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A New Solution for Solving Intuitionistic Fuzzy Data Envelopment Analysis Problems

Abstract

Nowadays, organizations try to improve their performance to obtain and retain loyal customers. Market orientation is among several tools and factors that can help a company achieve this goal. Therefore, this study aims to investigate the financial performance of pharmaceutical and medical chemical companies concerning market orientation and market capabilities. In this descriptive-applied research, the statistical population includes pharmaceutical and medical chemical companies on the Tehran Stock Exchange (TSE) from 2015 to 2020. Audited forms and attached notes of companies, available in Rahavard software and the Codal site, have been used to collect financial information. The research used the appropriate statistical tests and Eviews software to answer the main question. According to the findings, increasing intellectual capital (IC) increases the rate of return on assets (ROA). In addition, increasing regression increases the rate of ROA and the market value of pharmaceutical and medical chemical companies. It is concluded that chemical, pharmaceutical, and medical companies should prioritize strategies to increase market orientation, satisfy customers by improving efficiency and reducing prices, increase their profitability, and affect their financial performance.

Keywords: *Financial Performance, Market Capabilities, Market Orientation, Data Panel Approach*

Hanieh Daliran Chamanzamin [a], Mehdi Rouholamini[b,*], Seyed Ali Nabavi Chashemi[c], Mousa Rezvani Chamanzamin[d]

[a] *Department of Management, Babol Branch, Islamic Azad University, Babol, Iran, Email: daliran_management@yahoo.com*

[b] *Department of Management, Babol Branch, Islamic Azad University, Babol, Iran, Email: rouholamini.mehd@gmail.com*

[c] *Department of Management, Babol Branch, Islamic Azad University, Babol, Iran, Email: anabavichashmi2003@yahoo.com*

[d] *Department of Management, Astara Branch, Islamic Azad University, Astara, Iran, Email: musa2006az@yahoo.com*

1. Introduction

Peter Drucker believes that business has two main functions: marketing and innovation. Olvarita and Friedman have stated that even though market orientation and innovation are increasingly recognized as key strategic resources for marketing researchers and strategists, the results of the present study fail to support such a claim. New theories in the field of strategies have been developed in the last two decades to achieve superior business performance to research marketing management, strategic management, theories of organizational improvement and development, and a comprehensive combination of financial and economic criteria and business market [15].

Creativity and innovation are generally the foundation of a knowledge-based economy [22]. Today, innovation and distinction are considered necessary for every country due to business competitiveness, globalization, and technology explosion [19]. For nearly a century, the theory of economic evolution has defined innovation as the driving force of economic growth and development.

Innovation has become more vital in economic and social structures in recent years due to the knowledge-based economy manifestation. The pharmaceutical industry is one of the strategic industries which have gradually ranked first among the world industries in terms of profit margins. Today, the supply and dominance of pharmaceutical resources are used as a lever of pressure on third-world countries due to the vital role of medicine and its high dependence on technology and industrial facilities. By creating creativity and innovation in products or production processes, firms can surpass competitors, change the market structure from competitive to monopoly or vice versa, and increase their products and profits.

Most developing countries have not succeeded in using industrial technologies. This failure has the following reasons: importing and deploying disproportionate technologies to the existing talents in the country, incomplete absorption of imported technology, not having the level of best performance in technological efficiency, inability to modernize the dominated technologies, and inability to diversify technologies due to changing circumstances [30]. Therefore, "capabilities" is one of the most important keys and leverage concepts in technology development. Organizational capabilities are created based on the assets and resources of the organization or company. Organizational capabilities result from the proper configuration and arrangement of resources [5, 32]. Organizational capabilities are sustainable and learned patterns through which organizations systematically improve and enhance their current activities and work routines [11]. According to Elrich and Lak in one of the earliest articles in this field, organizational capabilities are responsible for producing products or providing services. Organizational capabilities are essentially the basis for the formation of competitive advantage. Organizational capabilities include three parts: "strategic capabilities," "technological capabilities," and "financial capabilities" [16]. These three parts are important but technological capabilities seem more important in developing countries. Strengthening and developing technological capabilities provides the necessary infrastructure for the technological growth and development of the country. The Islamic Republic of Iran doubly realizes this

need due to malicious people in the system under different conditions of sanctions [30].

