

# NEW METHOD TO EVALUATE FINANCIAL PERFORMANCE OF COMPANIES BY FUZZY LOGIC: CASE STUDY, DRUG INDUSTRY OF IRAN

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## ABSTRACT

Nowadays one of the main reasons that prevent investors from entering emerging markets is the uncertainty of these markets. To choose suitable portfolio in stock market, there are two common techniques; technical analysis and fundamental analysis. One of the most important parts of fundamental analysis is financial analysis. Different methods have been used to evaluate financial status of industries and organizations in different researches. In this research a method based on fuzzy logic introduced that will help investors assess the company's financial performance. Also this method takes more actions to rank the companies included in each industry. This article aims at using this methodology to consider drug & healthy product industry and rank the companies included in this industry as an empirical case. Finally, results obtained from this methodology have been tested through statistical tests (mean test) and this methodology was certified based on them.

**Key words:** technical analysis, fundamental analysis, decision making, Stock exchange, fuzzy logic.

**JEL codes:** G10

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## **I. INTRODUCTION**

Companies in the stock market have two kinds of investors: individual investors and institutional investors. The first group mainly has a little share of company's stocks but the second would have most percentage of their stocks. Also, the second usually contains pension funds, insurance companies, so on. This institutions need to have overall understanding of stock market companies and their financial performance. Keeping this in mind and stock market need taking up more capital, considering financial position of companies in stock market will find very importance (Gallizo, 2001, p.53).

As a whole we can categorize effective success factors of investors and shareholder into two parts. First part is related to the market situation that mainly reflexes economical, political, cultural and social context of a country, involving sum of financial and nonfinancial risks, known as systematic risk that its changes directly associated with local government decisions and global changes. But the second parts which can considerably effects on investor's success, is its analysis about market and its investment type, known as nonsystematic risk (Murphy, 1999, p. 15). In whole stock markets, generally, analysts utilize several types of analysis; technical analysis, fundamental analysis and combination of these two methods. Technical analysis is the study of market behavior, primarily through the use of charts, for the purpose of forecasting future price trends (Murphy, 1999 and Gallizo, 2001). There are three premises on which the technical approach is based: 1)market action discounts everything 2)prices move in trends 3)history repeats itself. a technical analyst believes that everything is concealed in price. But fundamental analysis is based on the premise that every share has a certain intrinsic value at a period of time. This intrinsic value changes from time to time as a consequence of both internal and external factors (Bragg, 2002 and Flavián, 2003). The theory of fundamental analysis submits that one should purchase a share when it is available below its intrinsic value and sell it when it rises above its intrinsic value. When the market value of share is below its intrinsic value it is undervalued, whereas if the market value of a share is above its intrinsic value it is overvalued. Fundamentalists thus seek to purchase under priced shares and sell overpriced ones. The most important factor in fundamental analysis is information about the economy, the industry and the company itself, any information that can affect the growth and profitability of the company and it is because of this, fundamental analysis is broken into three distinct parts: 1) The economy analysis, 2) The industry analysis within which the company is, and 3) The company analysis. As you see, one of the main parts of fundamental analysis is catching and analyzing information about industry and included companies in. So in this article we are going to introduce a method to analyze and ranking companies in an industry according to the financial ratios, the method is based on fuzzy logic. That is good to say that we examined this method in drug and healthy products industry in Tehran Stock Exchange as a useful and efficient methodology (Bragg, 2002 and Fluvial, 2003).

## II. LITERATURE REVIEW

In this part we are going to consider principles and concepts of fuzzy logic and fundamental analysis.

### A. Fuzzy Logic

Fuzzy Logic was initiated in 1965 by Lotfi A. Zadeh, professor for computer science at the University of California in Berkeley. Basically, Fuzzy Logic (FL) is a multivalve logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc. Notions like rather tall or very fast can be formulated mathematically and processed by computers, in order to apply a more human-like way of thinking in the programming of computers. A fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy. The precision of mathematics owes its success in large part to the efforts of Aristotle and the philosophers who preceded him.

Let  $X$  be a classical set of objects, called the universe, whose generic elements are denoted  $x$ . Membership in a classical subset  $A$  of  $X$  is often viewed as a characteristic function,  $\mu_A$  from  $X$  to  $\{0, 1\}$  such that (McIvora, McCloskeya & Humphreysa and Maguireb,2004, p.267-283);

$$\mu_A(x) = \begin{cases} 1 & \text{iff } x \in A, \\ 0 & \text{iff } x \notin A. \end{cases}$$

(N.B.: "iff" is short for "if and only if.")

