

An Application of Fuzzy Logic for Study of Intellectual Capital Role on Q Tobin of Pharmaceutical Firms in Tehran Stock Exchange

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ABSTRACT

In era of today's knowledge-based economy, intangible assets of companies and their intellectual capital are important factor for achieving them to sustainable competitive advantage. Present study is aimed to determining effects of three variables of Intellectual Capital includes: Human, Communication and Structural Capital on Market value On Book value of Asset (Q) of Pharmaceutical Companies in Tehran Stock Exchange. In this research, it was measured Intellectual Capital using questionnaire of includes standard constructs and 96% reliability coefficient, and Q using Companies Financial Statements. The results have shown that, variables of Human and Communication Capital, have had 0.496 and 0.423 positive effects on Q, respectively, and variable of Capital Structure have not had any significant effect on Q. Finally, it is concluded remarks including discussion, summary of implications for managers, and directions for further work.

KEY WORDS: fuzzy logic, Intellectual capital, Q Tobin, Pharmaceutical Industry

1-INTRODUCTION

Today's organizations act based on the knowledge and their most successful are those uses from these intangible assets in a better and faster way. Bontis' studies showed that unlike the reduction of output of traditional resources (such as money , machineries , etc...) , knowledge is a source for increasing the business performance . (Bontis, et al,1999) .Managers' challenges , is the providing an appropriate environment for growth and development of humans' mind in a knowledge-based organization (Bontis et al, 1996) . therefore the ability of knowledge management , is the basic skill of manager in these organizations(Quinn,1999) . In fact , the business environment knowledge based , in most of world's countries , needs a model and new naming that includes intangible factors of organization that in this terms , newborn discussion of Intellectual capital will attracts increasing attention toward itself. (Bontis, et al,). Also the evaluation of performance includes the use of tools and techniques regarding the financial statements and other data related to its, in order to achieve the useful information that the achieve data will be used in the evaluation of past performance and financial status of companies. One of the most important of systems' problems in the traditional accounting, inability of them in the measurement and evaluation of companies' Intellectual capital , especially the knowledge-based companies. (Andersson, 2004) in the knowledge-based communities , the output of Intellectual capital which were used in comparison with the financial capital in the determination of ability of proficiency and their financial efficiency has an significant importance . hence , trend to evaluate an consider the real value of properties which are non-observable based on the Intellectual capital increased more than ever. (Bontis, et al, 2000).

Up to now, many studies were done about the Intellectual capital and its effects on the companies' efficiency)Bontis, et al, 2000) (Bramhandkar, et al, 2007) (Tan, et al, 2007) (Rudez&Mihalic, 2007) (Appuhami, 2007) (Young Chu, et al, 2006) (Juma, & McGee, 2006) (Chen et al, 2005) (Wang & Chang, 2005) (Iswati&Anshori, 2007) (Youndt, & Snell, 2004) (Shiu, 2006) (Baum & Silverman, 2004) (Juma& Payne, 2004) (McPherson & Pike, 2001) (AsgarNezhad et al 2008).But the effect of Intellectual capital on the ratio of Q Tobin is a case that requires more studies yet . according to this , the purpose of execution of the current research , is the identification of effects of three variables composing the Intellectual capital i.e, human capital , communicative capital and structural capital on the ratio of Q Tobin of the Pharmaceutical companies in the Tehran stock exchange listed companies with the approach of fuzzy logic and presentation of discussion , conclusion and suggestions , and also some cases regarding the continuity and following the similar researches in the future.

