship between CEE, EVA, and financial performance.

Hypothesis 4

According to the fourth hypothesis, HCE and EVA are significantly associated with financial performance. Based on the results of multivariate regression analysis in Table 9, HCE has a beta coefficient of -1.442 and a p-value of 0.130, and EVA has a beta coefficient of -1.108 and a p-value of 0.287. Therefore, there is no significant relationship between HCE, EVA, and financial performance at 5% significance level.

Table 9. Testing the fourth hypothesis with multivariate regression analysis

Variable	Beta	Sig.	Result
HCE	-1.442	0.130	Rejected
EVA	-1.108	0.287	Rejected
Notes: Dependent variable: ROA			

Based on the results of fuzzy regression analysis, there is a significant relationship between HCE, EVA, and financial performance.

Hypothesis 5

According to hypothesis 5, SCE and EVA are significantly associated with financial performance. Based on the results of multivariate regression analysis in Table 10, SCE has a beta coefficient of 4.881 and a p-value of 0.008, and EVA has a beta coefficient of -1.108 and a p-value of 0.287. Therefore, the fifth hypothesis is also rejected.

Table 10. Testing the fourth hypothesis with multivariate regression analysis

Variable	Beta	Sig.	Result
SCE	4.881	0.008	Accepted
EVA	-1.108	0.287	Rejected
Notes: Dependent variable: ROA			

Based on the results of fuzzy regression analysis, there is no significant relationship between SCE, EVA, and financial performance, and the fifth hypothesis is rejected.

Discussion

Organizations, especially knowledge-based ones, need to identify and

effectively manage their intellectual capital in order to achieve competitive advantage. Therefore, developing a proper approach for managing intellectual capital (i.e. structural capital, human capital, and relational capital) is of utmost importance, and disregard for any of these intangibles will have irremediable consequences.

Intellectual capital plays an essential role in improving corporate performance and achieving sustainable profitability. However, economic value added is another important factor that can help investors in their decision-making and can create competitive advantage for organizations. Economic value added is the value created in excess of the required return of the firm's investors and can be used for evaluating the performance of firms and developing incentive schemes.

The present research examined the relationship between six variables (value added intellectual coefficient, intellectual capital efficiency, human capital efficiency, capital employed efficiency, structural capital efficiency, and economic value added) and financial performance of the chemical and pharmaceutical firms listed in Tehran Stock Exchange. The results of multivariate regression rejected all the hypotheses of the research. However, the results of fuzzy regression analysis suggested that all the relationships were significant except for the relationship between SCE, EVA, and financial performance.

Limitations

The first limitation pertains to value added intellectual capital, for researchers, such as Andriessen (2004), are of the opinion that this method cannot provide a thorough image of intellectual capital. They argue that this method focuses on human capital and structural capital while paying little attention to relational capital.

The second limitation is related to the lack of classified data in the database of TSE. Therefore, the researchers were forced to use the audited reports of the firms and data collection became a very time consuming process.

References

Abdullah, D. F. & S. Sofian (2012). "The Relationship between Intellectual Capital and Corporate Performance". *Procedia-Social and Behavioral Sciences*, 40(3), 537-541.

AL-Musalli, M. A. & K. N. I. Ku Ismail, (2012). "Intellectual Capital Performance and Board Characteristics of GCC Bank". *Procedia Economics and Finance*, 2(2), 219-226.

Andriessen, D. (2004). *Making Sense of Intellectual Capital: Designing a Method for the Valuation of Intangibles*. Butterworth-Heinemann.

Baum, J. A. C. & B. S. Silverman (2004). "Picking Winners or Building Them? Alliance, Intellectual, and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Startups*"*. *Journal of Business Venturing*, 19(3), 411- 436.

Besharati, E.; S. Kamali,; R. Heydari Mazhari & S. Mahdavi (2012). "An Investigation of the Relationship of Intellectual Capital and Innovation Capital with Financial Performance and Value of Companies Listed in Tehran Stock Exchange". *Journal of Basic and Applied Scientific Research*, 2(7), 1241-1245.

Bontis, N. (1998). "Intellectual Capital: An Exploratory Study that Develops Measures and Model*"*. *Management Decision*, 36(2), 63-76.

Bontis, N. (2001). "Assessing Knowledge Assets: A Review of the Models Used to Measure Intellectual Capital". *International Journal of Management Reviews*, 3(1), 41-60.

Bontis, N. (2004). "National Intellectual Capital Index: A United Nations Initiatives for the Arab Region". *Journal of Intellectual Capital*, 5(1), 13-39.

Bozbura, F. T. & A. Beskese (2007), "Prioritization of Organizational Capital Measurement Indicators Using Fuzzy AHP". *International Journal of Approximate Reasoning*, 44(2), 124-147.