$\{0, 1\}$  is called a valuation set.

### FUZZY NUMBERS AND LINGUISTIC VARIABLES

In this section, some basic definitions of fuzzy sets, fuzzy numbers and linguistic variables are reviewed (McIvora, McCloskeya, Humphreysa, Maguireb, 2004 andjadziev, 1991& Kandel, 1991).The basic definitions and notations below will be used throughout this paper until otherwise stated.

Definition 1. The height of a fuzzy set is the largest membership grade attained by any element in that set. A fuzzy set  $\tilde{A}$  in the universe of discourse  $X$  is called normalized when the height of  $\tilde{A}$  is equal to 1 (Kandel, 1991 & Klir 1995 and ng, 1995).

Definition 2. A positive triangular fuzzy number (TFN)  $\tilde{A}$  can be defined by a triple  $\tilde{A} = (a_1, a_2, a_3)$ .

Membership function.

Given any two positive TFNs,  $\tilde{m} = (m_1, m_2, m_3)$  and  $\tilde{n} = (n_1, n_2, n_3)$ , some main operations of fuzzy numbers  $\tilde{m}$  and  $\tilde{n}$  can be expressed as follows (Klir, 1995 &Yen, 1999):

$$\tilde{m}(+)\tilde{n} = (m_1 + n_1, m_2 + n_2, m_3 + n_3)$$

$$\tilde{m}(-)\tilde{n} = (m_1 - n_3, m_2 - n_2, m_3 - n_1)$$

$$\tilde{m} \otimes \tilde{n} \cong (m_1 n_1, m_2 n_2, m_3 n_3)$$

$$\tilde{m}(\div)\tilde{n} \cong \left( \frac{m_1}{n_3}, \frac{m_2}{n_2}, \frac{m_3}{n_1} \right)$$

Definition 3. A matrix  $\tilde{D}$  is called a fuzzy matrix if at least one element is a fuzzy number .

Definition 4. A linguistic variable is a variable whose values are expressed in linguistic terms. The concept of a linguistic variable is very useful in dealing with situations, which are too complex or not well defined to be reasonably described in conventional quantitative expressions For example, "weight" is a linguistic variable whose values are very low, low, medium, high, very high, etc. Fuzzy numbers can also represent these linguistic values (McIvora, McCloskeya, Humphreysa and Guireb, 2004).

## B. Fundamental Analysis

When the objective of the analysis is to determine what stock to buy and at what price, there are two basic methodologies:

1. Fundamental analysis maintains that markets may misprice a security in the short run but that the "correct" price will eventually be reached. Profits can be made by trading the mispriced security and then waiting for the market to recognize its "mistake" and reprice the security.
2. Technical analysis maintains that all information is reflected already in the stock price. Trends 'are your friend' and sentiment changes predate and predict trend changes. Investors' emotional responses to price movements lead to recognizable price chart patterns. Technical analysis does not care what the 'value' of a stock is. Their price predictions are only extrapolations from historical price patterns.

Investors can use both these different but somewhat complementary methods for stock picking. Many fundamental investors use technical for deciding entry and exit points. Many technical investors use fundamentals to limit their universe of possible stock to 'good' companies (Yen, Langari, 1999 McWhorter, and Lawson, 1994).

The choice of stock analysis is determined by the investor's belief in the different paradigms for "how the stock market works". See the discussions at efficient-market hypothesis, random walk hypothesis, Capital Asset Pricing Model, Fed model Theory of Equity Valuation, Market-based valuation, and

Behavioral finance. Fundamental analysis includes: 1. Economic analysis  
2. Industry analysis  
3. Company analysis

On the basis of this three analysis the intrinsic value of the shares are determined. This is considered as the true value of the share. If the intrinsic value is higher than the market price it is recommended to buy the share. If it is equal to market price, hold the share and if it is less than the market price sell the shares.

Fundamental analysis of a business involves analyzing its financial statements and health, its management and competitive advantages, and its competitors and markets. When applied to futures and forex, it focuses on the overall state of the economy, interest rates, production, earnings, and management. When analyzing a stock, futures contract, or currency using fundamental analysis there are two basic approaches one can use; bottom up analysis and top down analysis (Murphy, 1999 and Steven, 2002). The term is used to distinguish such analysis from other types of investment analysis, such as quantitative analysis and technical analysis.