2- Backgrounds and hypotheses

Using the Intellectual capital, the future value of companies can be calculated, because the Intellectual capital presents a perfect model to observe the real value of organization (Chu *et al.*, 2006). The Intellectual capital includes all the processes and properties that usually and traditionally will not be observed in the financial statement and also includes the properties which are intangible (such as commercial signs or commercial brands and their authorization) the modern accounting methods include them. (Roos *et al.*, 1997). Makki *et al.*, in their researches studies the Intellectual capital efficiency in the companies listed on the Lahore Stock Exchange that their results show that the Petroleum and Gas industries, chemical industries and cement include the most high efficiency, bank industry includes the medium and companies related to the government have the weakest efficiency of Intellectual capital. (Makki *et al.*, 2008). Saleh *et al.* in their researches have reviewed the relation of possession structure and Intellectual capital efficiency of Malay companies that the results showed that the family property has a negative effect on the Intellectual capital, while the external possession and foreign and state property have a significant effect on the Intellectual capital efficiency. (Saleh *et al.*, 2008). Bramhandkar *et al.* with reviewing the effect of Intellectual capital on 139 Pharmaceutical companies showed that there is a significant relation between the Intellectual capital and efficiency of companies (Bramhandkar, *et al.*). Tan *et al.* with reviewing the 150 public companies in the stock exchange of Singapore showed that firstly there is a significant positive relation between the Intellectual capital of companies and their current and future financial efficiency. Secondly, the effect of Intellectual capital on the financial efficiency of companies in the various industries is different (Tan, *et al.*, 2007). Rudez & Mihalic with reviewing the effect of Intellectual capital components in the financial efficiency in the Hoteling industry of Slovenia showed that firstly a positive significant relation is between the Intellectual capital components and financial efficiency in this industry. Secondly, communicative capital has a high impact factor in comparison with other Intellectual capital components on the financial components of companies (Rudez & Mihalic, 2007). Appuhami, 2007 in its research reviewed the relation of Intellectual capital (human capital, structural capital, communicative capital) on the efficiency of companies in the bank & insurance industry that results showed that a positive significant relation is between each one of Intellectual capital and efficiency of these companies. (Appuhami, 2007). Sebastian, *et al.*, 2007 *et al.* in a research reviewed the Intellectual capital & companies efficiency in Australia, that results showed that a positive significant relation is between the Intellectual capital and companies' efficiency (Sebastian, *et al.*, 2007). Young Chu, *et al.* also reviewed the relation between the components of intellectual capital (Human, communicative, structural capital) with the efficiency in the specialized advanced industries of ITRI and concluded that firstly a positive significant relation is between the intellectual capital components and efficiency of companies and secondly the increase of intellectual capital is dependent on the process of VALUE CREATION and their strategic storage in the organization. (Young Chu, *et al.*, 2006). Flavio, *et al.* in their research reviewed the intellectual capital components of companies on the criteria of companies financial efficiency from 2000-20 among thousands Brazilian companies that results showed that between the components of intellectual capital of companies and their financial efficiency in the under study companies is a positive significant relation. (Flavio, *et al.*, 2006). Juma, & McGee, 2006 in their research reviewed the effect of each of intellectual capital components on the efficiency of companies with high tech in USA, which the results showed that the components of intellectual capital (Human, structural, communicative capital) have a positive significant relation (Juma, & McGee, 2006). Subramaniam, & Youndt with reviewing the effect of intellectual capital components on the kinds of innovation among the 93 companies showed that there is a positive significant relation between each one of the intellectual capital components and innovations of organization (Subramaniam, & Youndt, 2005).

Chen *et al.* in their research reviewed the relation between the intellectual capital and market value and financial efficiency of Taiwanese companies using the Polic model that results showed that there is a positive significant relation between the intellectual and capital and market value and companies' financial efficiency. (Chen *et al.*, 2005). Wang & Chang in their research reviewed the effect of intellectual capital components' effect on the commercial efficiency of companies present in the IT industry using the cause and effect approach, results showed that the components of intellectual components directly are effective on the commercial efficiency of companies. Also a cause and effect relation is between the components of intellectual capital. (Wang & Chang, 2005). Bejar, 2005 in his research reviewed the effect of intellectual capital on the survival of institutes with the superior tech of France that from 1996-2004 was accepted in the Euronex stock exchange, that results showed that the quality of intellectual capital, will improve the graph of the IPO institutes' graph. (Bejar, 2005)