Managing and evaluating performance in a competitive environment plays a vital role for the organization, and resource scarcity is one of its prominent features [2]. The financial aspect is one of the performance aspects of organizations that have traditionally been at the center of attention. Financial performance and its measurement are crucial because making a profit is the main goal of many companies [29].

Investors with different incentives invest and provide the financial resources needed for economic units, such as profits, cash benefits, and the ownership of these units. People are interested in investing to increase their wealth. Gaining a good return on investment is one of the ways to increase health, and one of the return conditions is the return on investment. In other words, making a profit is one of the main reasons for buying securities. Profit is among important information in economic decisions that can be observed from the volume of studies and research on profits. When the company has a good performance in the past, present, and future, the company's profit increases and the investor also invests in the company with less risk [4, 6]. As a result, it is extremely important to notice companies' performance, especially financial performance, the affecting factors, and the extent of their impacts. Therefore, this study aims to investigate the financial performance of pharmaceutical and medical chemical companies concerning market orientation and market capabilities through the data panel approach.

2. Literature review and theoretical development

2.1. Financial performance

Company performance is one of the most important structures discussed in management research and criteria for measuring the success of companies and economic growth [7]. Performance is a multidimensional structure that should be measured by several criteria [18, 28]. One of the investors' main motivations to enter the capital market is to earn a good return and increase wealth. For this reason, the company's performance is an affecting factor in changing the stock's market value and changing the shareholder's wealth [4]. Financial performance shows how to pay rewards and rank managers of financial and non-financial enterprises [10]. Financial performance is the degree to which a company achieves shareholders' financial goals to increase their wealth. The company's operational goals include indicators and criteria based on which the financial performance of a commercial company is measured, and the company's CEO follows them to increase the shareholders' wealth [13].

Selecting an appropriate criterion is one of the most important strategies for shareholders to evaluate the company's performance and, consequently, the correct economic decisions to ensure that the company achieves its ultimate goal, maximizing owners' wealth [25]. Four approaches to performance criteria are the followings: [25]:

Accounting approach: This approach uses the listed numbers in the financial statements such as earnings, earnings per share, operating cash flows, ROA, and ROE to evaluate performance.

Economic approach: According to this approach that uses economic concepts, the business unit performance is evaluated according to the profitability of the company's assets, the rate of return, and the cost of capital used. This group also contains economic, adjusted, and market value-added.

Integrated approach: This approach uses a combination of accounting and market information to evaluate performance, such as the Q-Tobin ratio and the price-to-earnings ratio (P / E).

Financial management approach: This approach usually uses financial management theories such as the capital asset pricing model (CAPM) and the concepts of risk and return. This approach mainly emphasizes determining the additional return per share.

2.2. Intellectual capital

IC is related to employees' capabilities, organizational resources, operational methods, and communication with stakeholders that consists of a non-physical source of company value creation and determines each company's Value in the market environment. An accounting perspective defines IC as the difference between the market value and book value of a company's assets, which can turn into a benefit and profit even if it is not on the balance sheet due to its hidden nature [14]. When it comes to IC literature, most of the existing models have considered three components with a set of common features for IC [3]:

Human Capital. Human capital is a combination of knowledge, skills, innovation power, employees' ability to perform their duties, values, culture, and philosophy. Human capital is the basis of IC and the basic element for realizing IC.

Structural capital. Edinson and Malone define structural capital as hardware, software, databases, organizational structure, organizational patents, trademarks, and all organizational capabilities that support employee productivity. Structural capital is what remains in the company when employees go home.

Customer capital. Customer capital is a bridge and catalyst in IC activities. It is also one of the main determining requirements for converting IC into market value and business performance. Customer capital is one of the main components of IC that has valued the company's marketing and communication channels with its industry and business leaders.

New definitions have developed the concept of customer capital into communication capital, which includes knowledge

of the company's relationships with customers, competitors, suppliers, and government agents. IC components in terms of nature, scope and measurement parameters are listed in Table 1.