Fundamental analysis is performed on historical and present data, but with the goal of making financial forecasts. There are several possible objectives:

- to conduct a company stock valuation and predict its probable price evolution,
- to make a projection on its business performance, to evaluate its management and make internal business decisions,
- to calculate its credit risk.

Fundamental analysis is not for speculators. It is for those who are prepared to study and analyze a company; for those who arrive at a decision after careful thought and deliberation. Hegel once said, "To those who look upon the world rationally, the world in its turn presents a rational aspect". Fundamental analysis is for the rational man. The most important factor in fundamental analysis is information, information about the economy, the industry and the company itself, any information that can affect the growth and profitability of the company and it is because of this fundamental analysis is broken into three distinct parts (Murphy, 1999; Bragg, 2002; and Flavián, 2003). First is the economy. Second is the industry within which the company operates. Finally is the company.

At the final stage of fundamental analysis the investor analyzes the company. This analysis has two thrusts:

1. How has the company performed vis-à-vis other similar companies
2. How has the company performed in comparison to earlier years

It is imperative that one completes the politic or economic analysis and the industry analysis before a company is analyzed because the company's performance at a period of time is to an extent a reflection of the economy, the political situation and the industry. What does one look at when analyzing a company? There is, in my view, no point or issue too small to be ignored. Everything matters. As the billionaire Jean Paul Getty, one of the most successful stock market operators of all time, said, "Do not buy stock until you know all about it". The different issues regarding a company that should be examined are:

- The Management
- The Company
- The Annual Report
- Ratios
- Cash flow (Aghion, Bolton,1992, p. 489; McWhorter, Lawson, 1994 and Meyers, Dennis, 1997)

So, because of importance of financial statement and ratios in fundamental analysis and assess companies, we concentrate on this part of company analysis in fundamental analysis.

### **III. METHODOLOGY, PROPOSED MODEL AND RESULTS.**

In this research we are going to prioritize companies in an industry (or industries) based on their financial performance. To do so, we should after choosing appropriate industries take action to prioritize companies that operate within them. To choose these companies, we have used a pattern based on fuzzy logic proposed by Zade & Bellman 1970, called *Fuzzy decision making*. According to Zade & Bellman:

*Decision = interception of Objectives and Constraints*

At the first stage this research, we examined the objectives and constraints of this model. In the Zade & Bellman model there aren't any differences between constrains and objectives, so we can transform them to another. This is an important default of this article.

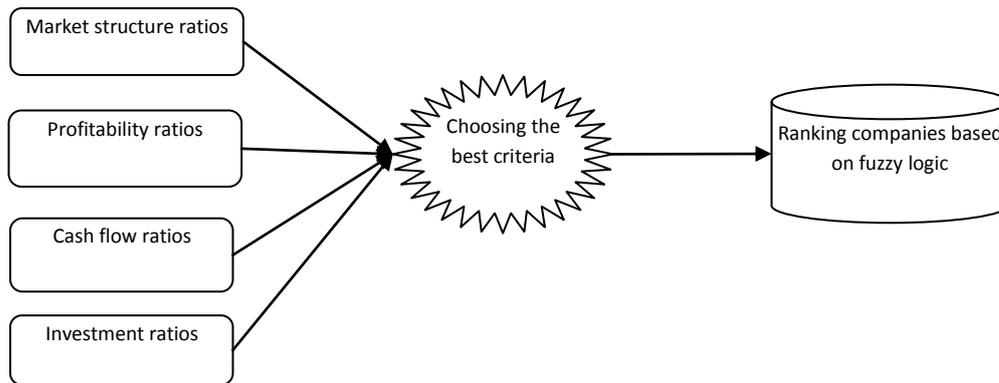
In this article we have three steps (figure1):

Step1: Choosing the industry. For this, with attention to whole trend of industries in Iran and world we use multi attribute decision making to rank the industries. So, we choose the best industry.

Step 2. Choosing the right criteria to select and ranking the company's stock. In this step we used Factor Analysis method.

Step 3: Appraisal and ranking the companies. According to chosen indexes we evaluate the companies and rank them.

**Fig. 1. Proposed Model.**



In this article we used the data of drug industry in Tehran Stock Exchange in 2007 (Table1).