Calabrese, A.; R. Costa & T. Menichini (2013). "Using Fuzzy AHP to Manage Intellectual Capital Assets: An Application to the ICT Service Industry". *Expert Systems with Applications*, 40(1), 3747–3755.

Carter, D. A., Simkins, B. J., & Simpson, W. G. (2003). "Corporate Governance, Board Diversity, and Firm Value". *Financial Review*, 38(1), 33–53.

Chan, K. H. (2009). "Impact of Intellectual Capital on Organisational Performance: An Empirical Study of Companies in the Hang Seng Index (Part 2)". *Journal of Intellectual Capital*, 16(1), 131-150.

Chang, C. J. (2004). "The Study of Relationships among Intellectual Capital,

Business Performance and Business Value for the Biotechnology Industry in Taiwan". *Management Decision*, 36(2), 63-76.

Chen, J.; Zhu, Z. & Xie, H. Y. (2004). "Measuring Intellectual Capital: A New Model and Empirical study", *Journal of Intellectual Capital*, 5(1), 195-212.

Chu, P. Y.; Y. L. Lin; H. H. Hsiung & T. Y. Liu, (2006). "Intellectual Capital: An Empirical Study of ITRI". *Technological Forecasting & Social Change*, 73(7), 886-902.

Costa, R. (2012). "Assessing Intellectual Capital Efficiency and Productivity: An Application to the Italian Yacht Manufacturing Sector". *Expert System whit Applications*, 39(8), 7255-7261.

De Barros Jr. L.; Aguiar, J. F.; L. F. C.Basso & H. Kimura (2010). "Intangible Assets and Value Creation at Brazilian Companies: An Application for the Brazilian Textile Manufacturing Sector". *Academy of Business and Economics*, 10(2), 39-53.

Dewet, J.H.V. (2004), "EVA and MVA and Adjustments to financial statement to reflect value Creation". *University of pretorial*, 6(1), 7-97.

Diez, J. M.; M. L. Ochoa; M. B. Prieto & A. Santidrian (2010). "Intellectual Capital and Value Creation in Spanish Firms". *Journal of Intellectual Capital*, 11(3), 348-367.

Garcia-Meca, E. & I. Martinez, (2007). "The Use of Intellectual Capital Information in Investment Decisions: An Empirical Study Using Analyst Reports". *The International Journal of Accounting*, 42(1), 57-81.

Ghanbari, M. (2007). "Relationship between EVA & MVA: An Empirical Analysis in Indian Automobile Industry". *Journal of Accounting Research*, 6(3), 7-22.

Ghosh, S. & A. Mondal (2009). "Indian Software and Pharmaceutical Sector IC and Financial Performance". *Intellectual Capital*, 10(3), 369-388.

Goh, P. C. (2005), "Intellectual Capital Performance of Commercial Banks in Malaysia". *Journal of Intellectual Capital*, 6(3), 385-386.

Hemmati, H.; Moen Aldin, M. & Mozafari Shams, M. (2010). "The relationship between intellectual capital and market value of non-financial corporations and financial performance". *Journal of Financial Accounting*, 7(2), 23-40.

Hsu, Y. H. & W. Fang, (2009). "Intellectual Capital and New Product Development Performance: The Mediating Role of Organizational Learning Capability". *Technological Forecasting & Social Change*, 76(5), 664-677.

Jafari Farsani, J.; M. Bidmeshgipour; M. Habibi, & M. M. Rashidi, (2012). "Intellectual Capital and Organizational Learning Capability in Iranian Active Companies of Petrochemical Industry*"*. *Procedia - Social Behavioral Sciences*, 62(6), 1297-1302.

Jahankhani, A. & Zarif fard, A. (1995). "Directors and shareholders of the criteria used for measuring the value of the company?". *Journal of Financial Research*, 7(2), 41-66.

Janis, R. Z.; Howard, F.T. & Bruce, C. (2005). "The MVA-EVA Relationship: Separation of Market Driven Versus Firm Driven Effects". *Review of Accounting and Finance*, 4(1), 32-49.

Kaplan, R. S. & D. P. Norton, (1992). "The Balanced Scorecard Measures that Drive Performance in Indian Pharmaceutical Industry". *Harvard Business Review*, 70(1), 71-79.

Kapopoulos, P. & Lazaretou, S. (2007). "Corporate Ownership Structure and Firm Performance: Evidence from Greek Firms Corporate Governance". *Journal of International Review*, 15(2), 144–158.

Laing, G.; Dunn, J. & S. Hughes-Lucas (2010). "Applying the VAIC^{TM} Model to Australian Hotels*"*. *Journal of Intellectual Capital*, 11(3), 269-283.