Table 1. Components of IC [1]

	Human Capital	**Structural capital**	**Customer capital**
In terms of essence and nature	Human thought or intelligence	Organizational procedures	Market relations
In terms of scope	Located in people's minds	Located in intra-organizational relationships	Located in the organization's relationship with outside the organization
In terms of measurement parameters	Size and fit based on the organization's needs	Efficiency and accessibility	Stability period
In terms of coding difficulty	Top	Medium	The highest level in terms of difficulty

2.3. Market orientation and market capabilities

Market orientation is a key and basic concept in marketing principles. The concept of market orientation was first introduced in the early fifties when Peter Drucker (1954) presented the customer as the foundation of organizations and a necessity for the organization's life. Levitt (1960) also supported Drucker's statements, who strongly believed that meeting customers' needs should be the principal goal of businesses. Cutler (2000) defines market orientation as the final stage of a business organization's development and believes that market orientation has emerged along with various business trends [18].

According to Morgan and Burton (2008), market orientation is the degree to which an organization recognizes its customers' needs and turns this information into a tool to predict the future and meet customer needs [9]. Passive market orientation reveals obvious customer needs, and all empirical analyses have addressed this dimension. Active Market orientation is the ability or continuous capability to analyze the customers' hidden needs [23]. Slater presents two types of market-oriented behavior [31]:

Traditional market-oriented behaviors - The first generation of market-oriented. Companies with traditional market-oriented behaviors pay attention to recognizing customers' needs in the market and building goods and services to meet those needs. Market-oriented companies increase their knowledge by investigating customers' needs and wants and can offer new goods and services based on the market and the customer. The market-oriented companies' activities seem useful at a superficial look, but these behaviors focus on satisfying customers' current needs, acting passively, and seeking unexpected learning. Managers and employees only follow their current customers' views and do not care about the beyond. The disadvantage of this market-oriented behavior is destroying the company's ability to innovate and threatens the company.

Modern market-oriented behaviors - The Second generation of market-oriented. The second generation of market-oriented companies is responsible for recognizing the stated and unstated customers' needs, competitors' capabilities and programs, and evaluating market information. These companies regularly create superior value for customers by informing the organization and coordinating the activities of the organization's departments with each other. Second-generation market-oriented companies explore the market more extensively, have a long-term horizon, and penetrate more into the market. The second generation of market-oriented companies has the same research techniques as the first generation of market-oriented companies. The second generation of market-oriented companies also uses other techniques to identify the unstated customers' needs. In the new market orientation, companies have a close relationship with actual and potential consumers and consider them as potential or actual customers with unmet needs who compare how to meet their needs in the market and expect the company the best solution to meet those needs. Second-generation market companies profit from advanced technology to communicate with the customer, but they are not completely

aware of market dynamics and fluctuations. Therefore, they use unexpected and exploratory learning to achieve the desired results.

2.4. Research background

Weqar and Haque [33] investigated the effect of IC on the financial performance of central government companies operating in India and showed a weak relationship between IC and profitability and market value but acts as a strong predictor of productivity. They concluded that human capital has the most effective element among all three components of IC to increase the financial performance of these companies. Forte et al. [12] investigated the effect of IC on financial performance and market value. They showed that IC positively affects the financial performance of companies, which is measured as the profitability, company growth, and market value. In addition, when it comes to its components, human capital's efficiency positively affects companies' financial performance, while structural capital efficiency negatively affects financial performance. Surprisingly, each component of IC harms the market value of companies. Morgan et al. [24] conducted a study on market orientation, marketing capabilities, and firm performance, investigating that market orientation and marketing capabilities are complementary assets contributing to the firm's superior performance. In addition, market orientation directly affects the ROA, and marketing capabilities directly affect the ROA and perceived performance of the company.