**Table 1. Chosen Company and their Codes**

Name of company	Alborz daru	Iran daru	Abureihan daru	kimidaru	Karkhanejate darupakhsh	Daru osve	Daru amin	Daru exir	Daru razak	Daru zahravi
Code	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>
Name of company	Daru abidi	Daru loghman	Daru kosar	Daru jaber-ben-hayav	Daru pakhsh	Tehran daru	Jam daru	Ruz daru	Shimi darupakhsh	
Code	X <sub>11</sub>	X <sub>12</sub>	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>17</sub>	X <sub>18</sub>	X <sub>19</sub>	

By use of questionnaire, taking view points of stock market experts (brokers, investment companies, universities professor) and finally factor analysis we selected 7 indexes among 30 indexes (table 2). Our sample for the developed questionnaire was 50 which we analyzed using SPSS.

**Table 2. Selected Indexes**

	Criteria	Type of fuzzy number	SUP(x)	fuzzy number
C1	Quick ratio	Triangle	$x = 1$	$\begin{cases} x & 0 \leq x < 1 \\ 2-x & 1 \leq x < 2 \\ 0 & \text{other} \end{cases}$
C2	ROE	Triangle	$0.7 \leq x < 1$	$\begin{cases} 1.42x & 0 \leq x < 0.7 \\ 1 & 0.7 \leq x < 1 \\ 0 & \text{other} \end{cases}$
C3	Financial leverage index	Triangle	$x = 1$	$\begin{cases} x & 0 \leq x < 1 \\ 2-x & 1 \leq x < 2 \\ 0 & \text{other} \end{cases}$
	Debt ratio	Triangle	$x = 0.5$	$\begin{cases} 2x & 0 \leq x < 0.5 \\ 2-2x & 0.5 \leq x < 2 \\ 0 & \text{other} \end{cases}$
C4	ROI	left -Triangle	$0.5 < x \leq 2$	$\begin{cases} 2x & 0 \leq x < 0.5 \\ 1 & 0.5 \leq x < 2 \\ 0 & \text{other} \end{cases}$
C5	Current ratio	Trapezoid	$1 \leq x \leq 2$	$\begin{cases} x & 0 \leq x < 1 \\ 1 & 1 \leq x < 2 \\ 2-x & 2 \leq x < 3 \\ 0 & \text{other} \end{cases}$
C6	P/E	Triangle	$0.5 \leq x < 2$	$\begin{cases} 2x & 0 \leq x < 0.5 \\ 1 & 0.5 \leq x < 2 \\ 0 & \text{other} \end{cases}$

You see the position of each company according to selected indexes in table 3. And the ranking of the companies presented in Table 4.

We know that when a model is presented for giving information to users to make some decision, it should have 6 characteristics which are as follows: relevance, predictability, update, comparability, reliability, consistency (Yen, 1999&Aghion, Bolton, 1992). To recognize whether our model present data with these characteristics, we used questionnaire and analyze it by SPSS. The results have been present in Table 5. As you see we have had 6 one-tail hypotheses with claimed amount 4 which is average of Likert continuum.