Iswati & Anshori in their research reviewed the effect of intellectual capital on the financial efficiency of insurance companies in Jakarta Stock Exchange that the main result of this research indicates that the intellectual capital is effective on the financial efficiency of insurance companies. (Iswati & Anshori, 2007). Mark in their research reviewed the effect of intellectual capital's component on the organizational efficiency that the results totally showed a positive significant relation between the intellectual capital's components and

organizations' efficiency.(Youndt, & Snell).Youndt, & Snell in their research reviewed the effect of intellectual capital on the three annual efficiency of 80 companies with high tech that results indicate a significant relation between the intellectual capital and companies' efficiency. (Youndt, & Snell).Chen et al in their research presented the intellectual capital evaluation model based on the qualitative indices that results indicate that a significant relation is between them. (Chen, et al, 2004). Baum &Silverman reviewed the test of relation between the intellectual capital components and decisions of financial risk and companies' efficiency and effect of these components on the future efficiency . the results showed that the components of intellectual capital have a significant effect on financial risk of current companies in the biotechnology industry. (Baum & Silverman, 2004).Juma&Payne in their research reviewed the effect of intellectual capital on the companies efficiency with high tech that results showed that a significant relation is between the intellectual capital and the studied companies efficiency (Juma& Payne, 2004).Pherson& Pike in their research reviewed the intellectual capital and efficiency in the hoteling industry that the results showed a significant positive relation between the efficiency and intellectual capital (Pherson& Pike , 2001).Yazdani also in his research reviewed the effect of intellectual capital on the efficiency of Mellat Bank (Tehran,Iran) . this research shows a relatively strong interaction between the intellectual capital components , but this capitals have no effect on the organization efficiency of Mellat Bank (Tehran branch, Iran) . (Yazdani , 2006).Haj Karimi et al in their research with studying the basic concepts and applied & scientific substructures of knowledge management and intellectual capital , emphasized on the necessity of organizations and governments and communities ' attention to this issue and in this research , quantitative and qualitative information were confirmed via a comprehensive and collective questionnaire and main hypotheses and sub-hypotheses by utilizing the modern statistical technologies. (HajKarimi et al 2006).AsgahrNezhad et al in their research reviewed the value of intellectual capital of investment companies listed in Tehran stock exchange that results indicate that a positive significant relation is between the intellectual capital and financial efficiency ; intellectual capital and future financial efficiency ; intellectual capital growth rate and financial efficiency's growth rate of investment companies in the stock exchange (AsgahrNezhad et al , 2009) . with referring to the aforementioned thematic literature , the following hypotheses have been reviewed and evaluated in the current research.

Research hypothesis:

H0: intellectual capital (human , communication , structural capital) has not a positive effect on the Q Tobin of pharmaceutical companies listed in Tehran stock exchange.

H1: intellectual capital (human , communication , structural capital) has a positive effect on the Q Tobin of pharmaceutical companies listed in Tehran stock exchange.

3- METHODOLOGY

Research statistical community of current research is comprised of 28 cases of pharmaceutical companies listed in Tehran stock exchange during 2008 . in order to measure the independent variables of research was used of 125 experts ' comments existed in these companies.