Fazeli Kebria et al. [10] investigated the effects of IC, creativity, and innovation on the financial performance of Mapna Electrical and Construction Engineering and Control due to the competitive environment between enterprises and knowledge-based economies' importance. They concluded an increase in the firm's financial performance index by increasing the IC index by one unit. In addition, increasing the indicators of creativity and innovation leads to the company's financial performance, indicating the significant importance of creativity and innovation in improving the firm's performance. Seif Elahi [26] conducted a study investigating the effect of market orientation and managerial stability on financial performance in companies operating in the TSE. He indicated that market orientation and the dimensions of cross-sectoral coordination, competitiveness, and customer orientation positively and significantly affect companies' financial performance. In addition, managerial stability positively and significantly affects companies' financial performance. Khan Ahmadlu [20] evaluated the relationship between organizational innovation and technological innovation capabilities to examine their effects on the performance of knowledge-based companies located in Tehran science and technology parks. Based on results, technological innovation capabilities mediate between organizational innovation and company performance. On the other hand, organizational innovation moderates the relationship between technological innovation capabilities and company performance.

3. Methodology

In this section, we incorporate intuitionistic fuzzy inputs and outputs within a standard DEA model and suggest a simple and direct solution technique.

3.1. Data collection

The study's statistical population includes TSE pharmaceutical and medical chemical companies from 2015 to 2020. The population was sampled using the elimination method (screening).

The following items were considered in the sample selection due to the possible limitations of the information of the statistical population.

1. The financial year should end on March 20 of each year.
2. No changes in their activities or financial years during the mentioned years.
3. The company should have been listed on the TSE since the beginning of 2015 and should not have left the TSE during the period under review.
4. It should not be a part of banks or financial institutions (investment companies, financial intermediation, holding companies, leasing companies) (elimination due to the special nature of the activities and returns of investment companies in other companies in the group).
5. The required data should be available during the two periods to measure the research variables and calculate them perfectly.

Finally, data from 65 chemical and pharmaceutical companies were analyzed after screening. TSE site and Iran Central Bank data were used to collect data and information related to research variables.

3.2. Research models and variables

The data panel approach has been used to answer the research question. The normality of the dependent variable is studied as one of the classical assumptions in the first step. In the second step, the unit root test is used to investigate the stationary of the research variables. The data are examined in terms of aggregate dor panel approaches using the Chow test after examining the heterogeneity of variance and the absence of test collinearity [8]. When the combined data approach is used (company year), the F-Limer F test should determine which aggregate or panel approach is suitable for model implementation. There are two ways to apply the panel approach: the *least-squares* dummy *variable* (LSDV) and the extended generalized least squares method (EGLS). The Hausman test is required to determine the appropriate. When the Hausman test statistic is not significant, in other words, its obtained probability is greater than the significance level of 0.05; it means that the mentioned effects are random and lead to heterogeneity of variance. Based on the research literature

and the performance of pharmaceutical and medical chemical companies, the present research models are presented.

$$ROA = IC_{i.t} + NI_{i.t} + FL_{i.t} + OS_{i.t} + \varepsilon_{it} \quad (1)$$

$$GMV = IC_{i.t} + NI_{i.t} + FL_{i.t} + OS_{i.t} + \varepsilon_{it} \quad (2)$$

Two main indicators of the rate of ROA and growth in market value have been used to measure financial performance.

The rate of ROA represents the profit or return derived from the investments made in the company's assets.

ROA: It is obtained from the following equation:

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

In the above equation, ROA is the rate of return on assets, NP is the net profit, and TA is the total assets.

GMV market value: It is equal to the product of the number of shares issued by the company at the stock market price on the last trading day of the year on the stock exchange.

The growth in market value is calculated using the following formula.

$$GMV = \frac{\left(\frac{M}{B}\right)t}{\left(\frac{M}{B}\right)t - 1}$$

$$M/_B = \frac{MV}{TA - TLTD}$$

GMV is the Gross Merchandise Value, M/B is the ratio of Market Value to Book value, TA is Total Assets, and TLTD is Total Long-Term Debt.

IC: The Palik method or value-added intellectual coefficient (VAIC) is used to measure IC indirectly by measuring the productivity of capital, the efficiency of human capital, and the efficiency of structural capital (Pourzamani, 2012). Therefore, the mathematical model of the research is presented as follows.