**Table 3. Situation of each company according to selected indexes**

Min	$\mu_G(x)$	ROI	$\mu_G(x)$	ROE	$\mu_G(x)$	current ratio	$\mu_G(x)$	debt ratio	$\mu_G(x)$	loan profitability	$\mu_G(x)$	P/E	$\mu_G(x)$	rapid ratio	
0.60	0.67	0.33	0.79	0.55	1	1.95	0.8	0.4	0.6	0.60	0.62	0.31	0.66	1.34	<b>X18</b>
0.59	0.69	0.35	0.83	0.59	1	1.67	0.82	0.41	0.59	0.59	0.78	0.39	0.94	0.94	<b>X6</b>
0.56	0.65	0.33	0.83	0.58	0.99	2.01	0.88	0.44	0.56	0.56	0.88	0.44	0.67	1.33	<b>X4</b>
0.51	0.59	0.30	0.82	0.58	1	1.34	0.98	0.49	0.51	0.51	0.56	0.28	0.88	0.88	<b>X14</b>
0.38	0.47	0.24	0.88	0.62	1	1.29	0.76	0.62	0.38	0.38	0.72	0.36	0.86	0.86	<b>X9</b>
0.38	0.62	0.31	1.00	0.81	1	1.31	0.76	0.62	0.38	0.38	0.42	0.21	0.61	0.61	<b>X10</b>
0.37	0.59	0.30	1.00	0.80	1	1.45	0.74	0.63	0.37	0.37	0.54	0.27	0.89	0.89	<b>X2</b>
0.35	0.35	0.18	0.55	0.39	1	1.26	0.92	0.54	0.46	0.46	0.4	0.2	0.8	0.8	<b>X13</b>
0.33	0.33	0.16	0.69	0.49	1	1.19	0.68	0.66	0.34	0.34	0.4	0.2	0.89	0.89	<b>X19</b>
0.31	0.31	0.15	0.37	0.26	0.74	2.26	0.82	0.41	0.59	0.59	0.32	0.16	0.92	1.08	<b>X17</b>
0.30	0.30	0.15	0.62	0.43	1	1.03	0.7	0.65	0.35	0.35	0.32	0.16	0.68	0.68	<b>X3</b>
0.30	0.35	0.18	0.83	0.58	1	1.1	0.6	0.7	0.3	0.30	0.44	0.22	0.8	0.8	<b>X5</b>
0.28	0.38	0.19	0.97	0.68	1	1.24	0.56	0.72	0.28	0.28	0.44	0.22	0.94	0.94	<b>X8</b>
0.27	0.48	0.24	0.56	0.39	0.67	2.33	0.78	0.39	0.61	0.61	0.52	0.26	0.27	1.73	<b>X11</b>
0.24	0.37	0.19	1.00	0.77	1	1.12	0.48	0.76	0.24	0.24	0.34	0.17	0.8	0.8	<b>X1</b>
0.18	0.18	0.09	0.59	0.42	0.95	0.95	0.44	0.78	0.22	0.22	0.32	0.16	0.65	0.65	<b>X12</b>
0.15	0.15	0.08	0.29	0.20	1	1.39	0.76	0.62	0.38	0.38	0.2	0.1	0.99	0.99	<b>X7</b>
0.10	0.10	0.05	0.52	0.37	0.84	0.84	0.28	0.86	0.14	0.14	1	0.7	0.55	0.55	<b>X16</b>
0.00	0.63	0.32	0.54	0.38	0.17	2.83	0.34	0.17	0.83	0.83	1	0.99	0	2.83	<b>X15</b>

**Table 4. Companies Final Ranking**

Company	Degree	Rank
X <sub>18</sub>	0.60	1
X <sub>6</sub>	0.59	2
X <sub>4</sub>	0.56	3
X <sub>14</sub>	0.51	4
X <sub>9</sub>	0.38	5
X <sub>10</sub>	0.38	6
X <sub>2</sub>	0.37	7
X <sub>13</sub>	0.35	8
X <sub>19</sub>	0.33	9
X <sub>17</sub>	0.31	10
X <sub>3</sub>	0.30	11
X <sub>5</sub>	0.30	12
X <sub>8</sub>	0.28	13
X <sub>11</sub>	0.27	14
X <sub>1</sub>	0.24	15
X <sub>12</sub>	0.18	16
X <sub>7</sub>	0.15	17
X <sub>16</sub>	0.10	18
X <sub>15</sub>	0.00	19

**Table 5. Test of presented model characteristics**

Character	Hypothesis	Result
Relevant	$\left\{ \begin{array}{l} H_0: R \geq 4 \\ H_1: R < 4 \end{array} \right.$	H0 accepted
Predictability	$\left\{ \begin{array}{l} H_0: p \geq 4 \\ H_1: p < 4 \end{array} \right.$	H0 accepted
Update	$\left\{ \begin{array}{l} H_0: u \geq 4 \\ H_1: u < 4 \end{array} \right.$	H0 accepted
Comparability	$\left\{ \begin{array}{l} H_0: c \geq 4 \\ H_1: c < 4 \end{array} \right.$	H0 accepted
Reliability	$\left\{ \begin{array}{l} H_0: Re \geq 4 \\ H_1: Re < 4 \end{array} \right.$	H0 accepted
Consistency	$\left\{ \begin{array}{l} H_0: Co \geq 4 \\ H_1: Co < 4 \end{array} \right.$	H0 accepted

#### IV. CONCLUSION

In this article as you observed we firstly choose the best industry and then we take some actions to prioritize companies included. In prioritizing these companies we used fuzzy logic as a new methodology by using financial ratios as of our criteria. However using fuzzy logic in financial cases is common but using that in this manner is very simple, new and efficient and verification and testimony of its efficiency is just to notice to mean test of model characteristics

(relevant, predictability, update, comparability, reliability, consistency) which have been justified by our research sample (broker and investment companies managers) using t test. As a result of using this model we found that X18, X6, X4, X14 companies according to selective criteria are the best companies in their industry on behalf of financial performance and by using of mean test and survey research we find that the results obtained from this method approximately are consistent with the expectations of financial experts in Iran stock market about Drug industry in Iran.

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