In the aforementioned sample , 76 % were men , 56 % were under 40 years old , 57 % has a work record more than 15 years and 82 % of them have the education level higher than bachelor. Three independent variables of human, communication and structural capital were measured by a questionnaire with standardized components and documented to the thematic literature, with a five-item scale from very low to very. The presented questionnaire , first in the personal referral , was offered to the members of statistical population and requisite explanations were given , then in the second personal referral their collection was performed . in order to measure the dependent variable Q tobin ratio as an functional criteria , was used of companies' financial statements (company market value on the properties book value) . In order to validation of research's questionnaire, was used of the extracting the measured variables and research's thematic value and then its localization was done by experts' comments as well as elementary sample. (Hult&Ferrel, 1997) (Bazarghan et al , 2008 , pp 166-171) (Sarookhani , 2004 , pp 139) .For this purpose , amongst the 230 collected indices related to the intellectual capital , human capital was 81 indices , structural capital was 90 indices and communication indices 59 indices . these indices with the aim of identifying the related indices which are appropriate for measurement of intellectual capital in the pharmaceutical companies of Iran , was distributed amongst the 12 individuals of experts. After investigation of this stage's results , according to the experts' opinion , 59 indices were selected which amongst these cases , 20 indices were related to the human capital , 20 indices to the structural capital and 19 cases to the communication capital.The aforementioned tool includes the 4 groups of question related to the demographic profile , 3 main groups of measuring the triple independent variables . then the proposed questionnaire, as a pre-test was at disposal of 10 experts and masters and 12experts from statistical population companies , then after collecting the their adjustment comments , the final questionnaire was proposed and used for the collected data.In order to define the reliability of measurement

tools , also the various methods is available that one of them is the measurement of internal consistency (Conca& et al, 2004). The internal consistency of measurement tool can be measured by Chronbach alpha coefficient (Churchill, 1979)(Cronbach, 1951). This is the method which in most of researched will be used (Peterson, 1994) . Although, the acceptable value for this coefficient must be 0.7 % , but the value of 0.6 and even 0.55 is also acceptable. (Van de ven& Ferry, 1979) (Nunnally, 1978) .in the recent research , reliability f measurement tool is 0.96 %.

For making fuzzy the questionnaire , initially the collected data based on Likers scale according to table will be converted to the triangular fuzzy numbers. (Saremi et al,2009) (Saremi et al,2009) (Chen,2000)(Shen Tai, 2008).

Table 1 : conversion of Likert scale's verbal comment to the triangular fuzzy numbers

Very low			low			medium			high			Very high		
1	1	2	1	2	3	2	3	4	3	4	5	4	5	5

After making fuzzy the numbers , the fizzy numbers must be summed using the fuzzy addition , for fuzzy addition in this research the importance of experts' comments according to the education level of experience degree of them (homogeneity) was considered the same, these values was defined per triangular fuzzy numbers

$\tilde{X}_i = (X_i^a, X_i^b, X_i^c)$ as well as were calculated for verbal expressions as follows :

$$\tilde{X} = \left(\sum_{i=1}^n X_i^a, \sum_{i=1}^n X_i^b, \sum_{i=1}^n X_i^c \right) \tag{1}$$

$$\bar{X}_\alpha = \{x \in R : \mu_{\bar{X}}(x) \geq \alpha\} \tag{2}$$

$$\bar{X}_\alpha^U = Sup \{x \in R : \mu_{\bar{X}}(x) \geq \alpha\} \tag{3}$$

After doing the fuzzy addition , the fuzzy numbers is achieved as follows :

$$\tilde{X}_i = (X_i^a, X_i^b, X_i^c) \tag{4}$$

The final fuzzy numbers must using the d.fuzzy principle , the final fuzzy numbers to be converted to a number

$$X_i = \frac{(X_i^b - X_i^a) + (X_i^c - X_i^a)}{3} + X_i^a \tag{5}$$

The d. fuzzy numbers indicates the independent variables were achieved from fuzzy process per each questionnaire that were answered by companies' experts .

4- Findings

According to this that in the recent research to answer the specific above question was used of regression equation model and correlation calculation and relation among the dependent and independent , therefore it is required to be investigated the quintet conditions (Norosis , 20089) of regression analysis application , that this was done too.Initially , measurement scale of all variables is the minimum rank . Secondly , distribution of variable amounts is normal that was confirmed by Kolmogorov-Smirnovand the result is shown in Table 2. Thirdly , the existence of linear relation between variables was confirmed by ANOVA and F statistics calculation.Fourthly , observations were independent from each other that this issue was investigated and confirmed by Durbin-watson test . Fifthly , the linear regression model , was appropriate that was confirmed and tested by correlation coefficient (R) and Identification coefficient (R Square) .