IC= VACA+ VAHU +STVA

VACA= VA/ CE

VAHU= VA/ HU

STVA= SC/ VA

VA= OUTPUT- INPUT

CE=TA-TIA

SC=VA-HU

In this equation, IC is intellectual capital, VACA is Capital Employed Efficiency, VAHU human capital efficiency, STVA structural capital efficiency, CE is the value-added, VA is capital employed, TA is total assets, TIA is total intangible assets, OUTPUT is the total revenue from the sale of goods and services, and INPUT is the total cost of materials, components, and services purchased.

Market Orientation (NI): Customer Satisfaction, Profitability, Service Quality, and Strategic Planning are obtained from the profitability ratio of net profit after tax.

Financial leverage (FL): Financial leverage is measured as the total long-term debt divided by total assets.

$$FL = \frac{TLTD}{TA}$$

Company Size (OS): It is considered a control variable. The ability of companies to effectively manage their risk is greatly influenced by the company's size and controls the company's previous success. Therefore, larger companies can better cope with external shocks and withstand the spread of unfavorable revenue periods. Company size is usually shown by the company's total sales or total assets. The natural logarithm of assets is used in the calculations as an index of the size of the whole organization because both indices represent a large number.

$$OS = LN(TA)$$

OS is the organization's size in the above equation, and the company and TA are the total assets.

4. Data analysis

As mentioned, the normality of the dependent variable is examined in the first step. The probability of normality is estimated by the Jarque test for the dependent variable of bank risk. The significance of the Jacque test for the dependent variable of research models is less than 5%, indicating that the dependent variable is not normal. According to Figures 1 and 2, the variables of ROA and market value (GMV) are converted to normality values using Johnson's conversion. One of the main assumptions has also been implemented with this conversion, and the execution of research model regression will not face any problems.