Li, J.; Mangena, M. & R. Pike, (2012). "The Effect of Audit Committee Characteristics on Intellectual Capital Disclosure", *The British Accounting Review*, 44(2), 98-110.

Longo, M. & M. Mura, (2011), "The Effect of Intellectual Capital on Employees' Satisfaction and Retention". *Information & Management*, 48(7), 278-287.

Marr, B. (2004). "Measuring and Benchmarking Intellectual Capital". *Journal of Intellectual Capital*, 11(6), 559-570.

Mehralian, G. H.; H. R. Rasekh; P. Akhavan, & A. Rajabzadeh Ghatari (2013). "Prioritization of Intellectual Capital Indicators in Knowledge-Based industries: Evidence from Pharmaceutical Industry". *International Journal of Information Management*, 33(3), 209-216.

Mosavi, S. A.; S. Nekoueizadeh & M. Ghaedi, (2012), "A Study of Relations between Intellectual Capital Components, Market Value and Finance Performance". *African Journal of Business Management*, 6(4), 1396-1403.

Mouritsen, J.; H. T. Larsen & P. N. D. Bukh (2001). "Intellectual Capital and the 'Capable' Firm: Narrating, Visualizing and Numbering for Managing Knowledge". *Accounting Organizations and Society*, 26(6/7), 735-762.

Namazi, M. & Ebrahimi, S.H. (2009). "Effect of Intellectual Capital on the

current and future financial performance of listed companies in Tehran Stock Exchange". *Accounting Research*, 4(3), 4-25.

Nogueira, C. G.; J. F. Aguiar, H. Kimura & L. C. Basso (2010), "Intellectual Capital and Profitability in the Leather Set Up, Leather Artifacts, Traveling Products and Footwear Sector in Brazil". *Journal of International Finance & Economics*, 10, 11(1), 79-90.

Pourzaman, Z.; Jahanshad, A. & Mahmoud Abadi, A. (2013). "The impact of intellectual capital on market value and financial performance". *Journal of Accounting and Auditing Reviews*, 2(3), 17-30.

Pulic, A. (1998). *Measuring the Performance of Intellectual Potential in Knowledge Economy*. Paper presented at the 2nd McMaster World Congress on Measuring and Managing Intellectual Capital.

Pulic, A. (2000). *MVA and VAIC Analysis of Randomly Selected Companies from FTSE 250*. available at: www.vaicon.net/download/ftse30.pdf.

Ramezan, M. (2011). "Intellectual Capital and Organizational Organic Structure in Knowledge Society: How are These Concepts Related?". *International Journal of Information Management*, 31(3), 89-92.

Richieri, F. L.; L. C. Basso & D. D. Leiva Martin (2008). *Intellectual Capital and the Creation of Value in Brazilian Companies*. available at: http://ssrn/abstract=1081849.

Rudez, H. N. & T. Mihalic, (2007). "Intellectual Capital in the Hotel Industry: A Case Study from Slovenia". *International Journal Hospitality Management*, 26(1), 188-199.

Smith, P. A. C. (1998). "Systemic Knowledge Management: Managing Organizational Assets for Competitive Advantage". available at: http://www.tlainc.com/article8.htm.

Tan, H. P.; D. Plowman, & P. Hancock, (2007). "Intellectual capital and Financial Returns of Companies", *Journal of Intellectual Capital*, 9(1), 76-95.

Tseng, S. H. (2006). "The Relationship between Human Capital, Innovation Capital, and Organizational Performance", available at: http://thesis.lib.ncu.edu.tw/ETD-db/ETD-search/view_etd?URN=944307008.

Van der Zahn, J. L. W. M.; G. Tower, & J. Neilson, (2004). "Intellectual Capital and the Efficiency of Value Added: Trends in the Singapore Capital Market 2000-2002". *Poseidon Book, Burleigh*. 8(1), 272-287.

Wagiciengo, M. M. & A. R. Belal (2012). "Intellectual Capital Disclosures by South African Companies: A Longitudinal Investigation". *Advances in Accounting*, 28 (1), 111-119.

Yahizadefar, M.; Abounazari, E. & Abadian, M. (2009). "Investigation of

the relationship between Economic Value Added and profitability ratios with stock market value of vehicle companies in Iran". *Stock Journal*, 6(2), 91-115.

Yang, S. & H., H. Kang (2008). "Is Synergy Always Good? Clarifying the Effect of Innovation Capital and Customer Capital on Firm Performance in Two Contexts". *Technovation,* 28(10), 667-678.

Zeghal, D. & A. Maaloul (2010). "Analyzing Value Added as an Indicator of Intellectual Capital and its Consequences on Company Performance". *Intellectual Capital*, 11(1), 39-60.