Table 2 : the test of identifying the normality of dependent variable values distribution

(Kolmogorov-Smirnov)		Dependent variable test
Significant level	statistics	
0.629	0.749	Q tobin ratio

As was mentioned before , one of the terms of use of regression equations model as well as identifying the correlation relation among the dependent and independent variables and consequently the test of current hypothesis test , is the normality of dependent variable values. In table 2 , the achieve significance level (more than 5 %) indicates that the distribution i.e , the ratio of property efficiency is normal , therefore we can use of regression equations model to identify the significant relation between the intellectual capital and Q tobin

ratio of pharmaceutical companies listed in Tehran stock exchange . Therefore the regression model used in this research can be presented as follows :

$$Q = \beta_0 + \beta_1 HCE + \beta_2 CEE + \beta_3 SCE + \eta$$

Which in the above relation $Q = Q$ tobinratio , $HCE =$ Human capital , $CEE =$ communication capital , $SCE =$ structural capital . in this current research in order to investigate and explain the relation between the independent variable of intellectual capital factors and the dependent variable of Q tobin ratio of companies , was used of 4 model that will be classified in two groups of proposed hypotheses and under test hypotheses as follows:

1-4 :Test of independent variables effectiveness hypothesis upon Q as two to one

Table 3: Results of statistical analysis of variables effectiveness as two to one

Durbin-Watson	Dependent variable = Q tobin ratio								Independent variables	model
	R ²	sig	R	F	sig	t	Beta	B		
1.910	0.560	0.000	0.748	15.889	0.001	-3.893	-	-3.098	Constant value of human and communication capital	first
					0.002	3.395	0.501	4.758		
					0.017	2.565	0.378	3.098		
1.947	0.445	0.001	0.667	10.019	0.039	-2.175	-	-1.954	Constant value of human and structural capital	second
					0.000	4.400	0.662	6.285		
					0.822	0.227	0.034	0.290		
1.984	0.371	0.003	0.609	7.375	0.093	-1.745	-	-1.649	Constant value of communication and structural capital	third
					0.001	3.762	0.648	6.123		
					0.457	-0.755	-0.130	-1.104		

The data of table 3 also indicates that in the first model ,standardized regression coefficient (Beta) was confirmed regarding the human and communication capital variables . in the second model of regression standard coefficient was not confirmed in the case of variable of structural capital , but was confirmed in the case of variable of human capital. In the third model of regression standard coefficient was not confirmed in the case of structural capital , but was confirmed in the case of variable of communication capital. Durbin – Wastontest of every models indicated that the observations are independent from each other , because the statistics of these tests is between 1.5-2.5. the final standardized regression model , effectiveness of independent variables upon the Q tobin ratio are :

$$Q = 0.501 HCE + 0.378 CEE + \eta$$

First model

$$Q = 0.662 HCE + \eta$$

Second model

$$Q = 0.648 CEE + \eta$$

Third model

4.2 :test of independent variables effectiveness hypothesis on Q as 3 to 1.

Table 4 : results of statistical analysis of variables effectiveness as 3 to 1

Durbin-Watson	Dependent variable =Q tobin ratio								Independent variables	model
	R ²	sig	R	F	sig	t	Beta	B		
2.004	0.570	0000	0.755	10.591	0.003	-3.247	-	-2.839	Constant value of human , communication , structural capital	4th
					0.003	3.328	0.496	4.711		
					0.014	2.638	0.423	3.997		
					0.462	-0.747	0.109	0.923		

$$Q = 0.496 HCE + 0.423 CEE + \eta$$

4th model

The data of table 4 indicate that in 4th model of standardized regression coefficient(beta) was not confirmed regarding to the structural capital variable, but was confirmed about the human capital variables and capital employed. . Watson-Durbin test of this model showed that , the observations are independent from each other because the statistics of this test is placed between 1.5 -2.5 and the final regression model , effectiveness of dependent variables on the Q tobin ratio as three-to-one is as follows :