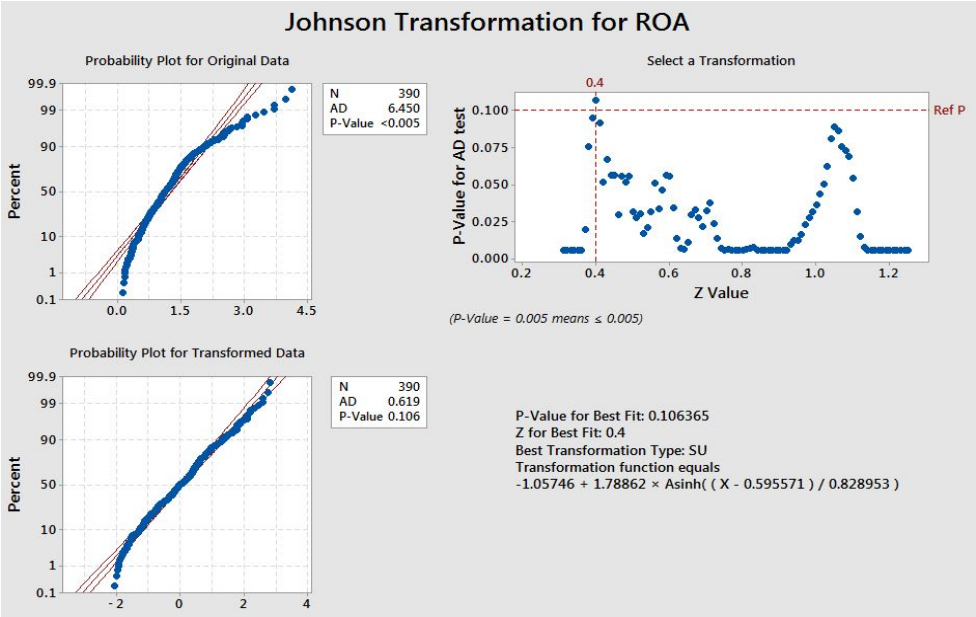

Figure 1. Normalization of a variable rate of ROA using Johnson's conversion

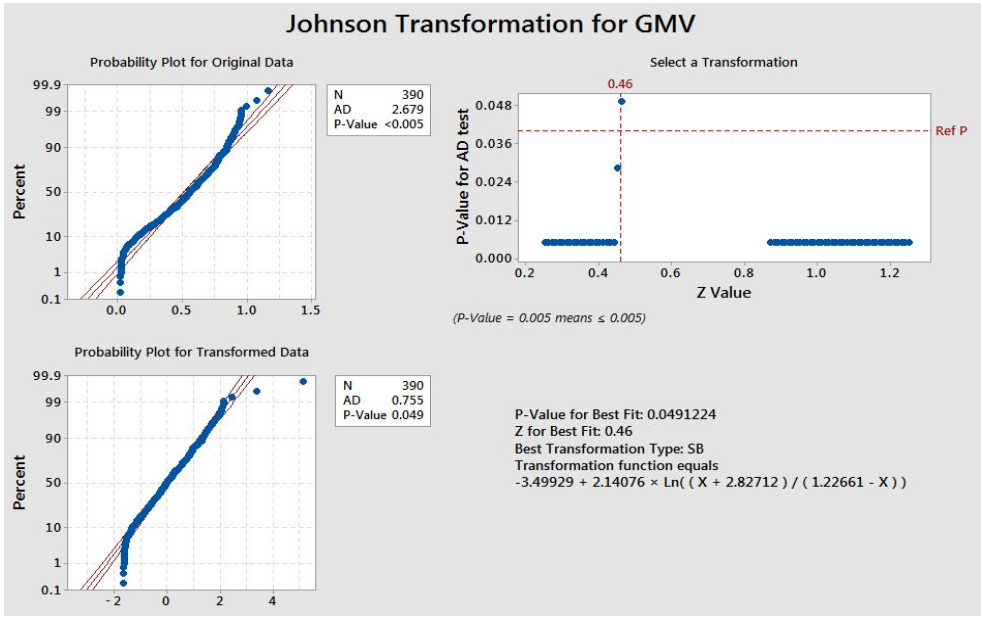

Figure 2. Normalization of market value variable residues by Johnson's conversion

The stationary test was performed to ensure the research results and the non-artificiality of the existing relations in the regression, and the significance of the variables. Levin, Lin, and Chou's test (2002) calculated the unit root of the research variables in the models. The results showed that all research variables were stations and not a time function [21]. Variance homogeneity is one of the most important assumptions of the linear regression model. Thus, the eit disorder components that appear in the community's regression function have the same variance, and there will be variance inequality if this assumption is not met [7].

The existence of variance inequality is accepted if the probability of the heterogeneity test in Table 2 for all variables less than 0.05 is equal to 95%.

Finally, it is necessary to investigate the absence of collinearity to investigate the absence of multiple common linear relationships between variables. For this purpose, the VIF index (variance inflation factor) was used to investigate multicollinearity between independent variables. Regarding the VIF index, values less than five are acceptable for this index [17]. Table 2 shows no multicollinearity between the independent variables.

Table 2. Examination of classical hypotheses (stationary, collinearity, and heterogeneity of variance)

Variable	Levin, Lin, and chou test		Test result	Index value VIF	ROA model variance heterogeneity statistics	GMV model variance heterogeneity statistics
	Statistics	probability				
ROA	-42.547	0.000	Stable	-	According to Bartlett and Levin test, there is a problem of variance inequality due to (sig <0).	According to Bartlett and Levin test, there is a problem of variance inequality due to (sig <0).
GMV	-51.211	0.000	Stable	-		
IC	-23.597	0.000	Stable	1.012		
NI	-34.794	0.000	Stable	1.009		
FL	-55.266	0.000	Stable	1.004		
OS	-36.540	0.000	Stable	1.010		

The model L-test (Chav) result in all four research models emphasizes using a panel model or data panel concerning a significance level of < 0.05 (Table 3). Hausman's test was also used to examine the fixed or random effects. According to Table 3, the results showed that the research models were estimated by fixed effects (a significance level < 5%). Finally, Table 3 shows the research models for testing hypotheses using the fixed effects method, considering variance heterogeneity and fixing it using generalized least squares (GLS).