$$Forth model : Q = 0.496 HCE + 0.423 CEE + \eta$$

5. DISCUSSION AND RESULTS

In this research , initially with evaluating the factors of intellectual capital and Q tobin ratio , the pharmaceutical companies listed in Tehran stock Exchange investigated the effect of intellectual capital upon Q tobin of companies , then finally resulting from 4 tests of hypothesis which were done , these results were achieved.Hence , in the studies of two to one , human capital and communication capital upon the Q ratio have a significant relation , but in studies of two to one of human capital and structural capital only human capital than Q tobin ratio has a significant positive relation as well as in 2 to 1 review of communication capital and structural capital only the communication capital on the ratio of Q tobin has a positive significant relation in companies too.

Finally , in the 3 to 1 reviews , the above results were confirmed such that amongst the triple factors , the intellectual , human , communication capital have a significant relation on the Q tobin ratio , but the structural Q tobin has a significant relation on Q tobin ratio.

About the consonancy of achieved results with performed researched , it can be expressed that relation of two components (human and communication capital) is consonant and in accordance with the most of past researches such as Bramhandkar *et al* (2007) Tan *et al* (2007) Rudez&Mihalic(2007) , RanjitApohami (2007) , Sebastian *et al* (2007) Yang Cheu *et al* (2006) , Flavio *et al* (2006) , Juma, & McGee (2006) , Subramaniam, &Youndt(2005) , Chen *et al* (2005) , Wang & Chang(2005) , Iswati&Anshori (2005) , Youndt, & Snell(2004) , Shiu(2004) , Baum & Silverman(2004) , Juma& Payne(2003) and Asgharnezhad *et al* (2008) as well as having not the relation of structural capital with the efficiency can be expressed that is in accordance with the research performed by Monavarian *et al* .

Therefore generally it can be said that triple independent variables of research , totally have the explanatory significant effects upon the dependent variable of research and therefore , results of current research have consonancy with the results of proposed researches. The aforementioned researchers also emphasized on these issues that the intellectual capital has a significant positive relation with Q ratio of companies , except the structural capital and Q ratio of companies , there is not a significant relation between them.

According to the achieved results in this research can be expressed that managers of pharmaceutical companies regarding to the existence of a significant positive relation among the human capital and communication with ratio of Q tobin is required to be applied a special attention to these two variables of companies. But , meanwhile despite the emphasis on the research literature upon the relation between the structural capital with the ratio of Q tobin in the under study statistical population was diagnosed that the structural capital has a significant relation with Q tobin , this issue implies to an important for managers that they must pay attention to the structure and communication factors.

These companies ' managers can do for creating the separate units in companies to measure and manage the intellectual capital of companies in line with exploitation from this intangible property, to gain the higher financial efficiency . also stock exchange organization can emphasize on the companies listed in stock exchange to act in clarifying the information for decision making of shareholders & investors to prepare their annual intellectual capital report.

6- Suggestions for future researches

According to the offered documents in this research , the following issues can be offered for performing the future researches in line with the research's subject :

- Use of other models for measurement of intellectual capital and test of them with companies' performance.
- The current model to be employed in many companies.

7- Restrictions

Some restrictions which can be implied in this research are : 1- The current research is done only in 28 companies while if this research to be done in all companies , would have a better interoperability. 2- the current research was done in a single –sectional form , whereas if was done for the different period of times , general process of research might be investigated and would have a better interoperability.

8. Footnotes

1. Intellectual Capital

2. Human capital

Human capital indicates the members' knowledge inventory of a organization.

3. Capital employed

Capital employed includes market for use in attraction and obtaining the customers .

4. Structural capital

Structural capital includes the sub-structural properties such as technology , processes and strategies as well as intellectual properties such as technical knowledge , brands and patent.

5. High tech

6. Alpha Chronbach

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