Table 3. Test results of research models (65 companies from 2015 to 2020)

	The first model ROA	The second model GMV
Company Size (OS)	(0.596) - 0529	(0.099)-1.652
Market Orientation (NI)	(0.002) 3.062 *	(0.004) 2.890 *
IC (IC)	(0.008) 2.636*	(0.561)0.582
Financial Leverage (FL)	(0.548) - 0.600	(0.995)0.006
The significance level of the Chow test	0.004	0.000
The significance level of the Hausman test	0.009	0.009
The value of the coefficient of determination R2	%64.1	%78.7
Probability of Fisher statistics	0.000	0.000
Durbin Watson Statistics	2.247	1.572
Number of observations	390	390

** Note: The numbers in parentheses are prob or significance level, and the other is the t statistic value. Significant values at the 95% confidence level are marked with a star

As can be seen, both models are 99% approved based on the results of estimating the research models and the significance level of the F statistic. In addition, the Value of Durbin Watson statistics is in the range of 1.5 to 2.5, which indicates a lack of autocorrelation between errors. According to the adjusted coefficient of determination of the variables used in the model, variables in the first model explain 64.1% of the dependent variable of ROA and 78.7% of the variance dependent variable market value in the second model.

The market orientation and IC variables have a significant relationship with the rate of ROA in the first model with a significance level of less than 5 percent and a value of t greater than 1.96 at a significance level of 95%. An increase in market orientation and IC increase the rate of ROA of pharmaceutical and medical chemical companies due to the positive coefficient. In the second model, there is a significant relationship between the market orientation variable and the market value concerning the significance level of less than 5% and the Value of t greater than 1.96 at the 95% significance

level. According to the positive coefficient, the market value of pharmaceutical and medical chemical companies has increased with market orientation.

5. Discussion and conclusion

Nowadays, performance and measurement play a vital role in organizations' success. The managers must be aware of performance in all financial and non-financial dimensions in organizations [34]. IC is one of the main drivers of organizational value and an important and effective factor in gaining companies' competitive advantage and financial performance [27]. Market orientation is an aspect of organizational culture in which employees consider the highest value for corporate profitability and customer retention by creating superior value. Market orientation is a spreading behavioral norm that meets the market and customer's present and future needs through innovation. Market-oriented companies have a competitive advantage in responding to the needs of the market and customers' needs. In addition, they effectively respond to market opportunities and threats [26].

This study investigated the financial performance of pharmaceutical and medical chemical companies concerning market orientation and market capabilities using the data panel approach. After statistical analysis, the rate of ROA of pharmaceutical and medical chemical companies has increased with growth in market orientation and IC. The findings also showed that the market value of pharmaceutical and medical chemical companies has increased with increasing market orientation.

There is a direct relationship between IC and the rate of ROA. Therefore, managers of chemical, pharmaceutical, and medical companies are suggested to pay more attention to the importance of IC in increasing financial performance. They should try to improve the IC quality and train competent employees to maximize the ROA of the company with IC. Therefore, the managers of these companies are suggested to pay attention to the quality and the quantity of IC.

The research results show that the companies have stronger financial performance, and they will be successful in achieving their goals when the market orientation is strengthened in chemical, pharmaceutical, and medical companies. According to the findings, market orientation accentuates meeting the consumers' needs and obtaining their satisfaction. Therefore, chemical, pharmaceutical, and medical companies are suggested to prioritize strategies to increase market orientation, satisfy customers by improving efficiency and reducing prices, increase their profitability, and affect their financial performance. Companies always have to identify the customer's wants and needs and perform better than competitors to meet their needs to guarantee profitability.

Developing customer relationships is another way chemical, pharmaceutical, and medical companies can improve market orientation. They can improve these relationships by creating specific means of communication, such as telephone lines to communicate with customer affairs and an SMS system to receive customer feedback, suggestions, and complaints to create a sense of customer satisfaction in terms of market orientation and improving financial performance.

Market orientation is a source of ideas for changing and improving, leading to product and process innovation and performance improvement if this trend is combined with the right capabilities. As a result, managers of chemical, pharmaceutical, and medical companies facilitate their innovation capability by improving market orientation, using innovation resources in different parts of the organization, and combining them. They also improve performance by offering products different from previous products and different from competitors' products.

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